REFYN

Putting Cape Heath Vegetation Back

May 2002

REFYN

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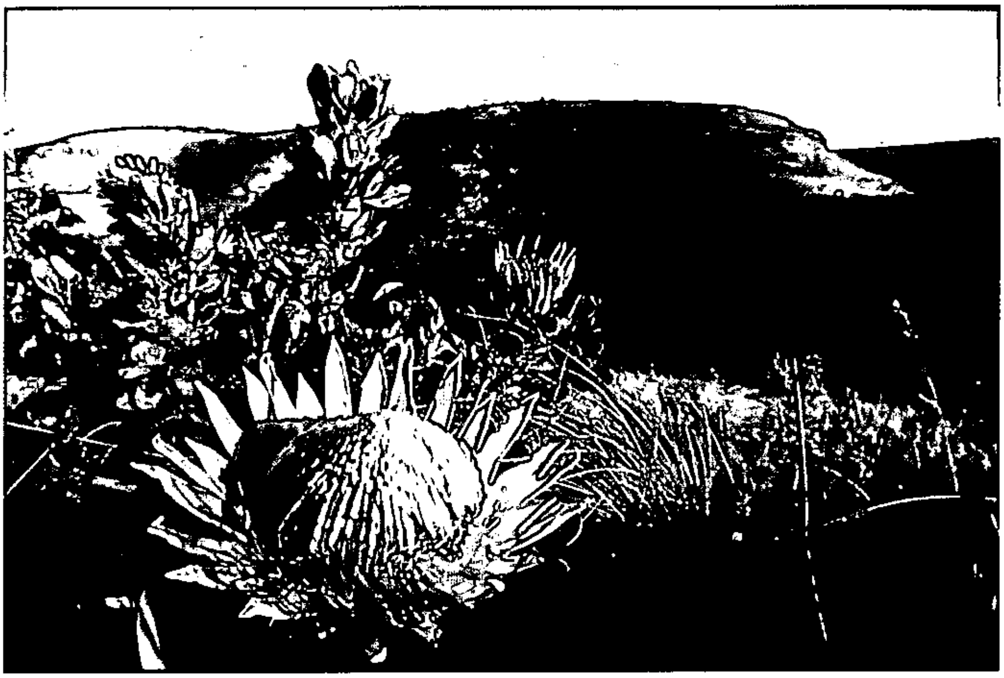

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ABSTRACT

Cape Heath Vegetation, known as Fynbos, is a unique South African vegetation type. The Grassy Fynbos, studied in this project, has long been neglected by the conservation organisations and only 16% of the Grassy Fynbos areas in South Africa are protected. In the study area the Grassy Fynbos was degraded mainly due to alien invasion. The national Working for Water Programme cleared the aliens but the cleared patches are susceptible to erosion and need to be restored. Restoration ecology generally works at the level of the plant community, thus it is important to know which ecological and management processes are important in controlling Grassy Fynbos at present and in the future. The objectives of Refyn were (i) to establish a baseline study in order to understand the process leading to the degradation of the Grassy Fynbos of the Featherstone Kloof area, (ii) to identify keystone species that could assist with the restoration of the area, (iii) to develop a management plan and implementation strategy; and (iv) to launch a public awareness programme that involves the local communities in helping to restore the Grassy Fynbos area.

The project had two main focus points, namely the ecology and the management of the Grassy Fynbos of Featherstone Kloof. The ecological studies showed that aliens and the different clearing methods have a significant effect on indigenous vegetation. For example, they have an effect on the fire intensity (more intense), which reflects on the soil seed bank (indigenous species seed loss), cryptobionts cover and abundance (intense fires have negative effect on cover/abundance), and on the regrowth of indigenous species in general. The project highlights the importance of bee pollination, herbivores, bird seed-dispersal, and arbuscular mycorrhizae for Grassy Fynbos vegetation growth, as well as the effect of smoke on the germination of seeds.

The present study also showed that Grassy Fynbos regenerates primarily from resprouters and geophytes. Seeders seem to be of less importance in initial recovery of Grassy Fynbos and are mostly found in slow-growing climax key species like *Erica chamissonis*. The nature of Grassy Fynbos species suggests that unassisted reestablishment of plants in degraded areas will be very slow with a high risk of the reestablishment of exotic species. In order to ensure that success is achieved manual reintroduction of key species will be necessary. Species will have to be reintroduced into burnt areas as young plants generated from cuttings or seedlings. However, it is not necessary to introduce Grassy Fynbos into the entire area, as long as patches of geophytic and resprouting species survive. These will be able to spread as long as a suitable cover crop is established to confine exotic regrowth.

The management studies showed that with the existence of the local Working for Water programme (and the Refyn project), the short-term management of Featherstone Kloof appears to be effective. An adaptive approach towards environmental management would be a suitable strategy to implement as it incorporates both scientific and non-scientific knowledge. Linking science and human purpose, adaptive management

serves as a compass to be used in searching for a sustainable future. However, none of the organisations involved with the Featherstone Kloof area at present have well defined or documented management plans. Therefore, the effective management of Featherstone Kloof as a Grassy Fynbos area in the near future is unfortunately unlikely particularly in the long term, unless current management practices change. For future preservation of the Featherstone Kloof area, a management plan must be drawn up, and sufficient resources allocated to the appropriate organisation for implementing the management plan. However, at present there is a severe lack of resources, both financial and human, within the Grahamstown Municipality.

The current goods and services of Featherstone Kloof include water catchment, wood collection (fuel, building) and medicinal plant collection. The Featherstone Kloof area also has the potential to provide communal grazing for livestock as well as the hidden economy of plant products sold and used in rural communities at a household level as craft materials or for ceremonial purposes. As Featherstone Kloof has been shown to be an area of high species diversity, especially in relation to other fynbos vegetation communities, we can assume that it has the potential to provide many ecosystem goods and services in the future. Lastly, the area is utilised for recreational purposes like bird watching, hiking, cycling, jogging and picnicking. There is the potential to intensify the recreational use of Featherstone Kloof, particularly in the line of ecotourism. Present and future recreational opportunities are related to the appreciation of biodiversity and the restoration of indigenous vegetation to the area.

Cover, Refyn logo *Gladiolus mortinius* (design, J. Sweetman)

Page I, *Protea cynaroides* in Featherstone Kloof (photo, Juan P. Moreiras, FFI/BP)

This report will also be available in PDF format at our website: http://www.botany.ru.ac.za/refyn.

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EXECUTIVE SUMMARY

Cape Heath Vegetation, known as Fynbos, is a unique South African vegetation type. A large proportion of species in the fynbos flora have small ranges and exists in small populations. The Cape Floral Kingdom is a global biodiversity asset, the smallest Floral Kingdom in the world and the only one to be found entirely in one country.

There are many threats to the biodiversity of fynbos; including alien invasion, indiscriminate agricultural and urban development, unsustainable use of resources (e.g. traditional medicine), and poor fire management (e.g. too frequent) (CAPE 2000).

The site to be studied in the Refyn project is situated in the former nature conservation area of Featherstone Kloof and Dassie Krantz on the Grahamstown Commonage in the Eastern Cape, South Africa. Grassy Fynbos has long been neglected by the conservation organisations and only 16% of the Grassy Fynbos areas in South Africa are protected. In the study area the Grassy Fynbos was greatly degraded mainly due to alien invasion. The local Working for Water programme cleared the aliens but the cleared patches are susceptible to erosion and need to be restored. Restoration ecology generally works at the level of the plant community, thus it is important to know which ecological and management processes are important in controlling Grassy Fynbos at present and in the future. Refyn identified four aims:

(i) To understand the process leading to the degradation of the Grassy Fynbos of the Featherstone Kloof area.

(ii) To investigate the natural restoration of the site (e.g. seed bank emergence) and the success of current restoration techniques used by the Working for Water programme.

(iii) To develop a management plan and implementation strategy through a participatory consultation process.

(iv) To create a baseline study by developing a network of local expertise (e.g. Working For Water programme, Botanical Society, Wild Life and Environment Society of South Africa), local communities and the public to preserve this unique area.

However, the overriding goal of the Refyn project is to launch a public awareness programme. This will be achieved by developing a booklet and a flyer through the consultation process, if possible with advice for the restoration practitioners and land managers. It will also be used for educational purposes and provide advice on e.g. medicinal plant collection for the local communities.

Ecological Studies

1.1 ALIENS AND THEIR INFLUENCE ON THE VEGETATION

***Acacia longifolia*: Clearing methods and their effectiveness**

The Australian *Acacia longifolia* is an invasive plant that has become a significant problem in the Eastern Cape region. There are a number of approaches that can be used to reduce or control the *Acacia*'s growth, including fire, clearing, chemical control, biological control, and grazing or browsing.

Clearing of *Acacia*'s with subsequent chemical spraying of seedlings and annual weeding for 3-4 years after clearing led to recolonisation of indigenous species in areas of the Cape Peninsula (Milton & Hall 1981). The use of *E. tef,* and *S. pterophorus* seemed to reduce the seedling growth of *Acacia* to some extent, but the seeds of *A. longifolia* are very persistent in the soil and are able to wait for years before germinating, therefore indigenous species should be sown in the *E. tef* stand during, or before they die out to prevent mass germination of *Acacia.*

Effects of galls on the reproductive ability of *Acacia longifolia*

The gall wasps, *Trichilogaster acaciaelongifoliae* lay their eggs in the young buds of the *Acacia*, resulting in the formation of galls instead of flowers. The main effect is that by reducing the seed output of the aliens, the first step towards eradication is made by preventing the formation of a persistent and long-lived soil seed bank.

The water use of alien plants

Acacia longifolia grows in dense stands, preventing almost any undergrowth and using much more water than the fynbos vegetation that is adapted to a low rainfall climate (Bromilow 2001). It was discovered that *Acacia longifolia* was using more water than the total rainfall over the same period of time

1.2 FIRE AND SMOKE AND THEIR INFLUENCE ON VEGETATION

The influence of smoke on seed germination

It was found that smoke extract does improve the germination of indigenous seeds, and that it can play a part in rehabilitation of areas by encouraging more seeds to germinate sooner. The smoke did not, however, bring about the maximum degree of germination possible, as was shown by the viability of the non-germinated seeds (tetrazolium technique).

The effect of smoke on gaseous exchange of *Chrysanthemoides monilifera*

This study clearly states the presence of a smoke response in the gas exchange of *C. monilifera*. The light saturated assimilation rate and the stomatal conductance of both CO_2 and water are considerably reduced after a single, one-minute smoke treatment. The effect of smoke on these parameters can have various implications for the gas exchange of *C. monilifera.*

Effect of fire on cryptobiont cover and diversity

Cryptobionts are important in ecosystems as they help bind the soil and provide safe sites for seed germination. There was a direct relationship between the time since the last burn and the diversity of cryptobiont species at that site. As the age since a burn increases so the diversity increases.

1.3 RESTORATION OF GRASSY FYNBOS FEATHERSTONE KLOOF: FACTORS OF IMPORTANCE

Featherstone Kloof: keystone species and species list

The objective of the present study was to collect the species present at Featherstone Kloof and similar site areas in order to compare the species to past vegetation recordings (for the complete plant checklist see Appendix I).

Grassy Fynbos and the importance of bee pollination

The continued existence, multiplicity and reproductive successes of many Grassy Fynbos species partially, or totally depend on honeybee pollination. They serve as pollinators, maintaining natural ecosystems and sustaining human life through pollination of crops, forage plants for domestic animals and wild plants that maintain water catchments, prevent soil erosion, remove greenhouse gases and provide recreation.

Recruitment of bird-dispersed seeds in Grassy Fynbos

No relationship was found between the bird perches and the thicket seedling density, and species diversity found underneath them. The thicket species can enter the Grassy Fynbos at a rapid rate, with a mean number of 25 seedlings. During the present study only the seeds that germinated were observed, in other words the potential number could be much higher.

A study of porcupine damage to the *Watsonia* community

The results showed that the dispersal of *Watsonia* at the four sites studied was not dependent on porcupines (Figure 22). The eating of bulbs by porcupine does stimulate the formation of new bulbs. The digging action of porcupines may also stimulate the growth of other species. Finally, denser patches of *Watsonia* are less damaged from porcupines and as a result they are healthier specimens, with much stronger leaves and flower stalks.

A survey of the soil seed bank

The seed bank for Grassy Fynbos tends to be small, as found by Musil (1991) and Pierce and Cowling (1991). Cues for germination of fynbos seeds in the soil are complex and varied. The right conditions might not have been met for some species and thus they did not germinate. A more likely reason is the recent and frequent fires at Featherstone Kloof. The time for seed bank accumulation for the control might have also been too short, as many plants need time (years) to reach maturity.

A mycorrhizal survey of indigenous plant species in Featherstone Kloof

It is of vital importance that the mycorrhizal status of plant species used for restoration purposes is known, (Allen 1991) as Mycorrhizae fungi will play a role in the reestablishment of Grassy Fynbos species, such as *Erica* spp. (Dames *et al.* 1999; Figure 25).

Restoration pilot study: Plant emergence and establishment

The post-clearing burn done by WFW intended to reduce the exotic species seed bank, acts instead as a stimulant for germination of exotic species such as, *Acacia longifolia* and *Acacia mearnsii* (Personal observation). The current solution to this problem is to use commercial herbicides such as Garlon 4 (J. Pryor, Pers. Comm.). An alternative to repeated spraying is the use of a cover crop to compete with, and shade out invasive seedlings (Holmes and Richardson 1999). Three species of perennial Asteraceous herbs, *Senecio pterophorus, Senecio chrysocoma* and *Helichrysum cymosum* were selected because they were noted to be pioneers in degraded areas. The objective of this study was to establish how the species regenerate, to find out which species could be used as a cover crop and how this could be assessed. The experimental data and observations indicate that *Senecio pterophorus* is most likely to be the best species for use as a cover crop. However because *Senecio chrysocoma* produces more seed per head, it may be economically more suitable than *Senecio pterophorus.*

Environmental Goods and Services and Management Studies

2.1 ECOSYSTEM GOODS AND SERVICES OF FEATHERSTONE KLOOF

This part of the management project focuses on the ecosystem and investigates the following goods and services:

1. Water, focusing on water yield in the Kowie river, by assessing soil moisture in the upper catchment as an indication of catchment contribution to water runoff, as well as ascertaining the water quality of the Kowie River.
2. The level of biodiversity (with regard to species diversity) of the area.
3. The use and relative abundance of selected medicinal plants.
4. The recreational and educational value of Featherstone Kloof was also investigated.

Soil moisture

There is certainly a negative correlation between surface moisture volume and alien infestation. If Grassy Fynbos species were planted alongside the forest margin (the ecotone) they would probably thrive.

Water quality and quantity

Water quality and quantity was tested with regard to temperature, velocity, discharge, pH, conductivity and dissolved substances at three sites, an upper, a middle and a lower site.

Medicinal Plants

It is clear from the long list of medicinal plants that can be found in the area, that the area of Featherstone Kloof has a high potential medicinal value. These ecosystem goods provide for improved health in the greater Grahamstown community and are an important source of income for both traditional healers and collectors.

Education

At present Featherstone Kloof is not being utilised as an educational tool by local schools, mainly because of the inaccessibility of the area – it is considered too far away for walking and the access road is not really suited to two-wheel drive vehicles. An experimental education package was compiled in order to demonstrate the potential of using Grassy Fynbos as a conservation education tool at a school level. This is included as appendix 4.

Recreation and Biodiversity

Ideas for recreation in the future were discussed with Kevin Bates (Parks and Forests Department of Grahamstown) who felt that ecotourism in Featherstone Kloof is a real possibility, bearing in mind that the areas' vegetation is unique and that 4 biomes meet there. As Featherstone Kloof has been shown to be an area of high species diversity, especially in relation to other fynbos vegetation communities, we can assume that it has the potential to provide many ecosystem goods and services in the future.

2.2 FEATHERSTONE KLOOF: PAST AND PRESENT INSTITUTIONAL ORGANISATIONAL DYNAMICS

Conversion of environmental goods and services into endowments

National Level

The present research revealed that when dealing with institutional issues, the involvement of all interested and affected parties is often difficult because of constraints such as insufficient or no financial and human resources. The Department of Water Affairs and Forestry have a number of forest and water related policies that influence the way in which municipal commonages are managed. This is important for Featherstone Kloof because Working for Water practically implements these policies and is one of the few examples where National policy has been translated into concrete action.

Regional Level

There is a system of fragmented public land management, with a traditional top-down approach to the decision-making process.

Local Level

It would appear that the municipality wishes to retain the current status of the Featherstone Kloof area, regardless of whether or not locals could improve their living conditions from agricultural activities in the area (such as grazing and plant collection or propagation).

Conversion of endowments into entitlements

National Level

Enabling mechanisms that allow rights of access to be converted into entitlements are absent at the national level.

Regional Level

By allowing access, even if regulated, it potentially enables a right of access to be converted into entitlement however, there are competing needs to use commonage land for grazing and resource services, and the need for the development of infrastructure and services.

Local Level

WFW and Refyn are working towards protecting indigenous biodiversity thereby converting the national level policies and legislation about the protection of biodiversity into action this in turn actively converts endowments into entitlements at the local level. At a local level there is a consensus amongst user groups that they may in fact act on their perceived moral right to have access to the municipal commonage. They are acting on this perception, and therefore are actively involved in converting their endowment into entitlement.

Conversion of entitlements into capabilities

National Level

WFW's policy of community development aims at providing skills for employees, Aids awareness programmes and family planning education.

Local Level

The perceived moral right to have access to Featherstone Kloof, as well as the more formal agreements with WFW to collect felled wood, has lead to entrepreneurship amongst wood collectors.

2.3 FEATHERSTONE KLOOF: PAST AND PRESENT MANAGEMENT STRATEGIES

With the exception of the period during which Featherstone Kloof was operating as a nature reserve, no specific management plan existed for the area. Currently, three organisations actively play a role in the state of Featherstone Kloof, Grahamstown Parks and Gardens, Albany Working for Water and the present Refyn project.

Grahamstown Parks and Gardens

The main role of the Parks & Gardens in Featherstone Kloof is that of maintenance and control. Lack of regulation is reflected in the use of and removal of resources in the area. Due to pressure by the Albany Working for Water a management plan for the area is in the process of being compiled by the Department of Nature Conservation, Parks and Gardens Department (Makana) and Albany Working for Water.

Working for Water

Their four aims are: Enhance water security - Improve ecological integrity - Restore the productive potential of land and promote sustainable use of natural resources - Invest in the most marginalized sectors of South African society (DWAF, 2001). The programme is a public sector institution, funded almost exclusively by the government.

Local Branch: Albany Working For Water

The Albany project produces an annual plan of operation. They are in the process of developing a draft proposal for Featherstone Kloof, however no real management plan exists at present. At present WFW is approximately half way through their initial clearing of Featherstone Kloof.

Rehabilitation Process

Working for Water's national policy maintains that the control programme for alien vegetation must include the following three phases, (i) - Initial control: drastic reduction of existing population, (ii) - Follow-up control: control of seedlings, root suckers and coppice growth, (iii) - Maintenance control: sustain low alien plant numbers with annual control (DWAF, 2001). A major factor to consider regarding Albany WFW's impact on Featherstone Kloof is that the project will hand the land back to the Grahamstown Municipality in a few years, as is the case for Refyn. The Municipality lacks the funds and the capacity for management of this land and as such, may struggle to monitor and maintain the condition achieved by the WFW and Refyn.

Analysis of Management Plans and future suggestions

Currently, Grahamstown Parks & Gardens do not involve all stakeholders, while Albany Working for Water does, to the best of their ability. With the existence of Albany Working for Water the short-term management of Featherstone Kloof appears to be effective. However, for the long-term preservation of the natural vegetation of the Featherstone Kloof area, a management plan must be drawn up, and sufficient resources allocated to the appropriate organisation for implementing the management plan.

General Discussion and Future Plans

Ecological research in progress

- Propagating the mycorrhizal fungi associated with the plant species, that will be used for restoration of the study site or reestablishment of the species (By: Nadine Rehfelt and Irma Knevel).
- Seedling growth experiments under controlled conditions in sterile soil with and without mycorrhizae (By: Nadine Rehfelt and Irma Knevel).
- Germination trails with other indigenous species that may be possible candidates for rehabilitation (By: Nadine Rehfelt).
- Seed collection for rehabilitation study in Spring 2002 (By: Jamie Pote and Nadine Rehfelt).

Management research in progress

- Stakeholder analysis and public participatory process (By: Sue Harker)

Eight key stakeholders have been identified:

- Municipality (Town Clerk, parks and gardens, Newly established environmental forum and other key decision makers)
- Working for Water
- Grahamstown Trust (Grahamstown business representation)
- Institute for Water Research (involved in wetland rehabilitation)
- Wood collectors
- Medicinal/food plant collectors
- Conservationist groups (Botanical/Wildlife society)
- Recreational Users

This process will be run in conjunction with the PR process described below.

Public Relations and Educational activities in practice

- Newspaper articles

Future research

- Rehabilitation experiment with seeds and seedlings in the field.

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INTRODUCTION

South Africa is one of the 12 biological 'mega-diversity' countries in the world, due in large measure to the Cape Floral Kingdom (CAPE 2000). The Cape Floral Kingdom is a global biodiversity asset, the smallest Floral Kingdom of the world and the only one to be found entirely in one country. The flora of the Cape is of an international conservation priority, but is severely threatened and under intense pressure (Moll *et al.* 1984, CAPE 2000, Internet 5).

What is fynbos?

Fynbos is a heath-like vegetation characteristic of the Cape Floristic Region and unique to South Africa and is the most botanically rich habitat on earth, with even higher plant diversity than the tropical rainforests (FFI 2001).

Fynbos refers to distinctive plant communities found within the Mediterranean-type climate of the South-west Cape, extending into the Eastern Cape (Figure 1). Many of the plants have fine stems and leaves and the vegetation has a bushy appearance, hence the name fynbos (meaning fine bush; Internet 4). Fynbos is a unique mixture of three plant families, which form the main elements of the vegetation, namely, Ericaceae (heath), Proteaceae (Protea) and Restionaceae (Cape reeds) (Internet 3). Besides Protea's, Erica's and Cape reeds, there are many geophytes – herbs with underground storage organs such as bulbs, rhizomes and tubers – and annual plants such as daisies (Asteraceae) (Internet 4). A large proportion of species in the fynbos flora have small ranges and exist in small populations. There are several fynbos types, including Grassy Fynbos that is characterised by a high proportion of grasses (*Themeda, Trachypogon, Heteropogon, Brachiaria, Eragrostis*) and is structurally similar to Mountain Fynbos, except for the prominence of grasses at the expense of restioid (reeds) (Moll *et al.* 1984; see Figure 1).

Fynbos dominates the sandy infertile soils within the Cape Floristic Region (Cowling 1992, Internet 3), forming low growing vegetation. The vegetation is fire prone but the fire is essential for regeneration and maintenance of populations (Van Wilgen *et al.* 1992). Owing to various factors including the low soil nutrient status, the low water holding capacity and the fact that regular fires stimulate regrowth of vegetation, fynbos is typically treeless.

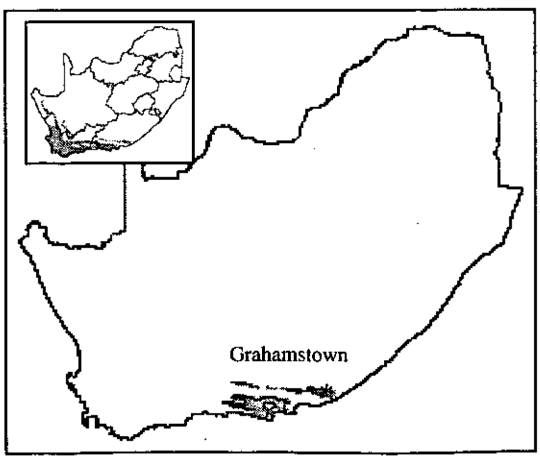


Figure 1. The distribution of Grassy Fynbos in South Africa extending east into the Eastern Cape up to Grahamstown (*) with the distribution of all fynbos in the left-hand corner (from Rebelo 2001).

Within the treeless fynbos there is an open ecological niche, which has facilitated the invasion of fast growing alien trees in the absence of their native pests and pathogens (Richardson *et al.* 1992, 1997). Besides the alien invasion there are other threats to the biodiversity of fynbos: indiscriminate agricultural and urban development, unsustainable use of resources (e.g. traditional medicine), and poor fire management (e.g. too frequent) (CAPE 2000). Fire is one of the most important factors and a natural part of fynbos ecology, without fire there would be no fynbos (Internet 4). Fire acts as a major mineralising agent, returning elements held in living plants and litter to the soil. The flush of nutrients after a fire helps the plants to reestablish in nutrient-poor soils. Many of the fynbos plants are killed by fire and rely on seed or sprouting for reestablishment (Cowling 1992, Internet 3, Internet 4).

Man is, in many cases, responsible for the destruction of natural habitats, which is also the case for fynbos. The alien plant invasion is a by-product of the presence of humans in the area, as is the development of housing, farming, and pollution, which narrows the fynbos' chances of survival even more (Internet 5). The importance of the conservation of the Fynbos biome was recognised in 1998 when the Cape Action Plan for the Environment (CAPE) was launched, co-ordinated by WFF South Africa in partnership with government, non-governmental organisations, communities and the private sector. CAPE developed a five-year action plan to investigate the state of biodiversity conservation and to develop a strategy in partnership with the Global Environment Facility (GEF) to secure the future of the Cape Floral Kingdom. The CAPE strategy provides an important example of how we would like to go about conserving our globally significant biodiversity (CAPE 2000).

Featherstone Kloof: Past and Present

The site to be studied in the Refyn project is situated in the former nature conservation area of Featherstone Kloof and Dassie Krantz on the Grahamstown Commonage in the Eastern Cape, South Africa. It consists of 200 acres of forest; heath and grassland situated on the south facing scarp slope of the Grahamstown hills, dominated by Grassy Fynbos. Grassy Fynbos replaces Mountain Fynbos in areas of relative fertile soils with a higher proportion of summer rainfall. Grasses largely replace the restioid component but the vegetation is otherwise typically fynbos (Low & Rebelo 1996).

Featherstone Kloof is located 8km south of Grahamstown, along the mountain drive road (Figure 2). The area forms part of the Kowie river catchment and has a number of depressions (or kloofs) along its length of about 6.5 kilometres from East to West. The mountain rises from about 485 meters to about 770 meters at the eastern end. It forms a barrier to the coast and is part of the Zuurberg range that stretches from Natal to the Cape, forming an important watershed. There are numerous cliffs, ridges and steep slopes with rocky outcrops and large boulders. Soils are sandy, acidic and nutrient poor (Martin, 1965).

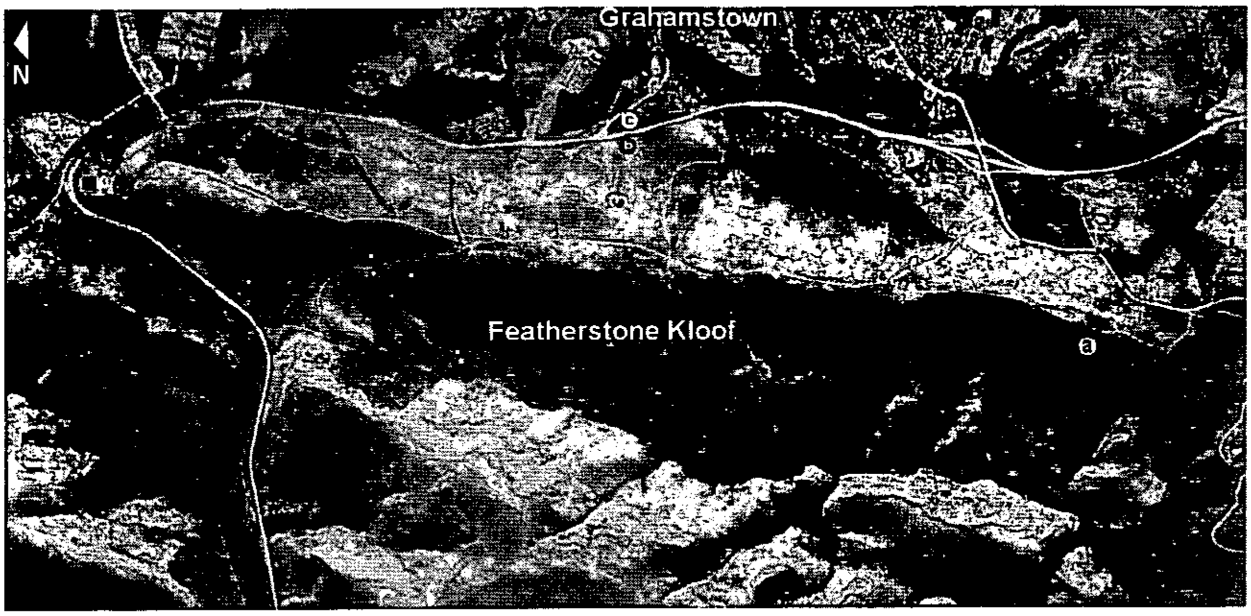


Figure 2. Aerial photograph of Featherstone Kloof situated near Grahamstown, Eastern Cape, South Africa with some of the study sites.

The climate reflects a bimodal rainfall, with spring peak between September and November, and an autumn peak during March and April. The average annual rainfall for the study period was 544.3-mm. Autumn and spring months appear to be the most suited to plant growth, due to increased rainfall during these periods.

Past situation

In the past the Featherstone Kloof area was under private ownership of land under European management. It all started in 1831 when the land was granted to the 1820 settler Hendry Ulyate who started the farm Kowiefontein that measured at that time approximately 1 264 Morgan 510 square roods and 43 square feet. In 1834 part of the Kowiefontein farm was acquired by Robert Featherstone, who renamed it Featherstone's Kloof. In 1886 the Grahamstown Municipality were given sections of Featherstone Kloof and leased it as grazing ground in 1925. In meetings in 1932 it was decided that a nature reserve was to be established in Featherstone Kloof, and in January 1933 a 50-year lease was awarded to the Grahamstown Nature Reserve Society for the establishment of a nature reserve (Yeomans 1934).

The municipality made a proposal to sell Featherstone Kloof, including part of the Nature Reserve, to a private buyer who would have most likely used the land as a sheep farm. Local protest, driven by the Nature Reserve Society and supported by Grahamstown schools and local and national organisations resulted in only 80 Morgan of the Reserve being taken over by the municipality in 1939.

In 1945 clearing of *Hakea*, which was considered to be invasive, began in Featherstone Kloof and the lease of the area was renewed for another 50 years and transferred to the Botanical Research Institute. In the 1990's the Botanical Research Institute terminated its management of the Grahamstown Nature Reserve. From 1995 onwards the area was under Public Ownership by the government. In 1997 the local branch of the Working for Water programme commenced with the removal of alien invasive species in the Featherstone Kloof area.

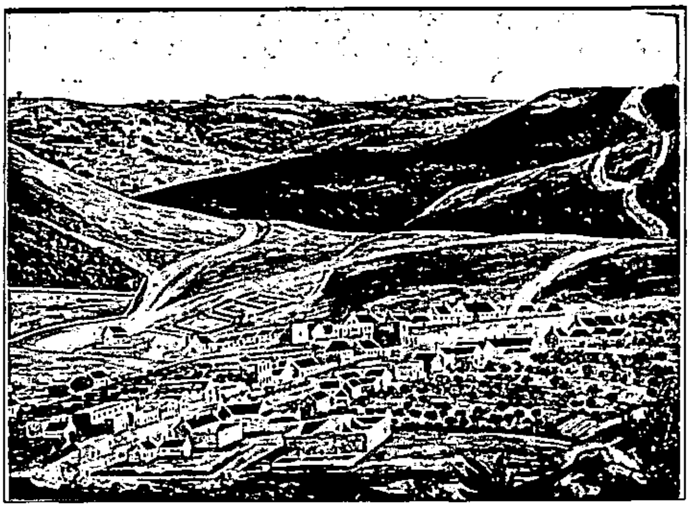


Figure 3. A Thomas Baines Painting of the Grahamstown hills from 1813.

Present situation

Grassy Fynbos and forest pockets occurring in the Featherstone Kloof area have previously been densely invaded with exotic species, including *Acacia longifolia*, *Hakea sericea*, *Eucalyptus* spp. and *Pinus* spp. Aerial photographs from 1933 already show heavy infestations of certain species (Jacot-Guillarmod, 1983). The lengthy time period of infestation together with frequent high intensity fires, as described by Martin (1965, 1966) and Richardson (1984) has impacted heavily on the natural vegetation occurring in these areas. Present removal strategies, involving a slash and burn technique by the Albany Working for Water Programme, has been committed to the removal of these trees as part of a catchment area clearing exercise. However, the clearing technique has numerous consequences. Although studies of the impact of burning on soil have shown it to have few negative or unrecoverable effects (Cass *et al.* 1984), the extent of time in which infestation has occurred together with the post-clearing burn have seriously impacted on indigenous seed banks. In addition, the post-clearing burn intended to reduce the exotic species seed bank, acts as a stimulant for germination of the exotic species such as *Acacia longifolia* and *Acacia mearnsii* (Personal observation). The very dense seed bank that remains is hence quick to reassert itself as a thick stand of aliens, especially if followed by favourable climatic conditions (warm weather and plenty of precipitation). The current solution to this problem, which is disfavoured by rehabilitators (Pryor Pers. Comm.), is to utilise commercial herbicides such as Garlon 4. These are sprayed liberally onto stands of seedlings, to eradicate them. In the process however, any other indigenous flora will also be eradicated, and this will ultimately prolong the rehabilitation process. An alternative to repeated spraying is the use of a cover crop to compete with and shade out invasive seedlings.

Albany Working for Water is using *Eragrostis tef* as a cover crop species at present. This commercial agricultural grass is fast growing under the nitrogen-enriched conditions, is easily obtainable in sufficient quantities and has a high, rapid germination rate. However many problems exist regarding its use. It is a hybridised non-indigenous species, giving it a single growth season. It has been noted that rehabilitation trials are rarely performed, as a hit and miss approach is often favoured. Seed is often planted at unknown or vaguely estimated densities, with very little quantitative data being collected.

Aims and objectives

The fact that alien trees have invaded the area heavily has led to a severe degradation of Grassy Fynbos within the study area (Figure 4). This invasion resulted in a loss of species and diversity, structural habitat changes and a change in the fire regime (more frequent and intense fires; Internet 4). Other threats include overgrazing, development and erosion (Holmes & Richardson 1999). The aliens present are the Long-Leaved Wattle (*Acacia longifolia*; Figure 4), Black Wattle (*Acacia mearnsii*), Lantana (*Lantana camara*), Sweet Hakea (*Hakea sericea*), and Cluster Pine (*Pinus pinaster*) and Blue Gum species (*Eucalyptus* sp.). At the study site, Featherstone Kloof, the Working for Water programme (WFW) has cleared the area of all aliens (Figure 4). This clearance of alien invasive trees gave us the perfect opportunity to monitor "natural restoration", to carry out rehabilitation trials and to reintroduce species which have become locally extinct, and which may not recolonise themselves naturally.

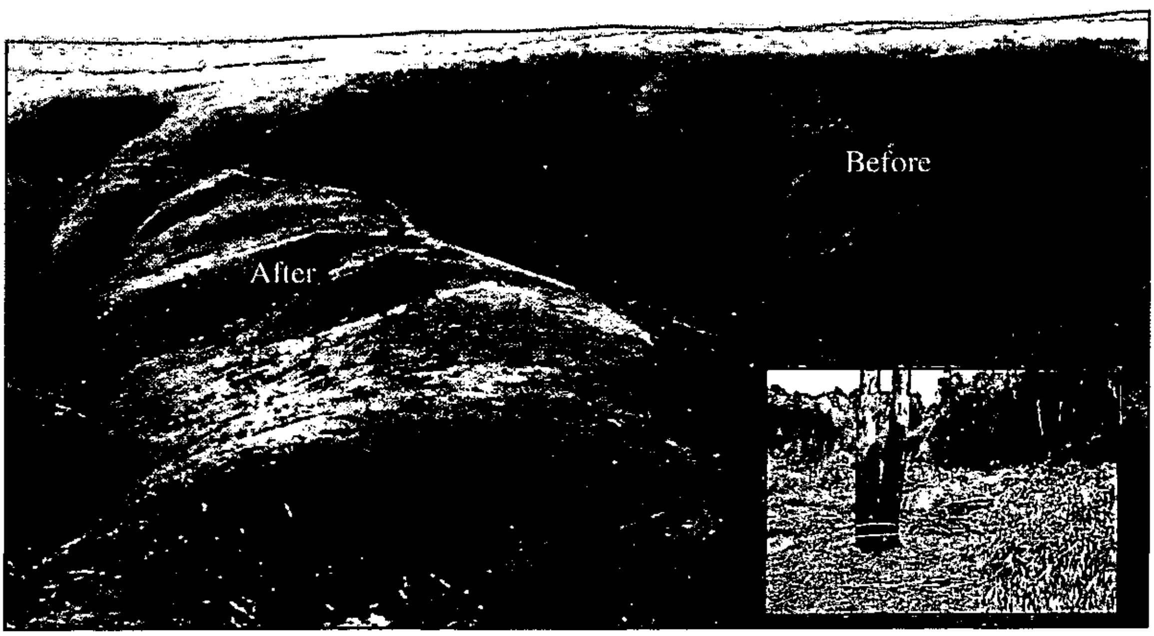


Figure 4. Featherstone Kloof area before (right from the road) and after (to the left) clearance of aliens, with clearance in progress (inset).

The general aim of a restoration project is to reestablish some or all of the links that control processes involved in the ecosystem. The degree to which links need to be repaired and natural functioning reinstated depends on the aims of the restoration project and the extent to which the site is transformed. To restore a particular function of an ecosystem we need to know how the assemblages of organisms that coexist form linkages that affect important processes (Cowling 1992, Van Wilgen *et al.* 1992). Therefore, the first aim is to understand the process leading to the degradation of the Grassy Fynbos of the Featherstone Kloof area, particularly those related to disturbance (e.g. alien invasion, seed bank depletion, mycorrhizae). The objectives of this aim are to identify the keystone species that could assist with the restoration of the area and to identify the mycorrhizal types associated with selected plant species.

The cleared areas are often bare and provide a perfect opportunity to study natural rehabilitation and to carry out rehabilitation experiments. Therefore, the second aim was to investigate the natural restoration of the site (e.g. seed bank emergence) and the success of current restoration techniques used by the Working for Water programme after the clearance of alien vegetation (Figure 5).

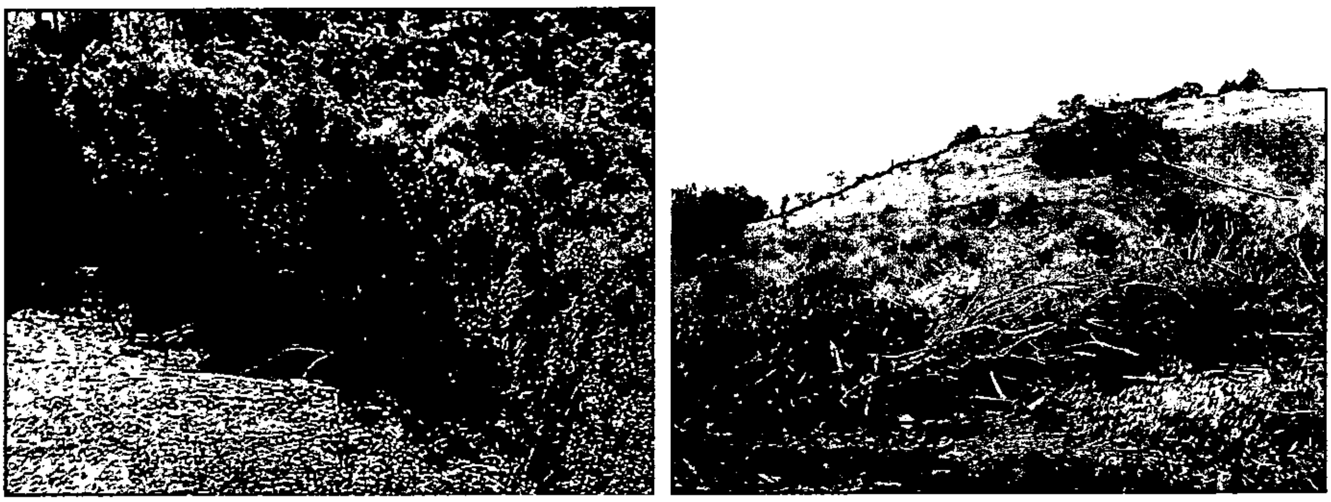


Figure 5. After the clearing of the dense stands of aliens (see left picture) the brushwood is piled on the site and burned.

After restoration, the site should be maintained and thus a management plan is needed. Therefore the third aim is to develop a management plan and implementation strategy through a participatory consultation process. The objectives of this part of the project are to develop a practical management plan that would ensure the future restoration of the Grassy Fynbos of the Featherstone Kloof area, as well as to assess the financial and organisational requirements for the implementation of this plan through a participatory consultation process with local authorities and environmental groups.
The study area is frequently utilised by the public either for recreational purposes, such as hiking along the Oldenburgia trail, or for medicinal plant and wood collection. Therefore the fourth objective is to create a baseline study by developing a network of local expertise (e.g. Working For Water programme,

Botanical Society, Wild Life and Environment Society of South Africa), local communities and the public to preserve this unique area.

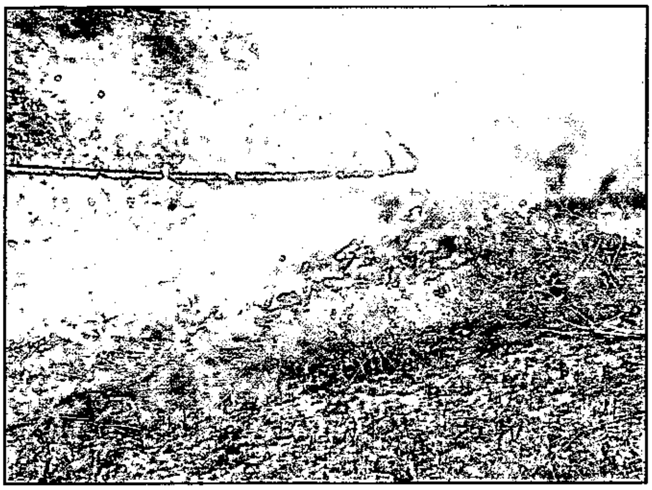
The main goal of the Refyn project is to launch a public awareness programme. This will be achieved by developing a booklet and a flyer through the consultation process, if possible with advice for the restoration practitioners and land managers. It will also be used for educational purposes and provide advice on e.g. medicinal plant collection for the local communities. Thus we will explain the importance of the restoration and the conservation of Grassy Fynbos in the Featherstone Kloof area, and encourage the public to take care of our natural heritage. Moreover, articles will be published in journals and magazines of the local and national organisations involved in nature conservation and environmental issues.

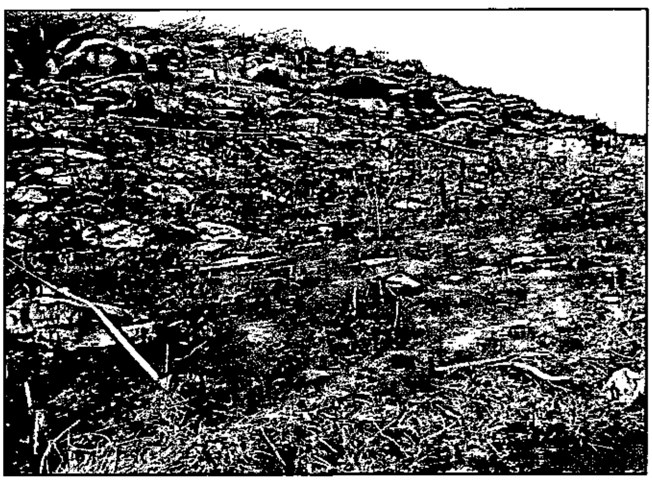
Outline of the report

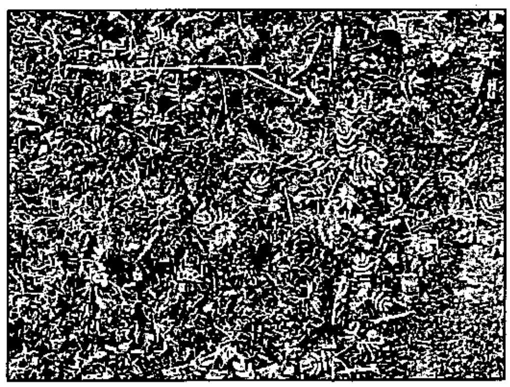
The report is divided into three main parts dealing with the ecological, management and public participation and publication aspects of the Refyn project. In the Ecological Studies the results of the plant collections, vegetation survey, a bee pollination study, the pilot restoration project, soil analysis, soil seed bank survey, Mycorrhiza survey, the water use of the aliens, and the influence of smoke on the germination of species and on mature plants are discussed among other things. In part two (Management) the management of past, present and future is laid out, and in part three (Participation and Publication) the public participation and publicity during the project is included. For each project the responsible team member is mentioned, but in general the work for the different projects was carried out with help from many of the other team members and participants.

PART I

ECOLOGICAL STUDIES







The general aim of a restoration project is to reestablish as many of the links with the processes that 'control' the ecosystem as possible. The degree to which links need to be repaired, and natural functioning reinstated, depends on the aims of the restoration and the extent of transformation of the site. We need to know how the assemblages of organisms that coexist form linkages that affect important processes in order to restore a particular function of an ecosystem (Cowling 1992, Van Wilgen *et al.* 1992). Therefore, the first aim is to understand the process leading to the degradation of the Grassy Fynbos of the Featherstone Kloof area, particularly those related to disturbance (e.g. Mycorrhizae, alien invasion, seed bank depletion). The objectives of this aim are to identify the keystone species that could assist with the restoration of the area and to identify the mycorrhizal types associated with selected plant species of Featherstone Kloof.

1.1 ALIENS AND THEIR INFLUENCE ON THE VEGETATION

The aliens have been very destructive to the Grassy Fynbos, not only due to the structural habitat change, but also due to the water use and water holding capacity of the aliens and the nitrification of the poor soils.

***Acacia longifolia*: Clearing methods and their effectiveness** By: Lisa McDonald

The Australian *Acacia longifolia* is an invasive plant that has become a significant problem in the Eastern Cape region. For instance, the trees have an effect on water loss, by changing the water catchment areas (decrease run-off and stream flow). They also increase fire risk and wildlife habitat loss. Control of the *Acacia*'s is of great importance because of these adverse effects on the fynbos ecosystem and community processes. Impacts on the ecosystem processes include change in nutrient status of the soil, a reduction of light for the undergrowth and increased fire intensity, due to very dense stands of *Acacia*'s. The alien trees affect the plant-plant interactions at a community level, resulting in a reduction in species diversity (MacDonald & Jarman 1984).

There are a number of approaches that can be used to reduce or control the invasive *Acacia*'s growth including fire, clearing, chemical control, biological control, and grazing or browsing. The topography of the area often dictates the method of control applied, however each of the clearing methods has some adverse effects on the fynbos for instance, plant damage and trampling damage by man and machine. The seed banks of the *Acacia*'s in South Africa are large due to the low seed predator pressure (Milton 1980, Holmes *et al.* 1987). Therefore, the control of *Acacia*'s should be directed towards soil seed bank destruction, prevention of germination and removal and/or destruction of seedlings.

Control methods

In many cultures and environments, fire is associated with death and destruction and leaves a black landscape in its wake (Davis & Midgley 1990, Pate 1993). It is quite the contrary with fynbos: Fire is the lifeblood, without fire fynbos would perish. Fynbos has the remarkable ability to use fire to develop a new generation of plants. There are a few ways to survive and re-grow after fire, namely; by forming underground storage organs (geophytes), by resprouting from protected buds on stem or root (resprouters), or by germination from the soil or aerial seed bank after fire (seeder; Wicht 1945, Bond & Van Wilgen 1996). A seeder plant is completely destroyed in a fire, leaving only the seeds of regeneration, while the sprouters sprout after the fire from protected buds. Although fire does, at first glance appear destructive, it triggers a chain of motion of biological events that ensures the rebirth of the fynbos. In the years between fires only 10 percent of the plants bloom, but in the short time after the fire up to 80 percent of the plants bear flowers. This display of blooming is not caused by the fire, but rather by the raised soil temperature caused by the removal of vegetation. The advantage of this blooming method is that it attracts pollinators, providing huge amounts of seeds, which in turn swamps the potential seedeaters. This tactic is known as predator satiation. Soon the flowers melt away and the fynbos patch returns to normal. After a few years this patch of fynbos is again mature and is ready for another blaze of fire.

The use of fire favours species that have large soil seed banks (Cunningham & Cramer 1965). The intensity of the fires in the fynbos has changed due to the aliens. The fire is hotter, resulting in more intense fires which destroys the top soil layer, resulting in a loss of nitrogen in the soil and the death of many indigenous species' seeds in the soil seed bank (Milton & Hall 1981, MacDonald & Jarman 1984). The alien seeds often survive the fires and the heat pulse and smoke from the fire stimulate germination of the *Acacia* seeds, resulting in mass germination. The alien seedlings suffocate the indigenous seedlings and resprouters that survive the fire. For this reason fire should not be used to remove the aliens in lightly infested fynbos areas where weeding is an option. Fire should also be avoided where the aliens have invaded steep slopes and unstable soil (Milton & Hall 1981).
The timing of fire is important since season determines the type of fire, which in turn affects seed availability. Burning, with a short interval between burns could significantly reduce the seed mass stored in the soil and is probably detrimental to the fynbos community (Milton & Hall 1981, MacDonald & Jarmen 1984). Fire should preferably be combined with other control measures like felling and stacking after clearing, biological control and chemical control.

A wide range of herbicides is available for use in eradication programmes and are available as sprays, for foliage and as pellets, for root systems. Herbicides are most useful as a follow-up treatment after clearing or fire (Figure 6). Combining clearing with subsequent burning and spraying of herbicides can effectively control *A. longifolia*. Useable wood is removed and the remaining branches are stacked and burnt and the emerging seedlings and regrowth of the aliens are sprayed with herbicides. The continuation of the spraying after clearance is of vital importance with this treatment as many alien seeds will still be present in the seed bank. Clearing of *Acacia*'s with subsequent chemical spraying of seedlings and annual weeding for 3-4 years after clearing led to recolonisation of indigenous species in areas of the Cape Peninsula (Milton & Hall 1981).

Figure 6. Post-clearing spraying of the aliens to prevent further regrowth. Agripron, a wetting agent is shown on the left.

Bio-control can reduce the reproductive efficiency and possibly the growth rate of the *Acacia*'s (MacDonald & Jarman 1984). Grazing and browsing is one option as goats are reported to have cleared the *A. longifolia* on the Cape flats. The goats feed on the leaves and pods of the trees, however goats are destructive feeders and the presence of browsers can alter the fynbos succession resulting in grasses replacing the fynbos species (Mundell 1977). Another option is the use of biological agents like gall wasps to reduce the seed output of the *Acacia*'s (see next section).

Situation at Featherstone Kloof

At the study site, Featherstone Kloof different treatments have been used to clear *A. longifolia* by the Working for Water programme including, clearing and burning (Figure 9), burning alone, clearing alone, sowing of the cover crop *Eragrostis tef* after burning, and chemical control seedlings. At some sites the indigenous pioneer *Senecio pterophorus* grew from seeds of the seed bank. This was also counted as a treatment. The sowing of *E. tef* has only recently begun; hence no long-term results could be obtained.

As expected, significantly more seedlings, with a higher cover were observed in the burned area. The correlation between the percentage cover of *Acacia* and *Senecio* seedlings was strongly negative (R^2 – 0.77), hence more *Acacia* seedlings resulted in a lower cover of *Senecio*. However, the growth of the *Senecio* seedlings after the burning seemed to control part of the *A. longifolia* by reducing the cover and number of seedlings (Table 1). *E. tef* formed a dense monostand, where hardly any *Acacia* seedlings were observed on the sites it was sown (Table 1).

Table 1. The average number of seedlings and average percentage cover of *A. longifolia* of the different sites, with the percentage cover of other species and bare ground.

Treatment	Number of *Acacia* seedlings	Cover (%)		
		Acacia	Other	Bare ground
Cleared	6 c	9 c	39 b	Wood
Burned	965 a **	84 a **	7 c	14 b
Burned + *Senecio*	633 b	59 b	34 b (27% *Senecio*)	10 b
Eragrostis tef	13 c	9 c	80 a *** (60% *Eragrostis*)	32 a *

The lowest numbers of seedlings of Acacia were observed in the cleared areas due to the fact that the seeds in the seed bank were not stimulated to germinate by fire. However the seeds are still there, waiting for the right conditions to germinate. The use of *E. tef*, and *S. pterophorus* seemed to reduce the seedling growth of *Acacia* to some extent. Due to the formation of the monostand by *E. tef*, the indigenous species were also excluded as 60% of the 'other species' category was *E. tef* seedling (Table 1). The grass, *E. tef* dies out after a year, giving the indigenous (but also the alien) seedlings a chance to reestablish. The seeds of *A. longifolia* are very persistent in the soil and are able to wait for years before germinating, therefore indigenous species should be sown in the *E. tef* stand during, or before they die out to prevent mass germination of *Acacia*.

Effects of galls on the reproductive ability of *Acacia longifolia* By: Jolene Dawson

As mentioned in the previous section the use of biological control agents, like gall wasps, is one way of substantially reducing the seed production of *Acacia longifolia*. *A. longifolia* was the first species to be targeted for bio-control in 1982 (Donnelly 1995). The method chosen was the use of the species-specific gall wasp, *Trichilogaster acaciaelongifoliae*. The wasps lay their eggs in the young buds of the *Acacia*, resulting in the formation of galls instead of flowers (Figure 7).

Figure 7. Flowers and galls formed from buds of *Acacia longifolia*.

How do these wasps affect the trees as a whole? It was found, by harvesting galled and non-galled trees of 1.5 to 2.5 m that the number of galls on a tree significantly reduced the number of flowers produced. The average leaf weight and tree size of the infected trees was much lower, which means that non-galled plants have more leaves, thus the galling has a strong effect on carbon allocation and hence, on the growth of the entire tree (Table 2). The plant size and flower size of the galled trees decreased in comparison to the control trees, but the differences were small (Table 2). The main effect is that by reducing the seed output of the aliens, the first step towards eradication is made by preventing the formation of a persistent and long-lived soil seed bank.

Table 2. Average of the galled and non-galled trees (control) for the parameters; total tree weight, leaf weight per tree, plant size and flower size.

