Chapter 4: Conservation Status of Ultramafic Sites and Flora in Swaziland

Introduction

Land use and natural vegetation

The effects of land use on vegetation range from almost total loss of the naturally occurring vegetation to increases in species richness. Some uses result in physical or chemical changes which make a return to a previous state unlikely. Should a change in land use allow a return to natural vegetation, dispersal limitations will affect the speed and degree of change. Large contiguous areas will take longer to revert to a natural state and are likely to have fewer species than smaller areas. Swaziland has a total land area of 17364 km^2. There are two major types of land ownership, namely Swazi Nation Land and Title Deed Land. The former is administered by Chiefs who allocate usufruct rights to individual Swazi families, who farm the land on a subsistence basis. Title Deed Land is mainly used for commercial farming (Swaziland Government Online information Portal).

There are many studies, primarily of pollution from old mine sites, which indicate mine workings or tailings from the late 1800s and early 1900s are either without plant cover or with very sparse and species poor cover (Grant *et al.*, 2001; Moore & Zimmermann, 1977; Rodriguez *et al.*, 2004; Rösner & van Schalkwyk, 1999). These mine sites are often a source of metals and other pollutants which may affect distant areas. Restoration, in which the displaced vegetation and ecological functions are re-established, or rehabilitation, where some acceptable cover is established should be planned from the beginning of mining operations to ensure the best chance of success (Bradshaw, 1997). If soils are removed in such a way that topsoil and subsoils are kept separate and are replaced in the correct order, and if the soil profile is re-established while the seed bank and vegetative survivors are still viable, a restored vegetation very similar to the original vegetation can result (Bradshaw, 1997). This ideal however is seldom achieved. Mine wastes are often chemically and physically difficult substrates for plant survival (Rodriguez *et al.*, 2004). In these cases the area, usually a tailings dump or slimes dam, is lost as habitat for natural vegetation and often affects surroundings by wind blown dust, runoff or leaching. Even in cases where rehabilitation is undertaken exotic species may be used, as for example an opencast coal mine in India revegetated with exotic trees (Dutta & Agawal, 2003). In the Swaziland context, mining operations are on a limited scale and a relatively small area of land is directly affected. In the study area there are large waste dumps at a discontinued iron mine at the south end of Malolotja Nature Reserve and at an asbestos dump and workings just north of the reserve. These sites are almost devoid of plant cover.

Plantations replace huge areas of natural vegetation. The relatively small areas that remain as fire breaks and along roadsides retain some species, but those species which compromise the effectiveness of the firebreak will not be retained. The management of firebreaks is likely to change their plant composition, as impacts on some species are likely to be greater than on other species and disturbance will benefit exotic weeds and weedy indigenous species. Shading will also play an increasing role as the timber matures. Changing land use from forestry back to natural grassland is not very likely for several reasons. Various sources indicate a high and growing demand for wood and pulp (China Daily 15/02/05, Wall Street Journal 14/02/05, Weiner & Victor, 2000). The demand for roundwood is increasing with a predicted rate of increase of about 0.5 % per year until 2050 (Weiner & Victor, 2000). Wood pulp has become China's third largest import after steel and petroleum and a significant use is for tissues and toilet paper (China Daily 15/02/05). The Wall Street Journal indicates strong demand for timber has created a strong demand for investment in timber production (Wall Street Journal 14/02/05). In terms of the Kyoto Protocol signed in Japan in 1997, countries can invest in afforestation in developing countries as a means of achieving their carbon emission reduction targets by funding carbon sequestration elsewhere. This anticipated increase in demand and the possibility of afforestation programmes to meet emission targets could result in increased forestry in Swaziland. With extensive areas of plantation a return to previous vegetation may take centuries, if it is possible at all. The need for long distance dispersal will result in slow recolonization and changes in soil conditions as a result of tree growth are likely to have an effect on the species composition of the secondary vegetation.