Parameter	Galled	Control
Total weight per tree	91 gram	582 gram
Leaf weight per tree	60 gram	140 gram
Plant size (Flower weight/leaf weight)	0.02	0.08
Flower size (flower number/flower weight)	49.0	51.3

The water use of alien plants By: Lori Winter, Benjamin Jackson, Zoe Hall, Joel Houdet

For many years Featherstone Kloof has been threatened by several alien species, particularly *Acacia longifolia*. (Figure 8) This species grows in dense stands, preventing almost any undergrowth and using much more water than the fynbos vegetation that is adapted to a low rainfall climate (Bromilow 2001). The invasive woody aliens are responsible for the loss of millions of litres of water daily, due to transpiration (Richardson *et al.* 1997). The clearing of the aliens by WFW was implemented in order to conserve water. Initially there were two schemes deemed feasible for conserving water; building dams and deforestation. The aim of this project was to estimate how much water *A. longifolia* uses at Featherstone Kloof. Traditionally the measurements of water use had been predicted by measurements on individual leaves or by measuring the flow of water in xylem via heat pulse methods. However, both methods are considered inaccurate, because the first method makes assumptions for the whole tree and the second method is inaccurate with regards to the calibration of the measurements.

In this experiment the actual water use of whole trees was measured instead of part of the tree (e.g. a leaf). The trees were from an even stand with trees of similar height and trunk diameter (up to 2-3m high – trunk diameter 22-23cm). The transpiration of these whole trees can then be linked to the associated weather conditions. Weather conditions are the major variables in the driving forces of transpiration. A model can be created to predict the water use by relating transpiration rates of the trees to the weather conditions.

Figure 8. *Acacia longifolia* in its natural environment in Australia with detail of the flowers on the right (Photo: http://www.anbg.gov.au/acacia/species/A-longifolia.html).

Water loss: The tree was cut off at ground level and transferred to a large container filled with water, which contained a second device that cut the tree underwater to eliminate airlocks in the xylem. The columns of water in the xylem are broken in the cutting process and the negative pressure (due to transpiration in the leaves) sucks air into the water conducting vessels creating an airlock when the trunk is submerged in water after the cutting. By re-cutting the tree underwater, the airlock is removed so that the new cut surface is exposed to water and not air. The tree was placed underwater in a measuring cylinder without removing it from the container; it was then removed from the water vessel. The water used (or lost) by the tree was then measured as the loss of a specific volume of water, measured at different times of the day over a period of time.

Vapour pressure deficits: Weather stations were set up in order to measure the vapour pressure deficits over the experimental periods. Relative humidity, temperature and wind speed were recorded during the water loss measurements of the cut trees. Humidity and temperature are of most importance as the vapour deficit can be calculated from these variables.

A whole-tree water loss model at landscape level could be constructed after measuring leaf area indices, validation, and scaling processes. *A. longifolia* was calculated to have an average water loss of 1476 litre/m^2/year under the prevailing climatic conditions at Featherstone Kloof. It can be seen that the water use of the trees is much higher when this value is compared to the total rainfall values of 745 litre/m^2/year. The results show a first attempt at predicting water use with a whole-tree water loss model. It must be noted that the week before measuring an unusual high rainfall was recorded. Therefore, the transpiration could have been higher than normal due to the high ground water tables. However, the yearly average is expected to be somewhat lower.

1.2 FIRE AND SMOKE AND THEIR INFLUENCE ON VEGETATION

The influence of smoke on seed germination of fynbos species By: Paul Barratt and Jamie Pote

It has already been stated that fire is important to fynbos, but smoke can also be of great importance. De Lange and Boucher (1990) were the first to report that plant-derived smoke stimulates seed germination. They found that smoke acted as a cue for breaking dormancy of the seeds of a monotypic Fynbos species (*Audouinia capitata*), while Afolayan *et al.* (1997) found the same for *Helichrysum aureonitens*. It was reported by Drewes *et al.* (1995) that light sensitive lettuce seeds (*Lactuca sativa* cultivar Grand Rapids) responded to smoke-derived extracts over a wide concentration range. Seeds of this species germinated within 24 hours in the dark at 20°C or 25°C and could be used as a simple, rapid bioassay for the detection of enhancing compounds in plant-derived smoke extracts (Baxter *et al.* 1995, Brown and Van Staden 1997). This suggests that smoke might have acted as an important evolutionary cue.

In the early experiments on the effects of smoke on seed germination, fresh and dry plant material from areas surrounding the study site was burned in a drum to generate smoke. The smoke was then led into a polythene tent and allowed to settle on the soil of an area that was undisturbed by man or alien invasion (Brown and Van Staden 1997). Further studies found that many plants produced the germination enhancing substance upon heating or burning (Baxter *et al.* 1995, Brown and Van Staden 1997). De Lange and Boucher were the first to show that the active components of aerosol smoke were soluble in water. Smoke-extract was produced by using compressed air to force smoke to bubble through water (Brown and van Staden 1997).

The species used in this study were *Senecio pterophorus, Senecio chrysocoma* and *Helichrysum cymosum. Senecio pterophorus* is an erect shrub of up to 1,5 metres high with yellow flowers appearing in the November-January period. It is a species known to thrive in disturbed areas. The plants of *Senecio chrysocoma* are erect, perennial plants of up to 1 metre in height. In the period, November-January the yellow to white flowers will emerge and set seed. Again, this pioneer species is characteristic of disturbed habitats, and of grasslands in particular. The third species *Helichrysum cymosum* is an erect, branched shrublet of up to 60 cm in height, which grows in more moist areas. The flowering period of this species is from November till March when the yellow flowers produce many small seeds. All three species produce large quantities of seeds, which can be harvested quite easily.

These species were chosen because they are amongst the primary colonisers of disturbed areas, be it through burning or clearing, and are common in the Grahamstown region. In addition, these plants serve as companion and nurse plants to the species that germinate and grow later in the natural succession that occurs following colonisation by primary coloniser species, such as trees, shrubs and ground-layer species (Egler 1954).

Part of the WFW programme, which involves the cutting down of the alien plants can potentially leave the ground bare as the alien species, like *Acacia* tend to grow in very dense stands, sometimes forming what is known as 'pole thickets' (Figure 8). It is important that the primary colonisers are encouraged to grow as quickly as possible to (i) shade out the seedlings of the alien species, (ii) prevent erosion of the soil, and (iii) provide suitable conditions for the germination of the seeds of plants that are more typical of undisturbed areas. The possibility of the species of the present study being used as the colonisers of the areas that have been cleared of aliens by the WFW programme was tested. However, it would be essential to ensure that satisfactory germination of the seeds occurred under field conditions. Therefore the aim was to determine the effect of smoke extract on the indigenous colonising species of the area.

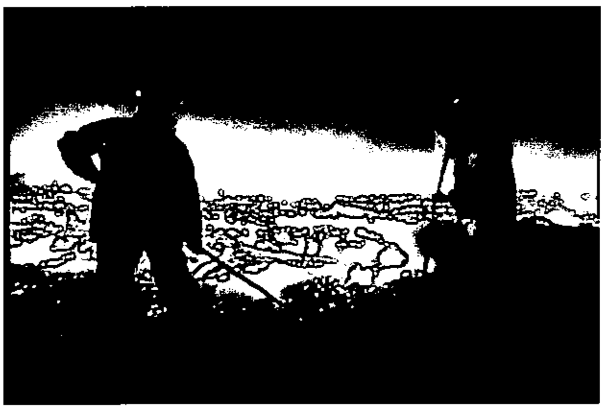
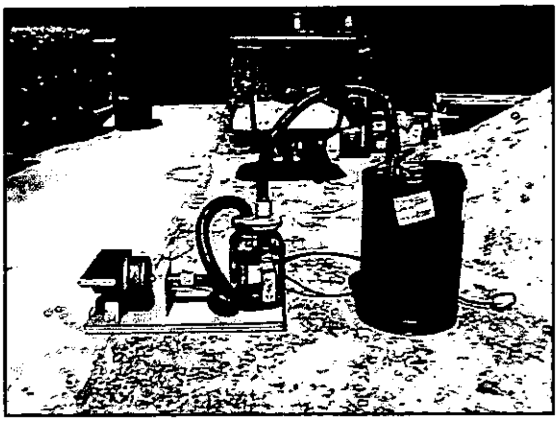


Figure 9. Fire at Featherstone Kloof (left) after the clearing of alien trees with the view of the site after the fire (right) (Photo: Juan P. Moreiras, FFI/BP).

Many of the indigenous colonisers have a low level of seed germination and by treating these seeds with smoke extract prior to sowing, it was expected that the degree of germination would increase. This would then allow greater numbers of the plants to germinate sooner, and thus out-compete the alien seedlings, prevent soil erosion and provide conditions suitable for the germination of plants that grow later in the succession of species. This will bring about a faster rehabilitation of the degraded areas.

Smoke extract was collected according to the method used by de Lange and Boucher (1990), except that instead of using compressed air to drive the smoke through the water, a vacuum was created to draw the smoke through the water until it darkened (Figure 10). The material used to generate the smoke was gathered from the Featherstone Kloof region and consisted mainly of grasses, and *Senecio* and *Helichrysum* plants.

A bioassay was carried out on lettuce seeds using the resulting smoke extract (Figure 10), which was similar to the method used by Drewes, Smith and van Staden (1995). This was done in order to determine the correct concentration of smoke extract to use, as too much smoke was reported to have an inhibitory effect on germination. It was decided, after the bioassay that eleven concentrations of smoke were used, namely, 1:2, 1:4, 1:10, 1:50, 1:100, 1:500, 1:1000, 1:5000 and 1:10 000, and a control.



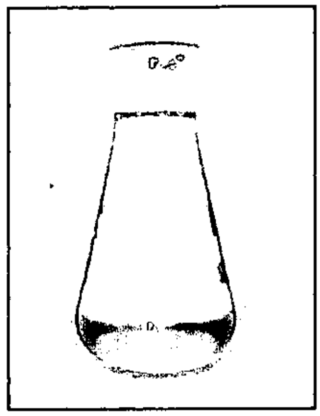


Figure 10 Smoke machine and collected smoke extract.

The smoke appeared to affect the germination time (shorter time to germination) and germination success (more seeds; see Figure 11) of the indigenous seeds. There was an initial improvement of germination of the seeds at scattered concentrations, however, by day 15, this improvement of germination relevant to the control seeds had completely disappeared, except for the species *S. pterophorus* (Table 3). This shows that there is a period of delay (lag phase) between initial inhibition and germination that the application of smoke breaks down, which might point to the fact that the seed dormancy was broken (Table 3). The seeds of *S. pterophorus* especially, seemed to start germinating in a shorter time when compared to the control, and also showed an improvement of germination success (Table 3).

The presence of smoke could perhaps indicate to the seed that there was a fire recently, and that there will be little or no competition for water from other plants. Therefore, earlier germination would be an advantage. The number of control seeds that germinated without the smoke cue increased rapidly after about day 13, catching up with the smoke treated seeds, hence no significant difference in mean germination response was found between the controlled and treated seeds for *S. chrysocoma* and *H. cymosum* (Table 3).

However, the germination pattern for the different smoke concentrations had very scattered distribution, hence no conclusion on a single concentration could be made (Table 3).

Table 3. The time to first germination (time) and the mean germination response (in %; with standard deviation S.D.) of the species *S. pterophorus*, *S. chrysocoma* and *H. cymosum* under different smoke extract concentrations. Any germination value within a species with the same letter does not differ significantly. Data analysed with ANOVA and contrasts obtained by Tukey comparison-of-means test. Level of significance is $P<0.001$ (*** in table).

Treatment	Germination response per species (%)								
	S. pterophorus			*S. chrysocoma*			*H. cymosum*		
	Time	Mean	(± S.D.)	Time	Mean	(± S.D.)	Time	Mean	(± S.D.)
Control	11	6.0	(2.3) b	7	47.0	(12.9) a	9	37.0	(20.1) a
1:2	9	29.3	(15.1) ab	8	37.0	(20.1) a	9	66.0	(12.2) a
1:4	10	30.0	(10.6) ab	7	61.0	(6.1) a	9	51.0	(46.1) a
1:10	9	14.0	(4.0) ab	8	57.0	(26.6) a	9	66.0	(36.1) a
1:50	10	28.0	(23.1) a	8	42.0	(4.0) a	9	52.0	(2.3) a
1:100	14	9.0	(2.3) ab	7	44.0	(8.3) a	9	44.0	(6.1) a
1:500	10	16.0	(4.6) ab	8	63.0	(8.3) a	9	44.0	(21.2) a
1:1000	9	37.0	(25.0) a ***	9	51.0	(20.5) a	12	46.0	(28.1) a
1:5000	9	25.0	(6.1) ab	7	60.0	(17.4) a	9	44.0	(2.3) a
1:10000	9	24.0	(21.2) ab	8	49.0	(6.1) a	9	43.0	(16.2) a

Even with the application of smoke to the seeds, there was still a large difference between the percentage of the smoke treated seeds that germinated, and the number of seeds that were viable according to the tetrazolium technique. It should be noted that the tetrazolium technique only shows those seeds that are living and is not able to distinguish between seeds capable of growth and seeds that have become infected with fungal pathogens.

It can be seen, from these experiments, that smoke extract does improve the germination of these indigenous seeds, and that it can play a part in rehabilitation of areas by encouraging more seeds to germinate sooner. The smoke has still, however, not brought about the maximum degree of germination possible, as was shown by the viability of the non-germinated seeds (tetrazolium technique). These test results also show that each species used in conjunction with the smoke extract needs to be tested first, to find it's optimum smoke concentrations.

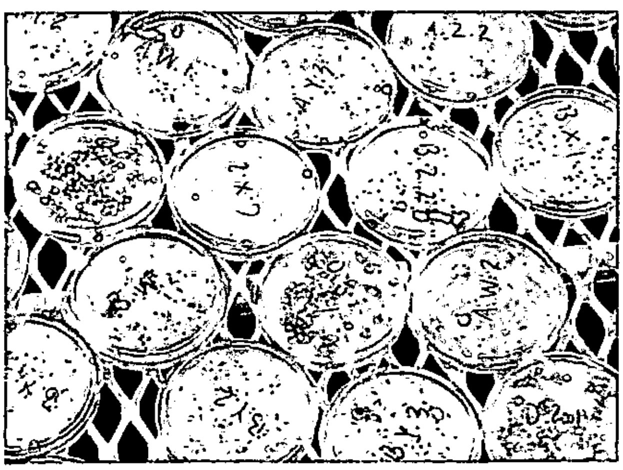


Figure 11. Seed germination in the greenhouse.

The effect of smoke on the gaseous exchange of *Chrysanthemoides monilifera* By: Matthew Gilbert

There are basically two ways plants survive fire, by being either a seeder or a sprouter. *Chrysanthemoides monilifera* belongs to the last group and forms sprouts from protected buds, after the fire (see Figure 12). Although fire does, at first glance appear to be destructive, it triggers a chain of motion of biological events.

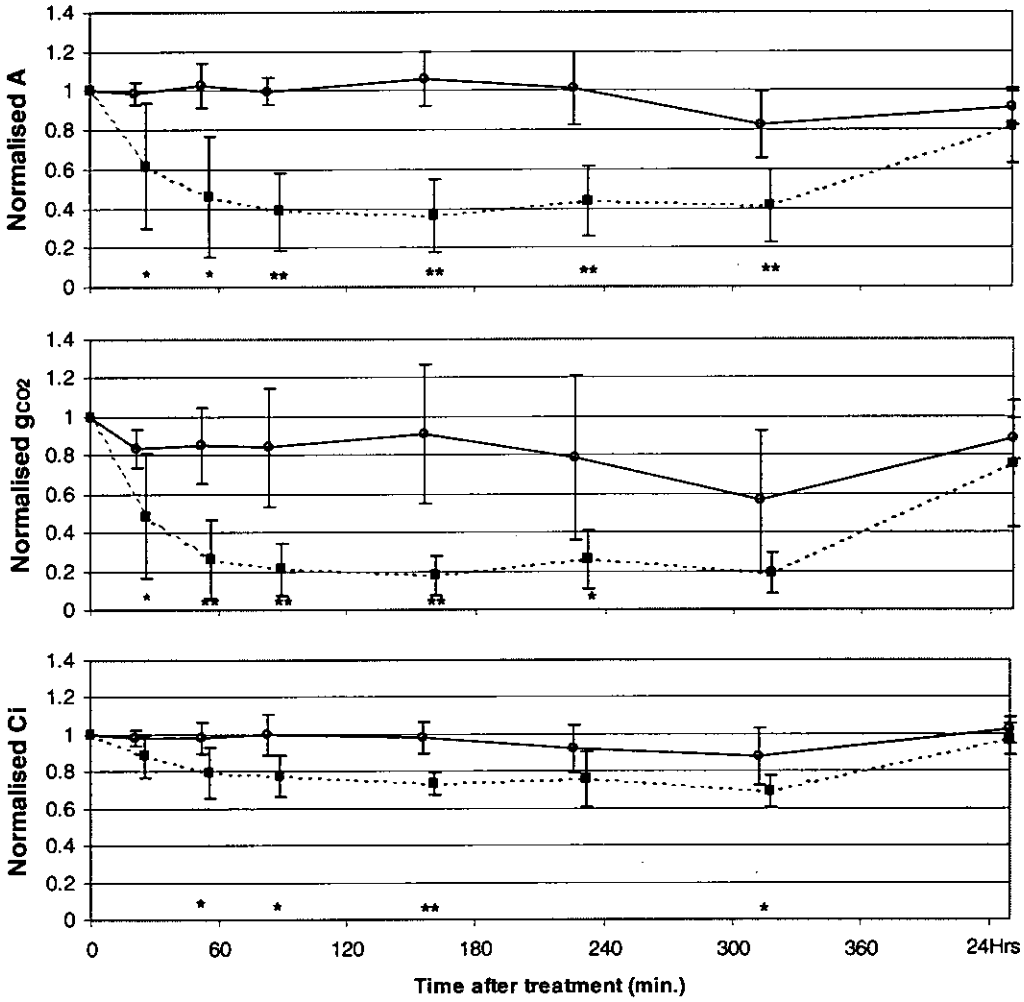
Most studies have focused on the effect of fire and smoke on the biomass accumulation, reproductive output (Hansen *et al.* 1993, Kruger & Reich 1997), survival of individuals (Carturla *et al.* 2000), and resprouting (Hodgkinson 1998, Bellingham 2000, Bond & Midgley 2001). However, hardly any work has been done on the effect of smoke on the gas exchange of plants growing in these fire-driven ecosystems.

Figure 12. *Chrysanthemoides monilifera* growing at Featherstone Kloof.

The stomatal and non-stomatal processes affect the gas exchange of *C. monilifera*. An initial field experiment showed a lack of effect of smoke on the gas exchange of plants in response to natural field fires. In laboratory experiments plants were smoked and it has subsequently been discovered that plants are greatly affected by smoke over a short timeframe by limitations in stomatal and non-stomatal responses. The plants smoked in the laboratory exhibited a drop in stomatal conductance and a partially associated drop in assimilation rate (see Figure 13).

Stomata in the plant leaves respond to various environmental factors and such responses affect the gas exchange of the plant. Some of the factors influencing the stomata response include the pressure difference in water vapour between the leaf and air, temperature, and light intensity. In addition to environmental factors, air pollutants also lead to stomatal closure as a result of their damaging effects (Robinson *et al.* 1998).

Figure 13. : Response of the mean normalised CO_2 assimilation rate (A), stomatal conductance to CO_2 (g_{CO2}), and internal CO_2 concentration (Ci) to a single, one-minute smoke treatment. Lines represent average values for control (solid line) and smoked plants (dotted line). N=5 and vertical bars represent standard deviations. The symbols * and ** indicate significant differences at a 0.05 and a 0.01 level of confidence respectively.



A secondary response to smoke is that the plants acclimate to the smoke treatment and after a few treatments no longer show any significant response in the stomatal conductance or assimilation rate. The crucial factor for this acclimation appeared not to be the temperature of CO_2 concentrations in the smoke. In conclusion this study clearly states the presence of a smoke response in the gas exchange of *C. monilifera*. The light saturated assimilation rate and the stomatal conductance of both CO_2 and water are considerably reduced after a single, one-minute smoke treatment. The effect of smoke on these parameters can have various implications for the gas exchange of *C. monilifera*. The response of transpiration and the transpiration ratio to assimilation is entirely attributable to a reduction in stomatal conductance to water.

Effect of fire on cryptobiont cover and diversity **By: Andrew White**

The soils in natural habitats and environments are teaming with microorganisms and micro-flora and fauna (e.g. bacteria, nematodes). The micro-flora in, and on healthy, natural soils are called cryptobionts and include organisms like mosses, algae and cyanobacteria, liverworts and lichens. Cryptobiont is a broad term used to describe a class of organisms that retain full metabolic activity following complete desiccation and dehydration. This unique characteristic permits these organisms to "preserve" themselves and survive in harsh environments that would otherwise damage their structure. Cryptobionts are important in ecosystems as they help bind the soil and provide safe sites for seed germination.

Cryptobionts do not have an organised vascular system and are therefore in constant threat of dehydration and desiccation. Cryptobionts are found mostly in and on soils that are constantly moist or wet after rains for this reason, they are also very fast growing in order to take advantage of favourable conditions. The aim of the present study was to describe the influence of fire (or burning) on cryptobiont populations growing near different alien and indigenous vegetation types. The study sites varied from being burnt roughly 6 months earlier to those that were burned 5 or 6 years ago. Many different vegetation types within the Grassy Fynbos area were chosen, and at each site the percentage cover of each cryptobiont was recorded in 20 quadrats (10x10cm). Cryptobionts were classed into mosses, lichen, liverworts, and algae. Soil samples were collected from each site for the determination of organic content of the soil. The slope and slope orientation as well as the vegetation type of each site were recorded, but the age/time since the last burn of each site was estimated as accurate information was not available. The diversity of cryptobionts was taken as the total number of different species found at each site divided by the number of sites of the same age (Table 4; see also Figure 14).

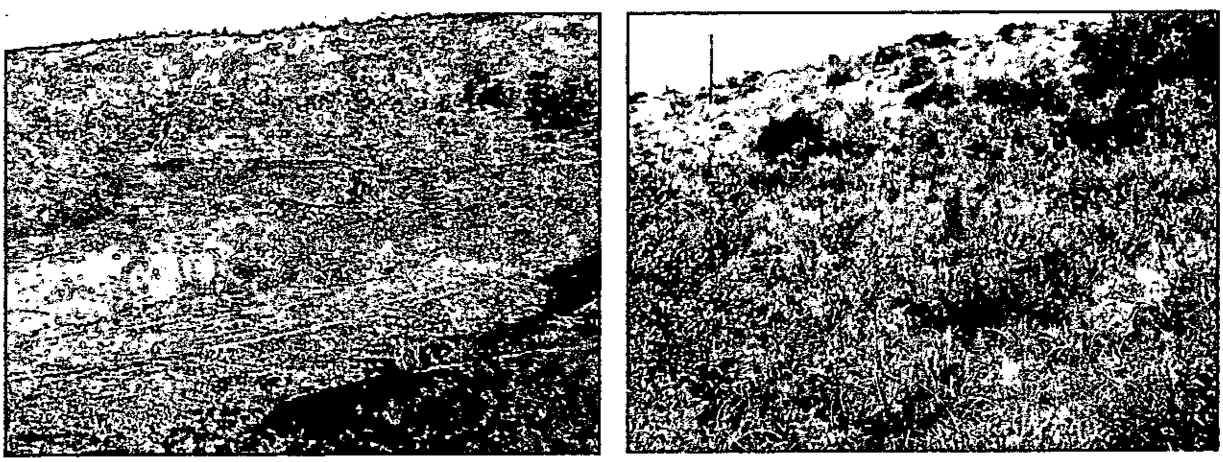


Figure 14. A bare slope after fire (right) and an 'older' *Erica* dominated vegetation (right).

Table 4. Cryptobiont survey results including information on the total cryptobiont cover, burning age, slope and organic matter content (%) sorted by burning age (young to old). At each site the dominant species in the vegetation is recorded.

Site with vegetation type and plot orientation		Age (years)	Slope (degrees)	% Organic matter	Total cover (%)
Bobartia field	N	0	18	4.6	22.9
Hakea thicket	SE	0	8	5.3	4.6
Acacia thicket	SE	½	8	3.9	0.0
Rhus/Chrysanthemoides	top	1	0	10.8	3.3
Cleared *Eucalyptus/Acacia*	S	1	8	5.3	27.0
Burnt *Hakea/ Eucalyptus*	S	1	19	4.8	0.0
Burnt + sprayed *Acacia*	SSE	1	27	7.6	24.2
Bobartia Grassy Fynbos	SE	1½	18	10.2	30.7
Chrysanthemoides field	N	2	21	7.9	16.6
Regenerating *Acacia*	S	2	9	15.9	48.9
Cut *Pinus* in fynbos	SSE	3	15	14.4	13.4
Eragrostis tussocks	N	4	14	10.2	3.9
Grassland	SW	4	11	4.1	23.9
Grassy Fynbos	SW	4	22	10.0	25.5
Bobartia grassland	N	5	22	4.9	5.0
Grassland	SE	5	20	6.7	4.3
Restio fynbos	S	6	11	6.9	13.2
Helichrysuml Erica fynbos	S	6	17	7.8	9.0
Restio veld + fynbos	S	6	30	9.6	5.9
Erica fynbos	SE	6	21	5.7	19.9

The results showed that mainly mosses dominate the total percentage cryptobiont ground cover. After a burn, a lag period was observed before cryptobionts started growing again, this was probably due to the fact that the sites needed to be colonised by the spores of the different species. This lag period was generally followed by an increase in the percentage cover of the concerned species due to the simultaneous germination of the cryptobiont spores after suitable conditions arose (e.g. mist or rain). Due to the lack of vegetation at the newly burnt sites the mosses and other species have enough light and nutrient richer soils to enable them to grow very rapidly, colonising the sites (see Figure 15).

An advantage of cryptobiont vegetation is that they provide suitable germination sites for other plant species. However, when these plant species begin to grow they will compete with the cryptobionts for light, resulting in the observed gradual decrease in the cryptobiont cover as the plant species colonise the area (see Table 4). Some cryptobionts, like the algae found on the north-facing rocky slope are more opportunistic cryptobionts and will grow rapidly again after rains at all sites of different 'burn age'. The south-facing slopes tend to have higher percentage ground cover results; this is due to the moister and cooler conditions experienced on these slopes. The north-facing slopes are generally hotter and drier and are therefore less favourable for cryptobiont growth. There was a strong correlation between the average number of cryptobiont species and the time since the last fire (Figure 15).

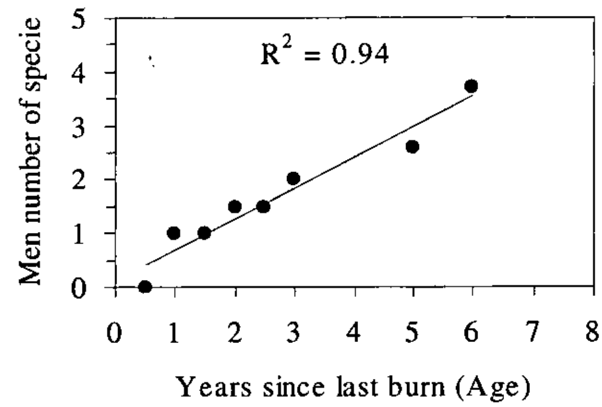


Figure 15. Mean cryptobiont species abundance after different burning periods.

This could be because only a few cryptobiont species are able to tolerate the exposed conditions in the early, post-burn stage while more species are better adapted to the more favourable conditions provided by an increase in vegetation canopy cover. Even though the (pioneer) vegetation may prevent light from getting to the soil level, it also traps moisture close to the soil surface and aids the growth of the cryptobionts. Organisms like the liverworts and algae require a lot of moisture to grow well, while lichens are much better at tolerating drier conditions.

There was no direct relationship between the organic content of the soils and the diversity or percentage cover of the soils by cryptobiont species. The cryptobionts were expected to prefer soils with higher organic content and, due to their short life cycle they would be providing the soil with new organic material all the time. This trend may not have been shown due to the method of soil sample collection. The soil samples were collected in the general area and not from underneath the moss colonies. The cryptobionts would also rely mostly on the inorganic minerals in the soil, as these colonies would not have been on the soils long enough for the organic material from their growth to be broken down into inorganic substances.

Thus, the percentage ground cover was largely dependent on when the site was last burned or cleared of vegetation. This relationship was mostly due to the characteristic vegetation cover (and possibly species) associated with the age of the site. There was no direct relationship between the organic content of the soils and the diversity or percentage cover of the soils by cryptobiont species. However, there was a direct relationship between the time since the last burn and the diversity of cryptobiont species at that site. As the age since a burn increases so the diversity increases.

1.3 RESTORATION OF GRASSY FYNBOS FEATHERSTONE KLOOF: FACTORS OF IMPORTANCE

Featherstone Kloof: keystone species and species list By: Paul Barratt and Kayombo Canisius

The Eastern Cape Province is a combination of overlapping and intergrading plant communities and biomes with high geological and climatic differences (Meyers 1988). Due to this, many 'hot spots' are present in the Eastern Cape. Hot sports are areas that feature exceptional concentrations of species with exceptional levels of endemism that are facing different degrees of threats (Meyers 1988, Meyers *et al.* 2000). The area around Grahamstown is known as the 'Albany Hotspot', particularly known for its great diversity of vegetation types. Unlike other hotspots, the Albany hotspot does not represent an area in the heart of a floristic region, but rather represents a complex transitional mosaic where different floristic regions and their associate vegetation types meet (Phillipson 1995), with an estimated 3 600 vascular plants in the area (Gibbs Russel 1981).

The study site, Featherstone Kloof contains several vegetation types including woodland, bushveld and thicket, grassland, herbaceous swamp and aquatic vegetation (White 1983). The objective of the present study was to collect the species present at Featherstone Kloof and similar sites in order to compare the species to past vegetation recordings. This was to update the 1965 species checklist of Featherstone Kloof, to develop a reference collection in the herbarium and, to complete the plant database of the herbarium. The main focus of this was on the Ericaceae, as this is one of the three characteristic groups of fynbos vegetation. The genus *Erica* was chosen, as it is the largest genus of the Ericaceae family (Low & Rebelo 1996) (Figure 16).

Figure 16. *Erica* dominated vegetation in the Featherstone Kloof area. (Photo: Juan P. Moreiras, FFI/BP)

The results show that the Cape fynbos species are growing at their eastern-most limits in Featherstone Kloof. Two of the other sites where species were collected (Zuurberg and Amatola mountains) had a few species in common with Featherstone Kloof. The Zuurberg and Amatola Mountains are dominated by South African evergreen and semi-evergreen bushland and thicket, which had a major influence on the

Featherstone Kloof vegetation. The Cape shrubland of Humansdorp had a much weaker species association when compared with the species of Featherstone Kloof. To compare similar sites is of importance for the seed collecting of species that need to be restored in the area. Seeds could be collected in those areas for restoration trials at Featherstone Kloof.
It could be concluded that for the genus *Erica* the Featherstone Kloof area was the point of merger between phytochoria. The *Erica* showed the influence of the Cape shrubland. However, of the total of 33 *Erica* species in the study area only 5 (15%) occurred in Featherstone Kloof (Table 5). Humansdorp and Zuurberg overlapped with Featherstone Kloof, whereas there was no overlap in *Eric*a's between Featherstone Kloof and Amatola (Table 5).

It was found, from the plant collections and vegetation studies at Featherstone Kloof that several of the plant species collected were not present on previous Featherstone Kloof checklists. These include the species *Blechnum capense, Gnidia capitata, Lobelia neglecta, Pelargonium capitatum, Polygonum meisnerianum, Senecio madagascariensis* and *Solanum capense*. Literature on the distribution of 36% of the plants occurring in Featherstone Kloof was either not available or not concise enough to be of use (for the complete plant checklist see Appendix I). In total, 37% of the plants occurring at Featherstone Kloof showed a distribution ranging from the Western Cape to the Eastern Cape, 10% showed a very wide distribution, from the Western Cape up into Zimbabwe, and part of the plant species (8%) only occurred in the Eastern Cape. The remaining 9% showed distribution from the Eastern Cape to either the Natal province, the Gauteng province or to Swaziland.

Table 5. Distribution of the species of the genus *Erica* with the species occurring at Featherstone Kloof highlighted.

Sampled area			
Featherstone Kloof	Amatola	Zuurberg	Humansdorp
	E. alopecurus		
	E. brownleeae		
	E. caespitosa		
	E. caffra	*E. caffra*	
	E. caffrorum		
	E. calycina		
E. chamissonis		*E. chamissonis*	*E. chamissonis*
E. cerinthoides		*E. cerinthoides*	*E. cerinthoides*
			E. chloroloma
		E. copiosa	*E. copiosa*
		E. curviflora	
			E. decipiens
E. demissa		*E. demissa*	*E. demissa*
			E. diaphana
	E. frigida		
			E. glandulosa
			E. glumiflora
			E. gracilis
			E. harvieana
			E. humansdorpensis
	E. leucopelta		
	E. maesta		*E. maesta*
			E. nemorosa
		E. pectinifolia	*E. pectinifolia*
			E. sessiflora
E. simulans		*E. simulans*	
			E. sparrmannii
E. sparsa			*E. sparsa*
			E. speciosa
		E. unilateralis	*E. unilateralis*
	E. woodii		

Grassy Fynbos and the importance of bee pollination

By: Admassu Addi Merti

The continued existence, multiplicity and reproductive successes of many plant species partially, or totally depend on honeybee pollination. Plant diversity and ecosystem services would be negatively affected by the absence of honeybees. They serve as pollinators, maintaining natural ecosystems and sustaining human life through pollination of crops, forage plants for domestic animals and wild plants that maintain water catchments, prevent soil erosion, remove greenhouse gases and provide recreation. The destruction of the natural habitat of honeybees may reduce species richness and the abundance of the pollinator population, which will result in the disruption of plant-pollinator interaction, reduction of the seed set and a change in gene flow of the plant population(s). We investigated which plant species are likely to be pollinated by honeybees and the extent to which Grassy Fynbos plants contribute to the nectar and pollen gathered by honeybees. The effect of weather on pollen and nectar collecting activities of honeybees was also studied.

A survey of honeybee-pollinated plants was conducted using direct field observation techniques in order to identify which plant species constituted a major nectar and pollen source. Pollen grains were collected using pollen traps that were fitted at the entrance of beehives and the collected pollen was sorted, weighed and identified at the species level using both light and a scanning electronic microscope.

Nectar was collected from plant species visited by bees, at hourly intervals using micro capillary tubes (10 micron capacity) and the volume of nectar per flower was determined from the column length in the collecting pipettes.

Twenty-four plant species were identified as bee pollinated plants, belonging to families Ericaceae, Asteraceae, Fabaceae, Myrtaceae, Berzeliaceae, Rutaceae, Cyperaceae and Celastraceae as well as the species that were flowering at the time of sampling. These are presented in Table 6.

The plant species identified as bee-pollinated differed considerably in the amount of pollen and nectar they produced and the duration of flowering. The most pollen was collected from *Metalasia muricata*, *Helichrysum odoratissimum*, and *Erica chamissonis*. The marked difference in terms of pollen weight among the plant species was attributed to a number of factors, such as the abundance of floral population, attractiveness of the flower, quantity and quality of floral reward and the nutrient condition in the soil.

The data collected from four nectar producing plant species (*Burchellia bubalina*, *Psychotria capensis*, *Syzygium cordatum* and *Callistemon viminalis*) were analysed to show the relationship between nectar volume, prevailing temperature and relative humidity.

Table 6. Plant species identified as pollen source in the Grassy Fynbos flowering during the sample period, presented with mean pollen weight collected and duration of flowering, sorted on pollen weight (low to high).

Plant species	Pollen weight (g)	Flowering period
Berzelia intermedia	0.6	Dec
Conyza ulmifolia	1.6	Dec
Maytenus acuminata	2.6	Dec
Cyperus spp.	10.1	Dec
Erica demissa	10.2	Sept-Oct
Agathosma ovata	12.9	Sept-Nov
Maytenus heterophylla	14.3	Oct-Nov
Psychotria capensis	16.3	Sept-Oct
Pelargonium zonale	20.5	Oct-Nov
Chrysanthemoides monilifera	22.2	Sept-Nov
Clutia pulchella	24.3	Dec
Agathosma peglerae	31.6	Nov-Dec
Helichrysum cymosa	50. 3	Dec
Eucalyptus camaldulensis	219.8	Sept-Oct
Erica chamissonis	350.9	Sept-Nov
Helichrysum odoratissimum	752.2	Nov-Dec
Metalasia muricata	1114.3	Dec-Jan

The volume of nectar for *Callistemon viminalis* and *Syzygium cordatum* was high from 05 am- 12 am but decreased rapidly towards midnight. This is due to the fact that both plants require cold temperatures to secrete nectar. The pattern of decrease of nectar volume during the day was relatively slow in the more concealed nectar of *Burchellia bubalina* and *Psychotria capensis*.

The nectar volumes vary at different times of the day due to changes in humidity and temperature (Figure 17, see also Figure 20). We discovered that nectar secretion ceases, almost entirely, during the night and is more active in the morning in all studied plant species. This indicates that the plants have adapted for day pollinators, like honeybees.

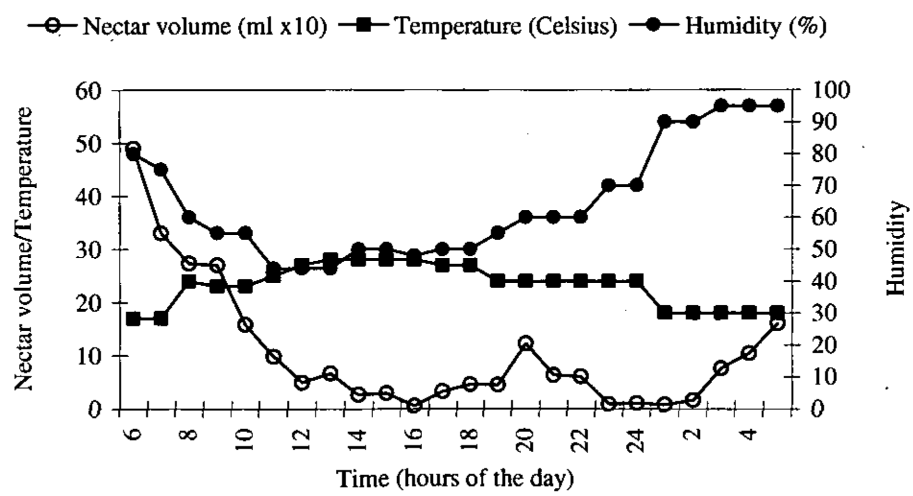


Figure 17. Nectar volume collected from *Brucellia bulbalina* flowers during a summer day at Featherstone Kloof.

It is clear that honeybees are crucial for the continued existence and reproduction of the Grassy Fynbos species through pollination. Honeybees are part of the fynbos, and their products (e.g. honey, beeswax) serve as food for many animals, as well as for man. Local communities could use this knowledge to generate income by establishing beekeeping facilities.

Recruitment of bird-dispersed seeds in Grassy Fynbos By: Elizabeth Muller

Subtropical thickets are composed of dense, woody vegetation, usually small trees and shrubs. Many thicket species are able to invade fynbos and grasslands, forming outcrops of thicket species in an area (Lubke *et al.* 1988). Most thicket species produce edible fruit that many birds feed on. Birds are well known as seed-dispersal agents and numerous studies of this, have been conducted (Bruton 1992). Birds seem to prefer certain perch sites to others after foraging, either different tree/shrub species, or rocks and termite mounds. This project looked at three different bird perch sites situated at various distances from the thicket margin, and identified and counted the number of thicket seedlings found near each perch site. The *Acacia karroo* perches were isolated and were found within the grassland on a gentle slope. They were approximately 1000m from the thicket margin. *A. karroo* is a thorny, spiny tree, which can grow to approximately 15m, and is found in a wide range of altitudes, from coastal shrub to wooded grassland (Coates & Palgrave 1977; Figure 18). The plants produce large amounts of pollen, which many bees use to make honey. Animals eat the leaves, flowers and seedpods. The second perch site is *Tarchonanthus camphoratus*, a tree growing up to approximately 9m high and often found in the fringes of mountain forest. The *T. camphoratus* sites chosen for this study were found along the thicket margin on the steep slope above the first site. The third perch site, a rocky outcrop was located between the *A. karroo* and the *T. camphoratus* sites and was situated approximately 700m from the thicket.

We expected to find a relationship between the distance from the perch site to the seed origin, and a relationship between the distance to seed origin and number of seedlings found under the perch site. A relationship between the perch site and the composition of the bird-dispersed, thicket species found underneath them was expected.

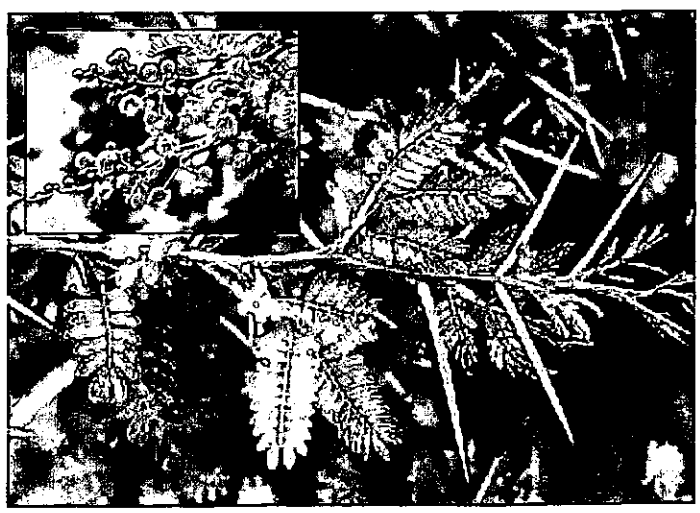


Figure 18. The thorny *Acacia karroo* with the flowers on the inset (Photo: http://www.floraguide.es/arboles/Acacia karroo.htm (main) and http://caliban. mpiz-koeln.mpg.de ~stueber/mavica/ (inset).

It was obvious from the results that the *A. karroos* were the preferred perch sites as they have the greatest maximum density (76 seedlings) and species diversity (8 species) under their canopies. Around the rocky outcrop a maximum of 58 seedlings of six species were observed, whereas under *T. camphoratus* trees a maximum of 32 seedlings of seven species were found (see Figure 19). It was assumed the latter perch sites would have the greatest number of seedlings as they were situated closest to the thicket margin. The island biogeography theory of MacArthur and Wilson (1967) states that the number and diversity of a species will be greater the closer their habitat is to the mainland. However, it can be seen that the perch sites closest to the thicket margin, the 'mainland', do not show the greatest frequency and diversity. It seemed that *T. camphoratus* was of little interest to the birds except for nesting and feeding purposes. The plants were parasitised by *Viscum obscurum*, which has large white fruit eaten by birds (Skead 1997). The perch sites presented in figure 19 are ordered in distance from the thicket (from close to far). It is clear that the species diversity under the perch sites increases with distance to the thicket margin, but only with a few species (Figure 19).

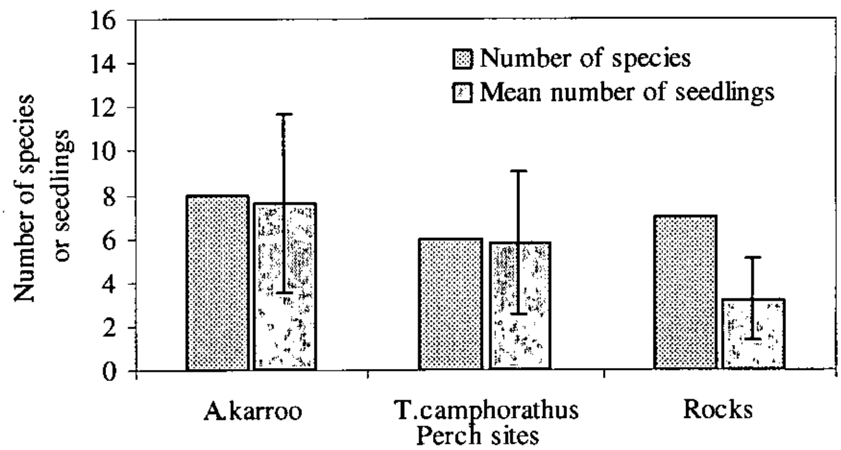


Figure 19. The number of species found under the different perch sites with the mean number of seedlings (± S.E.) per perch site.

The mean seedling density showed the opposite effect, with the furthest perch site showing the highest seedling density, but only when compared to the density of the rocky outcrop was this difference significant. The rocky outcrop seemed to be the least favourite perch site, with the lowest mean seedling density, but the number of species found is similar to the other perch sites. In total seedlings of 10 different species were found at the three sites, four of which occurred at all three sites, three occurring at two sites and three species only occurred at one of the perch sites (Table 7).

Table 7. The number of sites where the different species were found with the mean number of seedlings found, with standard error (over all the sites). Any value with the same letter does not differ significantly in mean number of seedlings found.

Seedling species	Number of sites where species found	Mean number of seedlings	
		Mean	(± S.E.)
Azima tetracantha	1	0.33	(0.58) b
Burchellia bubalina	3	25.33	(6.94) a **
Carissa bispinosa	1	1.00	(1.73) b
Diospyros villosa	3	5.00	(2.08) b
Halleria lucida	2	1.00	(0.71) b
Rapanea melanophloeos	2	6.67	(4.32) ab
Rhus chirindensis	1	5.33	(9.24) ab
Rhus dentata	3	3.00	(1.53) b
Rhus incisa	2	1.67	(1.47) b
Rhus pyroides	3	6.00	(2.08) b

The highest number of seedlings found was from *Burchellia bubalina*. The seedlings were found at all three sites with a mean density of 25.3 seedlings (Table 7 and Figure 20). The remaining species were significantly lower and showed a mean density of 2.6 seedlings (marked 'b' in Table 7).

In conclusion, no relationship was found between the bird perches and the thicket seedling density, and species diversity found underneath them. The thicket species can enter the Grassy Fynbos at a rapid rate, with a mean number of 25 seedlings. During the present study only the seeds that germinated were observed, in other words the potential number could be much higher.

Figure 20. The species from which the most seedlings were found: *Burchellia bubalina* (Photo: http://florawww.eeb.uconn.edu/acc_num/199500174.html).

A study of porcupine damage to the *Watsonia* community By: Gené Guthrie

Field observations in Featherstone Kloof showed a high proportion of damage to the *Watsonia* populations. It is known from literature that concentrated feeding by porcupines can affect the structure of plant communities. Plants have been uprooted and the entire corm (the new growth) eaten, with only the fibrous parts left over. This project was carried out to determine whether porcupines were damaging the *Watsonia* population.

The Cape Porcupine (*Hystrix africaeaustralis*) is widely distributed in southern Africa, but not abundant (Figure 21). The species occurs where there is a food supply and available shelter (De Gaaf 1981). Porcupines inhabit all types of vegetation as long as there is suitable rock or scrub cover (De Gaaf 1981), but they have a preference for vegetation types with hills and rocky outcrops (Smithers 1983). They are mainly vegetarian and consume roots and bulbs, as well as berries, fruit and tree bark (Figure 21). They are wasteful feeders consuming only part of the plants and leaving the rest to decay. They often damage far more than they actually eat (Smithers 1983). Porcupines are nocturnal animals and mainly forage alone or in small parties, and their feeding habits are seldom observed. In undeveloped areas, their normal diet consists of bulbs, corms and roots, mainly of *Gladiolus, Cyperus* and *Watsonia* species. They are known to eat very strange things and are able to cope successfully with the alkaloids and tannins in the bulbs and corms without difficulty (De Villiers & Van Aarde 1994). They have no climbing or jumping ability but are efficient and adept at digging (De Gaaf 1981).

In Featherstone Kloof there are three species of *Watsonia* namely, *Watsonia knysnana* (pale pink to purple flower), *Watsonia pillansii* (orange to orange-red flower), and *Watsonia angusta* (scarlet flower). It was difficult to distinguish between the different species because they were no longer flowering, but judging from the appearance of the leaves and some flower remains, most sampled species were *W. pillansii*, the most dominant of the three species.

Figure 21. Picture of porcupine (left) and exhumed *Watsonia* corms (right) (Porcupine picture from http://www.luddist.com/porc.htm).

The aim of the study was to determine the factors that were relevant to the survival and distribution of *Watsonia* in relation to porcupine predation. There are different factors that could be of influence. For example, plant density, plant cover, and the dominance of surrounding species in the area. The plant density seemed to be the main determining factor – the denser the population, the lower the proportion of dead *Watsonia* in unconnected field observations. This could be because the more successful populations were growing on slopes that were difficult for the porcupines to access, or it could be that the porcupines prefer less dense patches of *Watsonia*. Therefore the hypothesis of the present study is that porcupine-induced mortality of *Watsonia* is proportional to the plant density.

The results showed that the dispersal of *Watsonia* at the four sites was not dependent on porcupines (Figure 22). All the viable parts from the studied plants were eaten, and so those that were transported away from the original site accidentally served no reproductive purpose. The seeds of the plants are distributed via wind from long flower stalks. However, the eating of bulbs by porcupine does stimulate the formation of new bulbs. In Israel, digging for bulbs benefits the germination of seeds through the creation of microhabitats (De Villiers & Van Aarde 1994). This may also be the case for *Watsonia* as there are more dense populations where digging has occurred.

The digging action of porcupines may also stimulate the growth of other species. There were many unidentifiable seedlings growing in those patches disturbed by porcupines. The porcupines aerate the soil by digging and they disperse seeds of nearby species by shaking or rustling the plants while digging. Vegetation studied around the *Watsonia* populations indicates that the dominant fynbos species in each area have little to do with the density of *Watsonia*, or with the success (survival) of *Watsonia*. The higher the percentage cover of dominant species, the lower is the number of *Watsonia* found i.e. less cover will show more *Watsonia*. (This can be related to the fact that where the most diggings have occurred, the most disturbance has occurred and hence, the most dispersal of seeds). But this was not specific as to whether the *Watsonia* was living or dead, and so it cannot be used as a factor.
The number of dead *Watsonia* is not related to the number of living *Watsonia*. However, the total numbers are related to the number of living *Watsonia*. The higher the total number, the higher is the number of living specimens.

It was found, in a previous study of porcupine damage to vegetation that there was significantly more disturbance by porcupines when the predated species was dominant (De Villiers & Van Aarde 1994). The *Watsonia*'s were not dominant in this study and hence no such effect could be detected, however denser patches of *Watsonia* were found to have less damage done to them. This could be attributed to many factors. The most obvious would be that *Watsonia* grows best in rockier areas where the porcupines cannot easily uproot them or dig them out. This would result in the rocky areas having more successful populations of *Watsonia*. This does not necessarily mean that the porcupines cannot dig them up in rocky patches: evidence suggests otherwise. There were many uprooted specimens but because they also grew better on the rocky slope, a smaller proportion was damaged.

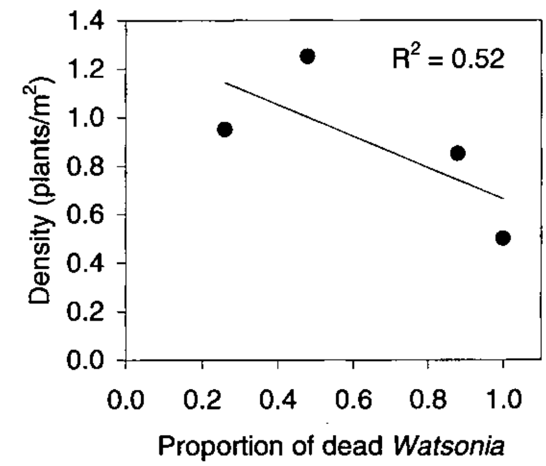


Figure 22. The relationship between the density (number of plants per m^2) and the proportion of dead *Watsonia* plants, with the correlation coefficient (R^2).

Perhaps porcupines prefer to feed off single or sparsely distributed plants. This could be because they feed alone or in small groups. Denser patches may be healthier (perhaps the growing conditions, or the lack of other predators) and therefore may regenerate from tiny remains after porcupine feeding. Whatever the reason, denser patches of *Watsonia* are less damaged from porcupines and as a result they are healthier specimens, with much stronger leaves and flower stalks. The results of the present study indicate that porcupines affect their habitat by selectively feeding on particular species and influence the substrate in which the plants are rooted.

A survey of the soil seed bank By: Alison Cook and Irma Knevel

The majority of reseeder species in fynbos have soil-stored seeds in the soil seed bank, although canopy storage (serotiny) is common among overstory dominants like Protea (Holmes & Cowling 1997). Regeneration from the soil seed bank is the most prominent mode among annuals and short-lived herbs and shrubs (Holmes and Richardson 1999). Studies of species' life span predicted that many reseeder fynbos species should have long-term persistent seed banks in the soil in order to avoid local extinction, since their life span is shorter than the average fire cycles (Van Wilgen and Forsyth 1992). Thus, the accumulation of viable seed reserves in the soil provides a mechanism for surviving disturbance and a buffer against annual variation in seed set (Thompson *et al.* 1997).

This prediction has been confirmed by the fact that under dense alien stands, in which indigenous seed input was halted, fynbos seeds were found in the seed bank (Holmes and Cowling 1997). However, individual species' seed banks tend to be small in fynbos (Musil 1991, Pierce and Cowling 1991) compared to those of European heathland species (Malik *et al.* 1984; see Figure 23).

The extent of the seed bank accumulation reflects the balance between seed inputs and seed losses through germination, decay and predation, however little information on soil seed banks in fynbos is available.

Figure 23. *Hebenstretia* and *Acacia* seedlings emerging from the soil seed bank after a fire.

At Featherstone Kloof five sites were sampled in a recently burnt patch of Grassy Fynbos and a control (not burnt for >1 year), 5 replicates were sampled at each. 200 ml soil was sampled with a 15 cm high cylinder at the different sites. The soil was spread out onto sand in the greenhouse and checked for moisture and germination every 3-4 days (Figure 24). The experiment was terminated after nine months and the species identified.

The seed bank for Grassy Fynbos tends to be small, as found by Musil (1991) and Pierce and Cowling (1991). Six species were found in the burnt site and seven species in the pristine site, these showed a 44% overlap in the species found (Table 7).

Table 7. Species richness and similarity for the burnt and pristine Grassy Fynbos soil seed bank.

Site	# Species (/200ml soil)
Recently burnt fynbos	6
Control	7
Species similarity	44%

Seeds were found in 49% of the samples. Seed of *Gamocheata* spp. was found in most of the sites with a mean of 6 seeds/200ml soil for the pristine site and 1 seed/200ml soil for the burnt site (Table 8). Hypoxis and Centella were found at more than 10% of the samples, but other species were only found on occasion (<10%; Table 8).

Table 8. The percentage of sites where seeds of each species were found with the mean number of seeds found per site.

Species	% Sites seed found	Mean # seeds (/200 ml soil)	
		Burnt	Control
Gamocheata	26	1.0	6.0
Acacia	7	1.0	2.6
Hypoxis	13	1.3	1.0
Isolepis	2	0	2.0
Eragrostis	2	0	1.0
Centella	11	1.5	1.0
Restio	2	1.0	0

The soil was not checked for ungerminated seeds; hence the mean number of seed per sample could be an underestimation as some ungerminated seeds could have been dormant. Cues for germination of fynbos seeds in the soil are complex and varied. They include the direct stimulation of germination by fire through seed exposure to heat and gasses such as ethylene and ammonia (Van de Venter and Esterhuizen 1988) released during fires (Russel *et al.* 1974). The second stimulation by fire is indirect; through soil mineral enrichment by burnt plant residues, seed contact with charcoal, increased diurnal soil temperature amplitude fluctuations in exposed burnt sides (Brits 1986, 1987). The right conditions might not have been met for some species and thus they did not germinate.

The seed bank of Grassy Fynbos seemed to be small, with few species and seeds per species present. This might be because the seed bank of Grassy Fynbos is transient, instead of persistent as was expected, but this is unlikely as the seeds of, for instance *Aspalathus* are known to be persistent (Jacot Guillarmod 1983). A more likely reason is the recent and frequent fires at Featherstone Kloof. The fires last year followed shortly after each other. The time in-between the fires was too short to produce seeds, hence no new seeds were stored in the seed bank (Jacot Guillarmod 1983). The seed bank could have been depleted after the first fire due to the germination of the seeds that were killed by the next fire. The time for seed bank accumulation for the control might have also been too short, as many plants need time (years) to reach maturity.

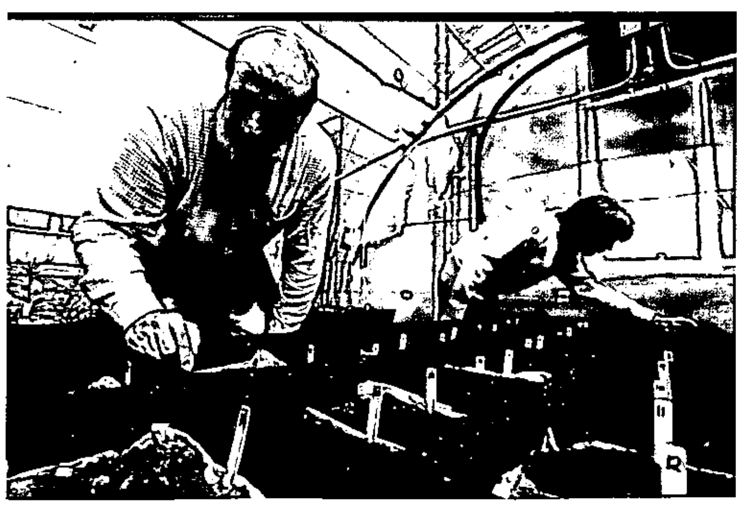


Figure 24. Checking the seed bank tray in the greenhouse (Prof Roy Lubke (left) and Paul Barratt (right)). (Photo: Juan P. Moreiras, FFI/BP)

A mycorrhizal survey of indigenous plant species in Featherstone Kloof By: Amy Skinner

Mycorrhizal symbioses are characterised by bi-directional movement of nutrients where carbon flows to the fungus and inorganic nutrients flow to the plant, thereby providing a critical link between plant root and soil (Smith & Read 1997). There are different categories of Mycorrhiza namely, ecto-mycorrhizal fungi (ECM fungi), arbuscular mycorrhizal fungi (AM fungi) and the specialised Mycorrhizal fungi forming a symbiosis with certain hosts, like the Ericaceae.

Mycorrhizae, on most plants are as much a natural component of roots as chloroplasts are components of the leaf. It is generally accepted that 90% of the terrestrial plant species form some kind of association with fungi in the root zone, however the mycorrhizal status in many species, is not known (Pfleger & Linderman 1996). The importance of mycorrhizal fungi in both managed and natural ecosystems has been well documented. The mycorrhizal benefits to plants include enhanced nutrient uptake, antagonism towards parasitic organisms and improved growth under adverse conditions (Berliner *et al.* 1989, Haselwandter & Bowen 1996, Staker 1996). Any shift in the mycorrhizal population could have great consequences for the composition of plant communities through factors such as survivorship and competition (Miller & Allen 1992). This can also work the other way around, where changes in plant communities have an effect on the mycorrhizae community. It is, therefore of vital importance that the mycorrhizal status of plant species used for restoration purposes is known (Allen 1991). Mycorrhizae fungi might play a role in the reestablishment of Grassy Fynbos species, such as *Erica* spp. (Dames *et al.* 1999; Figure 25).

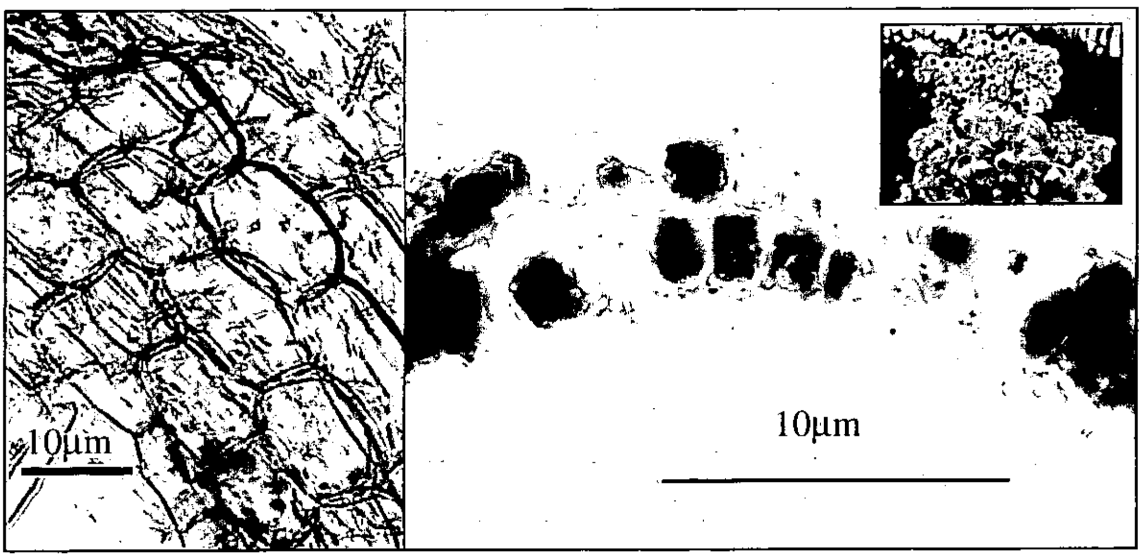


Figure 25. A mycorrhizal free root (left) and an 'infected' root of *Eric chamissonis* with fungal hyphae (dark substance) in cortical cells of the root.

Fynbos generally has a very poor soil and a diversity of nutrient-acquisition systems helps to constitute the fynbos flora (Allsopp & Stock 1993). Many fynbos species have associations with the non-host specific AM fungi. Since AM fungi are general, the invading alien plants also benefit from these mycorrhizae (Koske *et al.* 1992), but many introduced plants cannot cope with the nutrient poor soils and the AM fungi might not sufficiently benefit the aliens. The purpose of this study was to establish the mycorrhizal status of selected Grassy Fynbos species to facilitate their use in restoration projects. Of the 33 species examined, only two showed no Mycorrhiza in the roots, but most species showed associations with AM fungi (Table 9).

Table 9. Mycorrhiza associated with the various plant species examined, presented with the genus and the life form of each species.

Genus and species	Mycorrhiza association	Genus and species	Mycorrhiza association
ANACARDIACEAE		RUBIACEAE	
Rhus rigida	AM	*Canthium mundianum*	AM
ASTERACEAE		RUTACEAE	
Berkheya decurrens	AM	*Zanthoxylum capense*	AM
Arctotheca calendula	AM	*Agathosma ovata*	AM
Helichrysum anomalum	AM	EUPHORBIACEAE	
Chrysanthemoides monilifera	AM	*Euphorbia bupleurifolia*	AM
Oldenburgia arbuscula	AM	*Euphorbia epicyparissias*	AM
Metalasia muricata	AM	FABACEAE	
Tarchonanthus camphoratus	AM	*Psoralea pinnata*	AM
Arctotis spec.	AM	ERICACEAE	
Haplocarpha lyrata	AM	*Erica cerinthoides*	Ericoid
Arctotheca calendula	AM	*Erica chamissonis*	Ericoid
Brachylaena ilicifolia	AM	ORCHIDACEAE	
GERANIACEAE		*Habenaria arenaria*	Orchid ?
Pelargonium caffrum	AM	*Satyrium membranaceum*	Orchid ?
IRIDACEAE		PROTEACEAE	
Bobartia indica	AM	*Protea tenax*	none
SCROPHULARIACEAE		MESEMBRYANTHEMACEAE	
Sutera campanulata	AM	*Bergeranthus multiceps*	none
Halleria lucida	AM		
POACEAE			
Tristachya leucothrix	AM		
Eragrostis capensis	AM		
Festuca costata	AM		

Seedlings of many of the species in table 9 need the association with mycorrhizal fungi during establishment to provide the seedling with nutrients (Smith & Read 1977, Allsop & Stock 1992), especially those species that produce small seeds with hardly any food reserves like, *Metalasia muricata* and *Erica chamissonis* (see Table 9). The latter species is an important endemic of the Grahamstown area and an important species in the Grassy Fynbos of Featherstone Kloof. The *Erica* plants and seedlings will not grow without the ericoid mycorrhizas present in the roots (Figure 25; see also Staker 1996). This is important information for the reestablishment of this species and for its use in restoration projects in Featherstone Kloof.

In conclusion, mycorrhizal fungi do play an important role in the reestablishment of Grassy Fynbos species, and hence are needed when restoring the site.
The next step now is to isolate and propagate the mycorrhizal fungi associated with the plant species that will be used for restoration of the study site, or reestablishment of the species. This will be done by growing the seedlings under controlled conditions, in mycorrhizal inoculate soil to form the root-Mycorrhiza association. The seedlings will be planted in the field together with the inoculated soil to improve survival in the field.

Restoration pilot study: Plant emergence and establishment By: Jamie Pote
The extensive time period of infestation together with frequent high intensity fires, as described by Martin (1965 and 1966) and Richardson (1984) has impacted heavily on the natural vegetation occurring in these areas. The Present removal strategy, involving a slash and burn technique by the Albany Working for Water Programme (WFW), has been committed to the removal of these trees as part of a catchment area clearing exercise. The clearing technique used however, has numerous consequences. Although studies of the impacts of burning on soil have shown few negative impacts (Cass *et al.* 1984), the extent of time that infestation has occurred together with the post-clearing burn have serious impacts on indigenous seed banks. In addition, the post-clearing burn intended to reduce the exotic species seed bank, acts instead as a stimulant for germination of exotic species such as, *Acacia longifolia* and *Acacia mearnsii* (Personal observation). The dense seed bank that remains is quick to reassert itself as a thick stand of alien seedlings, especially if followed by favourable climatic conditions (Figure 26). The current solution to this problem is to use commercial herbicides such as Garlon 4 (J. Pryor, Pers. Comm.). These are sprayed liberally onto stands of seedlings, to eradicate them. However, any other indigenous flora will probably also be eradicated in the process. This will ultimately prolong the rehabilitation process. An alternative to repeated spraying is the use of a cover crop to compete with, and shade out invasive seedlings (Holmes and Richardson 1999). WFW is carrying out experiments with *Eragrostis tef* as a cover crop at present (Figure 26). This commercial, agricultural grass is fast growing under the nitrogen-enriched conditions, is easily obtainable in sufficient quantities and has a high, rapid germination rate.

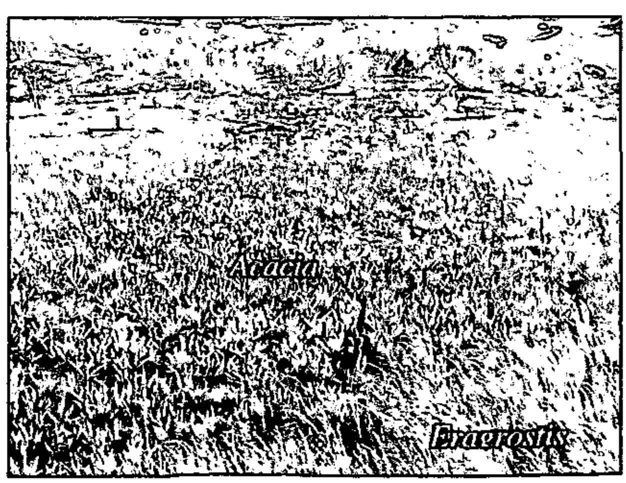


Figure 26. A recently burned field where *Eragrostis tef* was used as a cover crop to prevent mass germination of *Acacia longifolia*.

However, it is a hybridised, non-indigenous species, that will die back after one year of growth.
It has been noted that rehabilitation trials often have a 'hit and miss' approach where seeds are often sown/planted at unknown or vaguely estimated densities, with very little quantitative data being collected. Alternatively, it has been proposed that indigenous pioneer species may be more appropriate as a cover crop species. Three species of perennial Asteraceous herbs, *Senecio pterophorus, Senecio chrysocoma* and *Helichrysum cymosum* were selected because they were noted to be pioneers in degraded areas (Figure 27).

Figure 27. The plant species *Senecio chrysocoma* (left) and *Helichrysum cymosum* (Photo Juan P. Moreiras, FFI/BP) were selected for the pilot restoration experiment.

A number of characteristics need to be determined in order to assess these species objectively. Information such as seed germination rates, seedling growth and survival rates and the usefulness of smoke treatment are important considerations for implementing successful restoration efforts. Quantitative data will allow correct seed application rates and sowing treatments to be applied in order to maximise success rates. Smoke treatment of seed in the Western Cape has been shown to enhance germination rates of many species, but little information is available for local species. Smoke dilution rates are also hit and miss, and not based on quantitative experimental data (see also Section 1.2). Techniques useful for undertaking trials could also be developed, which can then be applied to other species. Greenhouse germination trials provide a comparative indication of which of the above indigenous, perennial herbs may be most suitable as a cover crop. This study was extended to field trials, but these proved to be unsuccessful due to bad seasonal timing and time constraints.

It is also important to identify the regeneration of fynbos species in the field, as these will ultimately have to be reintroduced as part of the rehabilitation effort. Plants have been found to have different mechanisms enabling them to cope with fire (Bond & Van Wilgen 1996). Species that are able to rapidly regenerate after fire are a good choice for a rehabilitation programme in an area that is fire prone. In the initial stages of rehabilitation after the removal of exotics, a seed bank exists which can lie dormant for many years. These seeds will be able to rapidly recolonise an area if a fire occurs. Thus it is important when selecting species for rehabilitation, that short term cover crop species and longer term, persistent species be incorporated. The objective of this study was to establish how the species regenerate, to find out which species could be used as a cover crop and how this could be assessed.

The study site was a recently burnt area (Late summer, January 2001) of Grassy Fynbos bordering on a forest margin on a south-facing mountain slope in Featherstone Kloof (Figure 28).

Figure 28. Regrowth of Grassy Fynbos at the study site at Featherstone Kloof after a fire.

Two transect lines of 30 meters were laid out and individual species were identified within 2x2 m quadrats within each transect, when possible and fire response noted (seeders, resprouters, geophytes or woody stems). Density, cover and average height were also noted. Six quadrats were laid out randomly per line. Soil samples were collected and sent to Cape Town for analysis.

Several quadrats (40 to 50 x 1m^2) were sampled in monostands of *Acacia longifolia, Senecio chrysocoma, S. pterophorus* and *Helichrysum cymosum* to determine the natural seedling emergence from the seed bank. Plant height, cover and density were also measured.

Seedling survival after germination experiments was also tested by planting the germinated seed from the experiment of Section 2.1 in seed trays filled with potting soil and sand. They were assessed after 3 months growth to compare their survival and growth abilities using a visual assessment.

Data from the transect indicated that 66% of the species regenerating were resprouters, 21% geophytes and 13% seeders. Resprouters included grasses such as *Festuca* and *Eragrostis curvula*, herbs including *Berkheya decurrens, Berkheya cardioides, Helichrysum* spp. and shrubs such as *Psoralea spicata* and

Anthospermum aethiopicum. Geophytes included *Hypoxis* spp., *Pelargonium* sp., *Clutia heterophylla* and *Bobartia macrocarpa*. There were few seeders, mainly small plants such as *Alloteropsis semialata, Senecio chrysocoma, Gerbera ambigua* and *Aster* sp. Species in the burnt area showed a very staggered flowering cycle with species such as *Hypoxis* spp. and *Pelargonium caffrum* flowering shortly after burning and others such as *Dierama pendulum* flowering only ten months after the fire. The results clearly suggest that recovery after a late summer burn is dependent on resprouters and geophytes rather than seeders (see also Richardson *et al.* 1984). This might be due to the fact that the seeds in the topsoil did not survive the fire or that seeders play a role during later successional stages.
From Table 10 it is clear that *Acacia longifolia* seedlings grow at very high densities with often a 100% cover compared to the indigenous species (Table 10). This is solely the result of the dense and persistent soil seed bank the species forms. The seedlings of *S. pterophorus* and *S. chrysocoma* showed much lower densities and showed a low cover (Table 10; see Figure 29). Although *H. cymosum* grows at very low densities, it tended to have a high percentage cover (Table 10). All species were about the same height during the measurements.

Table 10. Mean density, cover and height measurements with the standard deviation of selected pioneer species and *Acacia longifolia.*

Species	Density (per m^2)	Cover (in %)	Height (in mm)
A. longifolia	844.0 ± 63.76	100.0	
S. pterophorus	11.8 ± 0.74	15.8 ± 0.81	487.4 ± 10.03
S. chrysocoma	15.2 ± 0.87	17.6 ± 0.75	512.0 ± 8.56
H. cymosum	4.6 ± 0.16	48.0 ± 1.51	439.7 ± 5.15

The survival of seedlings in the greenhouse showed that seedlings of *S. pterophorus* showed the best growth and survival, followed by *S. chrysocoma* and with the poorest performance by *H. cymosum* (Figure 29). The seeds of *S. pterophorus* showed the lowest germination (see Section 2.1), but the seedlings showed the best survival under controlled conditions.

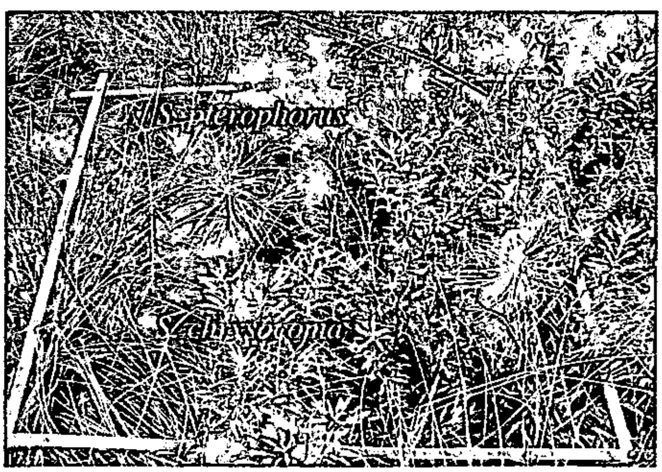


Figure 29. Plot with *S. chrysocoma* and *S. pterophorus* seedlings.

The data of the soil analysis showed that the soil is mostly sandy with little clay and silt (Table 11). The soils show an acidic pH (4.4) with highest amounts found for Calcium (Ca), Magnesium (Mg), Potassium (K) and Iron (Fe) (Table 11).

Table 11. Soil analysis mean values (± standard deviation) of the study site (n = 7).

Soil parameter	Mean	(± SD)	Soil parameter	Mean	(± SD)
Fe (mg/kg)	107.3	(15.29)	% Ca	41.4	(3.84)
P (mg/kg)	2.6	(0.57)	% Mg	19.7	(1.36)
Ca (mg/kg)	549.1	(77.57)	% K	4.4	(0.63)
Mg (mg/kg)	157.1	(19.36)	% N	0.2	(0.02)
K (mg/kg)	108.0	(16.72)			
Mn (mg/kg)	4.7	(1.03)	% Coarse Sand	23.1	(3.02)
Zn (mg/kg)	0.4	(0.11)	% Medium Sand	18.0	(2.37)
C (g/kg)	21.4	(2.12)	% Fine Sand	54.3	(4.12)
			% Silt	4.6	(0.65)
pH	4.4	(0.08)	% Clay	0.3	(0.07)

The present study showed that Grassy Fynbos regenerates primarily from resprouters and geophytes. Seeders seem to be unimportant in initial recovery of Grassy Fynbos and are mostly found in slow-growing climax species such as *Erica chamissonis*. This demonstrates that recolonisation of Grassy Fynbos communities will be very slow if left to occur via natural succession, because of low seed production. Species will have to be reintroduced into burnt areas as young plants, which will need to be generated artificially from cuttings or greenhouse germinated seeds.

Evidence supports the fact that light is important for certain pioneer species and that under such conditions, smoke treatment will not greatly improve germination in the screened species. A 1:1250 dilution of 'Firegro' solution may however be useful in stimulating germination for *Senecio pterophorus,* although a 10% improvement of germination may not necessarily warrant its use. It is also apparent that a bimodal dormancy period may be present in these seeds, in which case a second germination event may occur. This was, however not tested. The initial germination will be of primary importance for competition between the cover crop species and the invasive species. It is evident that *Senecio pterophorus*, although having a low germination rate has the growth and survival ability that will be necessary for an effective cover crop, allowing it to compete with fast-growing *Acacia longifolia* seedlings. Seed must be sown at sufficient densities to allow for a 45-65 percent initial germination to provide the final density required to act as a successful competitive cover crop. Assuming that *Senecio pterophorus* has an initial germination rate of 50%, an application rate of 120 seeds per square meter will be required to achieve germination of 60 plants per square meter. It will be easier to calculate the application rate for large-scale application, in terms of seed heads rather than individual seeds. The mass of the correct number of seed heads can thus be calculated, which should, on average contain the number of seeds required. Seed heads of *Senecio pterophorus* were calculated to contain an average of 70 seeds per head. Therefore, an application of 17000 seed heads per hectare is required. Assuming that *Senecio chrysocoma* has an initial germination rate of 50%, an application rate of 120 seeds per square meter will also be required to achieve germination of 60 plants per square meter. However, *Senecio chrysocoma* seed heads were calculated to contain an average of 200 seeds, thus only 6000 seeds per hectare need be applied. However, seed viability tests are necessary to support this. If a third of the seed is required for *Senecio chrysocoma* then a higher application rate may achieve the same end result, but with less seed required (see Figure 30).

The delayed germination in these species is an indication that a fast germinating grass species such as *Eragrostis tef*, which attained 98% germination in three days, will be required to enhance the prevention of alien regrowth. Further experiments using this and some indigenous grasses (such as *Eragrostis curvula*) will be required to verify this. Timing of planting or sowing will be crucial. Seed must be sown early enough to allow the cover crop to become established **before** the invasive species because of the slow, initial germination rate.

The nature of Grassy Fynbos species suggests that unassisted reestablishment in degraded areas will be very slow, with a continued high risk of the reestablishment of exotic species. To ensure that success is achieved, manual reintroduction of key species will be necessary. Techniques to do this do not necessarily require introducing Grassy Fynbos into the entire area, as long as patches of geophytic and resprouting species are established. These will be able to spread as long as a suitable cover crop has been established to confine exotic regrowth.

The experimental data and observations indicate that *Senecio pterophorus* is most likely to be the best species for use as a cover crop. However because *Senecio chrysocoma* produces more seed per head, it may be economically more suitable than *Senecio pterophorus.* Planting will have to take place immediately after burning or spraying, and a combination of fast-growing grasses and *S. pterophorus* and/or *S. chrysocoma* may be required to provide fast, competitive initial growth and a persistent, perennial cover crop that will out-compete alien species. Their biannual nature further increases their usefulness as a longer-term defence against invasion of exotic species. Timing of burning is crucial in order to allow the seed to be planted when rainfall is sufficient to support growth. Highly variable soil conditions could also be a factor to be considered when selecting species, however much more data will be required before predictions regarding this can be made. It also seems that if fire plays a role in nutrient recycling, then a post clearing burn should be performed.

A possible rehabilitation procedure could be as follows:

1. Cut exotic species.
2. Remove large stems and branches that will not burn completely.
3. Burn brushwood to kill immature seedlings and seeds in the seed bank, which will stimulate the germination of the left–over seeds in the seed bank.
4. Allow an initial germination of exotic species for a few weeks.
5. Apply an herbicide to eradicate them; because indigenous species have a delayed germination this could be performed before they emerge from the soil.
6. Apply cover crop, as discussed above, after herbicide has been degraded.
7. Introduce Grassy Fynbos species as rooted cuttings in island patches.

It is clear that while much research could still be performed, much of it can be incorporated into the rehabilitation programme, through monitored large-scale field trials. It is also clear that although assessments such as the one performed in the present study are essential for preliminary species selection, field trials will ultimately determine what is appropriate for on-site rehabilitation.

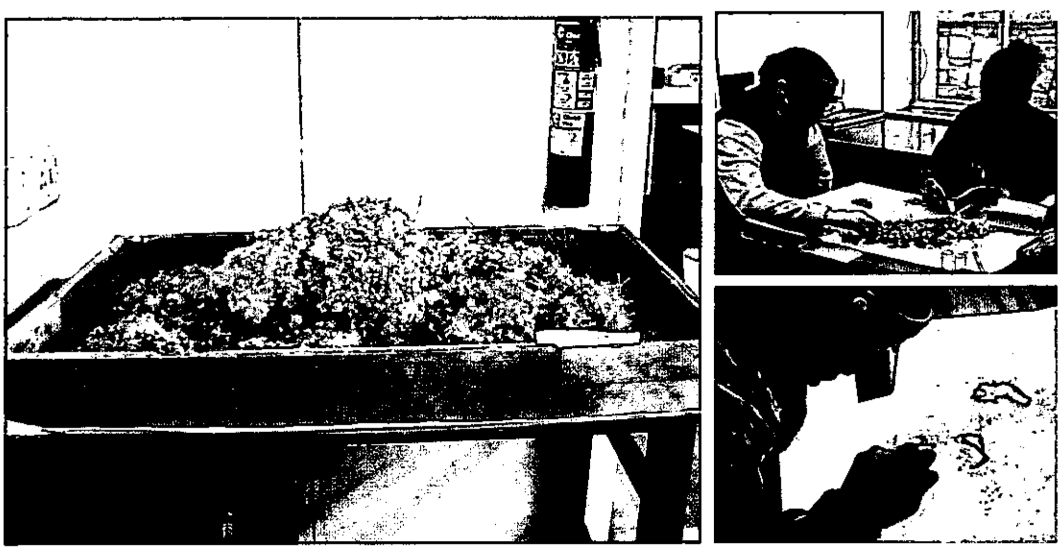
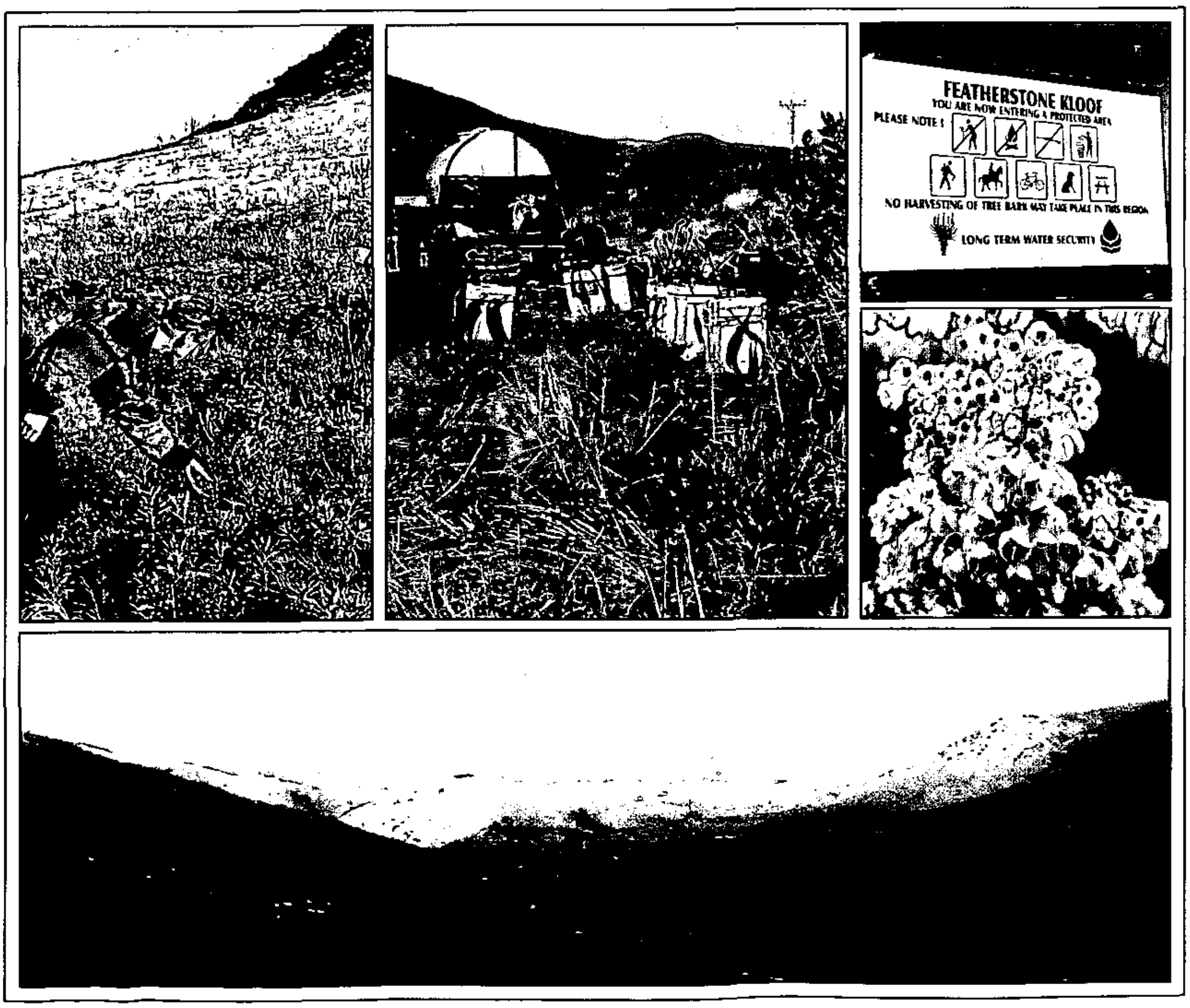


Figure 30. Seed drying, sorting and counting for restoration purposes.

PART II

ENVIRONMENTAL GOODS AND SEVICES AND MANAGEMENT STUDIES



The management part of the Refyn project investigated the various ecosystem goods and services flowing from Featherstone Kloof. These included: Water, biodiversity, vegetation change, medicinal plants, recreation and the educational value as goods and services. Another major focus of the research was the past and present institutional and organisational dynamics and the management strategies both past and present, which had been applied to Featherstone Kloof. This is to enable us to achieve the aims of the project, which are; to investigate the natural restoration of the site and the success of current restoration techniques, as well as to develop a baseline study, a management plan and implementation strategy by forming a network of local expertise through a participatory consultation process.

2.1 ECOSYSTEM GOODS AND SERVICES OF FEATHERSTONE KLOOF

This part of the management project focuses on the ecosystem and investigates the following goods and services:

1. Water, focusing on water yield in the Kowie river, by assessing soil moisture in the upper catchment as an indication of catchment contribution to water runoff, as well as ascertaining the water quality of the Kowie River.
2. The level of biodiversity (with regard to species diversity) of the area.
3. The use and relative abundance of selected medicinal plants.
4. The recreational and educational value of Featherstone Kloof was also investigated.

The Featherstone Kloof catchment provides for the headwaters of the Kowie River. At its source, the area of study, there is a wetland that has suffered from the invasion of alien vegetation. Since February 1997, Albany Working for Water in a joint venture with Grahamstown Municipality began clearing these dense stands of aliens (mostly *Acacia longifolia, Acacia mearnsii and Eucalyptus saligna*), which have plagued the area at the expense of indigenous grassy fynbos. It has been an ongoing project with a need for continual respraying and removal due to the highly resilient and aggressive nature of these exotics (A.WFW, 2000).

The riparian zone of rivers represents an important habitat for many vulnerable species. The wetland in the upper reaches of the Featherstone Kloof catchment is home to a number of endemic fauna and flora species in addition to providing important chemical, biological and hydrological services. (Begg, 1986; Illgner, 2001).

By making a study of the variability in soil moisture along a number of transects in the upper catchment, one can show how the interplay of variables such as aspect, degree of degradation, infestation and so on, affect moisture. This in turn can be extrapolated to predict the effects on hydrological functioning within the wetland and river channel. Both wetland and river provide an important ecosystem service to farmers (Dunne and Leopold, 1978).

Soil moisture is also of critical importance to man because it is from this meagre supply that we depend on our food. Water in the root zone of plants constitutes only 0.064% of the 39 million cubic meters of fresh water in the world and yet the physiological stresses placed upon plants during times of low soil moisture, form one of the major determinants to plant and animal distributions around the world (Miller, 2000). By being able to speculate where soil moisture is likely to be highest, this will benefit restoration ecologists who aim to restore Grassy Fynbos to this area.

The quality of water exported from this ecosystem is important to farmers downstream who use water from the catchment to irrigate their crops and to the growing communities of Bathurst and Port Alfred who extract the water for mostly domestic purposes. By testing water from specific sites within the Featherstone Kloof catchment, one will be able to determine whether or not the clearing and treating techniques employed by Working for Water (WFW) such as spraying of pesticides is having an impact on the quality of water.

In developing countries (and Africa specifically) a large proportion of the population rely on traditional medicine. This is because modern medicine is costly and often not accepted. This is often accompanied by a lack of capacity or training to correctly administer western medicine (Mbewe, 1999). For these reasons amongst others, traditional medicines have remained popular (and often the only option) for treating those in poor health.

However, with the high population growth typical of most African countries, the natural resources from which these medicines are extracted are coming increasingly under threat (Mander, 1998). From previous botanical surveys in the area, it is believed that Featherstone Kloof contains certain of these "useful" medicinal plants. By quantifying the abundance of some of the more popular medicinal plants one can assess Featherstone Kloof in terms of the medicinal service it currently provides (or has the potential to provide) to the greater Grahamstown community.

Featherstone Kloof has a potentially high education value. For scholars engaged in the natural sciences such as biology or geography, Featherstone Kloof is a living laboratory for the processes one learns about in textbooks. For example, the physical and hydrological processes which take place within a catchment or the storage and purification function of wetlands. With so much attention currently being paid to the area (such as WFW clearing and the BP restoration programme) there is also a need for research projects in the area.

Although many other goods and services are present, including nutrient and carbon cycling, the above were chosen because they were thought to be the most pertinent to the particular study being conducted and of particular interest to the stakeholders and other parties involved.

Water quality

To assess the integrity of the uppermost catchment in terms of moisture retention of the headwaters of the Kowie River, the following measurements were taken:

i) *Soil moisture* - Measurement of the extent to which topography aspect affects soil moisture in the upper Featherstone Kloof catchment;

ii) *Water quantity* - Assessment of the effect of alien infestation on moisture distribution in the area, as well as the impact of clearing techniques (such as burning) employed by Working for Water, on moisture retention.

iii) *Water quality* – Assessing water quality of the Kowie River at specific sites within the Featherstone Kloof catchment. This will give a good indication as to whether the restoration activities in the area (such as pesticide used by WFW) are having an impact on the quality of the headwater.

The results of this research are provided below.

(i) Soil moisture

<u>Methods</u>

Three surveys were undertaken in order to determine this variable. In the first survey, two vertical transects in the upper catchment were selected: one on a north- and the other on a south-facing slope. These were selected on the basis of a similar slope profile. *A. longifolia* had invaded pockets on the north-facing slope and there was also evidence of burning. In the second survey, two adjacent transects were selected on the south-facing slope (which removed the effect of aspect and different topography), but where one transect had alien regrowth along its length and the other ran along an indigenous forest pocket. The removal of the confounding variables mentioned above, allows for a direct comparison between slopes invaded by aliens and those that support natural vegetation. A repetition of the second survey was carried out on the north-facing slope such that the effect of aspect could be brought into consideration.

The soil moisture was recorded though an electronic sensor, the thetaprobe, which measures volumetric soil moisture content and works on a basis of responding to changes in the apparent dielectric constant. The volumetric soil moisture content, (a dimensionless parameter) is the ratio between the volume of water present and the total volume of the sample.

The soil moisture was found to be highly variable at the surface, even within a small sample area. Four readings were taken along the transect and were used to determine an average value. The standard deviation was then calculated, and represents a better measure for comparing soil moisture between different slopes and transects.

<u>Results</u>

A number of interesting results were found in testing the soil moisture of both the south- and north-facing slopes of Featherstone Kloof. For example, there is certainly a negative correlation between surface moisture volume and alien infestation. In the south-facing slope where there had been alien regrowth after clearance, the average moisture content in the surface soil was approximately half that of the area where indigenous vegetation remained intact. However, there was a high degree of variability between sampling points in both vegetation types. The north-facing slope showed a similar trend to the south, in that average moisture content was higher for the soils covered by indigenous vegetation, but the variability between samples in the alien quadrate was so high that according to the tetrazolium technique one could not effectively assume this difference to be significant.

It appears that factors operating at a micro-scale are more important in determining soil moisture at any particular point, because soil moisture is so variable (even over a scale of centimetres). These micro-variables have not been well documented, but could include: density of vegetation at any particular point (i.e. whether the root system is adventitious and close to the surface or deeper, but supporting a larger plant biomass), micro-scale changes in the physical properties of the soil such as degree of aggregation in surface soil particles, or even factors such as the degree of shading from supporting vegetation (the greater the leafy biomass, the more the surface soil will be shaded with consequently less evaporation).

One can make broad predictions from the findings of this research, with respect to the most suitable areas (in terms of moisture) for future restoration initiatives. For example, a good area in the upper catchment for rehabilitation would be on the south-facing slope close to the second indigenous forest pocket. If Grassy Fynbos species were planted alongside the forest margin (the ecotone) they would probably thrive as the available soil moisture is high and germinating species could gain seed dispersal benefits from birds that use the forest for food and nesting.

(ii) + (iii) Water quality and quantity

<u>Methods</u>

There were differing conditions under which the testing took place. The first survey was conducted during light, persistent rainfall whilst there was sunny and clear weather during the second survey. Three sites were tested for a number of water quality variables. These include temperature, pH, conductivity, total dissolved solids (TDS), ammonia, nitrates, dissolved oxygen (DO) and chlorides. Water quantity was measured in order to determine the velocity of the stream and its total discharge (*i.e.* the streamflow). PH was tested using a pH meter. Conductivity is the ability of water to conduct an electric current through the presence of dissolved ions, and was measured using a conductivity meter (units: Ms/m). This device was also used to measure temperature. TDS refers to the total quantity of dissolved material (organic and inorganic) in a sample of water. Samples were collected and TDS measured. Titration test (using the Mn test Kit) were used to determine the amount of: ammonia, nitrates, phosphates and chlorides. Different reagents were used for different tests and the results compared to the respective graduated colour beakers. Dissolved oxygen is an important determinant of the 'well being' of aquatic and terrestrial ecosystems (Miller, 2000). The water was sampled using an oxygen bottle and was taken to the laboratory and tested using the Mn test kit.

Water velocity and discharge were measured using a global flowmeter. Velocity was measured by inserting the flowmeter at different points across the stream channel. The rate of propeller rotation is then correlated to the stream velocity and is measured in meters per second. The mean velocity was then calculated for each site. The discharge is the volume of water flowing for a given period of time and is measured in cubic meters per second. Discharge is calculated from the product of velocity and the cross sectional area of the river (*i.e.* velocity X width X depth).

Results

Water quality and quantity was tested with regard to temperature, velocity, discharge, pH, conductivity and dissolved substances at three sites, an upper, a middle and a lower site.

Temperature: There was no significant difference in temperature between the different sites sampled along the Kowie headwaters. Although overhanging vegetation in the upper site shades runoff the channel was shallower, promoting more terrestrial heating. Though the stream in the lower site was exposed to more direct sunlight, the quantity of water was greater so convectional heating took place more slowly (Dunne & Leopold 1978, Rowntree 2000).

Velocity: Highest velocity of the Kowie headwaters was recorded for the middle site within the Featherstone Kloof region. Although the gradient of the river channel is steeper in the upper site, water velocity is reduced by friction from in-stream vegetation. A few small tributaries, in addition to sheet and base flow from the catchment, increases the volume of water in the middle site channel. As a result, a smaller proportion of the runoff was slowed due to frictional forces from the riverbed and atmosphere above, with a subsequent increase in stream velocity. This velocity was reduced in the lower site by the larger riverbed and shallower water that increased the frictional forces (Rowntree 2000).

Discharge: As expected, discharge was greatest in the lowest site and highest on a rainy day. This gives us some insight into catchment response time. When one compares the amount of precipitation with the increase in stream discharge at any particular point one can determine what percentage of the rainfall is infiltrating (either into the catchment soils or by supporting vegetation) and how much is actually contributing to stream runoff (Illgner 2001).

pH: The pH was slightly acidic (6.5), which is typical of most South African rivers (Paxton 1997).

Conductivity: Conductivity of the Kowie headwaters increases as one moves upstream. This correlates to the higher concentration of dissolved solids in the upper site for both surveys. In the case of the lower site, this decline in conductivity may be due to an increased water volume leading to dilution. It must, however, be stressed that conductivity shows a high degree of spatial and temporal variation depending on local inconsistencies such as in riverbed substrate, supporting vegetation and different chemicals (Rowntree, 2000).

Dissolved substances: It can be said that with the exception of chloride-ions, the Kowie headwaters contain very low concentrations of dissolved substances. This is expected since the catchment is not heavily impacted by human activities such as agriculture or industry. These high chloride levels could possibly be due to the weathering of rocks that are of marine origin. Four million years ago, before the area underwent significant uplift (forming the Post-African 2 erosion surface), Featherstone Kloof would have been significantly more influenced by coastal processes, as sea level was much higher. In fact, the Kowie between Bathurst and Port Alfred would have actually been underwater (Lewis 1999). The present levels of chloride will not, however, have a negative impact on normal ecosystem functioning, nor affect the quality of water for domestic and agricultural use downstream (Paxton 1997).

The presence of natural indigenous vegetation will serve to aid the maintenance of good water quality, in terms of maintaining low salinity levels. Nitrogen produced by exotic plants would build up and eventually become highly concentrated in the soil. Thus, through the reintroduction of indigenous vegetation, the nitrogen levels can be brought down.

Biodiversity

Part of the attraction of the Featherstone Kloof area is the high biodiversity. A total of 173 different species were found in the two 1000m2 quadrates of Grassy Fynbos sampled. There is a suggested relationship between biodiversity and ecosystem goods and services; for instance, an increased variety in nature provides greater potential for more human and non-human use of the area.

Figure 33. A first step towards conservation of the area is to raise the awareness of the public.

The Millennium Ecosystem Assessment Program, supported by the World Research Institute, lists biodiversity as an ecosystem good and believes it to have many human benefits. One of the emerging possible benefits comes from The Centre for Global Health and Environment who, in conjunction with the WHO (World Health Organisation) and UNEP (United Nations Environmental Programme) are currently working on a report assessing the links between human health and biodiversity (Internet 1). In a broader context, the World Research Institute believes that " the diversity of species undergrids the ability of an ecosystem to provide most of its other goods and services" (Internet 2). Biodiversity also benefits the wildflower industry, which uses fynbos flowers (e.g. King Protea) as cut and dried flowers. In 1993 this industry provided over 20 000 people with jobs in the Western Cape, and produced materials worth US$14 million in export (Cowling *et al.* 1997). This process has just begun in Grahamstown, and locally collected Protea's are being sold at the local supermarket, where imported cut flowers were predominantly used.

Besides the wild flower industry fynbos could provide essential oils from aromatic plants, plant products to be sold and used in rural communities, herbal tea (many fynbos species have untapped potential), edible plant parts and seeds and have possible pharmaceutical uses. Wehmeyer (1986) stated that there are about 1400 edible plant species in Southern Africa and only a small percentage of these have been studied for nutrient content or horticultural use (Cowling *et al.* 1997). Fynbos also provides the hidden economy of plant products sold and used in rural communities at a household level as building and craft materials, wood, or for medicinal/ceremonial purposes. As Featherstone Kloof has been shown to be an area of high species diversity, especially in relation to other fynbos vegetation communities, we can assume that it has the potential to provide many ecosystem goods and services in the future.

Medicinal Plants

Methods

Interviews were conducted with a number of people including a traditional healer. Questionnaires were also administered and a literature review was conducted. Field surveys were then conducted to ascertain the relative abundance of the more popular medicinal plants. There were thirty $1m^2$ quadrats that were sampled along two transects. The number of individuals present was recorded. Another transect was taken along the watercourse with ten $1m^2$ quadrats. This transect was done to assess the abundance of the aquatic plant, *Gunnera.*

Results

It is clear from the long list of medicinal plants that can be found in the area, that the area of Featherstone Kloof has a high potential medicinal value. However, since the numbers of many species are low, only a few selected species were surveyed, which made it difficult to determine the overall sustainability of this resource. However, the information will be useful as not much is known about medicinal plants in the Featherstone Kloof area. From the biodiversity survey conducted (see Section 2.2) it appeared that species richness in the area has not declined much since the last 1965 survey, therefore we estimate that there are still approximately 118 medicinal species available in the area.

In addition to potentially contributing towards the health and 'well-being" of the wider Grahamstown community these plants potentially provide essential income opportunities for collectors and healers as well as store owners. But, how sustainable is this harvesting? From interviews with local traditional healers, it is clear that Featherstone Kloof presently provides important ecosystem goods in the form of medicinal plants. Some of the key Grassy Fynbos medicinal plant species used in South Africa for traditional healing are:

Hypoxis hemerocallidea is a species found in abundance, between 296 to 3300 plants per ha. in the Songimvelo Nature reserve (Mbewe 1999). From this field survey it can be extrapolated that Featherstone Kloof has an abundance of *Hypoxis* almost double that of past highest estimates (Figure 31). Featherstone Kloof must thus be comparatively well endowed with this particular resource. *Hypoxis* is listed as a priority species for protection and monitoring, as there has been a steady increase in demand for its use. The bulb of the plant is ground into a strengthening tonic and has proved itself as a good immuno regulator. In recent years it has been listed as a threatened species on the Ecoport database since demand has risen rapidly, particularly with the AIDS epidemic in Africa (Van Wyk & Gericke 2000, Anon 2001). Corporate pharmaceutical companies have begun to use it in their commercial "immuno-booster" drugs, which of course places even greater pressure on the availability of this resource.

Figure 31. *Hypoxis hemerocallidea* from which the bulb is ground into a tonic used as an immuno regulator.

Alepidea amatymbica is the species found to be in the highest abundance in Featherstone Kloof. Scott-Shaw (1999) lists *Alepidea* as a threatened species in KwaZulu-Natal due to unsustainable harvesting for medicinal purposes. In Mander's 1997study of medicinal plants in the Bushbuck Ridge and Mpumalanga area, *Alepidea amatymbica* is ranked as the most popular medicinal plant collected. In Mander's Natal study (1998) it was found that 31.2 tonnes of this plant is used each year in the Durban medicinal trade. It is possible then that whilst this plant may be abundant in Featherstone Kloof, it has the potential to become scarce, due to high demand. No distinction is made between the different species of *Helichrysum* as they are collectively referred to as "Imphepho" in harvesting. "Impepho" is used as incense in traditional ceremonies and generally has a high cultural value. Mander (1998) ranked this species as the thirteenth most in-demand in Natal and is listed as a priority species in Mpumalanga (Botha 2001).

Polygala serpentanaria is used in conjunction with other plants for child stomach pain (Van Wyk & Gericke 2000) and is believed to have acquired its indigenous Xhosa name from its use in treating snakebites (Harvey 1860). It was not found in high abundance during this study, possibly because it exists in isolated populations, which were only brushed by the sample transects. There is no literature on the importance of this particular species in the medicine or muti trade, possibly because it is only found in the Eastern Cape and parts of Natal and very little research on the muti markets has been carried out at present.

Pelargonium reniforme was ranked sixth in the list of utilised species in the Bushbuck Ridge area and Mpumalanga province (Mander 1998). It has a wide variety of uses and distinctions are not always made between the different species (Van Wyk & Gericke 2000). It was not found in Featherstone Kloof at present. This could be due to the possibility that the species has been eliminated from the area since 1965, or that the population is very small and could have been missed by the sample transects.

Gunnera perpensa is twelfth in the list of important trade species as identified by street merchants in Natal muti markets (Mander (1997). It has a host of medicinal uses, mainly related to pregnancy (Van Wyk & Gericke 2000). It was also not found in Featherstone Kloof, which could be attributed to a number of different reasons including; low abundance with only small isolated populations or even individuals, over-exploitation to such a degree that numbers have declined or, high chloride concentration in the water (according to the water quality tests) that may affect its growth or reproductive ability.

From this study we can conclude that Featherstone Kloof has a high abundance of some of the key medicinal plants whilst it is also reported to be rich in medicinal plant species. These ecosystem goods provide for improved health in the greater Grahamstown community and are an important source of income for both traditional healers and collectors. The collection and use of medicinal plants is an important strategy employed, mostly by the poor, to improve their livelihoods. Recent evidence has shown that *Pelargonium reniforme* is being illegally harvested for export to a foreign pharmaceutical company and an investigation is currently underway.

However, in order to assess the sustainability of this harvesting and the impact that this livelihood strategy is having on the resource base one would need to undertake a more extensive study to examine the present level of utilisation and the regeneration of individual species in turn. However, the clearing of invasive exotics will certainly benefit this ecosystem by providing greater opportunity for indigenous species to reestablish themselves without having to compete with aliens for limited food and water resources. The ecosystem goods in the form of medicinal plants can continue to assist the livelihood of future generations with the creation of a sound management policy for the area so that harvesting remains sustainable.

Education

Methods

Two schools (Victoria Girls High and Graeme College) were interviewed. The sample design revolved around two different questionnaires, of which one was directed to an appropriate member of staff and the other to the pupils of the school. Fifty scholars were interviewed of which half were in standard nine and half in standard six. Two staff members from each school were also interviewed. This was done to determine whether there was a difference between the two standards in the reasons for their use/non-use of the area.

Open-ended questions allowed a personal response. Closed-ended questions required a simple yes or no and rated questions were given a response on a scale from 1- 5. There were three sections to the questionnaire. The first section comprised the basic administration questions related to school and standard. The second section was related to students who used Featherstone Kloof for educational purposes and the third section was related to pupils who did not use Featherstone Kloof for educational purposes. This was done in order to ascertain the reasons why they did not use the area, if they were using another natural environment in closer proximity or if field-work was not considered an important part of their education.

Results

Our research showed that at present Featherstone Kloof is not being utilised as an educational tool by local schools, mainly because of the inaccessibility of the area – it is considered too far away for walking and the access road is not really suited to two-wheel drive vehicles. Graeme College felt that all they needed for educational purposes was available to them within the school grounds. Both Graeme College and Victoria Girls High School did agree that they would be more inclined to make use of the area if transport constraints could be overcome, as they considered the area to be of high potential educational value. The vast majority of high school respondents did not know where Featherstone Kloof was. Those that did knew it mainly because their parents had taken them to the area or they used the area for riding or running. Most students were keen to learn more about the area, which is encouragement for future management plans to include a strong educational focus such as establishing an educational centre or overnight accommodation for school groups.

At present the potential educational service of the area remains untapped. Featherstone Kloof could certainly be marketed as an educational treasure if the access road was to be improved such that the area became accessible to two-wheel drive vehicles. For example: scholars could learn to appreciate first hand, what it takes to improve water supply and restore biodiversity to an area plagued by alien vegetation, by actually going out into the field and talking to, or even physically assisting a Working for Water team. If an educational centre was established or even basic overnight accommodation, school groups might be more interested in visiting the area as an extended field excursion. However, one would need to get commitment from the local schools before such an investment could be made. Regretfully, there was no response from any township schools regarding their perceptions on the area and whether they regard themselves as having rights of access to Featherstone Kloof. This is because township schools lack the resources like transport, which would allow them to access the area. This is an important issue, which must be addressed in the future.

Recreation

The aim of this study was to determine the **recreational** activities that occur in Featherstone Kloof, the extent to which various activities occur and to evaluate whether these activities have changed over time. The past, present and future potential recreational use of the land was evaluated through various questionnaires and interviews.

We acknowledge that these enquiries and only 20 interviews imply that our data is limited nevertheless, our results seem to indicate that Featherstone Kloof is definitely being used and enjoyed in a wide range of recreational activities, including hiking along the Oldenburgia trail (Figure 32). We plan to complete the data set through a participatory consultation process with the public stakeholders.

In terms of a change from past to present recreational services, it seems that the type of activities has not changed dramatically, but there has been an increase in the amount of people using Featherstone Kloof for recreational purposes. Several interviewees expressed the opinion that the clearance of alien vegetation has improved the Kloof and 'special events' such as mountain biking and botanical outings have been enthusiastically attended.

Figure 32. The area is often used for hiking, walking and horse riding.

Other initiatives such as the Wetlands Project, being run by the Institute for Water Research (RU, Grahamstown), aimed at restoring the wetland areas, will hopefully facilitate further improvements to the Kloof (such as increased bird and insect life) and thus have the potential to attract more users. Several interviewees made suggestions for other types of activities, which reflects peoples' enthusiasm for spending their recreational time in Featherstone Kloof, both now and in the future. One proposal for development in the future was suggested by Kevin Bates (Parks and Forests Department of Grahamstown) who felt that ecotourism in Featherstone Kloof is a wise option, bearing in mind that the areas' vegetation is unique and that 4 biomes meet there. An ecotourism based goal could establish Featherstone Kloof as an enclosed conservation area, building a limited number of chalets for environmental groups such as hikers and botanists, introduction of game with game viewing and game drives and an increase in the number of day trails (with a small fee being charged).

Benefits of making Featherstone Kloof a conservation area includes facilitating the monitoring of access to the Kloof, thus protecting it from excessive harvesting by traditional healers and wood collectors while creating work opportunities for local people. The income generated from creating the conservation area could be used for further conservation measures. Mr Bates of Parks & Gardens also expressed the view that - especially if the use of Featherstone Kloof were to increase in the future - it should be a priority to keep the ambience in the Kloof, i.e. that recreation should coexist with non-recreational (see Figure 33). However, this approach is not advisable as it excludes interest groups and ignores their needs, and to fence-off the area would be too expensive. A pro-active approach to management would therefore be more suitable.

2.2 THE PAST AND PRESENT INSTITUTIONAL ORGANISATIONAL DYNAMICS

This 'Institutional and Organisational Dynamics' (IOD) report is aimed at researching the past and present relationships between organisations and the rules they enforce. This will provide insight into the history of present organisations, institutions and policies as well as providing a platform from which to investigate the current situation. The main aim of this part of the project is the formulation of a basis for an integrative and participative management plan. National, regional and local, which includes documents and policies, and relevant stakeholders, were studied. The study takes special cognisance of relevant sustainability and land tenure issues that relate to Commonage management. Featherstone Kloof is seen as part of the Grahamstown commonage, which can be used by the communities in Grahamstown for grazing cattle and goats.