Commercial agriculture, like plantations, replaces natural vegetation over large areas. Economic conditions, climate and the political situation could all potentially result in commercial agriculture being scaled down or discontinued, but none of these potential threats appear to be imminent in Swaziland. Re-establishment of natural vegetation, should commercial farming cease, would probably take a very long time because of dispersal distance and because cultivation and fertilization will have changed the soil properties and will favour some taxa over others.

Traditional farming has a lesser impact on natural vegetation than either commercial agriculture or forestry. There is shifting use and cultivated fields may stay fallow for long enough for weeds, which colonise abandoned fields initially, to be replaced by vegetation very similar to that on uncultivated land. Natural vegetation returns to abandoned fields and remains on grazed land although the composition of the flora might be altered in re-colonised fields and in response to a high grazing load.

A mosaic of grazing areas, living areas and cultivated areas allows rapid recolonization of abandoned fields from surrounding areas. Manual weeding and clearing of land probably allows some plants to survive around the crop, unlike in more mechanised farming where cultivation is more through and herbicides are often used to maintain a monoculture. These persisting plants may contribute to what appears to be relatively quick regrowth of naturally occurring plants on abandoned lands. Prolonged overgrazing can result in a loss of species as more palatable plants are consumed faster than they can regenerate and species intolerant of disturbance or damage are killed. Intermediate grazing pressure, however, has often been found to increase species richness. Communal lands in the Bushbuckridge area in South Africa had significantly more plant species than adjacent protected areas (Shackleton, 2000). It is postulated that by opening living space, species which might otherwise be outgrown are able to survive (Noy-Meir *et al.*, 1989; Safford & Harrison, 2003). Another study, in a drier area of the South African lowveld than Bushbuckridge, found a decrease in the number of woody species in communal lands as compared with commercial cattle ranching and private game reserves (Higgins *et al.*, 1999). In Swaziland communal land (Swazi Nation Land) is the largest category of land use and is a mixture of family dwellings, usually in a cleared yard, and associated fields for subsistence cultivation and communal grazing. The landscape in the northwest of Swaziland is a mosaic of hills and valleys with a variety of underlying rock types. There are outcrops of rock and steep slopes which are a refuge for plants and small animals because they are unsuitable sites for huts, houses or cultivation, and even offer some protection from grazing livestock. Soapstone carving is an important source of income in the study area, with many stalls along the road catering to passing tourists. Soapstone quarrying is of limited extent and at a low level at present, so re-colonization by plants probably takes place fast enough for soapstone collection to be a minor threat to plant diversity as long as the intensity of mining is not increased. During field work I had the impression that there was an increase in the number of large carvings on offer which would result in a greater intensity of quarrying accompanied by an increased impact on the natural vegetation. An increase in population has resulted in Swazi Nation Land becoming more fragmented, with land holdings of under 1 hectare in size constituting 92% of the land in 2000/2001 compared with only 68% in 1996/97 (Swaziland Government Online Information Portal). Smaller land holdings probably mean more dwellings and living areas which displace vegetation. With less area available for cultivation it is likely that households may not be able to afford to abandon fields at all, or the period of non-cultivation may be shortened. HIV/AIDS is having a massive impact on society in Swaziland. This impact is negating the trend toward an increased intensity of Communal Land use. A recent study found that a reduction of 29.6% in the number of cattle has occurred, livestock having been sold to cover health care and funeral costs. Together with the reduction in the number of cattle there has been a reduction in the area cultivated. This is due to loss of labour because of death or illness and because of time spent caring for the ill and attending funerals. In households affected by AIDS the reduction in the area under cultivation is 34.2% and 22.8% of households surveyed were found to have experienced an AIDS related death (Muwanga, 2002).

Wattle invasion affects significant areas of the highveld in Swaziland. The wattles grow densely and no natural vegetation remains within the thickets that develop. Structural use and consumption for fuel constrains the spread of thickets. With AIDS impacting the activities of households to an increasing extent (Muwanga, 2002) it is possible that less labour and a decreasing working population might result in less demand/use of wattle and wattle will spread unchecked. Studies suggest that increasing CO_2 levels may increase the growth rate of trees, particularly at higher altitudes where CO_2 may be a limiting factor (Saxe *et al*., 1998; Tranquillini, 1979). Wattles are likely to have an increasing impact on natural vegetation if consumption decreases, control measures to retain grazing or cultivation are reduced and/or growth rate increases. Invasive plants can contribute to rarity or extinction in remnants of natural vegetation (Duncan & Young, 2000). Should wattle encroachment continue in Swaziland at least one species (*Ocimum motjaneanum*) could be lost as a direct result (McCallum & Balkwill, 2004).

Conservation of serpentine sites and plants

In the foreword to the proceedings of the Fourth International Conference on Serpentine Ecology there is a resolution endorsed by the delegates to further the protection of ultramafic sites wherever they are in danger of destruction or disturbance (Proctor, 2003). Many unusual geological phenomena around the world are protected, but it is generally the spectacular formations that are afforded protection, sites like Table Mountain, the Blyde River Canyon, Victoria Falls and Kilimanjaro. Unusual lithologies with distinct soils and floras are less secure, and for example in Southern California are often perceived as wastelands and used by off-road thrill seekers to the detriment of some rare species they support (Kruckeberg, 2003). In southern Africa, no ultramafic areas are protected because of their geology although a few happen to be within areas protected for other reasons.

Endemism, rarity and extinction risk

Plants endemic to an area or habitat type, particularly if the area or habitat is small in area, are more susceptible to extinction than more widespread taxa. This is because a small area has a greater potential to be lost as habitat through some land use or catastrophe and a smaller area supports a smaller population size. This is recognised in the IUCN 1994 Red Data List Categories which have small distribution and small area of occupancy as risk factors. A study of plant survival after urbanization found that rare plants, short plants and plants from habitats that showed the greatest loss of area had the greatest probability of becoming extinct (Duncan & Young, 2000). These attributes probably apply to extinction risk in Swaziland. The increased probability of extinction for lower growing plants in the research cited was because smaller plants were shaded out by invasive alien plants. In the Swaziland context, trees may survive wattle encroachment, but lower growing plants may be shaded out. Red Data plants are indicators of ecosystem health and can provide an early warning of environmental degeneration (Golding, 2002). It is thus important to ascertain those plants at risk, as persistence or decline of these taxa indicate retention or loss of plant diversity.

Palaeoendmics and neoendemics

Endemics have been classified by their stage in evolutionary history. The term Neoendemic is applied to endemic taxa of recent origin. If the genetic difference is not very great and the related taxa are not separated geographically a more recent divergence is inferred. The area of occurrence is the area of origin. Potential for an expansion in range is also a common feature of neoendemics. Palaeoendemics on the other hand are thought to be relicts of a much wider distribution. They are likely to have closest relatives with a large genetic divergence and a large geographical separation from them. The area of origin is not necessarily the area of survival and there would not be potential for an expansion in range (Richardson I.B.K., 1978).

Research questions

What is the conservation status of ultramafic areas in Swaziland?

Should Swaziland ultramafic areas be conserved?

Is the ultramafic flora likely to persist without active conservation?

Which taxa are endemic to ultramafic soils and what is their status?

Which Red Data species occur and do Red Data species favour ultramafic soils?

Methods and materials

Geographical information

Identification of ultramafic areas

Ultramafic sites were identified using the following maps:

Directorate of Overseas Surveys, United Kingdom

1:50 000 geological series edition 1 1979; 2531 CC (Sheet 1), 2631AA & part of 2630BB (Sheet 5).