At this point it is necessary to define the term 'institution' within the context of this study. According to Leach *et al.* (1997) institutions are "regularized patterns of behaviour that emerge, in effect, from underlying structures or sets of 'rules in use' and are maintained by peoples' practices, or in deed their active 'investment' in those institutions." Organisations in this context exist because there is a set of working rules and underlying institutions that define them and give them legitimacy.

The objectives of this research project were:

1. To identify the past and present institutions and organisations that are, or were connected in some way, to the use and control of resources in the Featherstone Kloof area.
2. To investigate the questions of access, use and control with respect to the resources at Featherstone Kloof and the impact that the various role-players and stakeholders have had on the area.
3. To identify past and present stakeholders and key interviewees that will enable us to establish their relationship with the Featherstone Kloof area i.e. whether they are authorities, user groups and/or interested and affected parties.
4. To investigate the potential and real conflicts that may exist between the different role-players and users.
5. To gain an understanding of the institutions such as, norms and rules that govern the behaviour of the stakeholders involved.
6. To clarify the relationships and gain insight into power relations between and within groups, for example, their perceived rights, roles and conflicting interests etc. This will allow for more efficient data triangulation.
7. Investment in and maintenance of institutions and organisations and how these were created.
8. By drawing on the knowledge gained from the above inferences, potential future scenarios and their appropriate management plans can be identified. The identification of an appropriate management plan is beyond the scope of this study, although the information concerning future scenarios will help in its formulation.

The 'Environmental Entitlements Framework' will be used in this section to highlight some of the problems being faced in the Featherstone Kloof area. This framework has proven itself useful in conceptualising national, regional and local level institutional and organisational dynamics, allowing information to be discussed at the appropriate scale by adopting a results-orientated systems approach. This allows an understanding of how individual rights may be converted into environmental goods and services, endowments, entitlements, and eventually, in a working system, into capabilities with direct reference to Featherstone Kloof. The environmental goods and services identified as significant to the local population include; fuel wood, construction poles, and medicinal plants.

Environmental Entitlements Framework

'Community-based sustainable development' has become a central approach to rural development and natural resource management in developing countries. This is particularly true to the development rhetoric of the 'New South Africa', whereby local communities are expected to be involved in decisions from which they were previously excluded. The 'Community-based sustainable development' approach has however tended to overlook both ecological variability, and the social differentiation and potential for conflict within local communities. These factors to the importance of diverse local institutions: for managing environmental conditions and risk, influencing who has access to and control over which resources, and arbitrating contested resource claims.

A poor understanding of these dynamic institutional arrangements has thus far impeded practical strategies for 'Community-based sustainable development, which as a result, have fallen short of expectations. Global Environmental Programme-supported Institute for Developmental Studies research has used an extended 'environmental entitlements framework' approach as the basis for an improved and operationally relevant understanding of social and ecological dynamics, based on the collaboration with local research institutions in various developing countries.

Through the use of an environmental entitlements framework, this research project shows how different social actors derive livelihoods from a range of natural resources and how access to and control over these resources is mediated by a set of interacting and overlapping institutions, which are embedded in the political and social life of the area. An understanding of this complex set of institutional relationships is seen to be a vital precursor to establishing a framework for competing claims and the exploration of any co-management options for Featherstone Kloof.

The environmental entitlements framework analysis is an approach that was first developed by Amartya Sen to explain how it is that people can starve in the midst of food plenty as a result of a collapse in their means of command over food (Sen 1981).Sen argues that undue emphasis is placed on aggregate food availability, which consequently diverts attention from the more fundamental issue of how particular individuals and groups of people gain access to and control over food. Thus "scarcity is the characteristic of people not having enough ... , it is not the characteristic of there not being enough. While the latter can be the cause of the former, it is one of many cases." (Sen 1981).

The following definitions of key terms have been adopted for use in this project:

- Environmental Goods and Services are essentially what are natural resources that are made available for consumption (tangible and intangible uses) by the natural environment. These goods and services provide a means of survival and enjoyment for many people – both present and future generations.
- Endowments can be defined as the "... rights and resources that people have." (Leach et al, 1997) These include perceived rights as well as policy and legislation.
- Environmental Entitlements can be defined as "... alternative sets of benefits derived from environmental goods and services over which people have legitimate effective command and which are instrumental in achieving well-being." (Leach et al, 1997) They are therefore the tangible results/benefits that are derived from the realisation of endowments through enabling mechanisms.
- Finally, capabilities can be described as "... what people can do or be with entitlements." (Leach et al, 1997) Capabilities are therefore often achieved when people make use of their entitlements. In doing so they affect the course of action that a natural resource users group will follow.

Institutions play a major role in determining the course of action that a natural resource users group will follow within the boundaries of their rights and expectations. In various ways this project illustrates the interactions among institutions at different scale levels, and the ways they restrict resource claims and management practices of different social actors or user groups. At the international level, for example, the policies of donor organisations play an important role not only in directly shaping local approaches to community-based natural resource management, but also in influencing domestic macroeconomic policy or governance in ways that cascade down to affect local natural resource management. At national level, government policies and legislation are of primary interest, including land tenure reform policies, or approaches to forestry, wildlife conservation and tourism. At progressively more local levels these intersect with rural livelihood systems, intra-household dynamics etc. but the relationships between scale levels are far more deterministic. Land claims at local level may spill over into national, state or provincial-level politics, for example and influence the direction of future policy and the scope of legally enforceable rights.
In general, the environmental entitlements framework offers "... a useful set of analytical tools, which can assist the tracking of particular actors' access to, use of and transformation of environmental goods and services" (Leach et al, 1997), which allows for a more simplified approach to people-environment relations in the context of community-based sustainable development, and for untangling the complexity of institutional relationships involved in particular cases.

Sustainability

The intricate links, which exist between people and their environment, have resulted in the need for sustainable systems to exist in order to ensure the long-term viability of these links. The following section defines sustainability in context and outlines its importance for the successful conservation and management of biodiversity.

Many of the world's poorest people are often the unfortunate victims and/or agents of environmental degradation. These people are constantly forced to meet short-term survival needs at the cost of loner-term sustainability, which can result in a cycle of poverty and limited opportunities becoming an inter-generational self-sustaining process. Faced with immediate survival needs, poor people often have no choice but to overexploit resources, although in doing so they diminish the options available to present and future generations. The security and living standards of poorer people are therefore inextricably linked to environmental management. The overriding ideology of sustainability, which has become prominent in potential and real sustainable management frameworks, is that human welfare needs to be improved without the natural environment incurring the negative aspects of this development.

Sustainable development can be defined as "development that meets the needs of the present, without compromising the ability of future generations to meet their own needs" (White Paper on Environmental Management, 1997). Thus development policies, plans, programmes and activities that do not address environmental concerns cannot claim to be sustainable. But world trends since then have shown that present and future prosperity revolves around issues of market access as well as the access to and control of natural resources (White Paper on Environmental Management, 1997).

On a national level, sustainability is incorporated into legislation through Section 24 of the Bill of Rights, according to which everyone has the right:

(a) To a safe and healthy environment,

(b) To have the environment protected (for present and future generations) through appropriate legislation and measures that

   a. Prevent pollution and ecological degradation,
   b. Promote conservation, and
   c. Secure ecologically sustainable development and use of natural resources whilst aiming for economic and social development (White Paper on Environmental Management Policy for SA, 1997).

Equitable access to, ownership and control of natural resources (renewable and non-renewable) by South Africans is imperative for the conservation and sustainable use of these environmental resources.

Sustainability depends largely on changes in behaviour with respect to resource extraction, spatial development, production, waste minimisation and pollution control strategies.
Additional goals for sustainable development, which also have long-term implications for both people and the environment, include the need to ensure that everyone experiences the benefits of a healthy environment; the need to sustain a healthy economy that affords the opportunity for a high quality of life; to ensure equity in opportunities for economic, social and environmental well-being; advocating the protection and restoration of natural resources for present and future generations; encouraging stewardship; creating opportunities for active participation in resource management; developing and implementing sustainable development policies; and finally, emphasising the importance of environmental education and awareness.

Sustainable systems are one of the many components of sustainable development. The following criteria have been identified as constituting the backbone of sustainable systems, which includes environmental, economic, social and institutional attributes. Environmentally sustainable systems can be achieved when the productivity of natural resources is conserved or enhanced for present and future generations. Sustainable economic systems can be achieved when the level of expenditure can be maintained over time. Sustainable social systems are achieved when social exclusion is minimised and equity maximised. Land and tenure reform are examples of mechanisms that attempt to address these issues. Finally, institutional systems become sustainable when prevailing structures and processes have enough capacity for long-term management.

The greater the separation between policy makers, producers and consumers, the less incentive for practising sustainable use. This is often compounded by the conflict that exists between customary and western tenure systems, especially in Africa, where the ownership of resources is regularly contested as the distinctions between open access and common property become unclear. Tenure is essentially "an array of different ways in which individuals and groups manage rights of access to, occupation and use of, resources" (Fabricius, 2000). If tenure agreements do not provide security to local users within a certain property regime, such as common property, then incentives for sustainable use are unlikely to exist (property describes a structure of rights and obligations that legally require the support and recognition from authorities). Grahamstown has a growing population, which could invariably lead to increased pressure and demand on commonage resources. Without mutually beneficial policy development and implementation, Featherstone Kloof risks over-utilisation and unsustainable harvesting of natural resources.

Institutional Development

Systems lacking appropriate institutions are often vulnerable to unsustainable practices, such as the uncontrolled over-harvesting of natural resources. Therefore, human development and welfare ultimately depend on the institutions that provide necessary support and enabling capacity. Overexploitation is often therefore the direct result of the inability of interdependent individuals and communities/groups to coordinate and enforce self-regulation and responsibility with respect to resource use. Effective institutions with respect to the Featherstone Kloof appear to be either absent or inefficient within and between certain resource user groups. For instance the various groups perceive rights of access differently.

Measures that can be adopted towards achieving the goals of institutional development include:

1. The recording of priorities with emphasis on social, political and institutional development;
2. Taking full account of the 'micro-political economy of institutional development' (i.e. adaptation of existing power structures);
3. Support through participation and interactive learning environments;
4. Institutional development needs to be managed as a learning process;
5. Capacity building, time management, new staff with institutional expertise need to be appointed as well as providing existing staff the opportunity to develop such expertise;
6. Cross-disciplinary and cross-agency collaboration by development agencies needs to occur.

Common Property Resources

According to Shackleton et al, (1998) the principles that have been identified as constituting long lasting common property resource management regimes include aspects relating to the social, institutional, economic, natural and policy of that regime. Social aspects include clearly defined community boundaries, vested interests by the community in the land, prior experience in collective action, and local knowledge of the resource. Institutional issues include the legal ownership status of all users, the recognised legitimacy of land tenure and resource access and use rights, the presence of local legitimate institutions, organisations and conflict resolution mechanisms (to monitor and manage the resources), and the decentralisation of management to appropriate levels. Economic issues include the presence of incentives as opposed to subsidies and dependence for creating an environment for collective management, and equitably enjoyed and distributed benefits. Resources that are easily defined and rapidly renewable are easier to manage. High dependency levels and resource scarcity result in more conscious efforts to manage the common property area sustainably. Relatively scarce resources force the community to be interdependent. Finally, policy issues advocate state recognition of the regime and its dynamics, as well as the role that the state and donor agencies have with respect to supporting and facilitating common property resource management (Shackleton et al, 1998).

There are a number of reasons for advocating common property regimes in South Africa. These include the fact that common property regimes act as safety nets for the poor who have few alternatives, such as food security; they offer more equitable land ownership and access to resources (more users have access to more resources); they spread risks and are economically rational – value and costs of alternative tenure agreements; they act as a buffer against economic fluctuations and unemployment; they can be effective for sustainable resource management and biodiversity conservation as well as providing a multiple livelihood basis (Shackleton et al, 1998).

However, according to Shackleton et al, (1998) in reality the following problems are often experienced with respect to common property regimes and their dynamics. These include:

- The difficulty experienced in defining the community and resource and their respective boundaries;
- The fact that competing interest groups often occur within communities, and between different institutions;
- The potential difference in scale that can exist between appropriate social units and resource management units;
- Inappropriate land tenure agreements;
- And an obvious lack of support and enabling capacity.

<u>Methods</u>

The methods outlined below were utilized and used appropriate sources of information at the national, regional and local levels.

Literature review

This method included looking at policies, organisational documents and records that related to the study area. This was so that background information could be established and that information from other sources (such as policy documents and legislation) could be verified.

Interviews

These were conducted with key role-players and stakeholders who are involved in the past and present organisational and institutional roles. These interviews took place in the working environment of the interviewees. The triangulation method of interview research was used. This is a method whereby information gathered from one source could be validated or refuted through interviews with other sources. Five interviews were conducted with wood collectors who collect wood from the eastern commonage. These were conducted in an informal, semi-structured manner and were conducted as the interviewees were collecting wood. A fellow researcher (Nomazibulo Ndikinda) acted as the interpreter.

Those who own donkey carts harvest firewood and building poles from the Featherstone Kloof area and are an example of where the local level information was obtained. Seven interviews were conducted and this revealed that the area is being used at the commercial level.

Medicinal plants are being harvested on an unsustainable basis. This is according to local municipality and Working for Water representatives. Thus, two traditional healers were interviewed, and one of the healers has a shop in Port Alfred, thus extending the importance of Featherstone Kloof.

IOD group members attended two meetings (chaired by Working for Water representatives). The first was a Public Steering Committee meeting. This aimed to inform interested and affected parties about WFW activities in the area. The second meeting was scheduled by students in order to gain relevant information.

Participant observation involved being present both in the field as well as in meetings and interviews. This allowed for information to be obtained through active involvement as well as observation.

Policies and Legislation relevant to the Management of Featherstone Kloof and Conversion of Environmental Goods and Services

Conversion of Goods and Services into Endowments

National Level

The South African White Paper on Land Policy (1997) aims to confer broad rights to all South African citizens in a number of ways. Firstly, the white paper aims to address past inequalities in land distribution and management regimes. In order to achieve this it outlines the need to involve local communities in the decision-making processes that govern state (municipal) land. The white paper also outlines the intention to provide state assistance to authorities involved in managing state resources.

However, the research revealed that when it comes to implementation, the involvement of all interested and affected parties is often difficult because of constraints such as insufficient or no financial and human resources. For example, Kevin Bates of Parks & Gardens acknowledged that all stakeholders should have been involved in the formulating of a draft management policy framework for Grahamstowns' commonages, but attempts to include all parties would have severely slowed down the process (which is already overdue). Simply, stakeholders not included in the original formulation will only get to read the plan, if anything. This effectively marginalizes the involvement of all affected users, thereby limiting the prospect of a sustainable management of Featherstone Kloof. However, if the Refyn project is allowed to conduct meetings and supervise the sharing of ideas of different stakeholders this can be avoided.

The Department of Water Affairs and Forestry have a number of forest and water related policies that influence the way in which municipal commonages are managed. Forest related policies include the Sustainable Forest Development in South Africa White Paper (1996), South Africa's National Forestry Action Plan (1997), the National Forest act (1998), the National Veld and Forest Fire Act (1998), and the National Water Amendment Act (1999). Water related policies include; the White Paper on National

Water Policy for South Africa (1997). All of these confer the right to municipalities to remove alien invaders, and at the same time conserve the indigenous forest species. This is important for Featherstone Kloof because Working for Water practically implements these policies and is one of the few examples where National policy has been translated into concrete action. Furthermore, WFW is a major role player in Featherstone Kloof and thus has a large say in policy formulation at a local level.

A number of acts are of particular relevance to Refyn and Working for Water projects as they provide legislation as to how and what is legally required. These are outlined below.

1. <u>National Forestry Act 84 of 1998</u>
   a. Section 5(a): any research related to forestry and forest management "must promote the objectives of forest policy and conform with national policies and programmes."
   b. Section 7(1): "No person may cut, disturb, damage or destroy any indigenous living tree, or remove such tree except in terms of
      i) A license
      ii) An exemption from the terms of this provision. . ."
   c. Section 10(1): no person may "cut, disturb, damage or destroy any forest produce" except in ways envisaged by the Act such as in terms of a "right of servitude" granted over the area, as stated in section 10(1)(c) of the Act. This allows for those currently responsible for rehabilitating the area, as well as for future managers, to viably protect the patches of indigenous forest found at Featherstone Kloof from exploitation, such as over-harvesting. Unfortunately the Act also prevents managers from introducing a programme for sustainable use of the land.

2. <u>National Environmental Management Act 107 of 1998</u>

Several sections of this Act affect present and will affect future management strategies of Featherstone Kloof and subsequently should be included in the relevant management plans. In particular, 8 sections are of importance.

   a. Section 11(1): "every province must prepare an environmental implementation plan within one year of the promulgation of this Act". Consequently any management plan regarding Featherstone Kloof since 1999 must correlate with what the provincial environmental management plan envisages for the Eastern Cape. The Eastern Cape has not yet drawn up an environmental implementation plan – therefore the present managers of Featherstone Kloof and Dassie Krantz do not have such a plan to comply with.
   b. Section 12(a): "The purpose of environmental management plans is to coordinate and harmonize the environmental policies, plans and decisions of the various national departments. . ." Section 12(c): "To secure the protection of the environment. . ." The effect of these two sections is not only to tie up any management plan for Featherstone Kloof into national policies, but also to make protection its central pillar.

c. Section 13(1)(b): Every environmental management plan must contain a description of how its policies fit in with "national norms and standards". Consequently any such management plan for the area must detail how it fits into the overall national vision for the protection of the environment.

d. Section 14: Every management plan must contain

    i) A description of priorities

    ii) Proposals for the promotion of objectives and plans

This section shculd be taken literally by managers to ensure that their plans for the area contain the basic elements necessary for efficient management of the area.

e. Section 17(2) allows for a "facilitator to call and conduct meetings of interested and affected parties with the purpose of reaching agreement. . ." This section is important because it requires that the community is involved in conservation. Refyn will address this issue after consultation with the relevant local authorities and is prepared to act as facilitator for the public participation process, which will include stakeholders and interested and affected parties.

f. Section 23(2) gives the objectives of integrated environmental management such as in S 23(2):

    (a) "to promote the principles of environmental management"

    (b) "to identify, predict and evaluate actual and potential impacts on the environment. . ."

   From this section it is realised that integrated environmental management (IEM) is obviously the favoured approach. If any development were to take place in Featherstone Kloof or Dassie Krantz, the objectives of IEM should be included in the management plans.

g. Section 24(7)(b) states that the potential impact of the activity on the environment and the cultural heritage must be assessed. The impact can be either negative or positive.

Working for Water's impact on the region has been assessed with regards to increased water flow due to the removal of invasives, greater potential for erosion due to reduced ground cover and the negative side-effects of using herbicides on invasives. Furthermore, as is stated in Section 24(7)(c), Working for Water has taken mitigatory measures to keep adverse impacts to a minimum. They plant hybrid grass species to provide ground cover and limit reinvasion and they use herbicides that break down quickly. The municipality has assessed the impacts of burning on the vegetation and has modified their burning cycles for optimum effect on Grassy Fynbos. However, in terms of the negative impacts of the illegal harvesting of indigenous vegetation, the municipality has made neither an assessment of the impacts or any attempt to control harvesting. This assessment should be carried out for all present and future management plans.

h. Section 28(b) allows rehabilitation to take place on another's land. This section gives Working for Water the authority to carry out the rehabilitation on land owned by the Grahamstown Municipality.

The municipality has no formalized, documented management plan and therefore it is only possible to assess whether they are complying with National Legislation. This can be determined by considering their present actions and information gained from personal communications with Kevin Bates as to what his present management of the area involves. In the case of Working for Water, it is a national, government-funded programme and therefore, in theory, it should comply with all National Legislation. After discussions with Andrew Knipe and Jonathon Pryor of the Albany Working for Water project it seems that they do comply with national policy, however this is difficult to monitor, as there is no management plan in place for Featherstone Kloof.

Regional Level

The **National Veld and Forest Fire Act (1999)** is interpreted at the regional level in a number of ways. The act states that whomever is responsible for controlled burning activities, is also held responsible for damages incurred during the burning process. For this reason then, at a regional level (as well as local - as will be discussed shortly), Department of Water Affairs and Forestry (DWAF) hires outside parties to conduct burning activities. Devolution then is the regional response, and in the case of the Grahamstown commonages there has been devolution of responsibility to the municipality, and further to the Department of Parks & Gardens. Ultimately this responsibility falls on Kevin Bates, head of Parks & Gardens.

National White Papers, policies and legislation provide the Grahamstown Municipality with a framework for commonage management, but that is all. Decisions have to be made that might not adhere to or implement these policy frameworks, this often occurs as a result of constraints (time, capacity, funding) and the non-participatory approach of old conservation ethics used by managers. The outcome is a system of fragmented public land management, with a traditional top-down approach to the decision-making process.

Communities in the Eastern Cape have access to commonages for regulated consumptive and non-consumptive use. This has been illustrated through the local Eastern Cape case studies of Bathurst, Peddie, Cathcart and Queenstown. Information gathered through interviews and policy data shows that this is also the case in Grahamstown.

Local Level

Despite legislation that calls for increased access in response to the Green Paper, the municipality has effectively kept people off Featherstone Kloof because of a need to accommodate wealthier residents and to ensure that this particular municipal area does not become as degraded as the eastern commonage, where cattle grazing and intensive harvesting occurs.

At a local level there is a perceived 'moral' right to utilise environmental goods and services in the Featherstone Kloof area as demonstrated by the interviews conducted. Most interviewees (including government and municipal officials) conveyed the sentiment that the government owns the land, the government is responsible to the people, and the people are suffering.

Grahamstown Municipality has made no attempt to request funds from the Department of Land Affairs in order to increase and improve commonage land and disadvantaged people's access to it. For the moment, the commonage area closest to the township is believed to be sufficient for the majority of residents. However, it is difficult to monitor utilisation. 'Allocating' the Featherstone Kloof area to recreational and conservationist activities ensures that the area does not become as degraded as the municipal land closest to the township (which is being used for grazing and harvesting). Wood (fuel and building) and medicinal plants harvesting is occurring at present in Featherstone Kloof (Figure 34). The wood collectors have an agreement with Working for Water to remove aliens that have been chopped down, but the harvesting of medicinal plants - by outsiders, more so than locals – is unregulated and is seen as a problem by the authorities and the traditional healers.

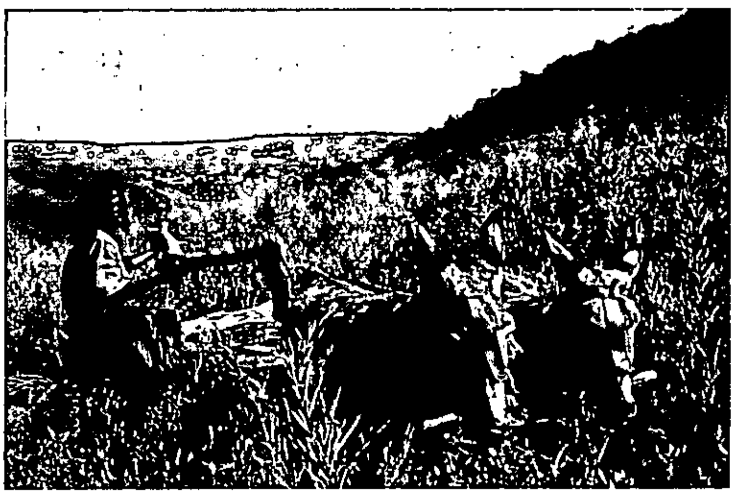


Figure 34. Fire wood collection with a donkey cart.

It would appear that the municipality wishes to retain the current status of the Featherstone Kloof area, regardless of whether or not locals could improve their living conditions from agricultural activities in the area (such as grazing and plant collection or propagation). According to the municipality, grazers are easier to police, but any harvesting that occurs is usually done when the harvesters are least likely to be caught i.e. at night. This idea of being caught suggests that people are worried that they are not allowed to make use of this municipal land. However, it is municipal land, and no official legislation exists to prohibit people making use of the land. Wood collectors and grazers that were interviewed had never used the area: to them it is too far, and is perceived as municipal property. They believe that 'their' commonage has been specially set-aside for them. This belief is perpetuated by the municipality, which has created a perception of the area as being 'off limits' to these sorts of activities i.e. it is an exclusive area for recreation and conservation. Only the authorities know the real status of the area, because the locals are not educated about the workings of the municipality and because of a lack of collective cohesion between potential users. Perhaps when the municipal land nearest the township ceases to have the capacity to support current land uses, such as wood collection and grazing, the municipality will look into expanding commonage areas. However, we believe that by increasing the amount of land available now, the chance of the existing commonage becoming denuded is lessened. It is expected however, that there will still be a clear distinction between municipal land for consumptive and non-consumptive use. The municipality's capacity to manage this expansion will surely face similar limitations, in the future, to those encountered today if adequate enabling mechanisms are not put in place.

The **Eastern Cape Provincial Environmental Conservation Bill** (2001) also makes provision for Local Authorities to set aside their own conservation areas on land under their control. The process of setting up such a reserve should be open and transparent giving the public an opportunity to object. The Local Authority must set up an advisory board to deal with regulations and policies for the conservation and management of the area. The Bill allows the Local Authorities to generate income from activities such as tourism, in these areas. The Bill also allows the authorities to permit and control sustainable harvesting of Natural Resources in the area.

Conversion of Endowments into Entitlements

National Level

Enabling mechanisms that allow rights of access to be converted into entitlements are absent at the national level. While there are broad policies and legislation, very few take the next step of providing a process for the conversion of these into tangible benefits. For example, while the Land Policy white paper does state that local communities should be involved in decision-making processes, in reality there is a need for extension services to be provided at a national scale, in order for these policies to actively convert endowments into entitlements.

Regional Level

Due to a lack of resources and fragmented governmental/municipal departments, local communities are not involved in decision-making processes by the municipality. Interviews with Kevin Bates revealed that there was a lack of resources to follow through with the policy laid out in the Land Policy white paper; this was reiterated through investigations into the past management of several Eastern Cape commonages. In this case, these resources included time, money and human capital. At this level it is recognised that in the past the Transitional Local Authorities (TLA's) were responsible for regulating access by consumptive users, and today this is the job of the Transitional Local Councils (TLC's). Thus by allowing access, even if regulated, it potentially enables a right of access to be converted into entitlement. Drawing from regional policy history, it is seen that there is an obvious lack of control and capacity in enforcing policy through management. This is exacerbated by racial conflicts, stemming largely from Apartheid-era policy in which most black residents were given little or no authority in policy dealings, and were largely excluded from policy decisions. This has led to unregulated open-access usage in many instances, with detrimental results for all concerned. Nonetheless, this has seen the conversion of environmental goods and services into entitlements by bypassing the endowments stage. Furthermore, there are competing needs to use commonage land for grazing and resource services, and the need for the development of infrastructure and services. This increased pressure on commonage resources has arisen due to more people moving from rural to peri-urban and urban areas. The resultant rapid urbanisation and population growth, combined with increasing poverty has resulted in increasing competition for commonage resources and space. These infrastructures and services are needed to accommodate the rapidly growing settlements and towns surrounding (and even occurring on) commonages.

Local Level

WFW and Refyn are working towards protecting indigenous biodiversity thereby converting the national level policies and legislation about the protection of biodiversity into action, this in turn potentially converts endowments into entitlements at the local level. This needs to work hand in hand with sustainable use that incorporates benefit sharing and involvement of all interested and affected parties, as protectionist strategies alone will not ensure this. For example, WFW actively removes alien invasives, and at the same time temporarily provides fuel wood and jobs (Figure 35).

WFW provides felled wood for both the consumptive users in Featherstone Kloof, and for the WFW workers. This is considered an institution because it is behaviour governed by WFW's policies regarding community development. At this point it is uncertain how much of a benefit this really is and there is a need for more research. At a local level there is a consensus amongst user groups that they may in fact act on their perceived moral right to have access to the municipal commonage. They are acting on this perception, and therefore are actively involved in converting their endowment into entitlement. The provision of recreation facilities, such as hiking trails, allows for non-consumptive users to utilise Featherstone Kloof, thus converting their right of access (endowment) into a tangible benefit (entitlement).

Figure 35. Clearing of alien species by Working for Water provides jobs for many people (Photo Juan P. Moreiras, FFI/BP).

Conversion of Entitlements into Capabilities

National Level

WFW's policy of community development aims at providing skills for employees, Aids awareness programmes and family planning education. All of these lead to capabilities, as will be discussed in the next section. For example, the skills that are provided enable independent contracts after employment with the WFW program. The active removal of alien invasive species at a national level leads to the removal of the associated threats of erosion and water depletion. This enables land to be used for other more productive purposes, thereby leading to new capabilities.

Local Level

The perceived moral right to have access to Featherstone Kloof, as well as the more formal agreements with WFW to collect felled wood, has lead to entrepreneurship amongst wood collectors. This is expressed through the acquirement of donkey carts and donkeys to transport the collected fuel wood and building poles.

WFW is supplying jobs at the local level, as well as making agreements with local wood collectors, allowing them to collect wood in the Featherstone Kloof. In the past the agreements were more formal, with a small levy being charged. At present this agreement is less formal, with no levy, but rules about where they can and cannot collect do exist.

Capabilities

The generation of income for household expenses, such as food and clothing, from the sale of wood and construction materials occurs. The income generation will give the community an increased social status made possible by the ownership of donkey carts through the wealth accumulated from the sale of wood collected with these carts. The improved indigenous biodiversity will provide people with a greater range of resources to be converted into livelihood options, and will lead to an aesthetically improved recreational zone, allowing for an improved sense of well-being.

Feedback Loops

The entitlements framework utilises a systems approach. Systems have feedback loops (either positive or negative) that may occur at any stage of the process. It is important to note that both the positive and the negative feedback loops can either perpetuate or alter processes within the system. Both have the potential to result in a run-away cycle, which may eventually cause the system to "crash".

Positive: Improved biodiversity leads to increased environmental goods and services.

The use of improved goods and services provides users with diversified livelihood options

Negative: The lack of involvement of all interested and affected parties in the management process will maintain the cycle of unsustainable use.

The lack of enabling mechanisms that allow endowments to be converted into entitlements and then into capabilities renders the national level policies redundant.

Conclusion

The entitlements framework clearly demonstrates that although there are conversions of environmental goods and services into capabilities, there are obvious shortcomings in this process. The most obvious of these is the lack of enabling mechanisms to 'map' endowments into entitlements, often at the cost of sustainable land management and policy. This top-down approach from the national to regional and local levels tends to focus on theory rather than practical application.

It became apparent through this research that this is occurring in Featherstone Kloof. For example, the White Paper on Land Policy (1997) stipulates the need to involve local communities in the decision-making processes that govern state (municipal) land and the intention to provide state assistance to authorities involved in managing state resources. Interviews with authorities and local users revealed that in both instances this was not occurring. The failure of the state to provide extension services to the authorities has resulted in the exclusion of local stakeholders from the decision-making process. This makes it difficult to meet with the policies stipulated by the White Paper on Land Policy.

Working for Water is perhaps the only practical application of policies at a national, regional and local level being converted into endowments and entitlements, with resultant capabilities. This is seen in the creation of employment, capacity building, social development and status. However, there are limitations. Employment is not long-term and WFW authorities work in close collaboration with municipal authorities and there is very little real application of local community involvement besides those directly employed. Furthermore, the entitlements provided (e.g. invasive felled wood for fuel or construction purposes) do not have the anticipated value amongst local users who find the wood to be faster burning and less durable than other species.

This lack of cohesion and involvement of all interested and affected parties combined with the potential for increased demand on commonage resources (from growing peri-urban populations, as illustrated in Grahamstown) is certain to lead to unsustainable resource utilisation. This is substantiated by research into various regional level case studies in the Eastern Cape that exhibit similar characteristics.

It is our recommendation that a set of criteria and indicators be developed to monitor and guide the institutional and organisational dynamics of the Featherstone Kloof area.

These criteria are:

- *User Group*
  - Clearly defined group membership rules
  - Appropriate size for resource base
  - Institutions and organisations as 'voice' for less powerful members

  - Identity of group promoted
- *Resource Management Group*
  - Clearly defined resource use rights
  - Clear resource boundaries
  - Clear and enforceable rules
  - Rules that promote sanctions
  - Rules that account for potential conflicts between different users
  - Rules that promote decision-making
- *Authority and Enforcement*
  - Appropriate levels
  - Clearly defined user relationships
  - Recognise legal identity of institutional arrangements
  - Provide conflict resolution mechanisms
- *Resources*
  - Identification of key resources
  - Temporal and spatial variability taken into account within usage rules

2.3. FEATHERSTONE KLOOF: PAST AND PRESENT MANAGEMENT STRATEGIES

This part of the project researched the organisations whose activities impact on Featherstone Kloof and investigated their management objectives and strategies. It then seeks to analyse the management plans, according to criteria developed specifically for the project.

Historically, Featherstone Kloof was never dedicated to any effective land use type for a long period of time. The land use types ranged from agricultural land, under many different tenants, in the 19th century, to vacant municipal land in the early 20th century, to a nature reserve in 1933, which only operated efficiently until 1945, after which the land fell into disuse. With the exception of the period during which Featherstone Kloof was operating as a nature reserve, no specific management plan existed for the area. Currently, three organisations are engaged in activities in Featherstone Kloof, Grahamstown Parks and Gardens, Albany Working for Water and the present Refyn project. The Grahamstown Tourism Bureau has no involvement in the area, and no management plans for it. The Albany branch of the South African Botanical Society occasionally sends 'hack teams' into the area, and would like to develop a visitor's centre in the area, but no plans have been made regarding this. The activities and ideas of the three main parties involved in the area are outlined below.

Grahamstown Parks and Gardens (Information: Kevin Bates, head of Parks & Gardens)

Grahamstown Parks & Gardens falls under the Grahamstown Municipality, the landowners of Featherstone Kloof. Parks & Gardens is under the directorship of the Institute of Environment and Recreation in Africa. The main role of the Parks & Gardens in Featherstone Kloof is that of maintenance and control. Maintenance of footpaths, fire protection and controlled burning, control of invading vegetation and reinstating natural vegetation, law enforcement and control of leases pertaining to the municipal commonage make up the bulk of the work of Parks & Gardens with regard to tourism and the environment (see Figure 36).

Figure 36. The preservation of the area ensures that the Sugarbird (Protea pollinator) can survive (Photo Juan P. Moreiras, FFI/BP).

However, no management plan existed in the past for Featherstone Kloof. A shortage of manpower and finances made the regulation and setting of limits and standards difficult, considering that only four staff members are available for the whole area. Lack of regulation is reflected in the use and removal of resources in the area. For instance wood collectors previously paid for wood that was taken out of the area, but after 1994 much control of this practise was lost. However, efficiency has been achieved in the field of fire control where there has been the introduction of block burning and burning cycles. Burning is divided into two seasons namely, a dry winter season and the summer season. The burning of firebreaks is on a two-year rotational basis, with fynbos being burnt in ten-year cycles. The result has been a reduction of 30% in the intensity of fires. The Municipality, having expertise with burning, controls fires on municipal grounds and those privately owned areas under Working for Water. Areas cleared of alien vegetation by WFW were maintained and thus further spreading of aliens was contained, but only for a period of three years.
The considerable lack of financial assistance, manpower and lack of interest on the part of the local council are the prime problems experienced by the Department. However, with the added financial backing and manpower provided by Working for Water, more productive conservation within the area is hoped to be carried out in the near future. Due to pressure by the Albany Working for Water a management plan for the area is in the process of being compiled by the Department of Nature Conservation, Parks and Gardens Department (Makana) and Albany Working for Water.

There is a proposal being developed to make the area a conservation area, linking with surrounding farms and the nearby Thomas Baines Nature reserve. The Refyn project aims through the public participation to be followed to further investigate this option and possibly through the involvement of interested and affected parties facilitate the development of a sustainable management plan. On the other hand, because of the costly upkeep of the area as alien-free commonage another possibility that does exist is for the area to be sold. It is therefore critical that the area be developed in a manner that is sustainable and allow the benefits of having it as commonage outweigh the costs of its upkeep.

Working for Water

The national Working for Water Programme was launched in South Africa in 1995 as a multi-departmental public works programme, in an effort to eliminate invading alien plants and unemployment concurrently. Three hundred projects are currently running in South Africa's nine provinces, the sites selected were based on the need for the follow-up of areas previously cleared, the impact on regional water resources, the extent and distribution of alien plants, the level of poverty and unemployment, sustainability, capacity and the potential for institutional partnerships. Working for Water present their vision as follows:

"The Working for Water Programme will sustainably control invading alien species, to optimise the potential use of natural resources, through the process of economic empowerment and transformation. In doing this, the Programme will leave a legacy of social equity and legislative, institutional and technical capacity" (DWAF, 2001). Their four aims are: Enhance water security - Improve ecological integrity - Restore the productive potential of land and promote sustainable use of natural resources - Invest in the most marginalized sectors of South African society (DWAF, 2001). The programme is a public sector institution, funded almost exclusively by the government. Although WFW prioritises public land for clearing, work is also undertaken on private land (DWAF, 2001).

Local branch: Albany Working for Water

The Albany Working for Water Project follows the guidelines of the National Programme, regarding both social aspects, such as training, as well as the rehabilitation process as important. The Albany project produces an annual plan of operation. They are in the process of developing a draft proposal for Featherstone Kloof, however no real management plan exists at present. The Albany Working for Water Project was initiated in 1997 and in their Draft Plan for Rehabilitation of Featherstone Kloof their project goals are stated as:

- The destruction of alien invader trees that threaten natural resources and natural biodiversity.
- The rehabilitation of seriously degraded areas to restore them to their natural state.
- The creation of direct job opportunities as well as training and social upliftment.
- The development of trainee contractors to become viable contractors in an open-market system.

At present WFW is approximately half way through their initial clearing of Featherstone Kloof (Figure 37). Currently there are 107 people employed by the project and eight clearing teams are available to the Albany Project, which are awarded three-month contracts. The contractors are from previously disadvantaged backgrounds. The contractors undergo training and are then contracted by Working for

Water – as in a "real world" situation. The teams are able to tender for contracts each month, the number of contracts offered each month being dependent on the money available to the programme (Knipe, pers. comm. 2001). Working for Water tries to develop strong links between themselves and individual landowners however, in the case of Featherstone Kloof, this area falls under the responsibility of the Grahamstown Municipality. According to Andrew Knipe (pers. comm. 2001), Working for Water has a good working relationship with the Grahamstown Municipality and hopes that the Municipality will employ some of the contractors after they have finished their clearing for Working for Water. Kevin Bates (Parks & Gardens) assists Working for Water in many ways. He offers financial support and advice as well as doing all the burning for the Project.

Figure 37. The local Working for Water team at work in Featherstone Kloof, clearing regrowth of *Acacia longifolia*.

Rehabilitation Process

Working for Water's national policy maintains that the control programme for alien vegetation must include the following three phases, (i) - Initial control: drastic reduction of existing population, (ii) - Follow-up control: control of seedlings, root suckers and coppice growth, (iii) - Maintenance control: sustain low alien plant numbers with annual control (DWAF, 2001).

The clearing of alien invader plants in Featherstone Kloof is done on a trial and error basis, although the managers draw on a great deal of experience and information already available in the industry. National studies on the clearing of the invader species have been undertaken, but no research has been done in this area. The current process followed is to burn the land intensely, and then spray herbicide on the regrowth. Four to five weeks after spraying the ground is ready to be planted with grass seeds. Working for Water has a policy against burning in accordance with the National Veld and Fire Act and therefore rely on outside people to come in and do their burning. In the case of Featherstone Kloof, the Grahamstown Municipality does the burning. Problems arise with regard to the clearing when the area is not seeded with a cover crop in time (sometimes as short as three weeks), which leads to the regrowth of invader species. The young grass is then not able to compete with the invaders, and the entire process must be repeated. The process is expensive and repeated burning damages the soil. The extent of the regrowth varies in different areas.

The seed species planted are *Eragrostis* and *Digitaria* – both commercial grass hybrids that grow quickly and are therefore able to compete with the alien seedlings (Figure 38). These two species are, however, not indigenous to the area. The Albany Project is looking into collecting indigenous seeds through grass cutting. The use of indigenous seeds would bring down costs; make the process more ecologically sound and also mean that herbicide would not have to be applied.

Figure 38. A recently cleared slope at Featherstone Kloof where *Eragrostis tef* was used as a cover crop.

Besides manual clearing techniques the Albany Working for Water Project also uses biological control however, this responsibility does not fall under the project manager. The bio-control and the release sites are under the control of Japie Buckle, a private consultant on rehabilitation. Once sections of land have been cleared to the satisfaction of Albany Working for Water, the land is handed back to the landowner, in this case the Municipality. A follow-up treatment is undertaken twelve months after clearing. (Knipe, pers. comm. 2001).

The Albany project is aware that indigenous plants from the Featherstone Kloof area are being harvested, mostly for medicinal uses and believes that the lack of a municipal or conservational presence contributes to the illegal harvesting of the plants. The presence of WFW in the area discourages collectors however, WFW is not in the area on a daily basis and once the clearing has been completed they will leave. Some of the collectors are from the local communities but outsiders collect the majority of the plants. These collectors come into the region, take as much as they can, and then leave. The method of collection is often unsustainable, especially when trees are being ring-barked, as this results in the eventual death of the tree (Pryor, pers. comm. 2001).

One solution discussed at the Public Steering Committee Meeting (2001) by the Albany Project is to paint a strip of each tree with PVA paint, which makes the bark undesirable to plant collectors. This practice has proven to be successful in Natal forests.

A major factor to consider regarding Albany WFW's impact on Featherstone Kloof is that the project will hand the land back to the Grahamstown Municipality in a few years, as is the case for Refyn. The

Municipality lacks the funds and the capacity for management of this land and as such, may struggle to monitor and maintain the condition achieved by the WFW and Refyn.

Analysis of Management Plans and future suggestions

The management plans of Grahamstown Parks & Gardens and Albany Working for Water were analysed according to six criteria. Regarding compliance to National Policy, the two organisations appear to do so. None of the organisations have well defined or documented management plans for Featherstone Kloof, although both appear to be in the process of developing them. Grahamstown Parks & Gardens do not actively monitor the area, while Working for Water does. The effective management of Featherstone Kloof as a Grassy Fynbos area is not likely in the long term unless the current management practices of Grahamstown Parks & Gardens change. Regarding long-term viability, Albany WFW cannot be involved in the management of the land in the long term, as the programme will be terminated in the near future. Currently, Grahamstown Parks & Gardens do not involve all stakeholders, while Albany Working for Water does, to the best of their ability. With the existence of Albany Working for Water the short-term management of Featherstone Kloof appears to be effective. However, for the long-term preservation of the natural vegetation of the Featherstone Kloof area, a management plan must be drawn up, and sufficient resources allocated to the appropriate organisation for implementing the management plan. At present, no long-term management plan exists for the area, and there is a severe lack of resources, both financial and human, of the landowner (Grahamstown Municipality).

In terms of any future management plans for the Featherstone Kloof area, an adaptive approach towards environmental management would be a good approach to follow. If any development occurs in the area however, national policy advocates an Integrated Environmental Management approach. The White Paper on Biodiversity, if passed, will become a very important piece of legislation to follow in any future management plans for the Featherstone Kloof area.

There are a number of environmental management approaches, for example Integrated Environmental Management (IEM) and Strategic Environmental Management. Another of these approaches is Adaptive Environmental Management; "the complexity and uncertainty associated with natural and human systems have also encouraged the development of what has become known as an adaptive environmental management process, or AEM." (Mitchell, 1997:287). Adaptive management involves an approach that can be easily modified depending on the situation. It incorporates both scientific and non-scientific knowledge. It is a precautionary approach and involves the continuous search for better solutions to issues. The major concepts behind the approach are to be able to adapt to the uncertain and unexpected, to learn from successes and failures and to make changes as new information relating to the relevant issues becomes available. Both positive and negative feedback loops are important in adaptive management. The adaptive management approach is both interactive and learning-based. According to Lee (1993:136) "adaptive management is an approach to natural resource policy that embodies a simple imperative; policies are experiments; *learn from them*.... Linking science and human purpose, adaptive management serves as a compass for us to use in searching for a sustainable future." Important to the success of adaptive management is the manager's ability to accept that things have not worked and to make the necessary adjustments.

PART III

PUBLIC PARTICIPATION AND PUBLICITY

First outing Featherstone Kloof with the local branches of the Wildlife Society, Botanical Society and the public to identify the problems of Featherstone Kloof area.

As was stated in one of the objectives of the REFYN projects, it is important to make the general public aware of the importance of restoration of the Grassy Fynbos in the Featherstone Kloof area. Thus, wherever possible, the Grahamstown public and the scientific community were encouraged to become involved, or at least learn about what was being done on this project.

In this section we present extracts taken from the publications and guides that were produced during the course of the REFYN study. These are more-or-less arranged chronologically and each is introduced briefly.

WESSA OUTING TO FEATHERSTONE KLOOF
The Grahamstown Branch of the Wildlife and Environmental Society asked Professor Roy Lubke and Peter Phillipson to take an outing to Featherstone Kloof to explain the problems of alien plant removal and rehabilitation of Grassy Fynbos. This outing was carried out on Wednesday the 21st March 2001. This was a South African holiday (Human Rights Day) and was a very convenient time to take out a group of people that were mainly from the local community, members of the Wildlife Society and Botanical Society. What follows is a three-page handout that was given to the participants on that excursion.

Wednesday 21st March 2001

Leaders: Roy Lubke and Peter Phillipson

Meeting Albany Museum 9am

First stop: Waterloo interchange – East London entrance to N2 9:20 – 9:30
Discussion of alien control – spraying of aliens and introduction of pioneer plants.

Questions:
- What makes a good invader?
- What does it do to the soil?
- What makes a good pioneer cover crop?
- What do we do about firewood?
- How do we remove new alien growth?

Second stop: Halfway up to Signal Hill from Woest Hill turn off
View of the millions of *Acacia longifolia* (long leaved wattle) plants that are becoming re-established following a fire in January 2001.

You are each provided a small quadrat. Measure the size of the quadrat. Place the quadrat on the ground at a random site and remove all of the seedlings of the *Acacia* plants. Count these and then calculate the number per square metre. We will pool all the results and calculate a mean number of seedlings per square metre. Those of you, who are mathematically inclined, can then calculate the number of seedlings over the whole area if we estimate the amount of hectares that have been removed of the Acacia pole-thicket.

Questions:
- Why are there so many seedlings of *Acacia longifolia*?
- Are there any other seedlings coming up at all?
- Are there any sprouters in this vegetation?
- What could we do to inhibit the inter-specific competition (between the indigenous species and *Acacia longifolia* seedlings) that is ousting the return of indigenous species?

- How would we test to see if there are any seeds of the indigenous species in the soil seed bank?

This area was completely covered by a dense pole thicket of *Acacia longifolia* prior to cutting and the fire that occurred in the area in January.

Third stop: Below Signal Hill adjacent to the forest and Grassy Fynbos
This is an attractive ridge of Witteberg quartzite where you can see the *Oldenburgia grandis* or "Rabbit ears" emerging after the fire. Jamie Pote is carrying out a study to show the interface between the forest vegetation and the Grassy Fynbos at this site. Walk along the path from the Grassy Fynbos into the forest and notice the changes in the type of vegetation and the different species that occur.

Questions:

- How many different types of indigenous plants can you see, e.g. herbs, annuals, shrubs, trees etc?
- Are some of these flowering after fire – which?
- Can you see if there are any annuals amongst the plants that are now growing?
- Can you distinguish between resprouters and reseeders?
- Are there some plants that have released their seeds due to the fire?
- How do you think we could enhance the restoration of this area following the fire?

The intensity of the fire in the area because of the aliens probably meant that the fire encroached farther into the forest than normally would be the case if there had simply been Grassy Fynbos growing in this area.

Fourth stop: Above Fernkloof
Fernkloof is a well-known small forest patch that was studied intensely by the late Professor Stanley Siegrief for his M.Sc. thesis in the 1950's. We have a copy of the thesis with us and I will show you some of the maps and diagrams that Professor Siegrief produced. It is hoped that we will be able to carry out a study to re-sample some of these sites and to use more sophisticated quantitative techniques to analyse the data that we obtain. In this way we may get some indication on how the vegetation has changed over the more than 50 year period between the two sampling dates. This area was also completely surrounded by a thicket of aliens, which have been cleared, but the fire did not penetrate right through this area. Walk up to the margins and perhaps a little way into the forest and see if you can identify some of the marginal trees that will be important to re-establish if we are going to extend the former range of these forest patches in a rehabilitation programme.

Fifth stop: halfway along Mountain Drive
This is just a quick stop to view the *Bobartia* veld that has returned. The flowers are past their best now but the grasses and a great variety of species are returning.

Questions:

- See if you can find the African potato, (*Hypoxis* sp.) which is growing in amongst the grasses along the slope.

Sixth stop: Next to the sawmills above Featherstone Kloof
In October last year, we sampled this area with our Botany 3 class and it was almost completely denuded of any vegetation, having been burnt a few months earlier. Notice how the pioneer weedy species *Conyza canadensis* or fleabane has predominated and covered the area. This is an introduced annual weed and although it is doing a good service as a cover crop, I am sure it would be much more attractive and beneficial for us to use our own indigenous pioneer species, such as *Senecio* pterophorus, *Senecio chrysocoma or Helichrysum cymosum.*

Questions:

- How many other species can you observe in this vegetation at present?
- Do you think that the indigenous species have been completely obliterated from the soil seed bank?

Stop seven: At the unburnt fynbos section of the nature reserve, almost at the bottom into Featherstone Kloof.
Note the great diversity of fynbos species here. This is the type of fynbos vegetation we are hoping to restore.

Questions:
- See if you can find *Erica chamissonis,* Grahamstown heath?
- What family do you think is the most abundant in this type of fynbos?
- How many species of Proteaceae can you find in this region?
- What are some of the predominant legumes or pea family species in the area?
- Are there many species of Restionaceae replacing the grasses in this type of fynbos?

Eighth stop: Top end of Featherstone Kloof at an area that has been rehabilitated with *Eragrostis tef*
This area was planted with plants of *Eragrostis tef*, an annual exotic grass, which forms a dense cover. Now it should have been replaced by many of the indigenous species, hopefully with fewer alien *Acacia* species returning. See how many different indigenous species you can find in this patch. We will now walk down towards the stream where a large number of alien weeds such as the bug tree, *Solanum mauritianum*, khakibos, fleabane etc have invaded. It is hoped to restore this to a forest patch leading into wetlands along the stream. The more ambitious can climb up the other slope and into the undisturbed Grassy Fynbos above, where there are a large number of species of fynbos plants present.

Tenth stop: A few 100 metres further down in Featherstone's Kloof we stop and look at the wetland vegetation along the river course.
Here you will have the opportunity to observe many of the wetland species and hopefully some of these will be in flower and we will be able to identify them.

Eleventh stop: 1km down Featherstone Kloof
At this stop we will examine the differences between the two slopes, the north facing slope which is a xerocline, and has mainly dry grassland, with occasional bushy clumps compared with the mesocline, south facing slope which is covered with Grassy Fynbos and forest patches in the kloofs.

Questions:
- Why do you think there are the differences between these two slopes?

Conclusion
I hope that you have had the opportunity to observe many of the problems and the conditions that occur in the region where many aliens have invaded the area for the last 150 years or so and are now being cleared. Rehabilitation is not going to be easy, because of the fact that the aliens keep returning. However, it will be of great advantage to return the great biodiversity and ecosystem function and structure to this area, both for maintaining the diversity of animal life and for providing attractive and interesting scenery for the future generations who will live in this area.

At this point we will return and drive straight back to Grahamstown.

Publications in various media such as the local newspapers, the Internet and international journals.

A fair amount of public interest was generated in South Africa and elsewhere and some of the publications are presented in the pages that follow.

Publication Sunday Independent by the REFYN Journalism Student Kelly Gunnell: 01-04-2001.

Rhodes students win conservation award

BY KELLY GUNNELL

Competing with more than 200 applications worldwide, a South African student team has won the BP Conservation Programme's top award of R77 000. The group of Rhodes university students came out tops with their research project, Refyn – Putting Cape Heath Vegetation (Fynbos) Back.

The BP Conservation Programme is a partnership between BirdLife International, Fauna and Flora International and BP. It aims at assisting and encouraging international teams of students to undertake conservation research projects.

These projects must have a long-term impact and strive to address global conservation priorities.

The BP Conservation Programme maintains this through a comprehensive system of support, training and awards.

This year the programme has given R1,4 million to 21 different projects from 13 different countries. Of that money, R495 000 goes to follow-up awards for teams proposing to continue with projects that were previously funded by the programme.

This year, the follow-up awards went to Madagascar, Russia and China respectively. Awards of between R33 000 to R77 000 went to projects receiving funding for the first time.

First-year awards went to countries as diverse and far afield as Uruguay, the Democratic Republic of Congo, Bolivia and Vietnam. The South African team won the top first-year award.

The Refyn team consists mostly of undergraduate students and a few postgraduate students. The project had minimal lecturer intervention.

Rhodes has a high percentage of foreign students and members of the team hail from South Africa, the Netherlands, France, the United States and Zimbabwe. This international mix provided a strategic advantage in the global competition.

The Rhodes team aims to provide a management plan for the Grassy Fynbos restoration of Featherstone Kloof and Dassie Krantz.

This site consists of 81 hectares of forest, heath and grassland situated on the south-facing slope of the Grahamstown hills.

THE SUNDAY INDEPENDENT
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27/4/2001

Winners of BP Conservation Awards Announced

Twenty-one international student teams have won awards in this year's BP Conservation programme to support groundbreaking research to safeguard some of the most endangered animals and habitats in the world - from the Crested Ibis in China and Marbled Duck in Dagestan to the Giant Otter in Bolivia and Grassy Fynbos Heathlands of South Africa.

Of the winning projects, ten will be studying birds; three studying primates, two studying amphibians and a further two are researching rare plant species. Three teams are based at UK universities while 18 teams will be undertaking research in their home countries. John Robinson, Senior Vice-President and Director of the International Conservation Programmes of the Wildlife
Conservation Society presented the Awards at a ceremony held in London last Wednesday, 25 April 2001.

This year awards ranging from £3,000 to £20,000 are being presented by the Programme to student-led research projects investigating issues of global priority for conservation. Two hundred applications were received by the Programme and were judged by the international selection panel of scientists and conservationists to select the 21 winning teams.

For further details visit http://www.bp.com/centres/press/conservation

Web Address: http://www.europaworld.org/issue32/winnersofbpconservation27401.htm

Publication SA's Floral Heritage: July/August 2001.

14 SA'S FLORAL HERITAGE

New crowns for floral kingdom

A GROUP of South African students have won a major award for their work in helping to restore the Grassy Fynbos ecosystem of South Africa's Eastern Cape.