1: 50 000 geological series edition 2 1980; 2531CD & part of 2531CB (Sheet 2) Geologial Survey and Mines Department, Swaziland

1:25 000 geological series; Sheet 1 1968, Sheet 2 1969, Sheet 3 1970, Sheet 4 1971 Surveyor General, Swaziland

1:50 000 1992, aerial photography 1989; 2531 CC (Sheet 1), 2531 CD & part of 2531CB (Sheet 2), 2631 AA & part of 2630 BB (Sheet 5), 2631 AC (Sheet 11)

Chief Director of Surveys and Mapping, South Africa

1:50 000; 2630 BD Bell's Kop second edition 1985

A GPS was used together with these maps to determine position on the ground. Four plant species, *Ocimum motjaneanum* McCallum & K. Balkwill, *Senecio coronatus* Harv., *Xerophyta villosa* (Baker) L.B. Smith & Ayensu and *Berkheya rehmannii* Thell. var. *rogersiana* Thell. are useful indicators of ultramafic soils. *Senecio coronatus* (Thunb.) Harv. occurs on a variety of soils and some populations, including those in this study, on nickeliferous soils accumulate Ni and thus if plants are shown to have a high Ni content an ultramafic soil is indicated.

Determination of present land use

Information from geological maps was overlaid on topographic maps in order to locate geology accurately on the maps. Aerial photographs were used where available to supplement land use data on the 1:50 000 maps. In this way land use for ultramafic sites could be seen on the map (Figure 4.1). The maps were scanned with a flat bed scanner and CorelDRAW 10 was used to produce a