The "Refyn" project beat competition from projects as far afield as Uruguay and Indonesia to win the BP Conservation Programme Gold Award and a £7,000 award.

Jamie Pote, the man behind "Refyn" and recipient of the BP gold award, spoke with real passion about the fynbos ecosystem he is dedicated to saving.

During his trip to Britain to collect the award he told *South Africa News*: "Grassy Fynbos is the most neglected fynbos type of the Cape Floral Kingdom".

With a big natural smile quite different from the identikit grin of the PR people hovering nearby, Jamie added: "Many of the species there are threatened by the invasion of alien species such as eucalyptus, overgrazing, poor fire management, development and erosion.

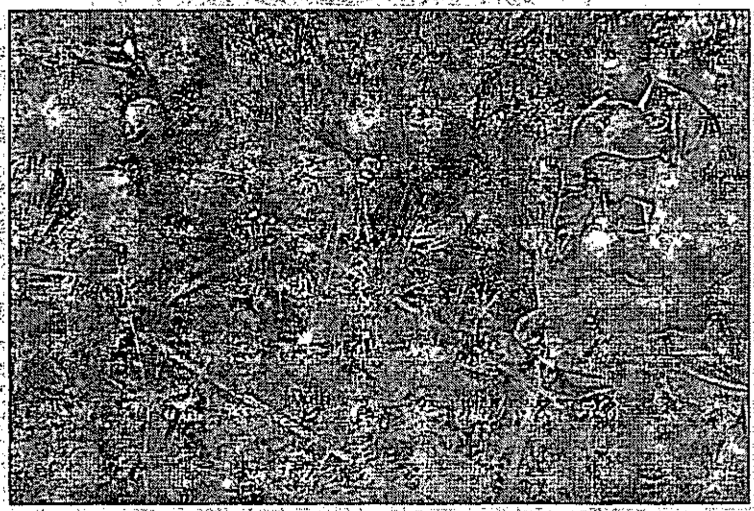
"For example the King Protea, which is South Africa's national flower, depends on the Cape sugar bird and the sunbirds for pollination, if the King Protea disappears the birds would disappear."

"But the ecosystem isn't just important for wildlife" stresses Jamie. "Local people depend on it too. For example, the Hypoxis, which is otherwise known as the African Potato, is also a product of the fynbos. It is highly nutritious and therefore has a great role in stopping HIV from developing into AIDS".

Refyn's ultimate aim is to restore the Grassy Fynbos. The group is intending to use BP's money to identify key species for restoration before developing a management plan for their study site on a former conservation area north of Grahamstown. The project also actively involves the participation of local people in its work.

I'm about to ask Jamie if he's worried that Refyn's good work will be used as something of a sop to BP's other more controversial activities, when the BP management tell me my time is up. They need to swish Jamie off to the official awards ceremony (journalists are not invited).

Once back in South Africa the award money will help rejuvenate the fynbos, and Jamie and his team will have become linked up in an international network of scientists dedicated to the conservation of the world's dwindling biodiversity. That alone is something that is priceless.



Jamie Pote (centre) searches for "keystone" fynbos species to help restore the Grassy Fynbos of the Eastern Cape

Publication EarthYear: July/August 2001.

BULLETIN BOARD

Students come out tops

Competing with more than 200 applications from across the globe, a South African student team has won the BP Conservation Programme's top award of £7 000. The group of Rhodes University students came out tops for their research project called REFYN – Putting Cape Heath Vegetation (Fynbos) Back.

The BP Conservation Programme is a partnership between BirdLife International, Fauna and Flora International and BP. It aims at assisting and encouraging international teams of students to undertake conservation research projects. These projects must have a long-term impact and work to address global conservation priorities at a local level.

This year the programme has given £125 000 to 21 different projects from 13 countries. Of that money, £45 000 goes to teams proposing to follow up on projects that were previously funded by the programme. First-time awards went to projects in Uruguay, Democratic Republic of Congo, Bolivia and Vietnam. The South African team won the top first-year award.

A South African student team wins the BP Conservation Programme's top award

The REFYN team consists mostly of undergraduate students and a few postgraduate students. It aims to provide a management plan for the Grassy Fynbos restoration of Featherstone Kloof and Dassie Krantz.

This site consists of 200 acres of forest, heath and grassland situated on the south-facing scarp slope of the Grahamstown hills. The study sites are Grassy Fynbos areas that are heavily infested by alien vegetation, currently being removed by the national Working for Water programme. The cleared patches are highly susceptible to erosion and need to be restored. The REFYN team has from April 2001 until April 2002 to complete the project. – *Kelly Gunnell*

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The Presentations at the South African Association of Botanists Conference in Grahamstown, January 2002.

The Annual SAAB conference, which is held in a different centre each year was fortuitously held in Grahamstown in January 2002 and a number of oral papers, posters and a field excursion on restoration ecology were presented to coincide with the conference. In the following few pages the details of the conference, the abstracts of papers and posters presented and the handout given to the delegates who went on the excursion are reproduced.

Programme of the annual South African Association of Botanist (SAAB) conference in January 2002.

SAGP SAAB

28th Annual Conference of the

South African Association of Botanists

13 - 16 January 2002
Rhodes University
Grahamstown

1st Announcement and Call for Papers

Conference Address
Secretariat SAAB Conference
The Botany Department
Rhodes University
Box 94
Grahamstown 6140

Website address
http://botany.ru.ac.za/saab/SAAB2002.htm

Plenary Speakers

The following speakers have been invited to participate in plenary sessions and workshops.

- **Dr C Stirton** (Horticulture & Plant Systematics)
  Director of National Botanical Gardens of Wales

Gardens in the 21st Century with emphasis on the /48 million Welsh gardens project.

- **Prof D Cutler** (Developmental Anatomy)
  Honorary Research Fellow, Royal Botanic Gardens, Kew & former Department Keeper & Head of the Plant Anatomy Section, Jodrell Laboratory.

Insights into current research on the use of fuel wood in developing countries &/or tree root systems.

- **Dr J M Anderson** (Palaeobotany)
  National Botanical Institute, Pretoria

Gondwana - the sixth extinction

Workshops

- ***Photosynthesis analysing systems*** (Mr B Ripley, Rhodes University) This will be a one day sponsored workshop to be held after the conference on the 17th January. Presented by representatives from LICOR, USA.

- ***Electrophysiology*** (Prof T Botha, Rhodes University) A short workshop outlining the microinjection & iontophoresis systems, currently developed and used in Rhodes Botany by Prof Ted Botha's research group. Techniques as well as a limited amount of 'hands on' experience using the systems to inject fluorochromes, measure membrane potentials and to measure cytosolic calcium will be undertaken. Space is limited. Scheduled as an evening or post-conference workshop, depending on the number of respondents.

Symposia & Presentations

The papers and poster papers will be presented within "symposia" which we will appoint convenors, who may act as chairpersons. If you are interested in convening a particular symposium please indicate on the reply form. Amongst the planned symposia are:

- ***Plant cell communication encompassing physiology, structure, function & relationships in plants.***
-

  Prof T Botha (Rhodes University).
- ***Restoration Ecology & Field Excursion to the Grassy Fynbos*** – *(REFYN restoration project).*
-

  Prof C Kellner (Potchefstroom University) & Prof R A Lubke (Rhodes University)

- ***Systematics of the Asteraceae***

  Dr N Barker (Rhodes University)

- ***Systematics of the Mesembryanthemaceae***
  Dr M Buys (Potchefstroom University)

Abstract of oral presentation at the annual South African Association of Botanist (SAAB) conference in January 2002. The screening of pioneer species as a cover crop for rehabilitation after the removal of exotic alien species: Presented by Jamie Pote

Grassy fynbos is a vegetation type found along the south-facing hills around Grahamstown. Its distribution extends from Humansdorp in the east to Grahamstown in the west. Although 16% is conserved mostly in the Zuurberg and Addo areas much has become degraded through various grazing and burning regimes together with invasion by alien species. After the Albany Working for Water project began operations in 1998, it became clear that post-operation rehabilitation was necessary in heavily invaded areas. Intervention was required to prevent re-infestation and also to restore biodiversity.

Exotic species, especially A. longifolia, form dense impenetrable pole thickets prone to frequent fires of high intensity. Since infestation began in the early to mid-1900s, stands of alien species have brown steadily replacing indigenous vegetation. These monoculture stands have had many impacts on the system. Frequent high-intensity fires destroy the existing seed banks, they eliminate existing species, soil properties are altered, and water runoff is severely reduced. Soil also becomes enriched by legume species such as the Acacias.

The Working for Water programme has been very successful in their cleaning programme, removing vast areas of the dominating exotics. Although certain areas, mostly previously occupied by pine and eucalyptus, recover rapidly. Those cleared of highly invasive Acacias result in either 2 situations developing. In the first, large burned areas are left with a few scattered plants or post-clearing burns stimulate the alien seed bank forming dense covers of alien regrowth.

Rehabilitation at present consists of 2 techniques: An exotic annual grass, which does not produce seed. E. tef is planted and broadcast seed or plugs. This grass successful out competes A. longifolia regrowth, but densities at which it is planted prevent indigenous species from returning. This treatment is also confined to areas where erosion may be prevalent. Secondly, herbicides are used which eliminate exotics but also any returning indigenous species, although efforts are made to avoid contact with non-alien species.

Field experiments in indigenous G. fynbos have shown that 77% of fynbos regeneration after fire is by resprouters or geophytes while only 13% are reseeders. This, together with soil seed bank experiments suggest that Grassy Fynbos has a poor ability to recolonise cleared areas without intervention, increasing the chances of re-infestation.

While *E. tef* is effective in the short term local pioneer weed species were considered as being a possible alternative. Two species, namely, *Senecio pterophorus* and *Senecio chrysocoma* were observed to occur at high densities in disturbed sites often previously occupied by exotic *Acacias*. They were noticed to be able to compete with exotics, while at the same time, allowing indigenous species to return. Low densities of *Senecio* were also found to have high percentage covers, an important factor when seed is to be produced and sown.

Greenhouse germination trials using the two species with various smoke treatments were performed. Filter paper soaked in three 'firegro' concentrations were used in petri-dish germination experiments. Dilutions used were 1:625; 1:2500 (the recommended dilution) and 1:2500. A control using distilled water was also used. Smoke treatment had a significantly important influence on *Senecio pterophorus* with the medium concentration, while the high concentration significantly reduced germination. Senecio chrysocoma, o significant effect was measured for all treatments.

A short germination delay was found while about 60% germination was achieved within 18 days for Senecio pterophorus and 9 days for Senecio chrysocoma. Final germinations of 50 – 65% were recorded for Senecio pterophorus ad 48 – 55% for Senecio chrysocoma depending on the treatment.

Although seed viability was not determined, the possibility of a bimodal dormancy would only enhance the effectiveness of the species.

Rehabilitation problems are many such as climate, which is bimodal and erratic thus influencing the best time to initiate rehabilitation. Previous studies in the western cape present various problems due to rainfall being mostly during winter.
Changes to soil are also present due to the burning regime used and do to excessive nitrogen production by the acacias. Loss of indigenous seed bank and the huge exotic seed bank further hamper rehabilitation. Loss of rare & endangered species such as Erica chamissonis and Lachenalia convallarioides add a further challenge to rehabilitation. Uncontrolled fires, damage by browsers and grazers including porcupines may also impact o rehabilitation. Finally a loss of an important timber source brought about by the clearing operation must be considered.

Future studies
Soil chemistry studies & improvement methods must be performed together with improved methods of reintroducing lost species that are often vegetative rather than seeders. Many plant/insect/animal relationships are still poorly understood and Management and future uses of the area in question must be considered when selecting the appropriate form of rehabilitation to allow for the needs of user groups to be met.

Poster presented at the annual South African Association of Botanist (SAAB) conference in January 2002.

REFYN - Restoration of Grassy Fynbos in the Eastern Cape, South Africa

Conservation priority

Grassy Fynbos is the most neglected fynbos type of the Cape Floral Kingdom where endemic species are under threat of alien invasion, overgrazing, poor fire management, development and erosion. There are many endangered species that part of the grassy fynbos ecosystem, with fragile relationships between flora and fauna.

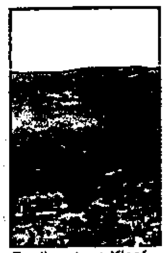
South Africa's national flower the King protea (*Protea cynaroides*).

For example the King protea (*Protea cynaroides* - South Africa's national flower) depends on the Cape sugar bird (*Promeops cafer*) and the sunbirds (*Nectarinia* sp.) for pollination, if the King protea would disappear, the birds would disappear as well.

Objectives

The four main objectives of REFYN are to:

1. Establish a baseline study for the future.
2. Identify keystone species for restoration.
3. Develop a management plan and implementation strategy.
4. Launch a public awareness programme.



Featherstone Kloof.

Main activities

- Recordings and comparative studies between the disturbed and undisturbed sites (identify/screen key species of plants, mycorrhizae, small mammals, herbivores, insects, and birds).
- Literature studies (historic lists and distributions, photos, old maps) to assess the state of degradation of study area.
- Soil seed bank sampling (Regeneration - what is there?).
- Seed sowing trails with keystone species will be carried out in the alien cleared areas to prevent erosion and to restore the site using indigenous species

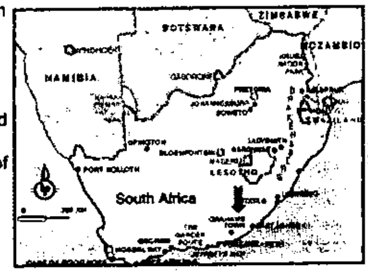
Cape Sugar bird.

Re-growth and germination after fire: *Erica chamissonis* (Grahamstown heath; left) and the alien invader *Acacia longifolia* (right).

Time scale	April	Mar	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
	2001									2002		
Inventory	X	X	X	X	X	X	X	X				
Seed work	X	X	X	X	X	X	X	X	X	X	X	
Comparative studies	X	X	X	X	X	X	X	X	X	X	X	
Mycorrhizae study	X	X	X	X	X	X	X	X				
Public survey, Consultation etc.				X	X	X	X	X				
Brochure							X	X	X	X	X	
Workshops	X				X			X			X	
Report writing										X	X	X

Study site

The study site is situated in the former nature conservation area of Featherstone Kloof and Dassie Kranz on the Grahamstown Commonage in the Eastern Cape, South Africa (26 30'E - 33 20' S). The area consists of 200 acres of forest, wetland and grassland, but is dominated by grassy fynbos situated on the south facing slope of the Grahamstown hills, which rise to a maximum height of 2,535 ft. (760m.)



South Africa, with Grahamstown situated in the Eastern Cape (map Lonely Planet).

Expected results

Short term:

To provide a full checklist/collection of the Grassy Fynbos key species at Featherstone Kloof/Dassie Kranz to understand the process of degradation.

Start with restoring the site using the key stone plant species is seed sowing trails to prevent erosion after alien clearance.

Field trip to Featherstone Kloof.

To develop information booklet for the public and to publish the data of the REFYN project in national journals concerned with conservation and rehabilitation (e.g. Veld & Flora, African wild Life and Oryx).

Ensure that the biological restoration strategies developed through the project can be effectively implemented in the study areas by developing a practical management plan.

Long term:

By actively involving the local interest groups (Working for Water, Wildlife Society, Botanical society, Diaz Bird club, tourism groups, schools) create a solid baseline study so that after the termination of the REFYN project the restoration work will be continued.

The REFYN team

The REFYN project is a project of Rhodes University, in cooperation with the University of Groningen (The Netherlands) and the University of Bremen(Germany). The REFYN team exists of 20 full time under- and post-graduate students at Rhodes University, originating from South Africa, Zimbabwe, Nigeria, Ethiopia, France, Germany and The Netherlands. The team has a broad scientific background including interests in Botany, Mycorrhizae, Environmental Science, Entomology, Zoology and Geography, as well as Law, Economics, and Journalism.

The team at work at Featherstone Kloof during a field trip together with the local branches of the Wildlife Society and Botanical Society.

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REFYN RHODES UNIVERSITY bp BirdLife

Outing at the annual South African Association of Botanist (SAAB) conference in January 2002.

REHABILITATION ECOLOGY EXCURSION - SAAB 2002

1. Introduction – Preamble
The Albany Working for Water Project was introduced in the late 1990's with an overall aim of reducing the number of aliens on the hills surrounding Grahamstown, increasing the water supply by increasing the runoff into streams and consequently rivers which supply our dams. The philosophy behind this programme is:

It is a joint venture between:
Working for Water
Department of Water Affairs and Forestry
Department of Environmental Affairs and Tourism

In reality there are many problems with the Albany Working for Water Project in clearing of alien vegetation. These are the things that we will address in this excursion.
The objectives of the Albany Working for Water programme have been itemized on notice boards that have been placed in various strategic points where they have been working. These are:
Alien Invader plant eradication
Long-term water security
Employment
Empowerment
Social Upliftment
Land care

There are even problems with some of these objectives which you listed above and we can discuss these at the site. One of the main problems of the project is that the rehabilitation goals are not clearly defined. We will see what the actual problems are with rehabilitation, and how with better planning and instigation of a rehabilitation programme, one you would be able to solve the problems.

2.The invasive aliens

Acacia longifolia *(Long leaved Wattle)*
Acacia mearnsii *(Black Wattle)*
Eucalyptus grandis (Blue gum)
Hakea sericea (Silky leaf Hakea)
Pinus pinaster (Pine)

We will stop at a site to examine the low diversity of species in the pole thicket.

The Alien Clearing Programme
We will visit sites where the aliens have been cleared by cutting and burning and the methods and the end result of degraded land for rehabilitation. Questions one may ask are:

Why do they burn the accumulated litter and other biomass?

What happens after the burning?
What about the seeds of the indigenous species in the soil?
Solutions to these problems?

3. The Aliens Return
We will now travel to a site that they cleared last year and in which numerous *Acacia longifolia* seedlings are growing in the soil.

There are few indigenous plants returning and many thousands of *Acacia longifolia.*

How have the indigenous plants returned – seeds, resprouting? This is one aspect that we have examined at one of the sites.

4. The Eradication Programme

The only attempt to out-compete the aliens used by the Working for Water programme is to plant the grass, *Eragrostis tef.* This plant competes well with the acacias but it is very patchy. It also provides a very thick plant cover that does not allow other indigenous species to invade very easily.

We will examine sites where *Eragrostis tef* is competing with *Acacia longifolia*

N.B. *Eragrostis tef* is also an alien, but it is non-invasive as it is an annual and does not form seed.

The net outcome of this process is: cuttings/spraying/cuttings/spraying – what is the alternative?

5. A Rehabilitation Programme
Rehabilitation should be based on scientific principles and follow sound management practice. Ideally it is based on the process of succession where one should introduce pioneer species that can cope with the altered environment and then allow for the introduction of secondary colonizers at various stages of the succession leading towards the climax vegetation. The process of rehabilitation therefore, is one of encouraging and speeding up the process of succession.

In order to introduce a programme of rehabilitation one would therefore be required to divide the area into different management units according to the type of succession in those units, and introduce the appropriate pioneers of the plants to form a climax community.

Grahamstown commonage is particularly diverse with:
Grassy Fynbos
Grassland
Afromontane Forest
Savanna
Thicket (Xeric Succulent)

a) What are the pioneers?
Ideally pioneers should be short-lived grasses, weeds that are annuals or short-lived perennials, many of which would enable other plants to become established with these pioneers. We will see these in the area and examine how ell they compete.

Secondary colonizers.
As the pioneers die out, other plants should be able to invade. Discuss which these second colonizers are, and under what conditions they become established. How do they modify the environment for the climax vegetation?

Climax vegetation.
On South-facing slopes Grassy Fynbos & forest prevails with thicket & savanna in the valleys and lower North-facing slopes. On most North-facing slopes are grasslands.

Studies that have been carried out by students in the REFYN programme:

Screening of pioneer species for use as a cover crop.
Germination trials of pioneer species.
Mycorrhizal associations with Grassy Fynbos
Site history and literature review.
Associations between *Gladiolus* spp. and Porcupines.
Management and social studies include past, present and future ecosystem services, institutions and management.
Water relations of Acacia longifolia
Seedbank studies of invaded and uninvaded sites.
Smoke treatment of seeds

Some of these are discussed in our first newsletter.

Jamie Pote January 2002
Co-leader REFYN Project.

REFYN News Letter

A newsletter was produced in September/October 2001 on the work, which had been done on the project. The following 8 pages are the information that was contained in the REFYN newsletter.

The BP CONSERVATION programme

BirdLife INTERNATIONAL

FAUNA & FLORA International

bp

RHODES UNIVERSITY

October 2001

news REFYN

Students come out tops

Competing with more than 200 applications from across the globe, a South African student team has won the BP Conservation Programme's top award of 7 000. The group of Rhodes University students came out tops for their research project called REFYN - Putting Cape Heath Vegetation (Fynbos) Back.

The BP Conservation Programme is a partnership between BirdLife International, Fauna and Flora International and BP. It aims at assisting and encouraging international teams of students to undertake conservation research projects. These projects must have a long-term impact and work to address global conservation priorities at a local level.

This year the programme has given 125 000 to 21 different projects from 13 countries. Of that money, 45 000 goes to teams proposing to follow up on projects that were previously funded by the programme. First-time awards went to projects in Uruguay, Democratic Republic of Congo, Bolivia and Vietnam. The South African team won the top first-year award.

The REFYN team consists mostly of undergraduate students and a few postgraduate students. It aims to provide a management plan for the Grassy-Fynbos restoration of Featherstone Kloof and Dassie Krantz.

This site consists of 1075 hectares of forest, heath and grassland situated on the south-facing scarp slope of the Grahamstown hills. The study sites are Grassy-Fynbos areas that are heavily infested by alien vegetation, currently being remove by the national Working for Water programme. The cleared patches are highly susceptible to erosion and need to be restored. The REFYN team has from April 2001 until April 2002 to complete the project. - **Kelly Gunnell**

Students collect vital data in the field pic: REFYN

Inside

Early visits
The site at the initial stages and the team ready for action
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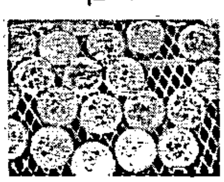
Progress reports
Plant collection and identification - looking at equipmnt and drying
p4



Background
Project background and outreach
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REFYN —————————————————————————— p2 October 2001

The official REFYN poster

REFYN - Restoration of Grassy Fynbos in the Eastern Cape, South Africa

Conservation priority

Grassy Fynbos is the most neglected fynbos type of the Cape Floral Kingdom where endemic species are under threat of alien invasion, overgrazing, poor fire management, development and erosion. There are many endangered species that part of the grassy fynbos ecosystem, with fragile relationships between flora and fauna.

South Africa's national flower the King protea (*Protea cynaroides*)

For example the King protea (*Protea cynaroides* - South Africa's national flower) depends on the Cape sugar bird (*Promerops cafer*) and the sunbirds (*Nectarinia* sp.) for pollination. If the King protea would disappear, the birds would disappear as well.

Objectives

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Featherstone Kloof.

Main activities

• Recordings and comparative studies between the disturbed and undisturbed sites (identify/screen key species of plants, mycorrhizae, small mammals, herbivores, insects, and birds).

• Literature studies (historic lists and distributions, photos, old maps) to assess the state of degradation of study area.

• Soil seed bank sampling (Regeneration - what is there?).

• Seed sowing trails with keystone species will be carried out in the alien cleared areas to prevent erosion and to restore the site using indigenous species.

Cape Sugar bird.

Re-growth and germination after fire: *Erica chamissonis* (Grahamstown heath; left) and the alien invader, *Acacia longifolia* (right).

Time scale	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
	2001									2002		
Inventory	X	X	X	X	X	X	X	X				
Seed work	X	X	X	X	X	X	X	X	X	X	X	
Comparative studies	X	X	X	X	X	X	X	X	X	X	X	
Mycorrhizae study	X	X	X	X	X	X	X	X				
Public survey Consultation etc.				X	X	X	X	X				
Brochure							X	X	X	X	X	
Workshops	X				X			X			X	
Report writing										X	X	X

Study site

The study site is situated in the former nature conservation area of Featherstone Kloof and Dassie Krantz on the Grahamstown Commonage in the Eastern Cape, South Africa (26 30 E - 33 20 S). The area consists of 200 acres of forest, wetland and grassland, but is dominated by grassy fynbos situated on the south facing slope of the Grahamstown hills, which rise to a maximum height of 2,535 ft. (760m)

South Africa, with Grahamstown situated in the Eastern Cape (map Lonely Planet).

Expected results

Short term:

To provide a full checklist/collection of the Grassy Fynbos key species at Featherstone Kloof/Dassie Krantz to understand the process of degradation.

Start with restoring the site using the keystone plant species in seed sowing trails to prevent erosion after alien clearance.

Field trip to Featherstone Kloof.

To develop information booklet for the public and to publish the data of the REFYN project in national journals concerned with conservation and rehabilitation (e.g. Veld & Flora, African Wild Life and Dayo).

Ensure that the biological restoration strategies developed through the project can be effectively implemented in the study areas by developing a practical management plan.

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The team at work at Featherstone Kloof during a field trip together with the local branches of the Wildlife Society and Botanical Society.

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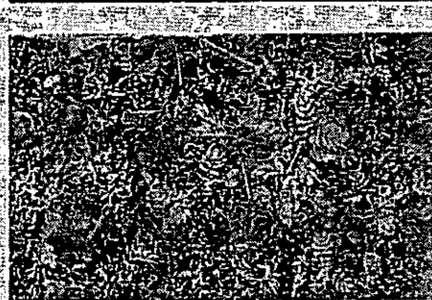
Early visits to Featherstone



All pictures above: Students counting the densities of Acacia longifolia regrowth after a controlled burn.

Left: Gladiolus albens, a local endemic species.

Below: A visit with the Botanical Society to Featherstone Kloof.

Below left: A student collecting soil samples on an early field visit.

all pics: REFYN

Reports from the field

Plant Collection and Identification

The aim of this project, undertaken by Kayombo Canisius, was to target specific plants where specimens from the study area of 138 plant collections were made from the Featherstone Kloof (From Grassy fynbos and forest patches) and have been identified.

Equipment which were used for collection:
Plant press, secateurs, hand lens, newspapers, note book, hammer or digger.
GPS and altimeter.

Drying: Electricity dryer was used to dry the plant specimens at the Schonland Herbarium drying room.

Identification: Identification tools like plant books and mounted plant specimens were used to confirm identification in the Schonland Herbarium.

Future prospects: The remaining unidentified plants will be completed during the September vacation and more targeted plants will be pressed in December vacation.

Whole water Use of *Acacia longifolia*

Experiments were performed on the use of water of whole *A. longifolia* trees by cutting the trees under water. A relationship was found between the tree trunk diameter and the total leaf surface area and thus the standard water loss per unit leaf area could be found for each tree. This standard water loss was related to the Vapour Pressure Deficit, which was monitored throughout the experiment. The water loss for one tree was scaled up to the water loss of a stand of trees by simple quadrat analysis of several stands of *A. longifolia* trees.
Thus a value for the amount of water a hectare of trees use per year, taking into account the hours of sunlight per day, can be calculated.

Mycorrhizal Survey of indigenous plant species in Featherstone Kloof

The Grassy Fynbos has long been neglected by conservation organisations in South Africa. Of the 59413 km^2 of Grassy Fynbos only about 16% is protected. Featherstone Kloof and Dassie Krantz, are Grassy Fynbos areas heavily infested with aliens currently being removed by the national Working for Water Programme. The cleared patches might be susceptible to erosion and need to be restored. This has initiated several projects for rehabilitation in these areas. Major biomes can be characterised by specific mycorrhizal types. Little is known about the mycorrhizal associations of Featherstone Kloof and Dassie Kranz area on the Grahamstown Commonage, Eastern Cape, South Africa and the impact that they might have on seedling re-establishment. This objective of this project is to determine the mycorrhizal status of a range of possible keystone indigenous plant species. This will involve the collection and identification of these species, the preparation of root material, characterisation of mycorrhizal type/s found, isolation and propagation of mycorrhizal fungi for use as inoculum.

The effect of smoke on the photosynthetic physiology of *Chrysanthemoides monolifera*.

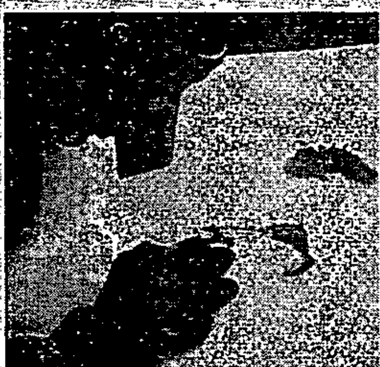
Recently, the effect of smoke on the germination of various fynbos species has been well documented. Little work has been done on the effect of smoke on the physiology of actual plants. This study has undertaken to investigate the physiological response to smoke on *Chrysanthemoides monolifera*, a plant that reacts to fire by resprouting. Initial results showed a lack of photosynthetic effect of smoke on plants burnt in the field. Any differences found may be ascribed to increased water availability or actual physical effects of the fire on the environment. Laboratory studies have subsequently shown that the plants are greatly affected by smoke, in the short term. The smoked plants show, a day long, drop in stomatal conductance and an associated drop in photosynthetic rate. A secondary response to the smoke is that the plants acclimate to the smoke treatments and after few treatments no longer show any significant response. The causal factor for this response appears not to be related to temperature or carbon dioxide concentrations in the smoke. The smoke-germination compound found by Van Staden *et al.* (2000) remains a likely candidate for the response.

Project Background

Ecosystem goods and services

Important Ecosystem services were identified and small research projects undertaken. Water quality has been analysed in the catchment and found to be of excellent quality. Soil moisture on north and south facing slopes was analysed using a theta-probe, in order to establish processes involved in the different communities. The extent or quantity of useful medicinal plants have been studied to provide information useful to future management strategies in terms of potential plant harvesting of such species. Point and Alpha diversity has been calculated for grassy fynbos in order to compare it to other well know vegetation communities.

Aerial photographs between 1942 and 1998 have been obtained and a grid-intercept method used to quantify the change in composition of vegetation communites (including grassy-fynbos, grassland, thicket, afromontane forest and exotic species) in Featherstone Kloof during this time period. This has been performed in order to quantify the extent of invasion by exotic species and also the loss of indigenous communites.



A student meticulously counts seeds for cover crop germination experiments
pic: REFYN

Two students at work in the field, collecting valuable data. pic: REFYN

Management: past and present

This group had the task of studying the manegerial aspect of Featherstone Kloof. To achieve this, the group looked at past management objectives of the area and the strategies employed to achieve these objectives. These have then been compared with specific management formulae found in legislation and environmental management paradigms in order to judge their effectiveness as well as to make possible suggestions as to what mangaement plan would be best suited to the area.

Anthony Colgrave, Richard Pio, Tracey Whitehead, Tracy Cummings, Lindsey McDermott, Fiona Pomgarten.

Public relations and media

Previously Kelly Gunnell produced a number of articles which were published in various forms, including newspapers (Sunday Independant) and magazines (Earth Year). Will Bendix has now taken up this role and will be providing regular updates of the project and new findings to the media to inform the public of the project on provide ongoing feedback. Publications such as Veld & Flora and local newspapers will be the focus.

Environmental education

In order to establish links with local schools, the Environmental Education Department has been approached. Together with them we aim to design activities which teach conservation and restoration and the importance/problems of indigenous and invasive species. This will be implemented during the fourth school term and will run over a number of weeks in collaboration with the Environmental Education Unit with the assistance of Ingrid Timmerma.

Western Cape expedition

In the last week of April, 20 students involved with the REFYN Project and Rehabilitation Ecology course at Rhodes University, visited the western Cape to see restoration projects in action.

On their first night out of Grahamstown, the students stayed at Rein's Coastal Nature Reserve near Albertinia. Here they saw how the reserve is being developed, taking into account the sensitive coastal environment with the emphasis on restoring vegetation that had been disturbed. The next three nights were spent at the Windstone Backpackers at Langebaan. This is adjacent to the old Chemfos mine which has been undergoing rehabilitation for the last five years. The horticulturalist and manager of the project, Deon van Eeden, was appointed by Top Turf for Billiton, who are the owners of the mine and require a closure certificate following rehabilitation. He has carried out various aspects of Strandveld restoration.

Brunsvigia bostraniae, a species found growing extensively in Strandveld near the Chemfos site.

The students were able to study the process in the field where alien Acacias and Blue Gums (Eucalyptus species) had been cleared and examined various sites with different types of management. Deon explained the process of growing plants in the nursery from cuttings, and the collecting and processing of seeds for germination and growth in the greenhouse or field. He has also developed a technique for producing smoke to stimulate the germination of seeds. An added feature was the visit to the fossil dig site and fossil museum as Chemfos has now become the West Coast Fossil Park.

"This was the ideal oppurtunity for students to get a firsthand experience of rehabilitation programmes"

A trip was made south to see rehabilitation projects in the Mountain Fynbos of the western Cape. Dr Pat Holmes, an expert in rehabilitation of the west-coast Fynbos, showed the students various areas where aliens had been cleared and the Mountain Fynbos restored. This entailed a circular trip through the Franschhoek Mountains, and then back via a wine cellar at DuToit's Kloof, and to see the N1 roadside rehabilitation, in which Deon had been involved.

Although it was a lot of travel, this was the ideal opportunity for students to get a firsthand experience of rehabilitation programmes in Fynbos vegetation.

Experts visit REFYN

Dr Pat Holmes of Cape Ecological Services and her husband Dr Tony Rebelo of the National Botanical Institute, visited Grahamstown in July and took the opportunity to go out on site to go and see some of the work which has been done in the removal of aliens from Featherstone's Kloof. Jamie Pote and Roy Lubke showed them where some experimental work had been set up, and the extent of the clearing of the *Acacia longifolia*. In many of the areas *Acacia longifolia* was returning, and in some areas the Working for Water Programme was doing rehabilitation by growing *Eragrostis tef* and planting out of trees.

At the South African Association of Botanists Conference in January 2002, there will be a mini-symposium on restoration. Dr Pat Holmes will probably deliver a paper at this meeting and a visit to the REFYN Project sites will provide an excursion as part of the symposium programme.

REFYN p8 October 2001

Zee Germans are comin'

In August, Roy Lubke and Brad Ripley (who are both supervisors of REFYN projects) returned from Germany having attended the 44th International Association of Vegetation Science Symposium in Freising - Weihenstephan in Bavaria. Roy Lubke presented a paper in the restoration of degraded ecosystems section, where he looked at the selection of species for restoration of degraded forests and grassy fynbos in the area around Grahamstown. This is a broader topic of the REFYN project which is being carried out by the Rhodes students on the Restoration of Grassy Fynbos (REFYN).

Once the invasive aliens such as the Acacia species have been removed from the area by the Albany Working for Water team, a more comprehensive rehabilitation programme is required, and many of the students are looking at aspects of the restoration of the fynbos. This topic, broadened to look at the restoration forests as well, was largely the content of Roy Lubke's paper. Prior to the symposium in Freising, the Rhodes researchers met with colleagues of the University of Bremen with the aim of drafting an exchange programme of research and student involvement. Professor Harmut Koehler and Raimund Kesel have developed a technique for rehabilitation of forest and woodland areas from islands of vegetation and biological soil components, thus speeding up the process of forest restoration. Four of their students who are now completing their degree will hopefully be coming to Grahamstown in January to work on the REFYN project. - **Roy Lubke**

Colleagues from Bremen (from the right) Hartmut Koehler, Marion Zimmerman and Raimund Kesel discuss the process of rehabilitation with Brad Ripley and Roy Lubke (not inpicture). A recently established island of vegetation is in the foreground with another two behind the group.

pic: Roy Lubke

Visit by FFI photographer

Juan Pablo Moreiras and his wife Maria recently visited the project in order to take high quality pictures of grassy-fynbos and the activities surrounding the project. They were on a visit to South Africa to photograph other Fauna and Flora International supported project, including Flower Valley in the Cape and Kruger National Park. These will be used by the REFYN project as well as Fauna and Flora International and BP International for various publications.

Visit the FFI website: www.fauna-flora.org

REFYN photographers Juan Pablo Moreiras and his wife Maria. pic: REFYN

Sasol National Festival of Science and Technology.

This festival is held in Grahamstown, in March each year and on this occasion Rhodes University mounted an exhibition of the *Environment in the Eastern Cape: the past, present and the future.* An important exhibition of rehabilitation in the hills around Grahamstown was mounted by the Department of Botany with the assistance of students who are involved in the REFYN Project. In addition, a rehabilitation ecology excursion was held on three occasions that was similar to the excursions run earlier by the wildlife society, although, by this time, more information had been gathered on the REFYN rehabilitation programme.

What follows is the three-page handout given to the delegates who went on the excursion. There are also five pages of the posters that were displayed at the conference.

REHABILITATION ECOLOGY EXCURSION – SCIFEST 2002

Introduction – Preamble

The Albany Working for Water Project was introduced in the late 1990's with an overall aim of reducing the number of aliens on the hills surrounding Grahamstown, increasing the water supply by increasing the runoff into streams and consequently rivers which supply our dams. It is a joint venture between:

- Working for Water
- Department of Water Affairs and Forestry
- Department of Environmental Affairs and Tourism

The objectives of the Albany Working for Water programme have been itemized on notice boards that have been placed in various strategic points where they have been working. These are:

- Alien Invader plant eradication
- Long-term water security
- Employment
- Empowerment
- Social Upliftment
- Land care

There are even problems with some of these objectives which you listed above and we can discuss these at the site. One of the main problems of the project is that the rehabilitation goals are not clearly defined. We will see what the actual problems are with rehabilitation, and how with better planning and instigation of a rehabilitation programme, one you would be able to solve the problems.

1. The invasive aliens

Acacia longifolia (Long leaved Wattle)

Acacia mearnsii (Black Wattle)

Eucalyptus grandis (Blue gum)

Hakea sericea (Silky leaf Hakea)

Pinus pinaster (Pine)

We will stop at a site to examine the low diversity of species in the pole thicket.

2. The Alien Clearing Programme

We will visit sites where the aliens have been cleared by cutting and burning and the methods and the end result of degraded land for rehabilitation. Questions one may ask are:

- Why do they burn the accumulated litter and other biomass?
- What happens after the burning?
- What about the seeds of the indigenous species in the soil?
- Solutions to these problems?

3. The Aliens Return

We will now travel to a site that they cleared last year and in which numerous *Acacia longifolia* seedlings are growing in the soil.

There are few indigenous plants returning and many thousands of *Acacia longifolia.*

How have the indigenous plants returned – seeds, resprouting? This is one aspect that we have examined at one of the sites.

4. The Eradication Programme

The only attempt to out-compete the aliens used by the Working for Water programme is to plant the grass, teff, *(Eragrostis tef).* This plant competes well with the acacias but it is very patchy. It also provides a very thick plant cover, which does not allow other indigenous species to invade very easily.

We will examine sites where *Eragrostis tef* is competing with *Acacia longifolia*

N.B. *Eragrostis tef* is also an alien, but it is non-invasive as it is an annual and does not form seed.

The net outcome of this process is: cuttings/spraying/cuttings/spraying – what is the alternative?

5. A Rehabilitation Programme

Rehabilitation should be based on scientific principles and follow sound management practice. Ideally it is based on the process of succession where one should introduce pioneer species that can cope with the altered environment and then allow for the introduction of secondary colonizers at various stages of the succession leading towards the climax vegetation. The process of rehabilitation therefore, is one of encouraging and speeding up the process of succession.

In order to introduce a programme of rehabilitation one would therefore be required to divide the area into different management units according to the type of succession in those units, and introduce the appropriate pioneers of the plants to form a climax community.

Grahamstown commonage is particularly diverse with:

- Grassy Fynbos
- Grassland
- Afromontane Forest
- Savanna
- Thicket (Xeric Succulent)

a) What are the pioneers?

Ideally pioneers should be short-lived grasses, weeds that are annuals or short-lived perennials, many of which would enable other plants to become established with these pioneers. We will see these in the area and examine how ell they compete.

b) Secondary colonizers.

As the pioneers die out, other plants should be able to invade. Discuss which these second colonizers are, and under what conditions they become established. How do they modify the environment for the climax vegetation?

c) Climax vegetation.

On South-facing slopes Grassy Fynbos & forest prevails with thicket & savanna in the valleys and lower North-facing slopes. On most North-facing slopes are grasslands.

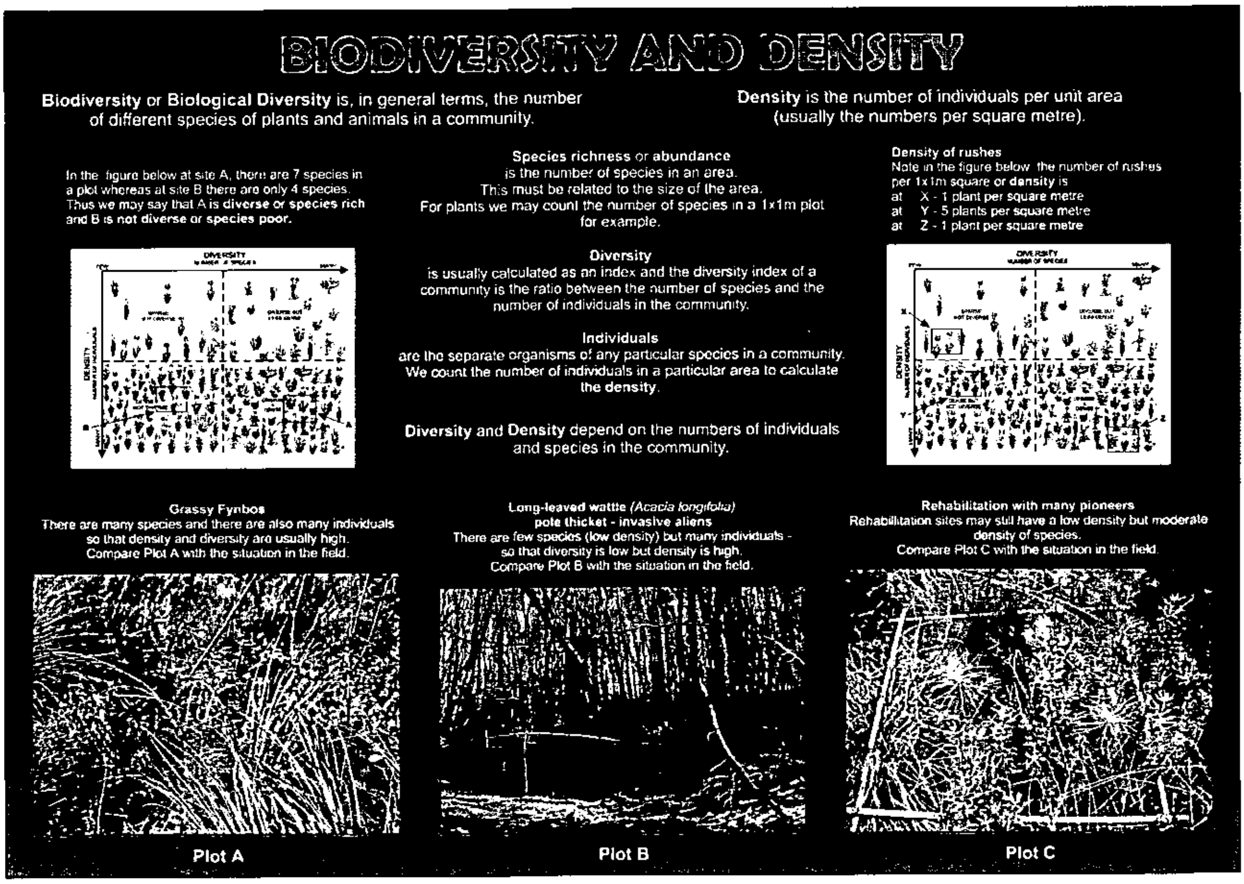
6. Studies that have been carried out by students in the REFYN programme:

- Screening of pioneer species for use as a cover crop.
- Germination trials of pioneer species.
- Mycorrhizal associations with Grassy Fynbos
- Site history and literature review.
- Associations between *Gladiolus* spp. and Porcupines.
- Management and social studies include past, present and future ecosystem services, institutions and management.

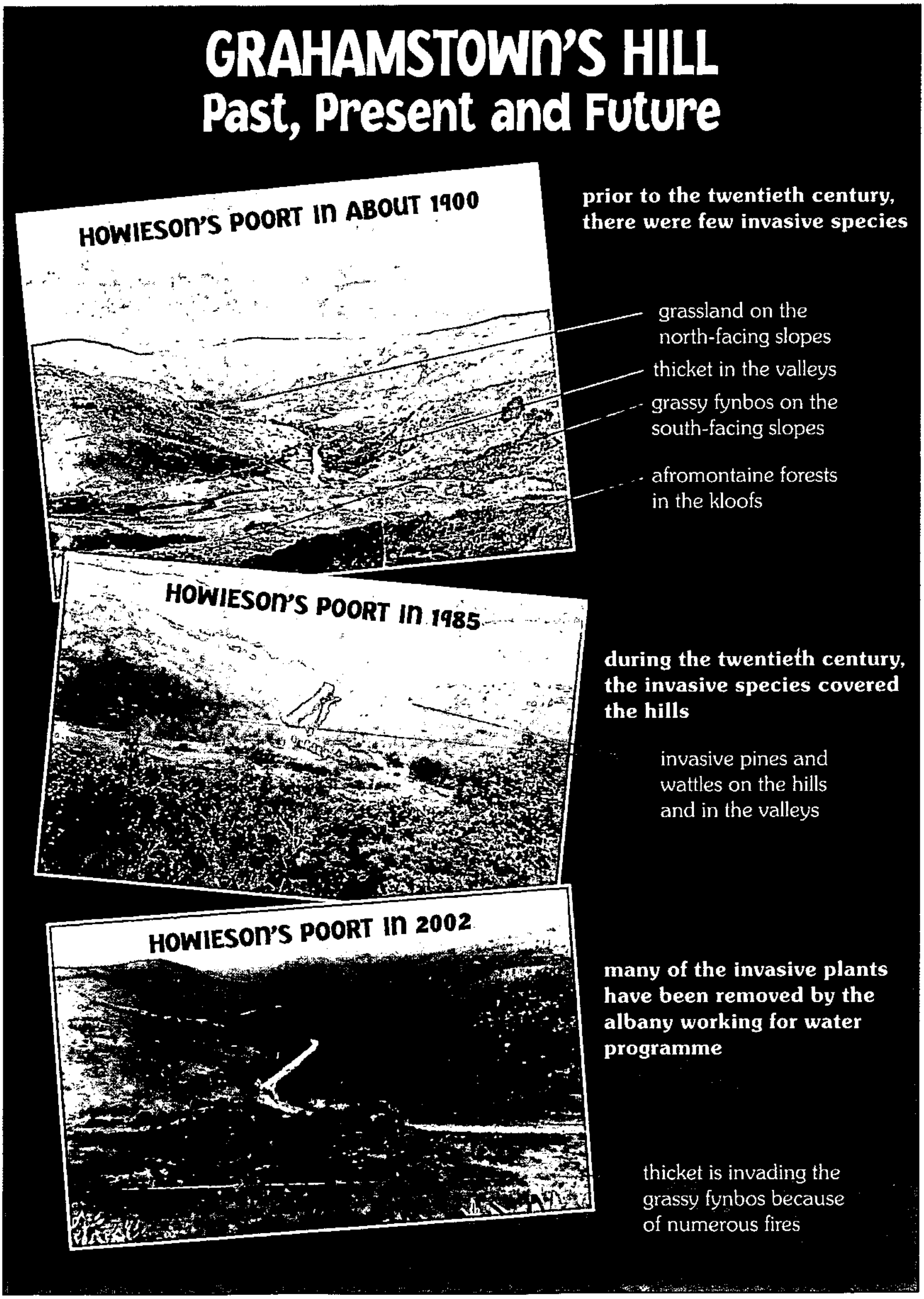
- Water relations of Acacia longifolia
- Seedbank studies of invaded and uninvaded sites.
- Smoke treatment of seeds

Science Festival (SCIFEST) Grahamstown 2002 – Posters displayed.

Biodiversity



Howieson's Poort



Pollination

The Value of Honeybee Pollination in Fynbos

Importance of honeybees

Honeybees are important for the continued existence, multiplicity of plant species and reproductive successes of many plant species partially or totally depend on honeybee pollination.

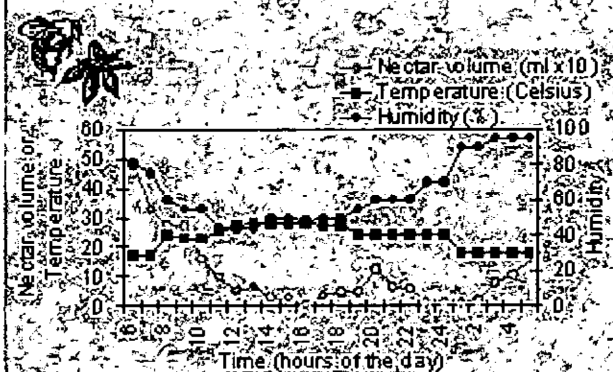
Without honeybee pollination, plant diversity and ecosystem services will be negatively affected.

Beehives situated in the field.

Plant diversity and honeybees

The diversity of fynbos plants with different flowering times ensures that bees can forage throughout the year with continuous honey production and pollination of plants.

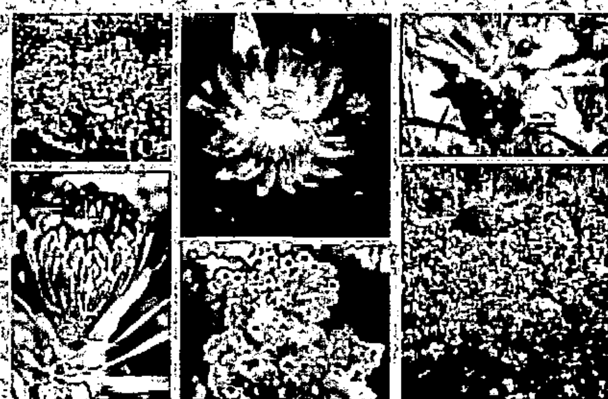
The volume of nectar produced by the plants is related to weather conditions. A relationship is found between nectar volume and temperature and relative humidity for *Burchellia bulbalina*.



Honeybees and grassy fynbos

The destruction of natural habitat of honeybees may reduce species richness and abundance of pollinator population, which result in disruption of plant-pollinator interaction, reduce seed set and change of gene flow of plant population.

A survey of the grassy fynbos showed that many plant species were identified as bee-pollinated plants. The species differed considerably in the amount of pollen and nectar they produce and duration of flowering. The most pollen was collected from *Erica chamissonis*, *Helichrysum odoratissimum*, *Eucalyptus camaldensis*, *Metalasia muricata*, *Agathosma pegleraе*, *Clutia pulchella* and *Chrysanthemoides monilifera*.



Honeybee products

Honeybees are part of the natural fynbos environment and their products, like honey, bee pollen, royal jelly and bee wax, serve as food for animal and man. The fynbos, therefore provides, besides the ecological importance (pollination) also a potential income for the beekeeping industry.

Medicinal Plants

People and Fynbos

Plants of the fynbos supply many useful goods and services that are used by people.

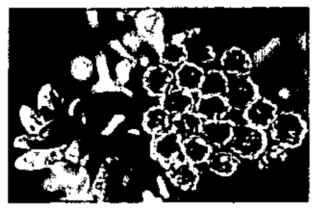
Medicinal Plants: Many fynbos plants are used by people for a variety of medicinal and cultural uses. They contain chemical compounds that act directly or indirectly to prevent or treat disease and maintain health.

Agathosma **(buchu) is part of the cultural heritage of the San and Khoi people. The leaves were chewed to relieve stomach complaints. This practice was later taken over by the early Dutch colonists and buchu or "boegoe" became a famous Cape medicine. The leaves were steeped in brandy and the tincture (commonly known as "boegoebrandewyn") was an everyday remedy for stomach problems.**

Bulbine **leaf sap is widely used for the treatment of wounds, burns, rashes, itches, ringworm, cracked lips and herpes. Roots are taken orally in the form of infusions to quell vomiting and diarrhea and for convulsions, venereal diseases, diabetes, urinary problems, rheumatism, and blood disorders.**

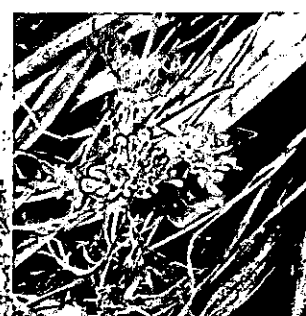
Agapanthus **(isicakathi or blue lily) is widely used orally or rectally as an antenatal and postnatal medicine, and also given to the baby immediately after birth.**

Helichrysum **(impepho) is used as incuse in traditional ceremonies and ailments treated include coughs, colds, fever, infections, headache and menstrual pain.**



Hypoxis **(african potato) Corms are used to treat dizziness, bladder disorders, as a tonic. The stems and leaves are mixed with other ingredients to treat prostate problems. Traditional uses are also said to include testicular tumours, prostate hypertrophy and urinary infections.**

Pelargonium **(geranium) Infusions of the tubers are used to treat diarrhoea and dysentery.**



Aster **(unozixekana) is a traditional headache remedy; the dried roots are powdered and used as snuff to induce sneezing.**

Scabiosa **(makgha, wild scabious) is a remedy for colic and heartburn.**

People and Fynbos

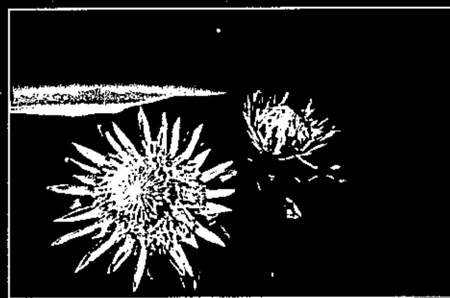
People and Fynbos

Plants of the fynbos supply many useful goods and services that are used by people.

Export flower industry:

The **wildflower industry** (using mostly cut and dried fynbos flowers) provided over 20 000 people (in 1993) with jobs and produced materials worth US$14 million in export.

- Aromatic plants are a potential source for essential oils.
- Horticultural plants for nurseries, gardens and export.
- Pharmaceutical uses.



Food and Raw materials:

Rooibos tea and **Honeybush tea** are made from plants of the Fynbos. These are not only used locally but are exported too.

Honeybees also use fynbos flowers for producing honey and wax.

There are about 1400 **edible plant** species in southern Africa, most of which have not been studied for nutrient content or horticultural use. Many people, especially in rural areas and poor communities are reliant on these as food sources.

The hidden economy of plant products sold and used in rural communities at a household level as building and craft materials, wood, or for medicinal/ceremonial purposes. Many raw materials are found in fynbos, including grass and reeds for **woven baskets** and **mats**, while **thatching** for houses is collected from indigenous vegetation as well. Many people also derive income from these products.

Tourism and Recreation:

The tourism industry in South Africa generates a huge amount of **foreign income** from fynbos, especially in the Western Cape. Included here are the Namaqualand daisies and the highly diverse Proteas and Ericas of the Cape. Many species of birds attract ornithologists (bird watchers) and the unique floral kingdom provides the perfect place for recreations such as camping, hiking, walking and game viewing.

Indirect uses:

All plants, and especially Fynbos plants, are very important to us indirectly as well. They are essential in **preventing soil erosion**, and recycling nutrients through ecosystems as well as producing Oxygen, which we breathe. Many other organisms including wild animals and **insects** are also dependant on fynbos plants and many of these (such as honey from bees) are also useful to us.

IAVS Symposium

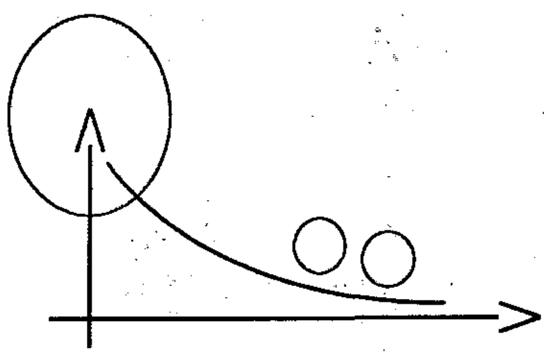
In July 2001, Professor Roy Lubke and Dr Brad Ripley attended the 44th IAVS Symposium in Freising-Westephan in Germany. Using some of the information from the REFYN project, Professor Lubke presented a paper on Fynbos and forest restoration. The abstract of the paper and details of the symposium, follow.

IAVS – Oral presentation international conference

44th IAVS Symposium

29 July - 4 August 2001

Freising-Weihenstephan, Germany



105·L

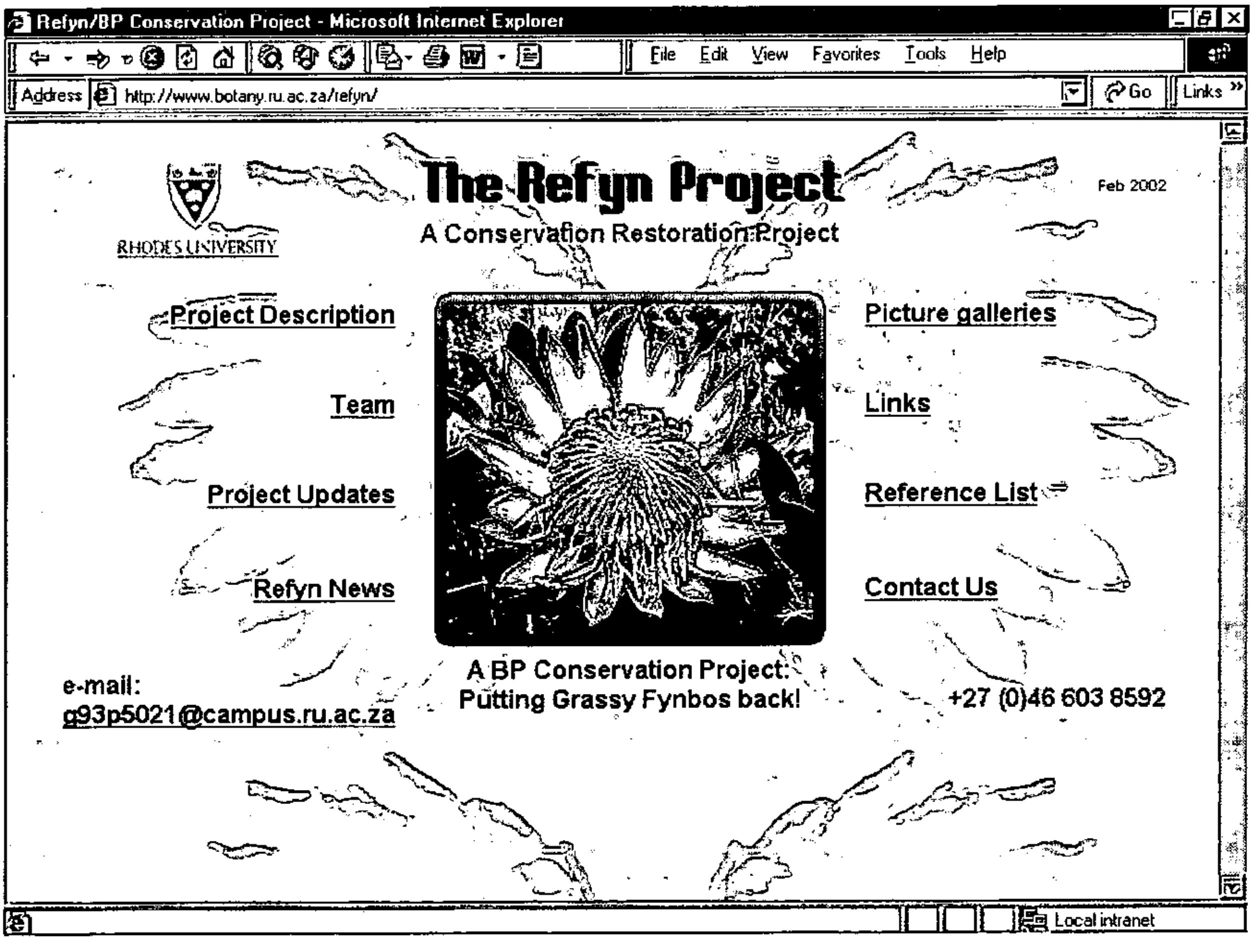
The screening of pioneer species for restoration of degraded forest and grassy fynbos (heath) [following removal of invasive woody aliens, in the Eastern Cape South Africa]

Lubke, R.A.

The indigenous vegetation on the hills around Grahamstown, Eastern Cape, South Africa has recently been cleared of invasive woody aliens such as Acacia spp., Pinus pinaster and Eucalyptus spp., Restoration of forest, grasslands and grassy fynbos (heath vegetation) is problematic because of the lack of a soil seedbank of indigenous species, aggressive behaviour of the re-emerging alien species, (especially seedlings of Acacia longifolia), and soil degradation. Earlier studies of the indigenous vegetation has provided benchmark information on potential species for rehabilitation. Screening of the species through germination trials, using smoke treatments to break dormancy, and field experiments has revealed satisfactory species to use for an annual cover crop, which will successfully compete with alien seedlings .Pioneer woody plants which characterise the early plant communities in succession towards the climax indigenous ecosystems have also been identified and used in greenhouse and field trials. Pilot studies thus provide information for a large scale restoration programme. Conservation of the flora and vegetation of this region is an important contribution towards conserving the Cape Floral Kingdom and the promotion of eco-tourism in the Eastern Cape.

Web page REFYN: http://www.botany.ru.ac.za/REFYN/

In October 2001 a Web page on the REFYN project was produced and the following 5 pages are details that were printed from the Web page.



The REFYN Team

The REFYN project is a project of Rhodes University, in cooperation with the University of Groningen (The Netherlands) and the University of Bremen (Germany).

The REFYN team exists of 20 fulltime under- and post-graduate students at Rhodes University, originating from South Africa, Zimbabwe, Ethiopia, France, Germany, Tanzania and The Netherlands.

The team has a broad scientific background including interests in Botany, Mycorrhizae, Environmental Science, Entomology, Zoology and Geography, as well as Law, Economics, and Journalism.

Project Description

Restoration of Grassy Fynbos in the Eastern Cape, South Africa

Conservation Priority

Grassy Fynbos is the most neglected fynbos type of the Cape Floral Kingdom where endemic species are under threat of alien invasion, overgrazing, poor fire management, development and erosion. There are many endangered species that part of the Grassy Fynbos ecosystem, with fragile relationships between flora and fauna.

For example the King Protea (Protea cynaroides - South Africa's national flower) depends on the Cape sugar bird (Promeops cafer) and the sunbirds (Nectarinia sp.) for pollination, if the King Protea would disappear, the birds would disappear as well.

Study Site

The study site is situated in the former nature conservation area of Featherstone Kloof and Dassie Krantz on the Grahamstown Commonage in the Eastern Cape, South Africa (26 30'E - 33 20' S).

The area consists of 200 acres of forest, wetland and grassland, but is dominated by Grassy Fynbos situated on the south facing slope of the Grahamstown hills, which rise to a maximum height of 2,535 ft. (760m.)

Main activities

- Recordings and comparative studies between the disturbed and undisturbed sites (identify/screen key species of plants, mycorrhizae, small mammals, herbivores, insects, and birds).
- Literature studies (historic lists and distributions, photos, old maps) to assess the state of degradation of study area.
- Soil seed bank sampling (Regeneration - what is there?).
- Seed sowing trails with keystone species will be carried out in the alien cleared areas to prevent erosion and to restore the site using indigenous species

Objectives

The four main objectives of REFYN are to:
1. Establish a baseline study for the future.
2. Identify keystone species for restoration.
3. Develop a management plan and implementation strategy.
4. Launch a public awareness programme.

Expected Results

Short term:

To provide a full checklist/collection of the Grassy Fynbos key species at Featherstone Kloof/Dassie Krantz to understand the process of degradation.
Start with restoring the site using the key stone plant species is seed sowing trails to prevent erosion after alien clearance.

To develop information booklet for the public and to publish the data of the REFYN project in national journals concerned with conservation and rehabilitation (e.g. Veld & Flora, African wild Life and Oryx).
Ensure that the biological restoration strategies developed through the project can be effectively implemented in the study areas by developing a practical management plan.

Long term:

By actively involving the local interest groups (Albany Working for Water, Wildlife Society, Botanical society, Diaz Bird club, tourism groups, schools, Municipality) create a solid baseline study so that after the termination of the REFYN project the restoration work will be continued.

Links Page

BP Conservation Programme
http://www.bp.com/conservation/
The Working for Water Programme
http://www-dwaf.pwv.gov.za/wfw/
Birdlife International
http://www.birdlife.net/
Link to REFYN BP.com page
http://www.bp.com/conservation/
Rhodes University
http://www.ru.ac.za/
South Africa: Department of Environmental Affairs and Tourism
http://www.environment.gov.za/
Vegetation of South Africa: Fynbos:
http://www.environment.gov.za/soer/nsoer/data/vegrsa/veg65.htm

Western Cape Schools Network: Fynbos notes
http://www.wcape.school.za/subject/biology/fynbos/index.htm

Fauna and Flora International
http://www.fauna-flora.org/
National Botanical Institute
http://www.nbi.co.za/http://www.nbi.co.za/
The Botanical Society of South Africa
http://www.botanicalsociety.org.za/
The Wildlife Society of South Africa
http://www.wildlifesociety.org.za/
The Protea Atlas Project
http://protea.worldonline.co.za/default.htm

WWF South Africa
http://www.panda.org.za/

UN documents shortcut
http://www.earthsummit2002.org/es/documents/default.htm

United Nations Environment Programme

Project Updates

The project is nearly at an end and many results have been obtained during the different projects. An update of some of the results is given below:

The aliens of the study site Featherstone Kloof have been cleared, but it was found that the density of the seeds of especially Acacia species in the seed bank was very high and the seeds very persistent. This had as result that after clearing and burning the thousands of seedlings of Acacia germinated after the first rain. One of the projects looked in detail at the effect of fire on the re-growth of Acacia longifolia. The focus was on several treatments, including fire, chopping, competition with commercial species, competition with indigenous species. The conclusion was that the effect of the four treatments on the growth of A. longifolia was very variable. The fire treatment showed the highest seedling emergence and survival compared to the other treatments. Due to the aliens the fires are hotter than with only indigenous vegetation, hence every thing burns to the ground, so even the indigenous vegetation was gone. Therefore it was concluded that when fire is used it should be combined with a supplementary treatment such as specific herbicide application to decline the growth of the Acacia seedlings. The Acacia seedlings grow very fast and form a monostand of seedlings, so precise application of herbicide would hardly effect any other vegetation. Chopping proved to be the most effective treatment to remove Acacia's and allowed the best regeneration of indigenous vegetation, showing the highest re-establishment of species. To compete with the seedling emergence the commercial grass Eragrostis tef was sown to out-compete the Acacia seedlings. The problem was that it also out-competed the indigenous species that germinated. The indigenous species (Senecio spec) did show a reasonable competition with the Acacia seedlings, and allowed other indigenous species to germinate.

After alien clearance the regeneration of the vegetation is important to prevent soil erosion. Besides the alien invaded areas of the Grassy Fynbos, some patches were that were not invaded also burned where the indigenous vegetation grew slowly back by re-seeding (13% of species), growth of geophytes (21%), but mainly due to re-sprouting (66%). The fire and the smoke of the fire were found to have profound effects on the plant re-growth of plant species. For instance the indigenous but on non-Grassy Fynbos species Chrysanthemoides monilifera reacts by slowing down its assimilation until all stomata of the leaves are closed. This might have a direct effect on the re-growth of the species, but after repeated smoke application the plants became 'used' to the smoke and showed no effect, hence the fast re-growth observed in the field. Smoke is also known the have an effect on the germination of seeds. Many species need smoke or fire to germinate in the first place. It was found that some of the pioneer species of the Grassy Fynbos showed an enhanced germination time (start sooner) after a smoke treatment. This is important as the Acacia's are fast germinating species, and by smoke-treating the indigenous pioneers have a higher change to out-compete the aliens seedlings by germination fast as well. Mosses, lichens, liverworts, and algae (cryptobionts) are very important as safe sites for seeds to germinate and seedlings to establish, but due to the hotter fires in alien invaded areas, the cryptobiont species do not survive the blaze of the fire. Besides that, the rapid seedling growth negatively effects the establishment and growth of cryptobionts. Only few cryptobiont species are able to tolerate the exposed conditions in the early post-burn stage. In a succession of older fields that were burned years, it was observed that the number of cryptobiont species increases with time since the site was last burn. Besides a save side for germination of seeds, many fynbos species are known to need mycorrhizal symbioses in the roots. Fynbos vegetation is usually growing on nutrient poor soils and the mycorrhizal benefits to the plant is that it enhances nutrient uptake and works as an antagonist towards parasitic organisms, hence improving the growth of the plant. It was found that most of the species showed to have an association with arbuscular mycorrhizal fungi (AM fungi) and few had specialised mycorrhizal fungi, for instance, the endemic *Erica chamissonis* (Grahamstown Heath), an important plant of the Grassy Fynbos. The seedlings of *Erica* will not grow without its Mycorrhiza present in the roots. The information collected in this project is important to know for the restoration of the site, because when the planting of seedlings is used to re-vegetate parts of Featherstone Kloof, the mycorrhiza's should be 'planted' as well. The nature of Grassy Fynbos species suggests that unassisted re-establishment in degraded areas will be very slow, with a continued high risk of the re-establishment of exotic species. In order to ensure that success is achieved, manual reintroduction of key species will be necessary. Techniques to do this do not necessarily require introducing Grassy Fynbos into the entire area, as long as patches of geophytic and re-sprouting species are established. These will be able to spread as long as a suitable cover crop has been established to confine exotic (or alien) re-growth. Experimental data and observations indicate that *Senecio pterophorus* is most likely to be the best species for use as a cover crop. However because *Senecio chrysocoma* produces more seed per head, it may be economically more suitable than *S. pterophorus*. Planting will have to be immediately after burning or spraying, and a combination of fast-growing grasses and S. pterophorus and/or *S. chrysocoma* may be required to provide fast competitive initial growth and a persistent perennial cover crop which will out-compete alien species. Their biannual nature further increases their usefulness as a long-term defence against invasion of exotic species. Timing of burning will be crucial to allow the seed to be planted when rainfall is sufficient to support growth. Highly variable soil conditions could also be a factor to be considered when selecting species, however much more data will be required before predictions regarding this can be made. It also seems that if fire plays a role in nutrient recycling, then a post clearing burn should be performed. A possible rehabilitation procedure could be as follows:

1. Cut exotic species.
2. Remove large stems and branches that will not burn completely.
3. Burn brushwood to remove and also to both kill and stimulate seed bank.
4. Allow an initial germination of exotic species for a few weeks.
5. Apply an herbicide to eradicate them; because indigenous species have a delayed germination this could be performed before them emerge from the soil.
6. Apply cover crop as discussed above after herbicide has been degraded.
7. Introduce Grassy Fynbos species as rooted cutting in island patches.

When the side is burned species need to re-sprout or germinate to re-establish the vegetation. When the fire it hot the indigenous seed bank might not survive, and seeds have to enter the area via dispersal. One of the possibilities is dispersal by birds. It was found that the birds do bring in many species. Under the different perch sites that were surveyed many species were found in reasonable densities. Unfortunately most species were thicket species; probably the Grassy Fynbos species are dispersed by other means like rodents, and ants. Besides the seed dispersal bulbs and corms of the geophytes can also be dispersed. It was noticed during plant collection trips that many Watsonia plants were uprooted and the corms were lying around, often rolling down the hill. It was though that the porcupines were responsible for the destruction and dispersal of the corms. A study showed that this was true and that they can be very destructive and often smaller populations were destroyed completely. The higher density populations showed less destruction. Porcupines are messy eaters and often corms would roll down the hill and were distributed in that way, given a chance to re-establish them selves. For more information on the other projects not mentioned in the summary see **The Team**

Further there is a Picture Gallery, Reference list, Contact addresses, description of the Team and a .PDF copy of the Refyn report.

GENERAL DISCUSSION AND FUTURE PLANS

GENERAL DISCUSSION

The importance of the conservation of the Fynbos biome was recognised in 1998 when the Cape Action Plan for the Environment (CAPE) was launched. CAPE developed a five-year action plan to investigate the state of biodiversity conservation and to develop a strategy in partnership with the Global Environment Facility to secure the future of the Cape Floral Kingdom. The CAPE strategy provides an important example of how we would like to go about conserving our globally significant biodiversity (CAPE 2000). Most of the fynbos can be found in the Western Cape region, with the last tail of fynbos in the Albany hotspot, including Featherstone Kloof.

At Featherstone Kloof the Working for Water programme cleared the area of most aliens, which gave Refyn the perfect opportunity to monitor "natural restoration", to carry out rehabilitation trials and to reintroduce species which have become locally extinct, and which may not recolonise themselves naturally. The general aim of a restoration project is to reestablish some or all of the links that control processes involved in the ecosystem. The degree to which links need to be repaired, and natural functioning reinstated, depends on the aims of the restoration project and the extent to which the site is transformed. To restore a particular function of an ecosystem we need to know how the assemblages of organisms that coexist form linkages that affect important processes (Cowling 1992, Van Wilgen *et al.* 1992), and how past, present and future management has an impact on the area. The different findings for each aim will be discussed below.

Processes leading to degradation of Grassy Fynbos

The first aim is to understand the process leading to the degradation of the Grassy Fynbos of the Featherstone Kloof area, particularly those related to disturbance. The objectives of this aim are to identify the keystone species that could assist with the restoration of the area and to identify the mycorrhizal types associated with selected plant species.

Over the last few decades *Acacia longifolia* has become a significant problem in Featherstone Kloof and in 1997 the clearing of alien vegetation began. Control of the *Acacia*'s is of great importance as they have adverse effects on the ecosystem processes and community processes of fynbos. Impact on ecosystem processes include change in nutrient status of the soil, a reduction of light for the undergrowth (dense growth), an increased fire intensity and frequency, water loss due to changes in the water catchment areas, habitat loss and a loss of species diversity.

For natural restoration, especially after disturbances like fire, the seeds stored in the soil seed bank are of great importance. However, the higher intensity and frequency of the fires changes the seed bank behaviour of the Grassy Fynbos vegetation. Firstly, the fire cycles are too short for some species to produce seeds resulting in less seeds stored in the seed bank and secondly, the seeds of indigenous species in the top soil layer often do not survive due to the higher fire intensity. Both processes lead to a smaller indigenous seed bank and hence a lower natural restoration after fire. Another problem is the fact that the seeds of *Acacia* form a very dense and persistent seed bank. The seeds of *Acacias* are stimulated to mass germinate after fire and because there are so many they smother seedlings from the slower emerging indigenous species that did survive the fire. Besides seeds from the seed bank, seeds in neighbouring vegetation patches are dispersed into the area and the cryptobiont patches (mosses, algae etc.), provide a safe-site for seeds to germinate. However, due to more frequent fires, the cryptobionts often do not have enough time to regenerate, and hence those safe-sites are lost.

In total over 660 species were found at Featherstone Kloof (including the aliens), which showed an overlap of 53% with the other similar, but less disturbed sites. Not all species on the list are Grassy Fynbos species, as a great diversity of vegetation exists in the Featherstone Kloof area because it is situated in the Albany Hotspot. At Featherstone Kloof many transitional vegetation mosaics are found where the different floristic regions meet. It was therefore not easy to establish the keystone species of the Grassy Fynbos. However, species like *Protea cynaroides*, *Erica chamissonis*, *Hypoxis* spp., *Pelargonium* spp., *Helichrysum* spp., *Bobartia macrocarpa*, *Berkheya* spp., to name a few, are all of importance. The Ericaceae are a very important part and characteristic of fynbos vegetation, therefore the genus *Erica* was investigated in more detail. It was found that of the 33 *Erica* species found at similar sites, only 15% occurred in Featherstone Kloof. This might imply that the Cape Fynbos species are at their eastern-most limits in Featherstone Kloof, or maybe part of the species has disappeared over time.
Erica has very small seeds with hardly any food reserves and seedlings and adults need the help of mycorrhizae to gather enough nutrients to grow. Without the mycorrhizae the seedlings would not survive. In general, fynbos grows in very poor soil, but a diversity of nutrient-acquisition systems helps the fynbos flora to grow, and thus mycorrhizal fungi do play an important role in the reestablishment of Grassy Fynbos species. However, due to changes in plant communities (e.g. alien invasion) the mycorrhizal population might shift. This could have severe consequences for the composition of plant communities as a whole as it will affect factors such as survivorship and competition. It is therefore of vital importance that the mycorrhizal status of plant species used for restoration purposes is known. Fortunately most Grassy Fynbos species (94%) from the alien cleared areas that were examined, still had their associations with *Arbuscular mycorrhizal* fungi. The next step is to isolate and propagate the mycorrhizal fungi associated with the plant species. These fungi will then be used for restoration of the study site or reestablishment of the species (See Future Research).

Natural and Experimental Rehabilitation

The cleared and burned areas are bare and are in need of restoration to prevent soil erosion. This formed the perfect opportunity to study natural and artificial rehabilitation experiments. The second aim of the project was to investigate the natural restoration of the site and the success of current restoration techniques used by the Working for Water programme, after the clearance of alien vegetation.

In a fire prone area like Featherstone Kloof, many species are able to rapidly regenerate after fire. It is important to study regeneration of Grassy Fynbos species in the field, as this will ultimately have to be used to restore the site or be used in artificial rehabilitation programmes. Thus, it is important when selecting species for rehabilitation, that short-term cover crop species and long-term persistent species be incorporated. In the initial stages of rehabilitation after the removal of exotics, the soil seed bank where many seeds lie dormant for years can rapidly recolonise an area. However, it was found that in Grassy Fynbos most species regenerate by resprouting, or were geophytes. This suggests that the initial recovery of Grassy Fynbos is more dependent on resprouters and geophytes than seeders. This might be due to the fact that the seeds in the topsoil germinated after a previous fire cycle (and were killed by the next), or that not enough seeds could be produced before the next fire, or that the seeds did not survive the fire. It could be that seeder species play more of a role during later successional stages. Therefore, recolonisation of Grassy Fynbos communities will be very slow if left to occur via natural succession, with a high risk of the reestablishment of exotic species. Therefore, (pioneer) Grassy Fynbos species will have to be introduced into burnt areas as young plants generated artificially from cuttings or greenhouse germinated seeds.

The mass germination of exotic seeds from the seed bank strongly hinders the restoration of Grassy Fynbos at Featherstone Kloof. The only way to eradicate these seedlings is by using herbicides, however in smaller areas weeding might be a solution. Another option is to prevent mass germination with a fast growing cover crop. The WFW successfully used the cover crop *Eragrostis tef* to out-compete and/or smother the *Acacia* seedlings. However, there are a few disadvantages when using *E. tef*. Firstly, it also smothers the indigenous seedlings, and secondly, the grass dies back after one year giving the exotics a second chance. Thirdly, by smothering the seedlings many *Acacia* seeds will not germinate, but will remain in the soil, ready to germinate later on. Experiments carried out with indigenous pioneer species indicated that *Senecio pterophorus* and *Senecio chrysocoma* are most likely to be the best species to use as an indigenous cover crop.

Sowing or planting will have to be done immediately after burning or spraying, and a combination of fast-growing grasses and *S. pterophorus* and/or *S. chrysocoma* may be required to provide fast competitive initial growth. Their biannual nature further increases their usefulness as a long-term defence against the invasion of exotic species and by the time the *Senecio*'s die back the natural vegetation will have been established. Timing of burning will be crucial to allow the seed/seedlings to be planted when rainfall is sufficient to support growth.

A possible rehabilitation procedure could be:

1. Cut exotic species.
2. Remove large stems and branches that will not burn completely.
3. Burn brushwood to remove and also to kill and stimulate seed bank germination (alien seed bank depletion).
4. Allow an initial germination of exotic species for a few weeks.
5. Apply an herbicide to eradicate them; because indigenous species have a delayed germination this could be performed before they emerge from the soil.
6. Apply cover crop, as discussed above, after herbicide has been degraded.
7. Introduce Grassy Fynbos species as rooted cuttings in island patches.

Management strategies

After restoration of the site, it should be maintained, and a management plan is needed. Therefore, the third aim is to develop a management plan and implementation strategy through a participatory consultation process. The objectives of this part of the project are to develop a practical management plan that would ensure the future restoration of Grassy Fynbos, as well as to assess the financial and institutional requirements for the implementation of this plan through a participatory consultation process with local authorities and environmental groups. However, to formulate the management plan a lot of information is needed on the goods and services of Featherstone Kloof. How the local communities use the area? What was and is the management strategies, and what the owners, the Grahamstown Municipality, plan for the future?

Goods and services: Usage of Featherstone Kloof

Featherstone Kloof is reported to have high species richness in medicinal plants. These ecosystem goods provide for improved health in the greater Grahamstown community and are an important source of income for both local traditional healers and other collectors. The collection and use of medicinal plants is one of the more important strategies employed, mostly by the poor, in order to improve their quality of life. However, in order to assess the sustainability of this harvesting and the impact that this livelihood strategy is having on the resource base one would need to undertake a more extensive study, which would examine the present level of utilisation and the regeneration of individual species in turn. However, the clearing of invasive exotics will certainly benefit this ecosystem by providing greater opportunity for indigenous species to reestablish themselves without having to compete with aliens for limited food and water resources. The ecosystem goods in the form of medicinal plants can continue to assist the livelihoods of future generations; with a sound management policy for the area to insure that harvesting remains sustainable.

Besides medicinal plants, the fynbos could provide wild flowers cut and dried for sale in local supermarkets, plant products sold and used in rural communities, essential aromatic oils, herbal tea (many fynbos species have untapped potential), edible plant parts and seeds, and have possible pharmaceutical uses. As Featherstone Kloof has been shown to be an area of high species diversity, especially in relation to other fynbos vegetation communities, we can assume that it has the potential to provide many ecosystem goods and services in the future.

Recreation

In terms of a change from past to present recreational services, it seems that the type of activities has not changed dramatically, but there has been an increase in the amount of people using Featherstone Kloof for recreation. Several interviewees expressed the opinion that the clearance of alien vegetation has improved the Kloof and special events are enthusiastically attended. Ecotourism based goals could include establishing Featherstone Kloof as an enclosed conservation area, building a limited number of chalets for environmental groups such as hikers and botanists, introduction of game with game viewing and game drives, and an increase in the number of day trails (with a small fee being charged). Benefits of making Featherstone Kloof an enclosed conservation area include facilitating the monitoring of access to the Kloof, thus protecting it from over-plundering by traditional healers and wood collectors, and creating work opportunities for local people. The income generated from creating the conservation area could be used for further conservation measures.

Management: Past, present and future

At a local level there is a perceived 'moral' right to utilise environmental goods and services in the Featherstone Kloof area as came through in the interviews conducted. Most interviewees (including government and municipal officials) conveyed the sentiment that the government owns the land, the government is responsible to the people, and the people are suffering.

Grahamstown Municipality has made no move to request funds from the Department of Land Affairs in order to increase and improve commonage land and previous disadvantaged people's access to it. The Land and Agrarian Reform policy in South Africa stated that the commonage is open to all Grahamstown residents, but this makes monitoring the area (e.g. medicinal plant collection) very difficult. Thus 'allocating' the Featherstone Kloof area to recreational and conservationist activities ensures that the area does not become as degraded as the municipal land closest to the township (which is mainly being used for grazing and harvesting). Wood (fuel, crafts, building) and medicinal plants harvesting is occurring at present in Featherstone Kloof. However, the harvesting of medicinal plants, especially by professional harvesters from outside the area, is unregulated and is seen as a problem by authorities and local traditional healers.

It would appear that the municipality wishes to retain the current status of the Featherstone Kloof area, regardless of whether or not locals could improve their living conditions from agricultural activities in the area (such as grazing and plant collection or propagation).

Local communities are not involved in decision-making processes by the municipality due to a lack of resources and fragmented governmental/municipal departments on a regional and local level.
In the past, no management plans existed for Featherstone Kloof. A shortage of manpower and finances made the regulation and setting of limits and standards difficult because only four staff members are available for the whole area. The use and removal of resources in the area is affected by the lack of regulation. For instance, previously wood collectors paid for wood that was taken out of the area, but after 1994 much control of this practise was lost. Currently, only two organisations actively play a role in the state of Featherstone Kloof; Grahamstown Parks & Gardens and Albany Working for Water, as the Grahamstown Tourism Bureau has no particular interest in the area and has no management plans for it.

At present the landowner, the Grahamstown Municipality has no long-term management plan for the area, and there is a severe lack of resources, both financial and human. More productive conservation is hoped for in the future with the added financial backing and manpower provided by Working for Water. However, effective management of Featherstone Kloof as a Grassy Fynbos area is not likely in the long term. Albany WFW cannot be involved in the management of the land in the long term, as the programme is due to be terminated in the near future. With the existence of Albany Working for Water the short-term management of Featherstone Kloof appears to be effective. But, for the indefinite preservation of the natural vegetation of the Featherstone Kloof area, a management plan must be drawn up, and sufficient resources allocated to the appropriate organisation for implementing the management plan.
In terms of any future management plans for the Featherstone Kloof area, an adaptive approach towards environmental management seems the most feasible. National policy advocates an Integrated Environmental Management approach to any development in the area. If passed, the White Paper on Biodiversity will become a very important piece of legislation to be used as a guideline in any future management plans for the Featherstone Kloof area.

Baseline study: Network of local expertise

The Grahamstown Nature Reserve is situated within the study area and is frequently visited by the public hiking along the Oldenburgia trail, and by local people collecting wood and muti (medicinal plants). Therefore, the fourth objective was to create a baseline study by developing a network of local expertise, local communities and the public to preserve this unique area for the future.

Several interviewees expressed the opinion that the clearance of alien vegetation has improved the Kloof and special events are enthusiastically attended. One of the special events is the 'alien hacks' organised by the local branch of the Botanical Society. There is a small group of dedicated local people that often go on these hacks as well as on rubbish clearing walks. They are mostly members of the local branches of the Botanical Society, Wildlife Society and the Grahamstown Trust who are already concerned with our environment. Unfortunately besides these people, not many others were involved, but our hope lies with future generations. Until recently the potential educational service of the area remained untapped. If the access road is improved so that the area is accessible to two-wheel drive vehicles, it could certainly be marketed as an educational treasure. For example, scholars could learn to appreciate first-hand what it takes to improve water supply and restore biodiversity to an area plagued by alien invasion, by actually going out into the field and talking to, or even physically assisting a Working for Water team. If an educational centre could be established or even basic overnight accommodation, school groups might be more enthusiastic to visit the area as an extended field excursion. However, one would need to get commitment from the local schools before such an investment could be made. Regretfully, there was no response from any township schools regarding their perceptions of the area, and whether they regard themselves as having rights of access to Featherstone Kloof. The project undertaken by Jenny Gon, to prepare an educational package (Appendix 4) has identified the lack of school-level awareness of conservation as an important threat to not only Grassy Fynbos, but other local ecosystems as well. This lack of awareness is noticed at a tertiary education level where student numbers with an ecological interest are very low. Refyn has become a resource provider for the Environmental Education Department and the Makana School Cluster and is involved with various activities.

Another initiative underway in Featherstone Kloof (besides the Refyn project) is the Wetland Project of the Institute for Water Research (Grahamstown). Their project focuses on the water catchment area and will hopefully make further improvements to the Kloof (such as increased bird and insect life) and thus have the potential to attract more users.

FUTURE PLANS

Ecological research in progress

- Propagating the mycorrhizal fungi associated with the plant species, that will be used for restoration of the study site or reestablishment of the species (By: Nadine Rehfelt and Irma Knevel).
- Seedling growth experiments under controlled conditions in sterile soil with and without mycorrhizae (By: Nadine Rehfelt and Irma Knevel).
- Germination trials with other indigenous species that may be possible candidates for rehabilitation (By: Nadine Rehfelt).
- Seed collection for rehabilitation study in Spring 2002 (By: Jamie Pote and Nadine Rehfelt).

Management research in progress

- Stakeholder analysis and public participatory process (By: Sue Harker)

  Although various stakeholders have been involved throughout the project, this will allow greater information sharing and participation since our final report will then be available. Stakeholder groups are to be contacted and meetings arranged for each one listed below. The Refyn report and summary pamphlet (Appendix 3) will be distributed to them before the meeting. Group meetings will be held with stakeholders to collect information regarding their concerns, etc, before a final open workshop is arranged for all stakeholder groups and decision makers, other interested and affected parties will also be invited.

Eight key stakeholders have been identified:

- Municipality (Town Clerk, Parks and Gardens, Newly established environmental forum and other key decision makers)
- Working for water
- Grahamstown Trust (Grahamstown business representation)
- Institute for Water Research (involved in wetland rehabilitation)
- Wood collectors
- Medicinal/food plant collectors
- Conservationist groups (Botanical/Wildlife society)
- Recreational Users

This process will be run in conjunction with the PR process described below.

Public Relations and Educational activities in practice

- Newspaper articles

  Journalist team member Will Bendix will be producing a series of informative and interesting articles for the local newspaper (Grocotts Mail). Aimed at the man in the street, this educational and information sharing activity will introduce and discuss some of the key topics raised by the Refyn project. The articles will hopefully stimulate some discussion with the general public and any responses will be used in the public participatory process above.

Future research

- Rehabilitation experiment with seeds and seedlings in the field.

THE TEAM
PARTICIPANTS
AND ACKNOWLEDGEMENTS

THE TEAM AND PARTICIPANTS

The project was carried out with a student team and a lot of support from the staff of the Department of Botany and the Department of Environmental Science of Rhodes University.

The team

The Refyn project is a co-operative project of the Botany Department and Environmental Science Programme of Rhodes University, Grahamstown, South Africa. The University of Bremen (Germany) and the University of Groningen (The Netherlands) are also involved in the Refyn project. From the University of Bremen one student joined the project to do part of their masters in South Africa. Prof. Jan Bakker and Dr. Renée Bekker of the University of Groningen are involved because they have great experience with soil seed banks and the role they play in restoration.

The Refyn team consists of 24 full-time under- and post-graduate students. Most of the students have two majors, which gives the team a broad scientific background. The team is international, with students coming from South Africa, Zimbabwe, France, Ethiopia, Tanzania, America, Germany and The Netherlands. The projects of the 24 team-members are mentioned in the next section. The team consisted of (in no particular order):

Kayombo Canisius	Sue Harker	Zoe Hall	Ben Jackson	Lisa McDonald
Liz Muller	Ed Rosenfels	Andrew White	Joel Houdet	Tracey Cumming
Nicola Ferrar	Timothy Matthis	Amy Skinner	Paul Barrett	Matthew Gilbert
Admassu Addi Merti	Nadine Rehfelt	Alison Cook	Jenny Gon	Lori Winters
Gene Guthrie	Jolene Dawson	Helen Fox	Jamie Pote *	Irma Knevel *

* Project leaders

The participants

The team members carried the responsibility of collecting the data, but often had help from other non-members. The participants of the project helped to collect a lot of data, and helped to write the individual reports as part of their course work, or on a voluntary basis. The student participants (and team members) of the project are listed behind the projects in which they participated:

Ecological projects:	**Names and degrees**	
The detection of ancient forest sites within the Grassy Fynbos	Zoe Hall and Katherine Casson	BSc
Water use of *Acacia longifolia*	Lori Winter, Zoe Hall, Ben Jackson and Joel Houdet	BSc
The recruitment of seedlings below suitable bird perches	Elizabeth Muller	BSc
Affect of wasp galls on Photosynthetic parameters	Edward Rosenfels	BSc
The effect of fire on cryptobiont cover and diversity	Andrew White	BSc
The effect of various treatments on *Acacia longifolia*	Lisa McDonald	BSc
Porcupine damage to *Watsonia*	Gene Guthrie	BSc
Effect of galls on the reproduction of *Acacia longifolia*	Jolene Dawson	BSc
Mycorrhizal Associations Grassy Fynbos species	Amy Skinner	Honours
Vegetation Featherstone Kloof and surrounding areas	Paul Barratt	Honours

Effect of smoke on seed germination	Paul Barratt	Honours
Effect of smoke on gas exchange *C. monilifera*	Matthew Gilbert	Honours
Seed banks of Indigenous species	Alison Cook, Irma Knevel	-
Seed germination experiments	Fungisai Matemadombo	BSc
Seed germination experiments and species description	Jodi-Anne Williams, Rosa Blaauw	BSc
Bird Survey of Featherstone Kloof	Justin Kemp	BSc
Compiled resource centre	Nomathemba Mhlanga	BSc
Plant Collecting and Identification	Kayombo Canisius	BSc
Honey-bee pollination in Grassy Fynbos	Admassu Addi Merti	MSc
Germination indigenous species	Nadine Rehfelt	MSc
Educational project	Jenny Gon	-
Management projects:	**Names and degrees**	
Ecosystem Services - Past	Timothy Matthis, Jamie Pote, Nuraan Khan, Michelle Stewart	BSc
Ecosystem Services – Present	Sarah Colvin, Phillipa Emmanual, Lungile Gaulana, Frances Crawford	BSc
Institutional and organisational dynamics - past and present	Nicola Ferrar, Ingrid. Butter, Nomazibulo Ndikinda, William Bendix, Landia Davies	BSc
Management Strategies – past and present	Tracey Cumming, Tracey Whitehead, Anthony Colgrave, Lindsey McDermott, Fiona Paumgarten, Richard Pio	BA & BSc
Other students involved:		
Logo design	Jane Sweetman	-
Design REFYN News	William Bendix	-
REFYN accountant	Bonani Boya	-
REFYN journalist	Kelly Gunnell	-

The advisors

Students had an ample back-up team of national and international advisors representing the different disciplines of interest in the Refyn project, especially during the developmental stages. The advisors are (in no particular order) with their field of expertise:

Name	Expertise
Prof. Roy Lubke	Rehabilitation ecology
Mr Brad Ripley	Ecophysiology
Dr. Nigel Barker	Taxonomy/Genetics
Mr Pete Illgner	Institute for water Research (Entomology/Biogeography)
Dr. Martin Villet	Zoology/Entomology/Pollination
Dr. Joanna Dames	Mycorrhizae
Ms Maura Andrews, Prof. Christo Fabricius & Dr. Charlie Shackleton	Environmental Science: Conservation and management.
Dr Patricia Holmes	Cape Ecological Services (Cape Town, Western Cape): Fynbos Restoration.
Dr Tony Rebelo	National Botanical Institute: Fynbos vegetation South Africa
Mr Deon van Eeden	Manager Chemfos Mine Rehabilitation project (Western

	Cape)
Mr Andrew Knipe and Mr Jonathan Prior	Local Working For Water Programme (Eastern Cape).
Mr Kevin Bates	Head of Grahamstown Parks & Gardens – recreation and conservation of Featherstone Kloof
Mr Tony Dold	Taxonomist/associate curator Selmar Schönland Herbarium, Grahamstown.
Ms Estelle Brink	Specialist Featherstone Kloof vegetation/associate curator Selmar Schönland Herbarium
Mr Pete Phillipson	Taxonomy/Ethnobotany/curator of the Selmar Schönland Herbarium
Prof Jan Bakker and Dr. Renée Bekker	University of Groningen (The Netherlands): Seed ecology/soil seed bank restoration

ACKNOWLEDGEMENTS

The project was carried out with a student team and with a lot of support from the staff of the Department of Botany, the Department of Environmental Science of Rhodes University and the herbarium. Many of the lecturers from both Departments were advisors and supervised those students who did part of their course work for the project. In particular we would like to thank Brad Ripley, Joanna Dames, Pete Phillipson, Nigel Barker, Maura Andrew, Charlie Shackleton and Christo Fabricius for all their help and for changing their courses so that the Refyn project could benefit from the data collected. Tony Dold and Estelle Brink, from the herbarium, helped with plant identification and were often prepared to help in the field.

Further we would like to thank all the students that helped in the collection of data, plants and counting seeds etc. The help of those students who were not part of the team or participants list, but came along for the often, laborious fieldwork was greatly appreciated. Many of the members of the Wildlife Society and Botanical Society showed interest in the project and were a source of information, as they knew the Featherstone Kloof area well. Thank you all for your valuable input. Lastly we would like to thank Roy Lubke for his inspiration and involvement in the project, for all his ideas and all the time he was prepared to give us. This research was made possible by the funding linked to the Golden Award from the BP Conservation Programme 2001. A final thanks must go to Marianne Dunn and Paul Matthews of the BP Conservation Programme for their support.

FINANCES

As the financial overview for March will only be available in April these costs could not be included, hence the balance is up to March 2002. Estimations of future costs for research that is in progress are mentioned in a separate trial balance.

Details (March 2001-February 2002)	**Balance (in Rand)**		
	Debit	**Credit**	**Balance**
Revenue (3/4)		**60 084.26**	
Pre-project expenses			
Stationery/computer disks	397.56		
Postage/fax/telephone	1 401.74		
Printing/photocopy	1 242.70		
Aerial photos	360.00		
Equipment (Measuring tapes, poles etc.)	5 608.73		
REFYN poster	357.50		
Subtotal	**9 368.23**		
Field expenses			
Wages (Expert advice, fieldwork assistance etc.)	17 312.92		
Books (Field guides)	1 130.90		
Travel (Field trips, field work etc.)	6 556.80		
Accommodation (incl. food)	4 137.59		
Soil analysis	5 454.52		
Rental car (incl. insurance)	1 463.09		
Subtotal	**36 055.82**		
Other			
Return ticket Germany-South Africa (incl. taxes)	11 264.00		
Air ticket UK	5 218.00		
Reimbursement ticket		5 077.19	
Reimbursement wages		549.10	
Web page (Design, wages etc.)	3 000.00		
Sub-total	**19 842.00**		
Balance	**64 906.05**	**65 710.55**	**804.50**
(Exchange rate March 2001 R11.44 to the pound)	(£5 673.61)	(£5 743.93)	(£70.32)

Costs estimates research in progress	**Balance (in Rand)**		
	Debit	**Credit**	**Balance**
Revenue (1/4)		**28 000.00**	
Future costs			
Report (Printing, binding, CD's)	3 000.00		
Final REFYN News (Printing, design etc.)	600.00		
Public participation study (Wages, workshop etc.)	11 000.00		
Travel costs (Seed and soil collection)	250.00		
Mycorrhiza propagation study (Material costs etc.)	800.00		
Balance	**14 650.00**	**28 000.00**	**13 350.00**
(Exchange rate at present R16.00 to the pound)	(£915.63)	(£1 750.00)	(£834.37)

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APPENDIX

Appendix I. Species checklist of Featherstone Kloof (FSKL) with the overlapping species found at Amatola Mountains (AMA), Humansdorp (HUMA) and Zuurberg (ZUUR).

Family	Species	FSKL	AMA	HUMA	ZUUR
MALVACEAE	*Abutilon sonneratianum* (Cav.) Sweet	1	1	1	1
FABACEAE	*Acacia karroo* Hayne	1	1	1	1
FABACEAE	*Acacia longifolia* (Andr.) Willd.	1	0	0	0
FABACEAE	*Acacia nigrescens* Oliv.	1	0	0	0
EUPHORBIACEAE	*Acalypha ecklonii* Baill.	1	1	0	1
EUPHORBIACEAE	*Acalypha glabrata* Thunb.	1	0	0	1
EUPHORBIACEAE	*Acalypha peduncularis* E. Mey. ex Meisn.	1	1	0	1
AMARANTHACEAE	*Achyranthes aspera* L.	1	1	0	0
ORCHIDACEAE	*Acrolophia capensis* (Berg.) Fourc.	1	0	0	0
EUPHORBIACEAE	*Adenocline acuta* (Thunb.) Baill.	1	1	1	0
EUPHORBIACEAE	*Adenocline pauciflora* Turcz.	1	1	1	0
ALLIACEAE	*Agapanthus comptonii* Leighton	1	0	0	0
ALLIACEAE	*Agapanthus praecox* Willd.	1	1	0	1
RUTACEAE	*Agathosma ovata* (Thunb.) Pillans	1	1	1	0
RUTACEAE	*Agathosma pegleriae* D□mmer.	1	0	0	1
RUTACEAE	*Agathosma venusta* (Eckl. & Zeyh.) Pillans	1	0	1	1
AGAVACEAE	*Agave americana*	1	0	0	0
ROSACEAE	*Agrimonia bracteata* E. Mey. ex. C. A. Mey.	1	0	0	0
POACEAE	*Agrostis lachnantha* Nees	1	0	0	1
LAMIACEAE	*Ajuga ophrydis* Burch. ex Benth.	1	1	0	1
HYACINTHACEAE	*Albuca longifolia* Bak.	1	0	0	0
ROSACEAE	*Alchemilla capensis* Thunb.	1	1	0	1
SCROPHULARIACEAE	*Alectra capensis* Thunb.	1	1	0	1
APIACEAE	*Alepidea capensis* (Berg.) R.A. Dyer	1	1	1	1
SAPINDACEAE	*Allophylus decipiens* (Sond.) Radlk.	1	1	1	1
POACEAE	*Alloteropsis semialata* (R. Br.) Hitchc.	1	1	0	1
ASPHODELACEAE	*Aloe ferox* Mill.	1	1	1	1
ASPHODELACEAE	*Aloe lineata* (Ait.) Haw.	1	0	0	0
ASPHODELACEAE	*Aloe maculata* All.	1	1	0	0
ASPHODELACEAE	*Aloe microcantha* Haw.	1	0	1	1
FABACEAE	*Amphithalea phylicoides* Eckl. & Zeyh.	1	0	0	0
FABACEAE	*Amphithalea williamsonii* Harv.	1	0	0	0
PRIMULACEAE	*Anagallis arvensis* L.	1	0	0	1
PRIMULACEAE	*Anagallis huttonii* Harv.	1	1	0	0
POACEAE	*Andropogon appendiculatus* Nees	1	1	0	1
RANUNCULACEAE	*Anemone caffra* Eckl. & Zeyh.	1	1	0	0
APIACEAE	*Anginon difforme* (L.) B.L. Burtt	1	0	0	0
MALVACEAE	*Anisodontea scabrosa* (L.) Bates	1	1	0	0
IRIDACEAE	*Anomatheca laxa* (Thunb.) Goldbl.	1	1	0	0
RUBIACEAE	*Anthospermum aethiopicum* L.	1	1	1	0

Family	Species	FSKL	AMA	HUMA	ZUUR
RUBIACEAE	*Anthospermum galioides* Reichb.	1	0	1	1
RUBIACEAE	*Anthospermum herbaceum* L.	1	0	0	1
RUBIACEAE	*Anthospermum herbaceum* L. f.	1	1	0	0
ICACINACEAE	*Apodytes dimidiata* E. Mey. ex Arn.	1	1	1	1
ASTERACEAE	*Arctotheca calendula* (L.) Levyns	1	0	0	0
ASTERACEAE	*Arctotis arctotoides* (L. f.) O. Hoffm.	1	1	1	0
FABACEAE	*Argyrolobium collinum* Eckl. & Zeyh.	1	0	1	1
FABACEAE	*Argyrolobium harveyanum* Oliv.	1	0	0	0
FABACEAE	*Argyrolobium molle* Eckl. & Zeyh.	1	1	0	1
FABACEAE	*Argyrolobium pumilum* Eckl. & Zeyh.	1	0	1	0
FABACEAE	*Argyrolobium stipulaceum* Eckl. & Zeyh.	1	1	0	0
FABACEAE	*Argyrolobium tomentosum* (Andr.) Druce	1	1	0	1
FABACEAE	*Argyrolobium tuberosum* Eckl. & Zeyh.	1	1	0	1
IRIDACEAE	*Aristea anceps* Eckl. ex Klatt	1	1	1	1
IRIDACEAE	*Aristea ecklonii* Bak.	1	1	0	1
IRIDACEAE	*Aristea pusilla* (Thunb.) Ker-Gawl.	1	0	1	0
IRIDACEAE	*Aristea schizolaena* Harv. ex Bak.	1	1	0	1
POACEAE	*Aristida junciformis* Trin. & Rupr.	1	1	1	1
ASCLEPIADACEAE	*Asclepias physocarpa* (E. Mey.) Schltr.	1	1	1	0
FABACEAE	*Aspalathus chortophila* Eckl. & Zeyh.	1	0	0	1
FABACEAE	*Aspalathus frankenioides* DC.	1	1	0	1
FABACEAE	*Aspalathus setacea* Eckl. & Zeyh.	1	0	1	0
FABACEAE	*Aspalathus sp.*	1	0	0	0
ASPARAGACEAE	*Asparagus aethiopicus* L.	1	0	1	0
ASPARAGACEAE	*Asparagus africanus* Lam.	1	0	1	0
ASPARAGACEAE	*Asparagus asparagoides* W. Wight	1	0	1	0
ASPARAGACEAE	*Asparagus plumosus* Baker	1	0	0	0
ASCLEPIADACEAE	*Aspidoglossum carinatum* (Schltr.) Kupicha	1	0	0	0
ASCLEPIADACEAE	*Aspidoglossum heterophyllum* E. Mey.	1	0	0	0
ASPLENIACEAE	*Asplenium adiantum-nigrum* L.	1	0	1	0
ASPLENIACEAE	*Asplenium aethiopicum* (Burm. f.) Becherer	1	1	0	0
ASPLENIACEAE	*Asplenium lunulatum* Swartz	1	0	0	1
ASPLENIACEAE	*Asplenium platyneuron* (L.) Oakes	1	1	0	0
ASPLENIACEAE	*Asplenium rutifolium* (Berg.) Kunze	1	1	1	1
ASPLENIACEAE	*Asplenium splendens* Kunze	1	0	1	1
ASTERACEAE	*Aster bakeranus* Burtt Davy ex C.A. Sm.	1	1	1	1
ASTERACEAE	*Athanasia dentata* (L.) L.	1	0	1	1
ASTERACEAE	*Athanasia pinnata* L. f.	1	0	0	1
SALVADORACEAE	*Azima tetracantha* Lam.	1	0	1	1
ASTERACEAE	*Berkheya angustifolia* (Houtt.) Merr.	1	0	1	0
ASTERACEAE	*Berkheya carduoides* (Less.) Hutch.	1	1	1	0
ASTERACEAE	*Berkheya decurrens* (Thunb.) Willd.	1	1	0	1
BRUNIACEAE	*Berzelia intermedia* (Dietr.) Schlechtd.	1	0	1	0
ASTERACEAE	*Bidens pilosa* L.	1	0	0	1

Family	**Species**	**FSKL**	**AMA**	**HUMA**	**ZUUR**
BLECHNACEAE	*Blechnum australe* L.	1	1	0	1
BLECHNACEAE	*Blechnum punctulatum* Swartz	1	0	0	1
IRIDACEAE	*Bobartia indica* L.	1	0	0	0
POACEAE	*Brachiaria serrata* (Thunb.) Stapf	1	0	1	1
ASCLEPIADACEAE	*Brachystelma schizoglossoides* (Schltr.) N.E. Br.	1	0	0	0
POACEAE	*Briza maxima* L.	1	1	1	0
ORCHIDACEAE	*Brownleea coerulea* Harv. ex Lindl.	1	1	0	0
AMARYLLIDACEAE	*Brunsvigia grandiflora* Lindl.	1	0	0	1
FABACEAE	*Buchenroedera multiflora* Eckl. & Zeyh.	1	0	0	1
ASPHODELACEAE	*Bulbine alooides* (L.) Willd.	1	0	1	0
ASPHODELACEAE	*Bulbine cf. filifolia* Bak.	1	0	0	0
ASPHODELACEAE	*Bulbine frutescens* (L.) Willd.	1	0	0	1
ASPHODELACEAE	*Bulbine latifolia* (L. f.) Roem. & Schult.	1	0	0	1
CYPERACEAE	*Bulbostylis humilis* (Kunth) C.B. Cl.	1	1	1	1
RUBIACEAE	*Burchellia bubalina* (L. f.) Sims	1	1	1	0
RUTACEAE	*Calodendrum capense* (L. f.) Thunb.	1	1	0	1
RESTIONACEAE	*Calopsis paniculata* (Rottb.) Desv.	1	1	0	1
RUBIACEAE	*Canthium ciliatum* (Klotzsch) Kuntze	1	1	1	0
RUBIACEAE	*Canthium inerme* (L. f.) Kuntze	1	1	1	1
RUBIACEAE	*Canthium mundianum* Cham. & Schlechtd.	1	1	1	1
BRASSICACEAE	*Cardamine africana* L.	1	1	0	0
CYPERACEAE	*Carex zuluensis* C.B. Cl.	1	1	0	0
APOCYNACEAE	*Carissa bispinosa* (L.) Desf. ex Brenan	1	1	1	1
CYPERACEAE	*Carpha glomerata* (Thunb.) Nees	1	1	0	1
MESEMBRYANTHEMACEAE	*Carpobrotus deliciosus* (L.Bol.) L.Bol.	1	0	1	0
MESEMBRYANTHEMACEAE	*Carpobrotus edulis* (L.) L.Bol.	1	0	1	0
CELASTRACEAE	*Cassine peragua* L.	1	0	1	1
CELASTRACEAE	*Cassine tetragona* (L. f.) Loes.	1	1	1	1
ICACINACEAE	*Cassinopsis ilicifolia* (Hochst.) Kuntze	1	1	0	0
LAURACEAE	*Cassytha ciliolata* Nees	1	0	1	1
ULMACEAE	*Celtis africana* Burm. f.	1	1	0	1
ASTERACEAE	*Cenia sericea* DC.	1	0	0	0
APIACEAE	*Centella asiatica* (L.) Urb.	1	1	0	1
APIACEAE	*Centella eriantha* (Rich.) Drude	1	0	1	0
APIACEAE	*Centella glabrata* L.	1	1	1	1
DIPSACACEAE	*Cephalaria attenuata* (L.f.) Roem.& Schult.	1	0	0	0
CARYOPHYLLACEAE	*Cerastium capense* Sond.	1	1	1	1
ACHARIACEAE	*Ceratiosicyos laevis* (Thunb.) A. Meeuse	1	1	0	0
ACANTHACEAE	*Chaetacanthus setiger* (Pers.) Lindl.	1	1	1	0
IRIDACEAE	*Chasmanthe aethiopica* (L.) N.E. Br.	1	0	1	0
ADIANTACEAE	*Cheilanthes quadripinnata* (Forssk.) Kuhn	1	1	0	0
ADIANTACEAE	*Cheilanthes viridis* (Forssk.) Swartz	1	1	1	1
CHENOPODIACEAE	*Chenopodium album* L.	1	0	0	0
CHENOPODIACEAE	*Chenopodium schraderanum* Roem. & Schult.	1	0	0	0

Family	Species	FSKL	AMA	HUMA	ZUUR
GENTIANACEAE	*Chironia melampyrifolia* Lam.	1	0	0	1
GENTIANACEAE	*Chironia tetragona* L. f.	1	0	1	1
POACEAE	*Chloris virgata* Swartz	1	0	0	0
ASPHODELACEAE	*Chlorophytum capense* (L.) Voss	1	0	0	1
ASPHODELACEAE	*Chlorophytum comosum* (Thunb.) Jacques	1	1	1	1
ASTERACEAE	*Chrysanthemoides monilifera* (L.) T. Norl.	1	1	0	1
ASTERACEAE	*Chrysocoma ciliata* L.	1	1	1	1
ASTERACEAE	*Cineraria geraniifolia* DC.	1	1	0	0
ASTERACEAE	*Cineraria lobata* L'H,rit.	1	0	1	1
ASTERACEAE	*Cineraria saxifraga* DC.	1	0	0	0
RUTACEAE	*Clausena anisata* (Willd.) Hook. f. ex Benth.	1	1	1	1
RANUNCULACEAE	*Clematis brachiata* Thunb.	1	1	1	1
ROSACEAE	*Cliffortia graminea* L. f.	1	0	0	0
ROSACEAE	*Cliffortia linearifolia* Eckl. & Zeyh.	1	1	1	1
ROSACEAE	*Cliffortia paucistaminea* Weim.	1	1	0	1
ROSACEAE	*Cliffortia repens* Schltr.	1	0	0	0
ROSACEAE	*Cliffortia serpyllifolia* Cham. & Schlechtd.	1	1	0	1
EUPHORBIACEAE	*Clutia affinis* Sond.	1	1	1	1
EUPHORBIACEAE	*Clutia heterophylla* Thunb.	1	1	0	1
EUPHORBIACEAE	*Clutia hirsuta* E. Mey. ex Sond.	1	1	0	0
EUPHORBIACEAE	*Clutia laxa* Eckl. ex Sond.	1	0	0	0
EUPHORBIACEAE	*Clutia pulchella* L.	1	1	1	1
CUCURBITACEAE	*Coccinia quinqueloba* (Thunb.) Cogn.	1	1	0	0
COMMELINACEAE	*Commelina africana* L.	1	1	1	1
ASTERACEAE	*Conyza bonariensis* (L.) Cronq.	1	0	0	0
ASTERACEAE	*Conyza pinnata* (L. f.) Kuntze	1	1	0	0
ASTERACEAE	*Conyza scabrida* DC.	1	1	0	1
ASTERACEAE	*Conyza ulmifolia* (Burm. f.) Kuntze	1	0	0	1
BRASSICACEAE	*Coronopus didymus* (L.) Sm.	1	0	0	1
ORCHIDACEAE	*Corycium nigrescens* Sond.	1	0	0	0
ASTERACEAE	*Corymbium africanum* L.	1	0	1	1
ASTERACEAE	*Cotula heterocarpa* DC.	1	1	0	1
CRASSULACEAE	*Cotyledon velutina* Hook. f.	1	0	1	1
CRASSULACEAE	*Crassula campestris* (Eckl. & Zeyh.) x Walp.	1	0	0	0
CRASSULACEAE	*Crassula cultrata* L.	1	0	1	0
CRASSULACEAE	*Crassula ericoides* Haw.	1	0	1	1
CRASSULACEAE	*Crassula lactea* Soland.	1	0	0	1
CRASSULACEAE	*Crassula mesembryanthoides* (Haw.) Dietr.	1	0	0	1
CRASSULACEAE	*Crassula multicava* Lem.	1	0	0	0
CRASSULACEAE	*Crassula muscosa* L.	1	0	1	1
CRASSULACEAE	*Crassula nemorosa* (Eckl. & Zeyh.) Endl. ex Walp.	1	1	1	1
CRASSULACEAE	*Crassula nudicaulis* L.	1	1	1	1
CRASSULACEAE	*Crassula orbicularis* L.	1	1	1	1
CRASSULACEAE	*Crassula pellucida* L.	1	1	1	1

Family	Species	FSKL	AMA	HUMA	ZUUR
CRASSULACEAE	*Crassula perfoliata* L.	1	0	0	1
CRASSULACEAE	*Crassula perforata* Thunb.	1	0	1	1
CRASSULACEAE	*Crassula spathulata* Thunb.	1	1	1	0
CRASSULACEAE	*Crassula vaginata* Eckl. & Zeyh.	1	1	0	1
CORNACEAE	*Curtisia dentata* (Burm. f.) C.A. Sm.	1	1	1	1
CONVOLVULACEAE	*Cuscuta cassytoides* Nees ex Engelm.	1	1	0	0
ARALIACEAE	*Cussonia spicata* Thunb.	1	1	1	1
COMMELINACEAE	*Cyanotis speciosa* (L. f.) Hassk.	1	0	1	1
POACEAE	*Cymbopogon marginatus* (Steud.) Stapf ex Burtt Davy	1	0	1	0
ASCLEPIADACEAE	*Cynanchum ellipticum* (Harv.) R.A. Dyer	1	1	1	0
POACEAE	*Cynodon dactylon* (L.) Pers.	1	1	1	1
BORAGINACEAE	*Cynoglossum hispidum* Thunb.	1	1	1	1
BORAGINACEAE	*Cynoglossum lanceolatum* Forssk.	1	1	0	0
CYPERACEAE	*Cyperus albostriatus* Schrad.	1	1	1	1
CYPERACEAE	*Cyperus obtusiflorus* Vahl	1	1	0	1
LOBELIACEAE	*Cyphia basiloba* E.Wimm.	1	0	0	0
LOBELIACEAE	*Cyphia longifolia* N.E. Br.	1	0	0	0
AMARYLLIDACEAE	*Cyrtanthus contractus* N.E. Br.	1	0	0	0
EUPHORBIACEAE	*Dalechampia capensis* Spreng. f.	1	0	0	1
SOLANACEAE	*Datura stramonium* L.	1	0	0	0
MESEMBRYANTHEMACEAE	*Delosperma calycinum* L. Bol.	1	0	0	0
SCROPHULARIACEAE	*Diascia capsularis* Benth.	1	0	0	1
SCROPHULARIACEAE	*Diclis reptans* Benth.	1	1	0	0
URTICACEAE	*Didymodoxa caffra* (Thunb.) Friis & Wilmot-Dear	1	1	0	1
IRIDACEAE	*Dierama pendulum* (L. f.) Bak.	1	1	1	1
IRIDACEAE	*Dietes iridioides* (L.) Sweet ex Klatt	1	1	1	1
POACEAE	*Digitaria diagonalis* (Nees) Stapf	1	1	0	0
POACEAE	*Digitaria monodactyla* (Nees) Stapf	1	0	0	1
POACEAE	*Digitaria natalensis* Stent	1	0	0	1
DIOSCOREACEAE	*Dioscorea sylvatica* (Kunth) Eckl.	1	1	1	1
EBENACEAE	*Diospyros lycioides* Desf.	1	1	1	1
EBENACEAE	*Diospyros pallens* (Thunb.) F. White	1	0	0	0
EBENACEAE	*Diospyros scabrida* (Harv. ex Hiern) De Winter	1	1	1	1
EBENACEAE	*Diospyros villosa* (L.) de Winter	1	1	1	0
EBENACEAE	*Diospyros whyteana* (Hiern) F. White	1	1	0	1
HYACINTHACEAE	*Dipcadi ciliare* (Zeyh. ex Harv.) Bak.	1	0	0	0
FABACEAE	*Dipogon lignosus* (L.) Verdc.	1	0	1	1
ORCHIDACEAE	*Disa sagittalis* (L. f.) Swartz	1	1	0	0
ASTERACEAE	*Disparago ericoides* (Berg.) Gaertn.	1	0	1	1
ORCHIDACEAE	*Disperis micrantha* Lindl.	1	1	0	0
FLACOURTIACEAE	*Dovyalis rhamnoides* (Burch. ex DC.) Harv.	1	0	1	1
DRACAENACEAE	*Dracaena hookeriana* K. Koch	1	0	0	0
DROSERACEAE	*Drosera cuneifolia* L. f.	1	0	0	0

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ASPIDIACEAE	*Dryopteris inaequalis* (Schlechtd.) Kuntze	1	1	1	1
ASTERACEAE	*Edmondia pinifolia* (Lam.) Hilliard	1	0	0	0
POACEAE	*Ehrharta calycina* J.E. Sm.	1	1	1	1
POACEAE	*Ehrharta ottonis* Kunth ex Nees	1	0	0	0
MELIACEAE	*Ekebergia capensis* Sparrm.	1	1	1	0
CYPERACEAE	*Eleocharis limosa* (Schrad.) Schult.	1	0	0	0
POACEAE	*Elionurus muticus* (Spreng.) Kunth	1	1	0	1
ASTERACEAE	*Elytropappus rhinocerotis* (L. f.) Less.	1	1	1	1
POACEAE	*Eragrostis capensis* (Thunb.) Trin.	1	1	1	1
POACEAE	*Eragrostis curvula* (Schrad.) Nees	1	1	1	1
POACEAE	*Eragrostis obtusa* Munro ex Fical. & Hiern	1	0	1	1
POACEAE	*Eragrostis plana* Nees	1	0	0	1
POACEAE	*Eragrostis racemosa* (Thunb.) Steud.	1	1	0	1
POACEAE	*Eragrostis sp.*	1	0	0	0
ERICACEAE	*Erica caffra* L.	1	1	0	1
ERICACEAE	*Erica calycina* L.	1	0	0	0
ERICACEAE	*Erica cerinthoides* L.	1	0	1	1
ERICACEAE	*Erica chamissonis* Klotzsch ex Benth.	1	0	1	1
ERICACEAE	*Erica demissa* Klotzsch ex Benth.	1	0	1	1
ERICACEAE	*Erica glumiflora* Klotzsch ex Benth.	1	0	1	0
ERICACEAE	*Erica leucopelta* Tausch	1	1	0	0
ERICACEAE	*Erica nemorosa* Klotzsch ex Benth.	1	0	1	0
FABACEAE	*Eriosema salignum* E. Mey.	1	0	0	1
ERIOSPERMACEAE	*Eriospermum natalense* Bak.	1	1	0	0
FABACEAE	*Erythrina caffra* Thunb.	1	0	1	0
EBENACEAE	*Euclea racemosa* Murr.	1	0	1	0
EBENACEAE	*Euclea undulata* Thunb.	1	1	1	1
HYACINTHACEAE	*Eucomis autumnalis* (Mill.) Chitt.	1	1	0	1
MYRTACEAE	*Eugenia zeyheri* Harv.	1	1	0	1
POACEAE	*Eulalia villosa* (Thunb.) Nees	1	1	0	0
ORCHIDACEAE	*Eulophia clavicornis* Lindl.	1	0	0	1
EUPHORBIACEAE	*Euphorbia epicyparissias* E. Mey. ex Boiss.	1	1	0	0
EUPHORBIACEAE	*Euphorbia kraussiana* Bernh.	1	1	1	1
EUPHORBIACEAE	*Euphorbia pugniformis* Boiss.	1	0	0	1
EUPHORBIACEAE	*Euphorbia silenifolia* (Haw.) Sweet	1	0	1	1
EUPHORBIACEAE	*Euphorbia striata* Thunb.	1	1	0	1
ASTERACEAE	*Euryops brachypodus* (DC.) B. Nord.	1	0	0	0
ASTERACEAE	*Euryops euryopoides* (DC.) B. Nord.	1	0	1	1
ASTERACEAE	*Felicia echinata* (Thunb.) Nees	1	0	1	0
ASTERACEAE	*Felicia filifolia* (Vent.) Burtt Davy	1	1	1	1
ASTERACEAE	*Felicia muricata* (Thunb.) Nees	1	1	0	0
POACEAE	*Festuca caprina* Nees	1	1	1	0
POACEAE	*Festuca costata* Nees	1	1	1	1
POACEAE	*Festuca scabra* Vahl	1	0	1	1

Family	**Species**	**FSKL**	**AMA**	**HUMA**	**ZUUR**
CYPERACEAE	*Ficinia elongata* Boeck.	1	0	0	0
CYPERACEAE	*Ficinia fascicularis* Nees	1	1	0	0
CYPERACEAE	*Ficinia nigrescens* (Schrad.) J. Raynal	1	0	1	0
CYPERACEAE	*Ficinia ramosissima* Kunth	1	0	1	0
CYPERACEAE	*Ficinia stolonifera* Boeck.	1	1	1	0
CYPERACEAE	*Ficinia trichodes* (Schrad.) Benth. Hook f..	1	0	0	0
CYPERACEAE	*Ficinia tristachya* (Rottb.) Nees	1	1	1	0
MORACEAE	*Ficus burtt-davyi* Hutch.	1	1	1	1
MORACEAE	*Ficus ingens* (Miq.) Miq.	1	0	0	1
MORACEAE	*Ficus sur* Forssk.	1	1	0	1
CYPERACEAE	*Fuirena hirsuta* (Berg.) P.L. Forbes	1	1	1	1
AIZOACEAE	*Galenia pubescens* (Eckl. & Zeyh.) Druce	1	0	0	1
RUBIACEAE	*Galopina circaeoides* Thunb.	1	1	0	1
ASTERACEAE	*Gazania linearis* (Thunb.) Druce	1	1	1	0
IRIDACEAE	*Geissorhiza bracteata* Klatt	1	0	1	0
GERANIACEAE	*Geranium caffrum* Eckl. & Zeyh.	1	1	0	1
GERANIACEAE	*Geranium ornithopodon* Eckl. & Zeyh.	1	1	0	0
ASTERACEAE	*Gerbera piloselloides* (L.) Cass.	1	1	1	1
IRIDACEAE	*Gladiolus maculatus* Sweet	1	0	0	0
IRIDACEAE	*Gladiolus permeabilis* Delaroche	1	0	1	0
IRIDACEAE	*Gladiolus tristis* L.	1	0	0	0
ASTERACEAE	*Gnaphalium vestitum* Thunb.	1	1	1	1
THYMELAEACEAE	*Gnidia anthylloides* (L. f.) Gilg	1	0	1	1
SCROPHULARIACEAE	*Graderia scabra* (L.f.) Benth.	1	1	1	1
LOBELIACEAE	*Grammatotheca bergiana* (Cham.) Presl	1	1	0	1
TILIACEAE	*Grewia occidentalis* L. f.	1	1	1	1
HALORAGACEAE	*Gunnera perpensa* L.	1	1	0	1
ORCHIDACEAE	*Habenaria arenaria* Lindl.	1	0	0	1
ORCHIDACEAE	*Habenaria falcicornis* (Burch. ex Lindl.) H. Bol.	1	1	0	0
ORCHIDACEAE	*Habenaria laevigata* Lindl.	1	1	0	0
AMARYLLIDACEAE	*Haemanthus albiflos* Jacq.	1	1	0	1
PROTEACEAE	*Hakea acicularis* R. Br.	1	0	0	0
SCROPHULARIACEAE	*Halleria lucida* L.	1	1	1	1
ASTERACEAE	*Haplocarpha lyrata* Harv.	1	0	1	1
ASTERACEAE	*Haplocarpha scaposa* Harv.	1	1	1	1
ANACARDIACEAE	*Harpephyllum caffrum* Bernh. ex Krauss	1	1	1	1
POACEAE	*Harpochloa falx* (L. f.) Kuntze	1	1	1	1
ASPHODELACEAE	*Haworthia monticola* (BAK.)FOURC	1	0	0	0
SELAGINACEAE	*Hebenstretia dentata* L.	1	0	0	0
ASTERACEAE	*Helichrysum anomalum* Less.	1	1	1	1
ASTERACEAE	*Helichrysum appendiculatum* (L. f.) Less.	1	1	1	1
ASTERACEAE	*Helichrysum cymosum* (L.) D. Don	1	1	1	1
ASTERACEAE	*Helichrysum felinum* Less.	1	1	1	1
ASTERACEAE	*Helichrysum foetidum* (L.) Moench	1	1	0	0

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ASTERACEAE	*Helichrysum nudifolium* (L.) Less.	1	1	1	1
ASTERACEAE	*Helichrysum odoratissimum* (L.) Sweet	1	1	1	1
ASTERACEAE	*Helichrysum oxyphyllum* DC.	1	1	0	1
ASTERACEAE	*Helichrysum petiolare* Hilliard & Burtt	1	1	0	0
ASTERACEAE	*Helichrysum pilosellum* (L. f.) Less.	1	1	0	1
ASTERACEAE	*Helichrysum rosum* (Berg.) Less.	1	0	1	1
ASTERACEAE	*Helichrysum rugulosum* Less.	1	1	0	1
ASTERACEAE	*Helichrysum spiralepis* Hilliard & Burtt	1	1	0	1
ASTERACEAE	*Helichrysum subglomeratum* Less.	1	1	1	0
ASTERACEAE	*Helichrysum umbraculigerum* Less.	1	1	0	0
ASTERACEAE	*Helichrysum xerochrysum* DC.	1	1	0	0
POACEAE	*Helictotrichon turgidulum* (Stapf) Schweick.	1	0	0	0
BRASSICACEAE	*Heliophila elongata* (Thunb.) DC.	1	1	0	1
ASTERACEAE	*Helipterum milleflorum* (L.) Druce	1	0	0	1
STERCULIACEAE	*Hermannia flammea* Jacq.	1	0	1	1
STERCULIACEAE	*Hermannia hyssopifolia* L.	1	0	1	1
STERCULIACEAE	*Hermannia velutina* DC.	1	1	1	0
IRIDACEAE	*Hesperantha falcata* (L. f.) Ker-Gawl.	1	0	1	0
IRIDACEAE	*Hesperantha radiata* (Jacq.) Ker-Gawl.	1	0	0	0
APIACEAE	*Heteromorpha arborescens* (Thunb.) Cham. & Schlechtd	1	1	1	0
POACEAE	*Heteropogon contortus* (L.) Roem. & Schult.	1	1	1	1
MALVACEAE	*Hibiscus aethiopicus* L.	1	1	1	1
MALVACEAE	*Hibiscus trionum* L.	1	1	1	1
SAPINDACEAE	*Hippobromus pauciflorus* (L. f.) Radlk.	1	1	1	1
ORCHIDACEAE	*Holothrix parviflora* (Lindl.) Reichb. f.	1	0	1	0
ORCHIDACEAE	*Holothrix schlechteriana* Schltr. ex Kraenzl.	1	0	0	0
ORCHIDACEAE	*Holothrix villosa*	1	0	0	0
POACEAE	*Hyparrhenia hirta* (L.) Stapf	1	1	0	1
RUBIACEAE	*Hyperacanthus amoenus* (Sims) Bridson	1	1	0	1
CLUSIACEAE	*Hypericum lalandii* Choisy	1	1	0	1
CLUSIACEAE	*Hypericum wilmsii* R. Keller	1	0	0	0
ASTERACEAE	*Hypochoeris radicata* L.	1	1	1	1
ACANTHACEAE	*Hypoestes aristata* (Vahl) Soland. ex Roem. & Schult.	1	0	1	0
ACANTHACEAE	*Hypoestes forskaolii* (Vahl) R. Br.	1	1	1	1
DENNSTAEDTIACEAE	*Hypolepis sparsisora* (Schrad.) Kuhn	1	1	0	0
HYPOXIDACEAE	*Hypoxis argentea* Harv. ex Bak.	1	0	0	0
HYPOXIDACEAE	*Hypoxis kraussiana* Buchinger	1	0	0	0
HYPOXIDACEAE	*Hypoxis rooperi* S. Moore	1	0	0	0
HYPOXIDACEAE	*Hypoxis villosa* L. f.	1	0	0	1
AQUIFOLIACEAE	*Ilex mitis* (L.) Radlk.	1	1	0	1
FABACEAE	*Indigofera fastigiata* E. Mey.	1	0	0	1
FABACEAE	*Indigofera hedyantha* Eckl. & Zeyh.	1	1	1	1

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FABACEAE	*Indigofera heterophylla* Thunb.	1	0	1	1
FABACEAE	*Indigofera hilaris* Eckl. & Zeyh.	1	0	0	0
FABACEAE	*Indigofera poliotes* Eckl. & Zeyh.	1	0	0	0
FABACEAE	*Indigofera stenophylla* Eckl. & Zeyh.	1	0	1	1
FABACEAE	*Indigofera stipularis* L.	1	0	0	1
FABACEAE	*Indigofera stricta* L. f.	1	1	1	1
FABACEAE	*Indigofera sulcata* DC.	1	0	1	0
ASTERACEAE	*Inulanthera dregeana* (DC.) Kallersjo	1	1	1	1
RESTIONACEAE	*Ischyrolepis eleocharis* (Mast.) Linder	1	0	1	0
CYPERACEAE	*Isolepis costata* (Boeck.) A. Rich.	1	1	0	0
CYPERACEAE	*Isolepis ludwigii* (Steud.) Kunth	1	1	0	1
JUNCACEAE	*Juncus capensis* Thunb.	1	1	0	1
JUNCACEAE	*Juncus lomatophyllus* Spreng.	1	1	0	1
JUNCACEAE	*Juncus oxycarpus* E. Mey. ex Kunth	1	1	0	1
POACEAE	*Karroochloa curva* (Nees) Conert & Tuerpe	1	0	1	1
FLACOURTIACEAE	*Kiggelaria africana* L.	1	1	1	0
ASPHODELACEAE	*Kniphofia uvaria* (L.) Oken	1	1	0	1
RANUNCULACEAE	*Knowltonia capensis* (L.) Huth	1	0	1	0
POACEAE	*Koeleria capensis* (Steud.) Nees	1	1	1	1
RUBIACEAE	*Kohautia amatymbica* Eckl. & Zeyh.	1	1	0	1
CYPERACEAE	*Kyllinga erecta* Schumach.	1	1	0	0
URTICACEAE	*Laportea peduncularis* (Wedd.) Chew	1	1	0	0
LOBELIACEAE	*Laurentia arabidea* (Presl) A. DC.	1	1	0	0
FABACEAE	*Lebeckia mucronata* Benth.	1	0	0	0
HYACINTHACEAE	*Ledebouria revoluta* (L. f.) Jessop	1	0	1	1
EUPHORBIACEAE	*Leidesia procumbens* (L.) Prain	1	1	1	1
LAMIACEAE	*Leonotis dubia* E. Mey.	1	0	0	0
LAMIACEAE	*Leonotis leonurus* (L.) R. Br.	1	1	0	1
BRASSICACEAE	*Lepidium sp.*	1	0	0	0
PROTEACEAE	*Leucadendron salignum* Berg.	1	0	1	1
SCROPHULARIACEAE	*Limosella aquatica* L.	1	1	0	0
LINACEAE	*Linum sp.*	1	0	0	0
LINACEAE	*Linum thunbergii* Eckl. & Zeyh.	1	1	1	1
BORAGINACEAE	*Lithospermum officinale* L.	1	0	0	0
BORAGINACEAE	*Lithospermum papillosum* Thunb.	1	1	0	0
LOBELIACEAE	*Lobelia anceps* L. f.	1	1	0	1
LOBELIACEAE	*Lobelia erinus* L.	1	0	1	1
LOBELIACEAE	*Lobelia tomentosa* L. f.	1	0	1	1
SOLANACEAE	*Lycium ferocissimum* Miers	1	0	1	1
LYCOPODIACEAE	*Lycopodium gnidioides* L. f.	1	1	0	0
PRIMULACEAE	*Lysimachia nutans* Nees	1	1	0	0
LYTHRACEAE	*Lythrum hyssopifolium* L.	1	1	0	0
CAPPARACEAE	*Maerua racemulosa* (A. DC.) Gilg & Ben.	1	1	1	1
CYPERACEAE	*Mariscus congestus* (Vahl) C.B. Cl.	1	1	0	0

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CYPERACEAE	*Mariscus thunbergii* (Vahl) Schrad.	1	1	0	0
CELASTRACEAE	*Maytenus acuminata* (L. f.) Loes.	1	1	1	1
CELASTRACEAE	*Maytenus heterophylla* (Eckl. & Zeyh.) N.K.B. Robson	1	1	1	1
CELASTRACEAE	*Maytenus nemorosa* (Eckl. & Zeyh.) Marais	1	1	1	1
CELASTRACEAE	*Maytenus peduncularis* (Sond.) Loes.	1	1	0	0
FABACEAE	*Medicago polymorpha* L.	1	0	1	0
POACEAE	*Melica racemosa* Thunb.	1	1	1	1
POACEAE	*Melinis nerviglumis* (Franch.) Zizka	1	1	1	0
LAMIACEAE	*Mentha aquatica* L.	1	1	0	0
POACEAE	*Merxmuellera cincta* (Nees) Conert	1	0	0	0
POACEAE	*Merxmuellera stricta* (Schrad.) Conert	1	0	1	1
ASTERACEAE	*Metalasia muricata* (L.) D. Don	1	1	1	1
ASTERACEAE	*Metalasia pulcherrima* Less.	1	0	0	0
POACEAE	*Microchloa caffra* Nees	1	1	0	1
LOBELIACEAE	*Monopsis scabra* (Thunb.) Urb.	1	1	0	1
MONTINIACEAE	*Montinia caryophyllacea* Thunb.	1	0	1	1
POLYGALACEAE	*Muraltia macowanii* Levyns	1	0	0	0
BORAGINACEAE	*Myosotis arvensis* (L.) Hill	1	0	0	0
MYRICACEAE	*Myrica integra* (A. Chev.) Killick	1	0	0	0
MYRICACEAE	*Myrica quercifolia* L.	1	0	1	0
MYRSINACEAE	*Myrsine africana* L.	1	1	1	1
SCROPHULARIACEAE	*Nemesia melissifolia* Benth.	1	1	0	1
ASTERACEAE	*Nidorella auriculata* DC.	1	1	0	0
ASTERACEAE	*Nidorella undulata* (Thunb.) Sond. ex Harv.	1	1	0	1
OCHNACEAE	*Ochna arborea* Burch. ex DC.	1	0	1	1
OCHNACEAE	*Ochna serrulata* (Hochst.) Walp.	1	1	1	1
ASTERACEAE	*Oedera laevis* DC.	1	0	0	0
ASTERACEAE	*Oldenburgia grandis* (Thunb.) Baill.	1	0	0	1
OLEACEAE	*Olea capensis* L.	1	1	1	1
OLEACEAE	*Olea europaea* L.	1	1	1	1
OLINIACEAE	*Olinia ventosa* (L.) Cufod.	1	0	1	1
POACEAE	*Oplismenus hirtellus* (L.) Beauv.	1	1	1	0
HYACINTHACEAE	*Ornithogalum conicum* Jacq.	1	1	0	1
HYACINTHACEAE	*Ornithogalum juncifolium* Jacq.	1	1	0	1
HYACINTHACEAE	*Ornithogalum longibracteatum* Jacq.	1	1	0	0
ASTERACEAE	*Osteospermum grandidentatum* DC.	1	1	0	0
ASTERACEAE	*Osteospermum herbaceum* L. f.	1	0	0	1
ASTERACEAE	*Osteospermum imbricatum* L.	1	0	1	1
ASTERACEAE	*Osteospermum junceum* Berg.	1	0	1	1
SANTALACEAE	*Osyridicarpos schimperianus* (Hochst. ex A. Rich.) A. DC.	1	1	0	0
FABACEAE	*Otholobium polyphyllum* (Eckl. & Zeyh.) C.H. Stirton	1	0	1	0

Family	Species	FSKL	AMA	HUMA	ZUUR
FABACEAE	*Otholobium sericeum* (Poir.) C.H. Stirton	1	0	1	0
FABACEAE	*Otholobium spicatum* (L.) C.H. Stirton	1	0	0	0
ASTERACEAE	*Othonna carnosa* Less.	1	0	1	0
OXALIDACEAE	*Oxalis bifurca* Lodd.	1	1	0	1
OXALIDACEAE	*Oxalis corniculata* L.	1	1	0	1
OXALIDACEAE	*Oxalis psilopoda* Turcz.	1	0	1	0
OXALIDACEAE	*Oxalis punctata* L. f.	1	0	1	0
OXALIDACEAE	*Oxalis smithiana* Eckl. & Zeyh.	1	1	1	1
OXALIDACEAE	*Oxalis sp.*	1	0	1	0
ASCLEPIADACEAE	*Pachycarpus grandiflorus* (L.f.) E. Mey	1	0	0	0
POACEAE	*Panicum aequinerve* Nees	1	1	0	0
POACEAE	*Panicum deustum* Thunb.	1	1	1	1
POACEAE	*Panicum ecklonii* Nees	1	1	0	1
POACEAE	*Panicum maximum* Jacq.	1	0	1	1
FABACEAE	*Paraserianthes lophantha* (Willd.) Nielsen	1	0	0	0
POACEAE	*Paspalum dilatatum* Poir.	1	0	0	1
THYMELAEACEAE	*Passerina vulgaris* Thoday	1	1	1	1
RUBIACEAE	*Pavetta lanceolata* Eckl.	1	1	0	1
MALVACEAE	*Pavonia columella* Cav.	1	1	0	0
GERANIACEAE	*Pelargonium alchemilloides* (L.) L'H,rit.	1	1	1	1
GERANIACEAE	*Pelargonium caffrum* (Eckl. & Zeyh.) Harv.	1	1	1	0
GERANIACEAE	*Pelargonium graveolens* L'H,rit.	1	0	0	1
GERANIACEAE	*Pelargonium peltatum* (L.) L'H,rit.	1	1	1	1
GERANIACEAE	*Pelargonium ribifolium* Jacq.	1	0	1	1
ADIANTACEAE	*Pellaea calomelanos* Swartz) Link	1	1	0	1
POACEAE	*Pennisetum macrourum* Trin.	1	1	0	1
POACEAE	*Pentaschistis angustifolia* (Nees) Stapf	1	0	0	0
POACEAE	*Pentaschistis curvifolia* (Schrad.) Stapf	1	0	1	1
PIPERACEAE	*Peperomia retusa* (L. f.) A. Dietr.	1	1	0	0
PIPERACEAE	*Peperomia tetraphylla* (G. Forst.) Hook. & Arn.	1	1	0	1
APIACEAE	*Peucedanum capense* (Thunb.) Sond.	1	1	1	1
POACEAE	*Phragmites australis* (Cav.) Steud.	1	1	0	1
RHAMNACEAE	*Phylica axillaris* Lam.	1	0	1	1
RHAMNACEAE	*Phylica gnidioides* Eckl. & Zeyh.	1	0	1	0
RHAMNACEAE	*Phylica paniculata* Willd.	1	0	1	1
EUPHORBIACEAE	*Phyllanthus maderaspatensis* L.	1	0	0	1
SCROPHULARIACEAE	*Phyllopodium cuneifolium* (L. f.) BENTH	1	0	0	0
APIACEAE	*Pimpinella schlechteri* H. Wolff	1	0	0	0
PITTOSPORACEAE	*Pittosporum viridiflorum* Sims	1	1	1	1
PLANTAGINACEAE	*Plantago remota* Lam.	1	0	0	0
ASTERACEAE	*Plecostachys serpyllifolia* (Berg.) Hilliard & Burtt	1	0	0	0
LAMIACEAE	*Plectranthus ciliatus* E. Mey. ex Benth.	1	1	0	0
LAMIACEAE	*Plectranthus laxiflorus* Benth.	1	1	0	0
LAMIACEAE	*Plectranthus madagascariensis* (Pers.) Benth.	1	0	1	1

Family	Species	FSKL	AMA	HUMA	ZUUR
LAMIACEAE	*Plectranthus strigosus* Benth.	1	1	0	1
LAMIACEAE	*Plectranthus verticillatus* (L. f.) Druce	1	1	1	1
POACEAE	*Poa binata* Nees	1	1	0	1
FABACEAE	*Podalyria burchellii* DC.	1	0	1	1
FABACEAE	*Podalyria velutina* Burch. ex Benth.	1	0	0	0
PODOCARPACEAE	*Podocarpus falcatus* (Thunb.) R. Br. ex Mirb.	1	1	1	1
PODOCARPACEAE	*Podocarpus latifolius* (Thunb.) R. Br. ex Mirb.	1	1	1	1
ILLECEBRACEAE	*Pollichia campestris* Ait.	1	0	0	1
CARYOPHYLLACEAE	*Polycarpon tetraphyllum* L. f.	1	0	0	1
POLYGALACEAE	*Polygala hispida* Burch.	1	1	0	1
POLYGALACEAE	*Polygala illepida* E. Mey. ex Harv.	1	0	0	1
POLYGALACEAE	*Polygala microlopha* DC.	1	0	1	1
POLYGALACEAE	*Polygala ohlendorfiana* Eckl. & Zeyh.	1	1	0	0
POLYGALACEAE	*Polygala refracta* DC.	1	1	0	0
POLYGALACEAE	*Polygala virgata* Thunb.	1	1	1	0
POLYGONACEAE	*Polygonum aviculare* L.	1	0	0	1
POLYGONACEAE	*Polygonum undulatum* (L.) Berg.	1	0	1	0
POLYPODIACEAE	*Polypodium vulgare* L.	1	1	0	0
ORCHIDACEAE	*Polystachya pubescens* Reichb. f.	1	1	0	1
ASTERACEAE	*Printzia pyrifolia* Less.	1	1	0	0
ASPARAGACEAE	*Protasparagus macowanii* (Bak.) Oberm.	1	1	1	1
PROTEACEAE	*Protea cynaroides* (L.) L.	1	0	1	1
PROTEACEAE	*Protea tenax* (Salisb.) R. Br.	1	0	1	0
FABACEAE	*Psoralea cordata* Thunb.	1	0	1	0
FABACEAE	*Psoralea oligophylla* Eckl. & Zeyh.	1	0	0	0
FABACEAE	*Psoralea pinnata* L.	1	1	1	1
RUBIACEAE	*Psychotria capensis* (Eckl.) Vatke	1	1	0	1
DENNSTAEDTIACEAE	*Pteridium aquilinum* (L.) Kuhn	1	1	1	1
ADIANTACEAE	*Pteris dentata* Forssk.	1	1	0	1
CELASTRACEAE	*Pterocelastrus tricuspidatus* (Lam.) Sond.	1	1	1	1
ASTERACEAE	*Pteronia teretifolia* (Thunb.) Fourc.	1	0	1	1
ASTERACEAE	*Pulicaria scabra* (Thunb.) Druce	1	1	0	1
CYPERACEAE	*Pycreus nitidus* (Lam.) J. Raynal	1	1	1	0
RANUNCULACEAE	*Ranunculus multifidus* Forssk.	1	1	0	1
MYRSINACEAE	*Rapanea melanophloeos* (L.) Mez	1	1	1	1
ASTERACEAE	*Relhania pungens* L'H,rit.	1	1	1	1
RESTIONACEAE	*Restio sejunctus* Mast.	1	1	0	1
RESTIONACEAE	*Restio triticeus* Rottb.	1	0	1	1
RHAMNACEAE	*Rhamnus prinoides* L'H,rit.	1	1	1	0
RESTIONACEAE	*Rhodocoma fruticosa* (Thunb.) Linder	1	0	1	1
SANTALACEAE	*Rhoiacarpos capensis* (Harv.) A. DC.	1	0	1	1
VITACEAE	*Rhoicissus rhomboidea* (E. Mey. ex Harv.) Planch.	1	0	0	0
VITACEAE	*Rhoicissus tomentosa* (Lam.) Wild & R. B. Drumm.	1	0	1	1
VITACEAE	*Rhoicissus tridentata* (L.f.) Wild & R. B. Drumm.	1	1	1	1

Family	**Species**	**FSKL**	**AMA**	**HUMA**	**ZUUR**
ANACARDIACEAE	*Rhus chirindensis* Bak. f.	1	1	1	1
ANACARDIACEAE	*Rhus dentata* Thunb.	1	1	1	1
ANACARDIACEAE	*Rhus fastigiata* Eckl. & Zeyh.	1	1	1	1
ANACARDIACEAE	*Rhus lucida* L.	1	0	1	1
ANACARDIACEAE	*Rhus pyroides* Burch.	1	1	0	1
ANACARDIACEAE	*Rhus refracta* Eckl. & Zeyh.	1	0	1	1
ANACARDIACEAE	*Rhus rehmanniana* Engl.	1	1	1	1
ANACARDIACEAE	*Rhus rigida* Mill.	1	0	0	1
ANACARDIACEAE	*Rhus tomentosa* L.	1	1	0	0
FABACEAE	*Rhynchosia caribaea* (Jacq.) DC.	1	1	1	1
FABACEAE	*Rhynchosia ciliata* (Thunb.) Schinz	1	0	0	0
FABACEAE	*Rhynchosia totta* (Thunb.) DC.	1	0	1	1
IRIDACEAE	*Romulea autumnalis* L. Bol.	1	1	0	1
ROSACEAE	*Rubus pinnatus* Willd.	1	1	0	1
ROSACEAE	*Rubus rigidus* J.E. Sm.	1	1	1	1
POLYGONACEAE	*Rumex angiocarpus* Murb.	1	0	1	0
POLYGONACEAE	*Rumex crispus* L.	1	1	0	1
POLYGONACEAE	*Rumex sagittatus* Thunb.	1	1	0	1
LAMIACEAE	*Salvia runcinata* L. f.	1	0	0	0
ORCHIDACEAE	*Satyrium longicolle* Lindl.	1	0	0	0
ORCHIDACEAE	*Satyrium membranaceum* Swartz	1	0	1	1
ORCHIDACEAE	*Satyrium parviflorum* Swartz	1	1	0	0
DIPSACACEAE	*Scabiosa albanensis* R.A. Dyer	1	0	0	0
DIPSACACEAE	*Scabiosa columbaria* L.	1	1	1	1
ASTERACEAE	*Schistostephium crataegifolium* (DC.) Fenzl ex Harv.	1	1	0	1
ASTERACEAE	*Schistostephium flabelliforme* Less.	1	1	0	0
SCHIZAEACEAE	*Schizaea pectinata* (L.) Swartz	1	1	1	1
ASCLEPIADACEAE	*Schizoglossum cordifolium* E. Mey.	1	1	1	1
ASCLEPIADACEAE	*Schizoglossum linifolium* Schltr.	1	0	0	0
CYPERACEAE	*Schoenoxiphium sparteum* (Wahlenb.) C.B. Cl.	1	1	1	1
FABACEAE	*Schotia latifolia* Jacq.	1	1	1	1
HYACINTHACEAE	*Scilla sp.*	1	0	0	0
FLACOURTIACEAE	*Scolopia mundii* (Eckl. & Zeyh.) Warb.	1	1	1	1
FLACOURTIACEAE	*Scolopia zeyheri* (Nees) Harv.	1	1	1	1
RHAMNACEAE	*Scutia myrtina* (Burm. f.) Kurz	1	1	1	1
GENTIANACEAE	*Sebaea grisebachiana* Schinz	1	0	0	0
GENTIANACEAE	*Sebaea hymenosepala* Gilg	1	1	0	1
GENTIANACEAE	*Sebaea ramosissima* Gilg	1	0	0	0
GENTIANACEAE	*Sebaea stricta* (E. Mey.) Gilg	1	0	0	0
ASCLEPIADACEAE	*Secamone alpini* Schultes	1	1	1	0
SELAGINACEAE	*Selago corymbosa* L.	1	1	1	1
ASTERACEAE	*Senecio angulatus* L. f.	1	0	1	0
ASTERACEAE	*Senecio burchellii* DC.	1	0	1	0

Family	Species	FSKL	AMA	HUMA	ZUUR
ASTERACEAE	*Senecio coronatus* (Thunb.) Harv.	1	1	0	1
ASTERACEAE	*Senecio crassiusculus* DC.	1	0	0	1
ASTERACEAE	*Senecio deltoideus* Less.	1	1	1	0
ASTERACEAE	*Senecio erubescens* Ait.	1	1	1	0
ASTERACEAE	*Senecio glutinosus* Thunb.	1	0	0	0
ASTERACEAE	*Senecio gramineus* Harv.	1	1	0	1
ASTERACEAE	*Senecio isatideus* DC.	1	1	0	1
ASTERACEAE	*Senecio juniperinus* L. f.	1	1	0	1
ASTERACEAE	*Senecio lineatus* (L. f.) DC.	1	0	0	1
ASTERACEAE	*Senecio mikanioides* Otto ex Harv.	1	0	1	0
ASTERACEAE	*Senecio othonniflorus* DC.	1	1	1	1
ASTERACEAE	*Senecio oxyriifolius* DC.	1	1	1	1
ASTERACEAE	*Senecio paniculatus* Berg.	1	0	0	0
ASTERACEAE	*Senecio pinifolius* (L.) Lam.	1	0	0	1
ASTERACEAE	*Senecio pterophorus* DC.	1	1	0	0
ASTERACEAE	*Senecio purpureus* L.	1	1	0	0
ASTERACEAE	*Senecio quinquelobus* (Thunb.) DC.	1	1	1	1
ASTERACEAE	*Senecio retrorsus* DC.	1	1	0	1
ASTERACEAE	*Senecio rigidus* L.	1	0	0	0
ASTERACEAE	*Senecio speciosus* Willd.	1	1	0	0
ASTERACEAE	*Senecio tropaeolifolius* Macowan	1	0	0	0
POACEAE	*Setaria lindenbergiana* (Nees) Stapf	1	0	0	1
POACEAE	*Setaria sphacelata* (Schumach.) Moss	1	1	1	1
MALVACEAE	*Sida rhombifolia* L.	1	1	0	0
MALVACEAE	*Sida ternata* L. f.	1	1	1	1
SAPOTACEAE	*Sideroxylon inerme* L.	1	0	1	1
CARYOPHYLLACEAE	*Silene burchellii* Otth	1	1	1	1
CARYOPHYLLACEAE	*Silene gallica* L.	1	0	1	1
CARYOPHYLLACEAE	*Silene undulata* Ait.	1	1	0	0
BRASSICACEAE	*Sisymbrium capense* Thunb.	1	0	1	1
ASCLEPIADACEAE	*Sisyranthus imberbis* Harv.	1	0	0	0
SOLANACEAE	*Solanum americanum* Mill.	1	0	1	0
SOLANACEAE	*Solanum nigrum* L.	1	0	0	0
SOLANACEAE	*Solanum rigescens* Jacq.	1	1	0	1
SOLANACEAE	*Solanum sodomaeodes* Kuntze	1	0	0	0
ASTERACEAE	*Sonchus asper* (L.) Hill subsp. *asper*	1	1	1	0
ASTERACEAE	*Sonchus dregeanus* DC.	1	1	0	1
ASTERACEAE	*Sonchus oleraceus* L.	1	1	0	1
HYPOXIDACEAE	*Spiloxene trifurcillata* (Nel) Fourc.	1	0	0	0
POACEAE	*Sporobolus africanus* (Poir.) Robyns & Tournay	1	0	1	1
POACEAE	*Sporobolus centrifugus* (Trin.) Nees	1	1	1	1
LAMIACEAE	*Stachys aethiopica* L.	1	1	1	1
CARYOPHYLLACEAE	*Stellaria media* (L.) Vill.	1	0	0	0
ORCHIDACEAE	*Stenoglottis fimbriata* Lindl.	1	1	0	0

Family	Species	FSKL	AMA	HUMA	ZUUR
POACEAE	*Stenotaphrum secundatum* (Walt.) Kuntze	1	0	1	0
POACEAE	*Stipa dregeana* Steud.	1	1	1	1
GESNERIACEAE	*Streptocarpus meyeri* B.L. Burtt	1	0	0	1
GESNERIACEAE	*Streptocarpus rexii* (Hook.) Lindl.	1	1	1	1
THYMELAEACEAE	*Struthiola argentea* Lehm.	1	0	1	1
THYMELAEACEAE	*Struthiola macowanii* C.H. Wr.	1	0	1	1
THYMELAEACEAE	*Struthiola myrsinites* Lam.	1	0	0	0
THYMELAEACEAE	*Struthiola parviflora* Bartl. ex Meisn.	1	1	1	1
SCROPHULARIACEAE	*Sutera campanulata* (Benth.) Kuntze	1	1	1	0
SCROPHULARIACEAE	*Sutera cordata* (Thunb.) Kuntze	1	0	0	0
SCROPHULARIACEAE	*Sutera mollis* (Benth.) Hiern	1	0	0	0
ASTERACEAE	*Tarchonanthus camphoratus* L.	1	0	1	1
SCROPHULARIACEAE	*Teedia lucida* Rudolphi	1	1	0	0
FABACEAE	*Tephrosia capensis* (Jacq.) Pers.	1	1	1	1
FABACEAE	*Tephrosia grandiflora* (Ait.) Pers.	1	1	1	1
CYPERACEAE	*Tetraria capillacea* (Thunb.) C.B. Cl.	1	0	1	0
CYPERACEAE	*Tetraria cuspidata* (Rottb.) C.B. Cl.	1	1	1	1
LAMIACEAE	*Teucrium africanum* Thunb.	1	0	0	1
POACEAE	*Themeda triandra* Forssk.	1	1	1	1
SANTALACEAE	*Thesidium minus* A.W. Hill	1	0	0	0
SANTALACEAE	*Thesium fructicosum* A.W. Hill	1	0	0	1
SANTALACEAE	*Thesium gnidiaceum* A. DC.	1	0	0	1
SANTALACEAE	*Thesium junceum* Bernh.	1	0	1	1
SANTALACEAE	*Thesium squarrosum* L. f.	1	0	1	1
SANTALACEAE	*Thesium strictum* Berg.	1	0	1	1
ACANTHACEAE	*Thunbergia capensis* Retz.	1	0	1	1
ASTERACEAE	*Tolpis capensis* (L.) Sch. Bip.	1	1	0	1
POACEAE	*Tribolium hispidum* (Thunb.) Desv.	1	1	1	0
HAMAMELIDACEAE	*Trichocladus ellipticus* Eckl. & Zeyh.	1	1	1	1
FABACEAE	*Trifolium burchellianum* Ser.	1	1	1	0
FLACOURTIACEAE	*Trimeria trinervis* Harv.	1	1	0	1
POACEAE	*Tristachya leucothrix* Nees	1	1	1	1
IRIDACEAE	*Tritonia lineata* (Salisb.) Ker-Gawl.	1	1	1	0
IRIDACEAE	*Tritoniopsis caffra* (Ker-Gawl. ex Bak.) Goldbl.	1	0	0	0
ALLIACEAE	*Tulbaghia alliacea* L. f.	1	0	0	0
ASTERACEAE	*Ursinia anethoides* (DC.) N.E. Br.	1	0	1	1
LENTIBULARIACEAE	*Utricularia bisquamata* Schrank	1	0	0	0
VALERIANACEAE	*Valeriana capensis* Thunb.	1	1	0	0
RUTACEAE	*Vepris lanceolata* (Lam.) G. Don	1	1	1	1
VERBENACEAE	*Verbena bonariensis* L.	1	1	0	1
ASTERACEAE	*Vernonia capensis* (Houtt.) Druce	1	1	1	1
ASTERACEAE	*Vernonia dregeana* Sch. Bip.	1	1	0	0
FABACEAE	*Vicia sativa* L.	1	0	0	0
VISCACEAE	*Viscum capense* L. f.	1	0	1	0

Family	Species	FSKL	AMA	HUMA	ZUUR
VISCACEAE	*Viscum obscurum* Thunb.	1	1	1	0
POACEAE	*Vulpia bromoides* (L.) S.F. Gray	1	1	1	0
CAMPANULACEAE	*Wahlenbergia capillacea* (L. f.) A. DC.	1	1	0	1
CAMPANULACEAE	*Wahlenbergia krebsii* Cham.	1	1	0	1
CAMPANULACEAE	*Wahlenbergia madagascariensis* A. DC.	1	1	0	1
CAMPANULACEAE	*Wahlenbergia procumbens* (Thunb.) A. DC.	1	1	0	0
CAMPANULACEAE	*Wahlenbergia stellarioides* Cham. & Schlechtd.	1	1	0	0
IRIDACEAE	*Watsonia pillansii* L. Bol.	1	1	1	0
ASCLEPIADACEAE	*Xysmalobium involucratum* (E. Mey.) Decne.	1	1	0	1
SCROPHULARIACEAE	*Zaluzianskya capensis* (L.) Walp.	1	0	1	0
ARACEAE	*Zantedeschia aethiopica* (L.) Spreng.	1	1	0	1
RUTACEAE	*Zanthoxylum capense* (Thunb.) Harv.	1	1	1	1
CUCURBITACEAE	*Zehneria scabra* (L. f.) Sond.	1	1	1	1

Bird checklist - Featherstone Kloof - Eastern Cape

Compiled by Justin Kemp (July 2001)

Scientific Name	Common Name	Habitat / Observations / No. Sightings
Falco tinninculus	Rock Kestrel	Upper ridge grasslands, hunting of power lines, female feeding on large beetle. (>2)
Buteo rofofuscus	Jackal Buzzard	Soaring along north facing slope. (1)
Columba guinea	Rock Pigeon	Three individuals flying along valley, pair perched on rocks near mountain drive at A-m forest edge. (2)
Promerops cafer	Cape Sugarbird	Pair in Grassy Fynbos, male displaying above bush, top end of wetland. (1)
Cinnyris afer	Greater Double-collared Sunbird	Grassy fynbos, feeding on numerous flowering species, males and females both present, sometimes in mobs, very common.
Lanius collaris	Fiscal Shrike	Grassy fynbos, forest fringe, riverbank vegetation and succulent thicket, usually individual birds. (5-10)
Saxicola torquata	Stone Chat	Upper ridge grassland on north and south facing slopes, individual birds. (5-10)
Pycnonotus barbatus	Black-eyed Bulbul	Forest and its fringes, also succulent thicket, usually in groups of three to five, (5-10)
Streptopelia capicola	Turtle Dove	Burnt vegetation along riverbank, one of few spp seen in alien tree stands, usually in pairs, v. common.
Dendropicos fuscescens	Cardinal Woodpecker	A-m forest, only heard vocalizing, (1)
Ptynoprogne fuligula	Rock Martin	Single individual seen soaring above upper grassy reaches of N-facing slope.
Dicrurus adsimilis	Fork-tailed Drongo	Forest fringes, river side vegetation and succulent thicket, single individuals only, (3)
Telophorus olivaceus	Olive Bush Shrike	Numerous individuals heard vocalizing in A-m

		forest kloofs on S-facing slopes, no direct sightings, (± 10), Endemic to South Africa
Cisticola fulvicapilla	Nedicky	Very common in scrub along fringes of A-m forest and in regenerating land where wattle's have been removed (>10).
Zosterops pallidus	Cape White Eye	One individual in A-m forest (S-facing)
Anthus similes novaeseelandiae or *A.similes Similes*	Nicolson's or Richard's Pipit	Single individual on top of S-facing slope, rocky grassland. (1)
Estrilda astrild	Common Waxbill	Burnt vegetation along riverbank and thicket, feeding on ground. (<5).
Lonchura cucullata	Bronze Mannikin	In small parties on edge of succulent thicket along river, usually 3-7 individuals, often cohabiting with spp below. (>10)
Coccopygia melanotis	Swee Waxbill	As above
Quelea quelea	Red-billed Quelea	Large flocks of 20+ individuals moving up and down wetland and riverside burnt vegetation. Very common. (>50)
Motacilla capensis	Cape Wagtail	Single individual seen feeding on flying insects above stream near oak tree, juvenile. (1)
Cossypha caffra	Cape Robin	Seen twice, both times in fringe of succulent thicket along stream.

- Very little bird activity seen in the wattle stands and recovering slopes with only the very common Turtle Dove and Nedicky observed.
- Possible audio "sighting" of a Red-chested Cuckoo, not confirmed but one of its host species (i.e. Cape Robin) is present so good chance of it. Was heard on the S-facing slopes in Kloof near Mountain Drive.

Appendix 3: Information Brochure to be used in the Stakeholder Analysis and Public Participation process.

FEATHERSTONE KLOOF STAKEHOLDER PARTICIPATION

A pamphlet presenting some of the issues about Featherstone Kloof and the people of Grahamstown

The Refyn project began in 2001 with an international Gold BP Conservation Award being presented to students of the Rhodes University Botany and Environmental Science departments. The key goal of the project is to assist in the conservation and restoration of Grassy Fynbos in Featherstone Kloof as well as the long-term management thereof. This pamphlet is one of the many documents the project has produced, and is the culmination of research performed throughout the year by a team of students in many fields of study. The students felt that it was critical that the project involve the local community of Grahamstown in the area's future as they are the users, beneficiaries and protectors of the area. The next stage in the project is to organise a public participation process that will determine what the views and needs of the people of Grahamstown are, with regard to Featherstone Kloof. Most residents are not familiar with the area, but to some it is a place for recreation and scenic beauty, while for others it is a potential livelihood source. These can often be conflicting interests that Refyn hopes to clarify, enabling the bodies concerned to address potential issues and conflicts.

FEATHERSTONE KLOOF Interest groups and their preferences

Research performed by members of the REFYN project during 2001 identified the following groups interested in the Featherstone Kloof area and its resources.

1. Grahamstown Municipality and Grahamstown Parks and Gardens

Featherstone Kloof is owned and managed by the **Grahamstown Municipality**. The **Parks and Gardens Division** is responsible for management and involves itself in maintenance and control of Featherstone Kloof. A shortage of manpower and finances makes managing FK difficult – only four staff members are available to Grahamstown Parks and Gardens, and FK is only a small portion of the land they must manage.

2. Albany Working for Water

The **Albany Working for Water** project was initiated in 1997 as part of the national Working for Water Program (launched in 1995). Working for Water is a public sector institution, and is funded almost exclusively by the national government. Albany WFW is approximately half way through their initial clearing of alien trees in Featherstone Kloof. Once **WFW** has completed its task the area will again be handed over to the municipality, who then become responsible for future maintenance and alien control.

3. REFYN and conservation groups

REFYN is a Rhodes University student research project funded by the BP conservation programme and organized by 20 full-time postgraduate and undergraduate students. It is advocating for the conservation of Grassy Fynbos and is conducting research that could facilitate this. The project aims to assist with the formation of a rehabilitation and management plan for the area, through a process of *research, public participation* and *education.*

4. Botanical Society

The **Albany Branch of the South African Botanical Society** has little active involvement in Featherstone Kloof, although "hack groups" are sent into the area occasionally to chop down invasive species. They were interested in converting a disused house in the area into a visitor's centre, but no solid plans have been made as yet.

5. Consumptive users – wood and medicinal plant collectors

This includes individuals who collect, or wish to collect wood for fuel and commercial purposes (to sell it), and traditional healers who would like to utilize the medicinal plants in the area.

Research conducted by Refyn revealed that **Wood collectors** feel they have a moral right to use the commonage, although they are aware that the municipality controls it. However, the collection of wood from Featherstone Kloof is minimal, due to its distance from the township. In the past, **donkey-cart owners collecting wood** had to pay R2, 50 to the Parks and Recreation Department for each load of wood removed from the Featherstone Kloof area. However, due to lack of Municipality manpower, this is no longer being enforced. Donkey-cart owners collect wood on a daily basis from Featherstone Kloof, and sell it to Grahamstown residents. Wood collectors cut down *exotic trees* themselves, and seldom use the wood that the Working for Water Project has already cut down.

Some **local traditional healers** collect plants from Featherstone Kloof (including *Hypoxis hemerocallidea, Alepidea serrata, Gunnera perpensa* and *Polygala serpentaria*). However, it is alleged that medicinal plants are also being collected by outsiders who spend a day in the area collecting as much as they can. They then usually sell them to a muti shop or traditional healer from another town. This type of plant collecting is considered to be a threat to the indigenous plants and could result in the complete removal of these plants from the area.

6. Non-Consumptive resource users

These users include bird watchers, hikers, cyclists, joggers and picnickers. Access to the area is free. Members of the Wildlife Society, the Botanical Society, the Bird Watching Society and the Grahamstown Hiking Club utilize the area. The Oldenburgia Hiking Trail was established four years ago and starts at the Toposcope on Mountain Drive, passing through Featherstone Kloof and ending in Thomas Baines Nature Reserve. However, the area is under-utilised and no income is generated from these activities that could be used for the rehabilitation and management of the area.

7. Grahamstown Trust

The **Grahamstown Trust** facilitates projects for the benefit of the Grahamstown community. The Trust built the Toposcope on Mountain Drive and initiated the development of the Oldenburgia Hiking Trail.

Current and potential goods and services in Featherstone Kloof

Resources

Medicinal plants – Approximately 118 medicinal species are available in the area, at varying densities. These could be harvested sustainably under controlled management. This could contribute to the overall health and income earning potentials of the wider Grahamstown community.

Biodiversity – Featherstone Kloof's rich diversity gives it a high existence value. However, there has been an increase in the number of exotic species and a decline in unique systems, such as indigenous fynbos, forest, grassland thicket and wetlands in South Africa. There is a need for rehabilitation and management to protect and enhance biodiversity.

Wood – Individuals collect wood for personal use and for selling purposes. Wood collection for personal use is minimal due to the distance from the township. Those who collect wood to sell in Grahamstown own donkey carts, increasing the amount of wood they can transport. Grahamstown has a need for areas where communities can utilize wood. Other sensitive areas often get plundered when access to these resources is denied. However, Featherstone Kloof is not a major source of wood and there are other wood resources closer to the users, which are important to develop.

Grazing – Featherstone Kloof has the potential to provide grazing for livestock and has been used for this in the past however, due to its distance from Grahamstown East and existing policies it has not yet been utilized. But, as grazing becomes scarcer around Grahamstown East, Featherstone Kloof becomes a viable future option; certain parts could serve to reduce the load in other areas, especially during drier times.

Services

Water – The Featherstone Kloof catchment is at the headwaters of the Kowie River. This river provides water for both domestic use and irrigation. The wetland at its source has been infested by alien plants, which are currently being eradicated by Working for Water.

Education – A high educational value for surrounding schools exists due to the wide diversity of ecosystems in a small area. However, due to lack of knowledge, transport services and facilities at the site, this service is not being utilized to its full potential.

Recreation – The area is utilized for bird watching, hiking, cycling, jogging and picnicking. There is the potential to intensify the recreational use of Featherstone Kloof particularly in the line of ecotourism, which when well managed can have minimal impacts. Present and future recreational opportunities are related to the appreciation of biodiversity and the restoration of indigenous vegetation. Featherstone Kloof also provides a conveniently placed opportunity for Grahamstown residents to appreciate the scenic beauty of the Eastern Cape.

Legislation – pertinent to the management of Featherstone Kloof

The **National Environmental Management Act 107 of 1998** stipulates that every province must prepare an environmental implementation plan, and that any management plan must correlate with the national management plan. The Eastern Cape, however, has not yet drawn up its management plan. The environmental management plan must coordinate and harmonize the environmental policies, plans and decisions of the various national departments. The Act allows for a facilitator to arrange and conduct meetings of interested and affected parties, with a view to creating an integrated environmental management approach. It also calls for the potential impact of any activity on the environmental and cultural heritage to be assessed.

The **National Forests Act 84 of 1998** states that any research related to forestry and forest management must promote the objectives of forest policy and conform to national policies and programmes. No person may cut, disturb, damage or destroy any indigenous living tree, or remove such tree except in terms of (i) a license or (ii) an exemption from the terms of this provision. Nor may a person cut, disturb, damage or destroy any forest produce, except in ways envisaged by the Act, such as in terms of a right of servitude granted over the area.

...

The **White Paper on Biodiversity Conservation** discusses the importance of biodiversity, and the dangers of loosing it. It outlines six goals: -

- Conserve South Africa's biodiversity;
- Use biological resources sustainably and minimize adverse impacts on biodiversity;
- Ensure that benefits derived from the use and development of South Africa's genetic resources serve national interests;
- Expand the human capacity to conserve biodiversity, to manage its use, and to address factors threatening it;
- Create and implement conditions and incentives that support the conservation and sustainable use of biodiversity; and
- Promote the conservation and sustainable use of biodiversity at the international level.

The **Eastern Cape Provincial Environmental Conservation Bill** (2001) also makes provision for Local Authorities to set aside their own conservation areas on land under their control. The process of setting up such a reserve should be open and transparent giving the public an opportunity to object. The Local Authority must set up an advisory board to deal with regulations and policies for the conservation and management of the area. The Bill allows the Local Authorities to generate income from activities such as tourism, in these areas. The Bill also allows the authorities to permit and control sustainable harvesting of Natural Resources in the area.

Future Options

Outlined below are the options Refyn hopes will be considered viable by the stakeholders during the participatory consultation process. All future options described here have one common thread – to implement an ongoing rehabilitation process. Four possible scenarios are presented, as identified by the REFYN project through consultation with various bodies and individuals.

Option	Brief Description	Pros and Cons
Status Quo (remains as it is)	• FK remains relatively unchanged, with regard to ownership, management and land use. • Working for Water would leave the land once the clearing of alien vegetation is complete. • The Municipality would need to set up a team (possibly consisting of old Working for Water contract workers) to maintain the land.	**Pros** • With a monitoring team, indigenous vegetation can be conserved, but the municipality and local ratepayers will carry costs. **Cons** • No generation of income to aid management and future rehabilitation of the area. • Municipality does not have the resources or capacity to maintain alien eradication follow-up program after Working for Water leaves – therefore aliens are likely to return. Nor do they have the capacity to monitor or regulate use. • Without increased monitoring and policing, illegal, unsustainable harvesting may increase, and damage the indigenous vegetation.
Sale or Lease of Land	• Municipality might decide to sell or lease the land for *farming*, to reduce costs and generate income • Municipality might decide to lease or sell the land for *eco-tourism* to generate income.	**Pros** • Financial burden of Featherstone Kloof is taken off Municipality. • Income will be generated for the Municipality. **Cons** • Loss of access for consumptive and non-consumptive users if land is privately owned/leased, unless eco-tourism is encouraged. • Agriculture will disturb indigenous vegetation. • Lease or sale of land will result in the loss of a valuable resource to the Grahamstown community and future conservation options, but will create jobs.
Makana Conservancy local nature reserve	• Possible amalgamation of land belonging to the Port Alfred, Bathurst and Grahamstown municipalities (including Thomas Baines Nature Reserve) and private farms to form a	**Pros** • Increased financial and human capital for management of entire conservation area. • Indigenous integrity of Featherstone Kloof is retained. • Conservation of a unique ecosystem.

	larger conservancy area. • Joint management can be formed to market entire region as an eco-tourism/conservation resource. • Land use change from limited use to ecotourism, game farming and education. • Featherstone Kloof is included in the conservancy and utilized as wilderness area. • Income can be generated via tourism and education.	**Cons** • Local inhabitants may not necessarily benefit - through loss of access for consumptive users (depending on permits).
Community Based Natural Resource Management	• Local consumptive and non-consumptive users will have access. • Sustainable harvesting of indigenous plants. • Cover crops for grazing in certain areas, under well-managed conditions. • Small-scale industries, such as beekeeping, plant and other resource harvesting. • Woodlots for fuel, wood and building materials. • Requires strong institutions within local community.	**Pros** • Benefit to consumptive users through income generation. • Long-term financial benefits, capacity building and possible ecotourism through hiking trail, etc. • Indigenous flora and fauna conserved, including some endemic and rare species. **Cons** • If community does not have strong institutions, CBNRM is unlikely to succeed. • Obtaining funds to sustain this management technique will be difficult, perhaps impossible.

Appendix 4: The following report was produced as an assignment for the Rhodes University Environmental Education Department showing a possible schools educational package, teaching about conservation and Grassy Fynbos. This is, however, a draft and is not complete. Many diagrams will have to be replaced with more appropriate ones for it to accurately represent Gassy Fynbos and Featherstone Kloof. This has been identified as a potential project for the follow-up reward.

Ecological Studies

by

Jennifer Ruth Gon

Assignment for ACEE / ADEE: Environment and Environmental Issues

Tutors: Professor Pat Irwin & Ingrid Timmermans

May 2002

PLANNING (AND CONDUCTING) AN ECOLOGICAL STUDY

Grassy fynbos: habitat description and project background

The Grahamstown area represents the eastern most occurrence of fynbos which is the dominant vegetation type of the Cape Floral Kingdom. The fynbos biome is celebrated for its rich floral diversity in a relatively small region. The three main families of plants that characterise the fynbos biome are the proteas, the ericas (heaths) and the restios (Cape reeds). The eastern sector of the Cape Floral Kingdom experiences a higher proportion of summer rainfall than the Western Cape, and the restio component of fynbos is mostly replaced by grasses; this type of fynbos is referred to as **grassy fynbos**. Grassy fynbos is found on the south-facing slopes of the Grahamstown Hills. In the Grahamstown area much of the grassy fynbos habitat has been invaded by alien vegetation, and the habitat has been severely degraded by human disturbance. Grassy fynbos is the most neglected fynbos type of the Cape Floral Kingdom.

The Albany Working for Water programme has been clearing large areas of invaded grassy fynbos in Featherstone Kloof for the past three to four years; however, little is known about the restoration ecology of grassy fynbos. In 2001, a project proposal by students from Rhodes University to establish baseline information for the restoration of grassy fynbos in Featherstone Kloof received the top award from the international BP Conservation Programme. The project, known as the REFYN project, was funded from April 2001 - March 2002.

This ecological study of grassy fynbos is a pilot EE study to help create awareness of grassy fynbos, one of the objectives of the REFYN project.

1.2 Study site

The most accessible site of the study area (Featherstone Kloof) is the eastern end of Signal Hill (just beyond the toposcope). School buses can drive there; the school group can walk down from there to a small patch of grassy fynbos on the south-facing slope of Signal Hill. It is a good site in that a comparison could be made between the grassland on the north-facing slope and the grassy fynbos on the south-facing slope. The terrain is very steep though, and the area of grassy fynbos quite small which might pose a problem for a group of 40 learners. An alternate larger area of pristine grassy fynbos occurs further east along Signal Hill, but is not that accessible by car, and would require extra time to walk to and from the site (down hill there, up hill back, allow 40 minutes extra time?). See also note in Section 1.6 below.

I think the potential exists to do the study at the Thomas Baines Nature Reserve, where there is an overnight educational facility and other EE studies could be done as well, as part of a broad educational experience.

Note: The optimal time to do a grassy fynbos ecological studies outing would be August - November as this is the time when most plants are flowering.

1.3 Activity Plan

Refer to Section 1.4 for background information to the development of the Learner Support Materials (LSMs) referred to in this section. Copies of the LSM's can be found in Appendix 1.

Activity 1: Gathering information and reporting (in the classroom) (1 or 2 lessons?)

The educator finds out what the learners know about the fynbos biome. He / she then introduces the class to the fynbos biome - using the Share-Net (1999) *Fynbos* Enviro Fact Sheet, the *Fynbos* Hands-On booklet (Kelly, 19??) and any other information available to him / her (refer Appendix 2). Explains where the term 'fynbos' comes from. It would be useful to show the learners a map showing the distribution of fynbos (e.g. the landscape biodiversity map), and some photographs of the fynbos habitat, including proteas, ericas and restios. The introduction needs to cover the fact that there are different types of fynbos (with different communities of plants), and that the type of fynbos that grows in the Grahamstown area is grassy fynbos. The educator may also possibly need to introduce the concept of alien plants.

Each learner gets a copy of the Share-Net *Fynbos* Enviro Facts Sheet, and copies of the *Grassy Fynbos* Fact Sheets (refer Table 1). The educator breaks the class up into a minimum of four groups and gives each group one of the topics to read up and questions to answer as detailed below. (The educator can use his/her discretion as to how many groups to use, and how to allocate the questions. The topics may also be researched further in depth using references and reference material supplied in Appendix 2). The learners make a poster based on their findings and then report back to the rest of the class on each topic. The topics and some suggested questions are as follows:

(1) <u>Fynbos and life in fynbos</u>

1. Why is the Cape Floral Kingdom so remarkable?
2. What are the three main families of plants that you find in fynbos?

3. Give three facts that demonstrate the richness of fynbos plant life.
4. Why do we not see many large animals in fynbos?
5. Name two bird species that are only found in fynbos. Why are they important for fynbos plants?

(2) Comparison of fynbos and grassy fynbos

Why do you get different types (communities) of fynbos?
How does grassy fynbos differ from other types of fynbos?
Why does grassy fynbos occur in the eastern region of the Cape Floral Kingdom?
Where would you find grassy fynbos around Grahamstown?

(3) Threats to and values of grassy fynbos in the Grahamstown hills

Which alien plant has had the most impact on grassy fynbos locally?
Describe four impacts that this plant has had on the grassy fynbos habitat.
What are other threats to grassy fynbos?
What is the biggest limiting factor to the survival of grassy fynbos (all fynbos)?
Why is it important to conserve grassy fynbos?

(4) Fynbos and fire

6. Why is it important for fynbos to burn?
7. What is the optimum fire cycle for fynbos?
8. What happens to fynbos if there are too many fires?
9. Describe three ways how fynbos plants have adapted their life styles to fire.
10. How does fire affect grassy fynbos?

Activity 2: Investigation of the habitat (allow 2½ hrs?)

Outing to the chosen site in Featherstone Kloof (refer Section 1.2 above). Beforehand, the educator needs to prepare the learners for the outing (strong shoes, hats, water, warn them about snakes etc). The educator divides the class into groups. Each learner (or group?) is equipped with a reference identification sheet and an observation sheet. Each group has a copy of the Share-Net Hands-On *Fynbos Life* and *Grassland Life* booklets and the Hands-On *Grassy Fynbos* Sheet, a magnifier and litmus paper / Universal Indicator**. Clipboards would be useful for writing. Each group needs to take a small container with a lid (e.g. a film canister) or a plastic bag with them to the field to take a soil sample.

(1) Physical aspect of the habitat

The educator draws the attention of the learners to the habitat on the north-facing slope of the hill, and to the position of the sun. When the learners reach the grassy fynbos area, the educator again draws the attention of the learners to the aspect of the slope and the learners need to fill in the information on their cross section (on observation sheet). (This could be done in the classroom afterwards - see Activity 3).

- Each group is to take a small soil sample (20 g - about a film canister full), to test the soil for presence of clay and for acidity. To test for clay soils, spit onto a sample. If it is sticky when moist, clay will be present.

** To test for acidity, place the sample in a small container of water (100 ml) and stir. Leave for 20 minutes, then stir again, and use the Universal pH indicator or litmus paper to test (see notes in Appendix 1. (This can be done on return to the classroom).

(2) Plants and animals

The educator allocates different areas of grassy fynbos (rocky, grassy, bushy etc) to different groups to do the following activities:

- Identify the major types of plants occurring in their area using the identification reference sheet, the *Fynbos Life* and *Grassland Life* Hands-On booklets and *Grassy Fynbos* Hands-On sheet. The groups can also try to identify specific plants from the information provided. Use the magnifier to look at details of plants.

- Record the identified plants / plant types on their observation sheet.

- Make a note of animals seen (not forgetting to pay special attention to the insects). The learners must also be encouraged to listen for animal sounds (e.g. bird calls), look out for droppings, quills, feathers etc, and to record these sightings / listenings on the observation sheet.

(3) Alien plants

If it is possible, the outing could also view a grassy fynbos site that has been invaded, or has been previously invaded and is in the process of being cleared, or that is in the process of being restored, depending on the status of the alien clearing operations. (Not catered for on the observation sheet).

Activity 3: Reporting and analysing field study observations

Discussion time and completion of field sheets with the educator back in the classroom. (Two lessons??)

(1) Educator draws a schematic cross section on black board - and asks where did the grassy fynbos occur in the diagram? [south-facing slope] Why does it occur there? What type of plants occurred on the north-facing slope? Can you explain why? Where is the sun? Discusses the answers with the learners, and learners complete the diagram on their observation sheets.

(2) What type of soil? Is the soil acid or alkaline?

(3) Draw up a list of all the plants observed on the outing, based on each group's observations. What was the most common plant? Possibly discuss the different methods of pollination utilised by fynbos plants.

(4) List all animals and signs of animals recorded by the class - what animals occur in grassy fynbos based on this evidence?

(5) How do the animals use the plants? Did you see animals using plants for food, nectar, shelter, nesting materials, etc? Possibly break the class up into smaller groups and get each group to research a specific relationship, e.g. porcupines and watsonias, sugarbirds and proteas, ants and restios (see e.g. Wcape school website info in Apendix 1), honeybees and fynbos (see REFYN poster in Appendix 2). Learners can also draw up a grassy fynbos food pyramid using Ashwell (2001) as an example (refer Appendix 2 and Figure 1, p 13).

(6) Discuss with the class the amount and types of animals seen, and ask them why they think they saw so few animals.

(7) Discuss with the learners what they can do to help preserve grassy fynbos? Is there anything we can do to address the threats? (Refer to the fact sheet on threats to grassy fynbos for some contact phone numbers of organisations that can tell you what they are doing and how you could help).

Optional activity

If there is time, each group can make their own grassy fynbos poster, showing the interactions between the plants and the animals, based on their findings. (Show the learners a copy of the Botanical Society of South Africa fynbos poster (refer Appendix 2)).

1.4 Learner Support Materials (LSM's)

Existing fynbos habitat LSM's typically focus on the fynbos associated with the mountains and flats of the Western Cape. Two comprehensive Teacher's Guides on the botanical realm have been compiled for Active Learning to be applied in Cape Town schools (Ashwell, 2001) and in southern Cape schools (Ashwell, 2000). Both these guides contain good suggestions for learning activities in the fynbos habitat (refer Appendix 2 for a couple of examples) and some of these ideas have been incorporated into this study. In addition, Share-Net has published Hands-On *Fynbos Life* and *Grassland Life* booklets and also Enviro Fact Sheets for these habitats.

These LSM's provide a useful starting point, and it is possible to use the Share-Net Hands-On *Fynbos Life* and *Grassland Life* booklets as Field Guides, but supplementary LSM's for grassy fynbos, incorporating organisms that occur locally, are necessary to make the study relevant to the local context. Studies can also be supplemented by information from research projects being carried out by Rhodes University and associated institutes.

With this in mind, I compiled three *Grassy Fynbos* Fact Sheets (still in draft form) to describe aspects of the grassy fynbos habitat, to be used in conjunction with the Share-Net Enviro Fact Sheet on *Fynbos* (Table 1 and Appendix 1). I also compiled a Reference Sheet for identification of organisms in the field (based on three field trips and discussions with Jamie Pote and Professor Roy Lubke); it combines organisms from the *Fynbos Life* Hands-On book, but also incorporates organisms (mainly grasses) from the *Grasslands Life* Hands-On book, as well as additional plants observed in the field that are not included in these books. The diagrams for the additional plants were extracted mainly from Gledhill (1981); one of the grasses was copied from Roberts (1973). The Share-Net Hands-On booklets were supplemented by a Hands-On *Grassy Fynbos* Field Guide sheet (Table 1).

The compilation of the grassy fynbos materials for this study focused on Featherstone Kloof but should also be trialed in other grassy fynbos habitats around Grahamstown and be modified to be generally applicable to grassy fynbos in the Grahamstown Hills. Ideally the LSMs should be compiled in such a way that they could be easily adapted for learning in the Humansdorp area, for example.
The following LSM's could be supplied for an ecological study:

Activity 1: Gathering information and reporting	* Share-Net *Fynbos* Enviro Facts 34 * *Grassy Fynbos* Fact Sheet + * *Threats to and Values of Grassy Fynbos* Fact Sheet + * *Fire and Fynbos / Grassy Fynbos* Fact Sheet +
Activity 2: Field investigation	* Share-Net Hands-On *Fynbos Life* ++ * Share-Net Hands-On *Grassland Life* ++ * Hands-On *Grassy Fynbos* Sheet (to complement the Share-Net booklet) + * Field Identification Reference Sheet * Field Observation Sheet * Magnifier
Activity 3: Reporting and analysing field study observations	* Litmus paper / Universal pH indicator * Share-Net Hands-On *Fynbos Life* ++ * Share-Net Hands-On *Grassland Life* ++ * Hands-On *Grassy Fynbos* Sheet (to complement the Share Net booklet) + * Field Identification Reference Sheet * Field Observation Sheet

Table 1: LSM's used in the Grassy Fynbos Ecological Study (refer Appendix 1 for copies of these LSM's)

+ currently in draft format, compiled by myself, have not been edited or evaluated yet
++ available from the Resource Room, RU Environmental Education Unit

Note: Appendix 2 contains information supplementary to the Fact Sheets and Hands-On booklets that can be used for activities, as well as additional references.

1.5 Educational processes

The activities were designed for Grade 8's (Senior Phase). They could be modified to cater for lower or higher grades within the Senior phase.

(1) Learning skills / outcomes

Activity	Learning skills / outcomes The learners will ...
Activity 1: Gathering information and reporting	* learn about the grassy fynbos habitat from different perspectives * critically evaluate the information on the fact sheets * work as members of a team * practise communication skills
Activity 2: Field investigation	* observe the physical setting * observe plants and animals in their natural habitats * distinguish between and identify common plants and animals * look for evidence of animal activity * record observations
Activity 3: Reporting and analysing field study observations	* organise, analyse and critically evaluate information collected on the field study * understand the relationships between organisms * reflect on ways that they can make a difference * discuss observations and draw conclusions

The approach used of learners working in smaller groups and reporting back to the class embraces the method of cooperative learning.

1.6 Additional notes

(1) Featherstone Kloof as an educational venue

The REFYN project approached local schools to find out the level of interest of educators in Featherstone Kloof as an educational environment. The findings are quoted below from the draft Final Report.

At present Featherstone Kloof is not being utilised as an educational tool by local schools, mostly because of the inaccessibility of the area – the area is considered too far away for walking and the access road is not really suited to two-wheel drive. Graeme College felt that all they needed for educational purposes was available to them within the schools grounds. Both Graeme and Victoria Girls did agree that they would be more inclined to make use of the area if transport *constraints could be overcome, as they considered the area to be of high potential educational value. The vast majority of high school respondents did not know where Featherstone Kloof was. Those that did knew it mostly because their parents had taken them to the area or they used the area for riding or running. Most students were keen to learn more about the area, which is encouraging if future management plans were to include a strong educational focus such as establishing an educational centre or overnight accommodation for school groups.*

At present the potential educational service of the area remains untapped. If the access road were to be improved such that the area would become accessible to two-wheel drive vehicles, the area could certainly be marketed as an educational treasure. For example: scholars could learn to appreciate first hand what it takes to improve water supply and restore biodiversity to an area plagued by alien invasion, by actually going out into the field and talking to or even physically assisting a Working for Water team. If an educational centre could be established or even basic overnight accommodation, school groups may be more enthusiastic to visit the area as an extended field excursion. However, one would need to get commitment from the local schools before such an investment could be made. Regretfully, there was no response from any township schools regarding their perceptions on the area and whether they regard themselves as having rights of access to Featherstone Kloof.

(2) Other studies that could be done on grassy fynbos

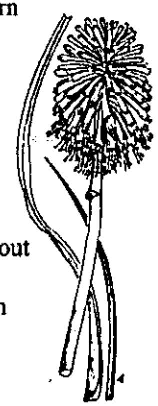
11. There is potential for this study to be expanded to investigate the uses of (grassy) fynbos plants (see Appendix 2 for additional information).
12. The impact of alien invader plants can be incorporated into the field study if there is enough time; the class could also be motivated to do a hack (refer to contact phone numbers on the back of *Threats to Grassy Fynbos* Fact Sheet).

Agapanthus spp.

Features: Evergreen long strap shaped leaves, lightly channelled. Cluster of blue bell-shaped flowers, up to 7cm long, at the end of a long straight stem.
Traditional use: Portions of the rhizome of *Agapanthus praecox* are added to necklaces worn by young Xhosa brides.

Aloes and aloe-like plants

Kniphofia uvaria (Red-hot poker)



Features: Leaves are strap-shaped, keeled, the margins are very finely toothed. Flower stem about 50 cm long; bright orange red to yellow flowers about 3-4 cm long crowd at the head. Occurs on damp slopes and marshy places.
Traditional use: ???

Aloe micracantha (Grassy aloe)

Features: Grasslike leaves are spirally arranged. The leaves are long, narrow, u-shaped and deeply channeled; they are spotted on both surfaces. The red to pink flowers are about 4 cm long and occur as a flower head on a single stem.. Flowers in summer from November to February. This is the only grass aloe that occurs in fynbos vegetation.

4

HANDS-ON

GRASSY FYNBOS

for the

GRAHAMSTOWN HILLS

(to be used in conjunction with the
Share-Net Hands-On Fynbos Life and Grassland Life booklets)

Erica chamissonis (Grahamstown heath)

Features: Forms an erect shrublet, 60 cm tall and produces so many flowers that little of the rest of the plant can be seen. The flowers are delicate, giving the plant a soft feathery look. The flowers are shallowly cup-shaped, pink, 5 mm long, with dark brown stamens. Best flowering time is from August to October.

Did you know that the Grahamstown heath is not only found in the Grahamstown area? It can be found from Grahamstown as far west as Humansdorp.

1

Oldenburgia grandis (Rabbit's ears)

Features: Shrub or small gnarled tree, up to 5 m high with rough black stems about 20 cm thick. Leaves are clustered towards the end of the branches in rosettes. Leaves are oblong to ovate. They are stiff and leathery on top and whitish and soft (like felt) below. Young leaves are covered with soft 'wool' on both sides. Flowerheads are large (up to 13 cm diameter) in stalked terminal clusters, purplish cream. The fruit is a small nutlet, tipped by a tuft of bristly hairs.

65

Did you know that the Oldenburgia is a member of the daisy family? It is endemic to the Eastern Cape and is found on rocky outcrops of Witteberg quartzite.

Indigenous legumes

Features: these plants have pea flowers and bean pods, and often have a fine trifoliate compound leaf.

7

10

2

Geophytes

Are plants that have underground storage organs, like bulbs, corms and rhizomes. These plants usually have long, flat leaves. The families of irises which includes the Watsonia (refer the Fynbos Life Hands On booklet) and lilies are geophytes.

Bobartia orientalis

1a 1b

Features: Evergreen perennial forming loose tufts. Leaves are long and whip like. Flowers in dense clusters crowded at the tops of willowy stems, bright yellow. Flowers almost all year long but mainly September to November. It grows on stony open sandstone slopes.
Uses: the leaves are used for making baskets.

Hypoxis spp. (African potato)

Features: Cormous geophyte. Long narrow leaves, covered with hairs, spreading out along the ground. ++++ Yellow flower.

Medicinal uses: the African potato plants have many medicinal values. The corms are used to treat dizziness, for bladder disorders and as a tonic. The stems and leaves are mixed with other ingredients to treat prostate problems.

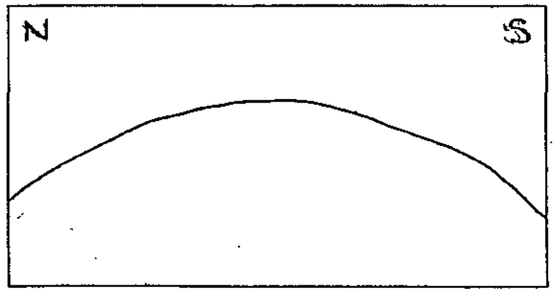
3

OBSERVATION SHEET
GRASSY FYNBOS OUTING TO FEATHERSTONE KLOOF

Name: .... Date: ....
Weather: ....

1. **Physical characteristics of the grassy fynbos study site**

(a) The diagram below represents a north south cross section through the hill slope of the study site (a cross section takes a slice through the hill). Draw on the diagram the locality of the grassy fynbos, and the position of the sun. What type of habitat occurs on the other slope? Why?



(b) **Soil qualities**: Take a small soil sample (20 g). To test for clay soils, spit onto a sample. If it is sticky when moist, clay will be present. Test for acidity of the soil using the litmus paper. Soil description:

....
....
....

3 Using the identification sheet and Fynbos Life Hands On booklet, identify and record any animals that you see. Also record signs of animals such as quills, nibbled or dug up plants, burrows, droppings etc. Make notes of any interesting observations (e.g. animal behaviour, animals using plants etc). Also listen for sounds of animals.

	Type	Notes
Invertebrates		
Birds		
Reptiles		
Mammals		

2. Record all the different plants that you see. Try to identify them using the identification sheet and the Hands On booklets. Give the plant an identifying code if you cannot recognise the species and describe any special features of the plants that helped you identify them.

	Name / code	Description
Protea family		
Erica family		
Geophytes (bulbs)		
Indigenous legumes		

Daisy family		
Pelargoniums		
Aloes and aloe like plants		
Restios		
Grasses		
Sedges		

Draft Fact Sheet

Threats to and Value of Grassy Fynbos (with specific reference to the Grahamstown hills)

Threats

The threats to grassy fynbos listed below are all caused by man either directly or indirectly. Many of the threats are inter-linked.

- The introduction of invasive alien vegetation has been very destructive to the grassy fynbos habitat on the Grahamstown Hills. Examples of the most common alien plants found there are the Australian long-leafed wattle (*Acacia longifolia*), hakea, gum trees and pine trees. The Australian long-leafed wattle has had the most impact on the grassy fynbos habitat in Featherstone Kloof:
  - Dense stands of wattles have replaced large areas of grassy fynbos on the southern slopes of the hills, reducing plant diversity and resulting in a habitat loss for wildlife;
  - The wattles have increased the nutrient levels of the soil due to the nitrogen-fixing bacteria in their root nodules, thus making the soil habitat unsuitable for typical fynbos plant species; and
  - the alien plants also use up a lot of water, decreasing stream flow in the area.
- The Australian wattles also increase the fire risk as the Australian wattles are adapted to fire. Fire in these plants is hotter, resulting in more intense fires which alter the properties of the top soil layer and destroy the soil seed bank of the indigenous plant species. In addition, seeds of the Australian wattles are also adapted to surviving high temperatures, resulting in mass germination with the seedlings of the alien plants suffocating the indigenous re-growing vegetation.

Useful contacts

Who you can contact if you want to help conserve the fynbos habitat in the Grahamstown Hills:

- Albany Working for Water: 046 636 1449
- Albany Branch of the Botanical Society of SA: 046 636 1370
- Grahamstown Branch of the Wildlife and Environment Society of SA: 046 622 5822
- Restoration of Grassy Fynbos in the Eastern Cape, South Africa (REFYN) project, Rhodes University: 046 603 8592

Further Reading

Henderson, L. (2001). *Alien Weeds and Invasive Plants. A complete guide to declared weeds and invaders in South Africa.* Plant Protection Research Institute Handbook No. 12. Pretoria: Agricultural Research Council.

Higgins, S.I. & Cowling, R.M. (1997) The ecological economics of fynbos ecosystems. *Veld & Flora*, 83(1), 4-5.

Kelly, A. (19??). *Hands-On Fynbos Life: A Field Guide*. Howick: Share-Net.

Share-Net (Publisher), (1999). *Fynbos*. Enviro Facts 34. Howick: Share-Net.

Web sites:

Working for Water: http://www-dwaf.pwv.gov.za/wfw/

Western Cape Schools:
http://www.wcape.school.za/subject/biology/fynbos/intro.htm

Fact sheet compiled by Jenny Burkinshaw in May 2002, as part of assignment for the Environmental Education Unit, Rhodes University.

- The natural fire cycle of fynbos has been disturbed by man. Fires that burn in the wrong season or too frequently wipe out indigenous species.

- Other threats to grassy fynbos in general are overgrazing (but unpalatable), poor management, development, erosion and unsustainable use of resources (e.g. traditional medicine).

Value of fynbos and grassy fynbos (very draft)

- Conservation of fynbos is important as the plants provide a habitat and food for a wide range of animals. For example the King protea (*Protea cynaroides* - South Africa's national flower) depends on the Cape sugar bird and the sunbirds for pollination. Honeybee pollination plays an important role maintaining plant diversity and ecosystem services.

- A large number (70%) of plant species are endemic to the fynbos biome. Grassy fynbos supports some rare and critically endangered species.

- Mountain catchment areas are a vital source of water and these catchment areas function best when covered with indigenous fynbos. The low-growing fynbos requires little water for growth and it allows most of the water to be "sponged" up by the soil. The soil slowly releases large quantities of high quality water into rivers and streams.

- Fynbos plants bind the soil to prevent soil erosion.

- Fynbos provides economic benefits through the tourist industry, as well as the flower industry. Several plant species of grassy fynbos have traditional uses, e.g. the African potato.

- Fynbos areas have immeasurable aesthetical value in providing city dwellers with a pristine wilderness experience.

Notes

Draft Fact Sheet

Fire and Fynbos / Grassy Fynbos

Role of fire in fynbos

Fire is a natural and normal process in fynbos. Fynbos plants have lifestyles that have been shaped by fire. Although a burnt fynbos landscape may look bleak and black, fire triggers a chain of biological events that ensures the rebirth of fynbos as many of the plants' life cycles depend on fire.

In disturbing the habitat, fire also eliminates competition between plants and creates the space for the high plant diversity of fynbos to be maintained. Fire also plays a role in nutrient recycling as it returns the mineral elements held in the plant material to the soil, increasing the availability of resources. Without fire fynbos would lose its high plant diversity and would ultimately perish.

There is an optimum fire cycle for fynbos. Just as too infrequent fires cause fynbos to go moribund and die, too frequent fires kill the plants before they can set seed. The ideal frequency of fires in fynbos is between 10 and 30 years. Lightning is the primary natural source of ignition for fynbos fires.

Regrowth of fynbos after fire

Many of the fynbos plants show special adaptations to fire, especially with respect to the regeneration of the plants after fires. These plants either:

- **resprout** from underground root-stocks or from bulbs (geophytes) after a fire, e.g. watsonias; or
- they generate **seeds** that need fire or the smoke of fire to germinate, e.g. restios need the smoke from fire to stimulate germination. Most proteas, which are completely destroyed by fire, depend on the fire to stimulate seed production.

Further Reading

Cowling, R. (Ed.). (1992). *The Ecology of Fynbos Nutrients, Fire and Diversity*. Cape Town : Oxford University Press.

Kelly, A. (19??). *Hands-On Fynbos Life: A Field Guide*. Howick: Share-Net.

Mustart, P. (2000). Life after death in fynbos. The story of fire and seeds. *Veld & Flora*, 86(2), 73-74.

Saunders, R. & Saunders, R. (2000). Does fynbos need to burn? *Veld & Flora*, 86(2), 73-74.

Share-Net (Publisher), (1999). *Fynbos*. Enviro Facts 34. Howick: Share-Net.

Web site:

http://www.wcape.school.za/subject/biology/fynbos/intro.htm

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Some plants store their seeds in fire-proof cones that remain closed on the plant retaining all the seeds. The heat from a fire dries the cone out and after the fire the cone will open; the seeds are undamaged and are then dispersed by wind to ensure the plant's survival, e.g. *Protea repens* and the Leucodendrons. Other plants have ant-fruits which induce ants to bury the seeds, protecting them from fires.

Fires in grassy fynbos

On average most fynbos plant communities burn every 12 to15 years. In grassy fynbos the life cycle tends to be slightly shorter. This is because there are more lightning strikes in the grassy fynbos areas, and also because of the increased grassiness of grassy fynbos (compared to the fynbos found in the Western Cape, for example). The high cover of grasses makes grassy fynbos more susceptible to burning. (Does this occur naturally or is it a result of more frequent crop rotation burning?)

Field experiments in the grassy fynbos of the Grahamstown Hills have shown that grassy fynbos regenerates mostly from resprouters and geophytes. Seeders seem to be unimportant in initial recovery of grassy fynbos and are mostly found in slow-growing climax species such as the Grahamstown heath, *Erica chamissonis*. There is concern that frequent fires may cause the local extinction of the slow maturing non-sprouting fynbos shrubs. In addition, the faster growing grasses could out compete seedlings of the slower growing fynbos species in the early post-fire stages.

Many of the tall shrubs of the Proteaceae which dominate the upper storey of many fynbos communities in the western and southern Cape, are rare in grassy fynbos where they are confined to habitats which burn less frequently than the surrounding grasslands.

Notes

Draft Fact Sheet

Grassy Fynbos in the Eastern Cape with special reference to the Grahamstown Hills

Fynbos

Fynbos is the major vegetation type of the small botanical region known as the Cape Floral Kingdom. The Cape Floral Kingdom is the smallest and the richest floral kingdom in the world. It has the highest known concentration of plant species: 1300 per 10 000km^2. It covers the magnificent mountains, valleys and coastal plains of South Africa's southern and south-western Cape, in a crescent shaped band from Niewoudtville in the north to Cape Town in the south and east to Grahamstown.

Many of the plants have small fine stems and leaves and the vegetation has a bushy appearance, hence the name **fynbos**. Fynbos is characterised by three plant families: the Proteaceae (proteas), the Ericaceae (heaths) and Restionaceae (Cape reeds). The heath types consist of fine-leaved plants while the protea types are usually bushy plants with larger, flatter, hairy or waxy leaves. The reed types have tubular, wiry stems and are often used for making brooms and thatch.

The most diverse fynbos types grow on some of the poorest soils in the world; they typically are found in areas of Mediterranean climate or areas of high winter rainfall. Proteas and Cape reeds have special roots to mop up nutrients. Ericas and other plants use fungi to get their nutrients. Normal garden fertilisers will poison and kill most fynbos plants.

What is grassy fynbos?

The communities of plant types found in fynbos vary. For example, in some communities proteas may be the dominant plant type, in others, ericas may be the dominant type. The development of different plant communities is influenced by factors such as rock

Further Reading

Cowling, R. (Ed.). (1992). *The Ecology of Fynbos Nutrients, Fire and Diversity*. Cape Town : Oxford University Press.

Kelly, A. (1977). *Hands-On Fynbos Life: A Field Guide*. Howick: Share-Net.

Low, A.B. & Rebelo, A.G. (Eds.). (1996). *Vegetation of South Africa, Lesotho and Swaziland*. Pretoria : Department of Environmental Affairs & Tourism.

Manning, J. (2001). *Eastern Cape South African Wild Flower Guide 11*. Cape Town: Botanical Society of South Africa in association with the National Botanical Institute.

Share-Net (Publisher), (1999). *Fynbos*. Enviro Facts 34. Howick: Share-Net.

Web site:

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type, soil type and fertility, drainage, climate, landscape and slope aspect (direction that the slope faces).

Grassy fynbos occurs in the eastern region of the Cape Floral Kingdom, in areas of finer grained, relatively fertile soils with a high proportion of summer rainfall. Its distribution extends from Humansdorp in the west to Grahamstown in the east.

In grassy fynbos, grasses largely replace the reed (restioid) component but the vegetation is otherwise typically fynbos with proteas, ericas and restios being present. Other plant families that occur in grassy fynbos on the Grahamstown Hills include the Asteraceae (daisies), legumes, aloes and geraniums (pelargoniums), as well as many flowering geophytes (bulbs and corms) such as the iris family (e.g. watsonias), Hypoxidaceae (African potato) and agapanthus. Some species of plants are only found in grassy fynbos, e.g. the Grahamstown heath, *Erica chamissonis*.

In the Grahamstown area, grassy fynbos can be found on the south-facing slopes of the Grahamstown Hills. These slopes tend to be more moist than the north-facing slopes. The north-facing slopes are typically covered by grassland which is adapted to drier conditions.

In the Eastern Cape, grassy fynbos is preserved in the Zuurberg National Park, the Groendal Wilderness and Baviaanskloof Wilderness areas. However, grassy fynbos has long been neglected by the conservation organisations in South Africa and only 16% of grassy fynbos areas have been protected.

Notes

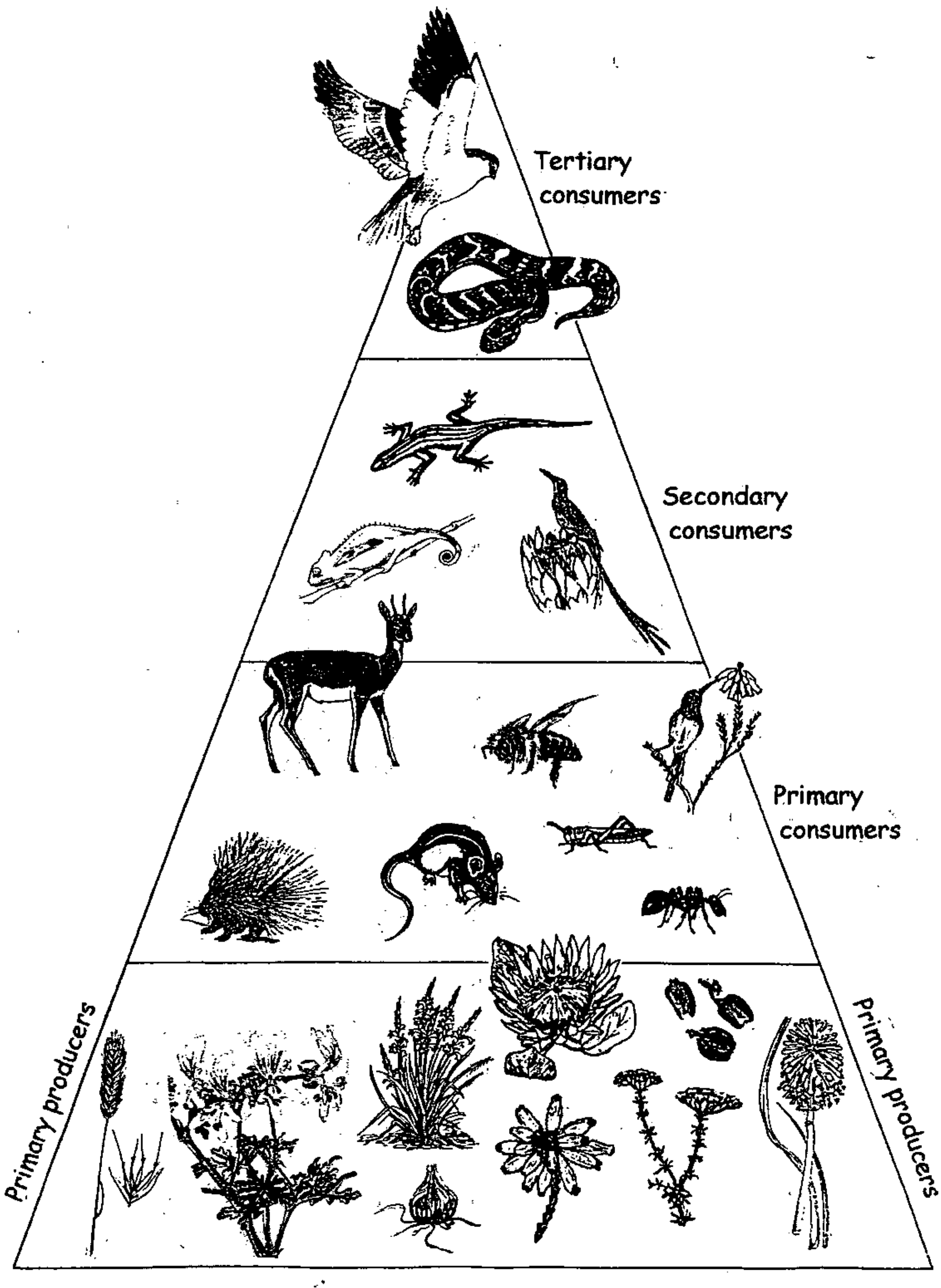
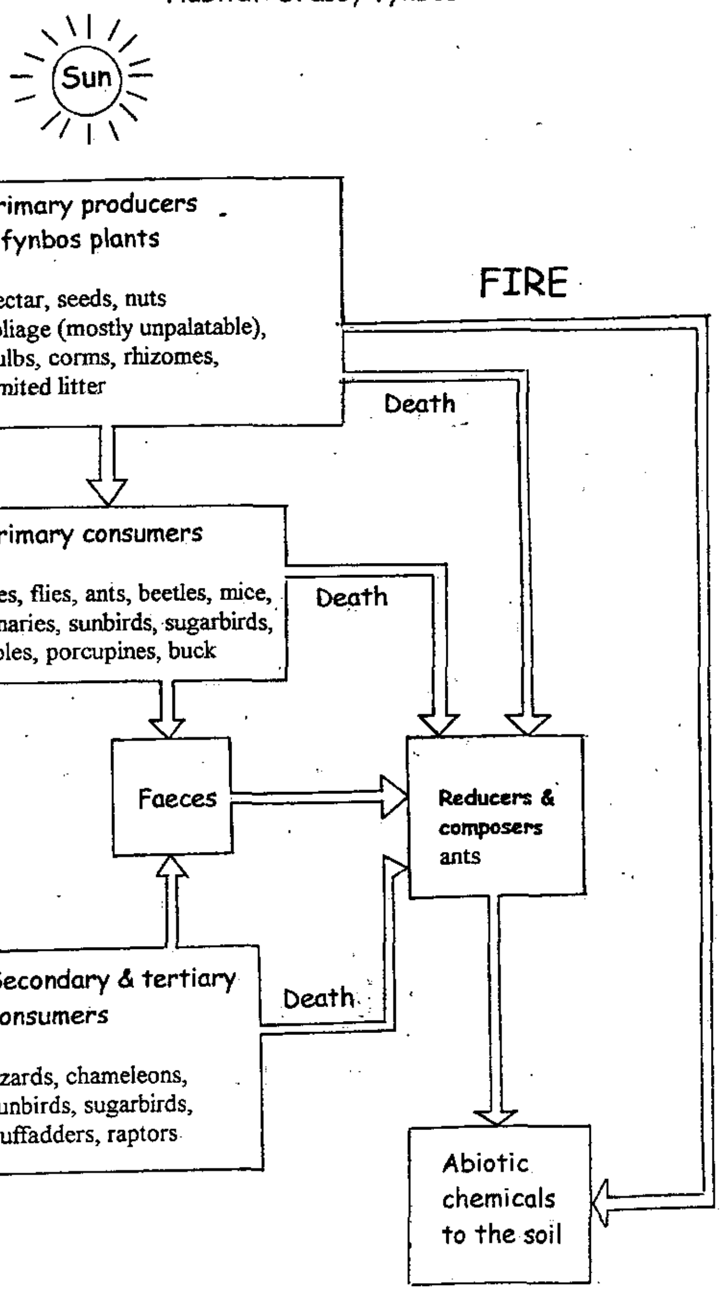


Figure 1. Grassy fynbos food pyramid (adapted from Ashwell, 2001).

Figure 2. **ENERGY FLOW DIAGRAM**

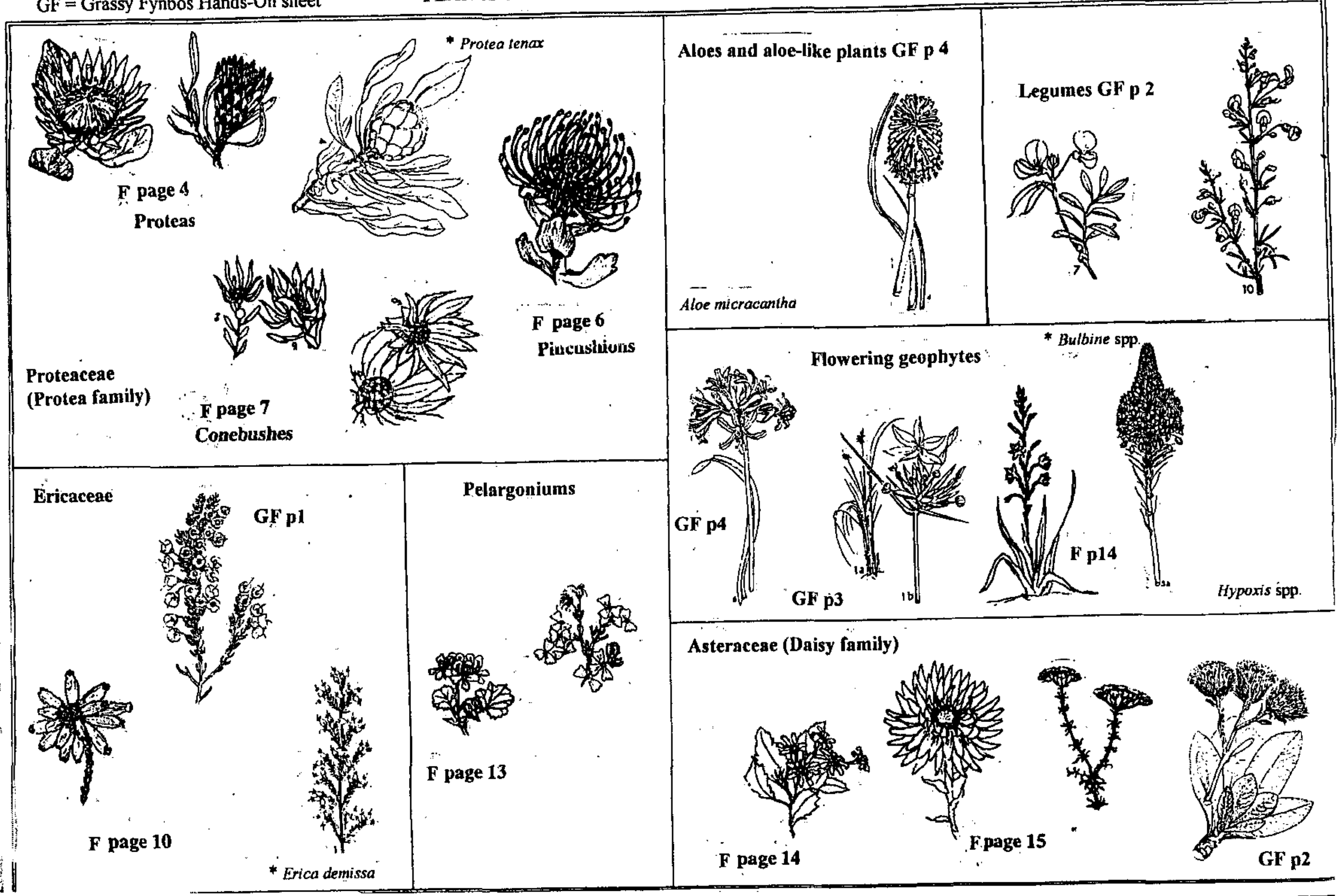
Habitat: Grassy fynbos



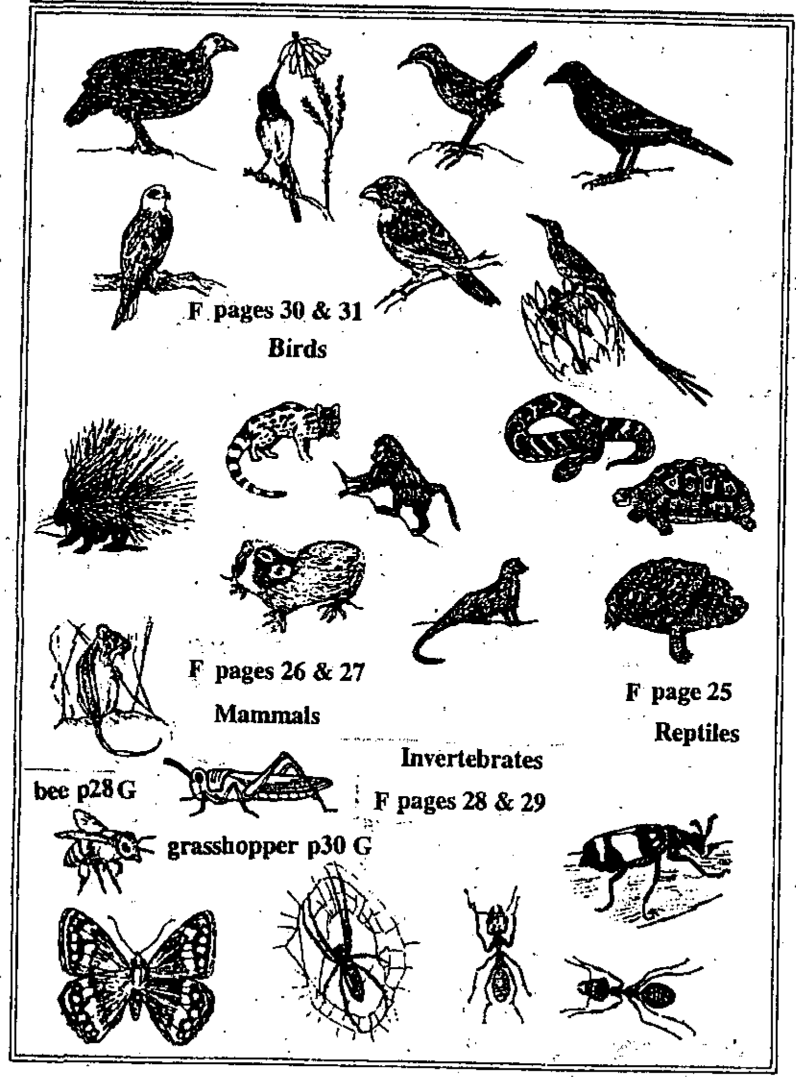
F = Fynbos Life Hands-On booklet
G = Grassland Life Hands-On booklet
GF = Grassy Fynbos Hands-On sheet

IDENTIFICATION REFERENCE SHEET
PLANTS of GRASSY FYNBOS - GRAHAMSTOWN HILLS

* Not presently in Hands-On material



PICTURE REFERENCE SHEET:



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PICTURE REFERENCE SHEET
GRASSY FYNBOS - GRAHAMSTOWN HILLS
Restios, Grasses and Sedges