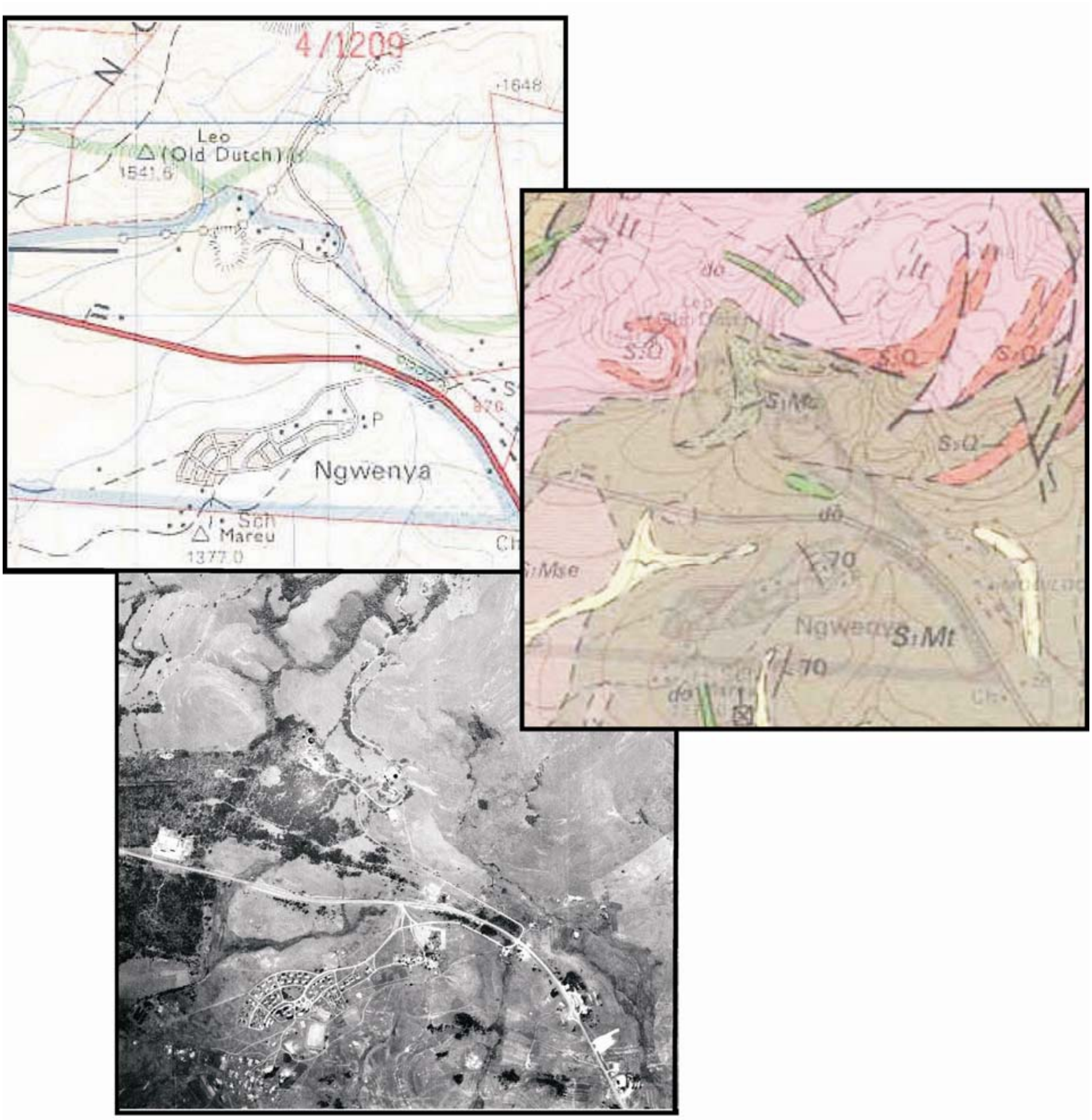

Figure 4.1. From top to bottom part of a 1:50 000 map, the same area on a geological map and an aerial photograph of the area. Information from these sources was superimposed to produce a map showing ultramafic areas in Swaziland.

montage of the study area for both topographical and geological maps. The areas of ultramafic rock on the geological maps were hand traced using the computer mouse to produce a map of the ultramafic areas in Swaziland. A map of land use was produced from the topographical maps in a similar way and the map of ultramafic areas was made partially transparent and overlaid on the land use map so that land use for ultramafic soils could be determined.

Ground truthing and reference to a few available aerial photographs supplemented the land use information. The area of ultramafic soils and the areas for land use were determined using an image analysis program, Simple PCI 5.1. The land use for the immediate area of the ultramafic soils was obtained by measuring the areas for each type of land use in a 15 km wide strip that included the ultramafic areas.

Conservation Status of Flora

Ultramafic Endemics

In this study 413 taxa were collected on ultramafic soils only. A process of elimination first removed those species known to occur on non-ultramafic sites, then Retief and Herman (1997) and Germishuizen and Meyer (2003) were used to remove those species that had a distribution which extended beyond ultramafic areas. The few remaining taxa were further reduced by examining herbarium material at the C.E. Moss Herbarium (J.) and consulting literature (original descriptions, revisions etc.) and removing those taxa either found on non-ultramafic soils, or found in areas without ultramafic soils, from the list.

Red Data Species

The Red data species were determined from Southern African Plant Red Data Lists (2002) edited by Janice Golding, Red Data List of Southern African Plants (1996) by Craig Hilton-Taylor, updates published in Bothalia (Hilton-Taylor 1996(2), 1997) and the Interim Red Data List of South African Plants downloaded from *http://www.nbi.ac.za/frames/biodiversityfram.htm* on 12 January 2006.

Results

Ultramafic soils in Swaziland

The approximate area of ultramafic soils in Swaziland is 57.5 km^2 with 14.1 km^2 a serpentinite sequence and 43.4 km^2 a sequence of serpentinous and tremolitic schists and tremolite amphibolite serpentinous shists.

Land use for ultramafic soils in Swaziland

Five main land uses can be recognised, communal land (Swazi Nation Land), plantations, commercial farming, blackwattle thickets, and conserved areas. Communal land (62%) is the largest land use with conserved areas (4%) the smallest (Figure 4.2). The land use in the study area has changed since 1962, when, based on South Africa 1:50 000 sheet 2631AA Forbes Reef first edition and South Africa 1:50 000 sheet 2531CD Shiyalongubo, the land use in the study area was all Swazi Nation Land except the area near Piggs Peak which had extensive pine plantations. Subsequent to this two nature reserves have been created in the study area, plantations have extended west of Piggs Peak and an extensive area of commercial farming now exists at the northern side of the study area (Figure 4.3). There are differences in the relative proportions for each land use in the study area as a whole compared to the ultramafic areas. The latter have a greater proportion under land uses with the greatest negative impact on vegetation and less area protected in nature reserves. Table 4.1 shows the estimated areas for the major land use categories for the study area as a whole and the ultramafic areas.

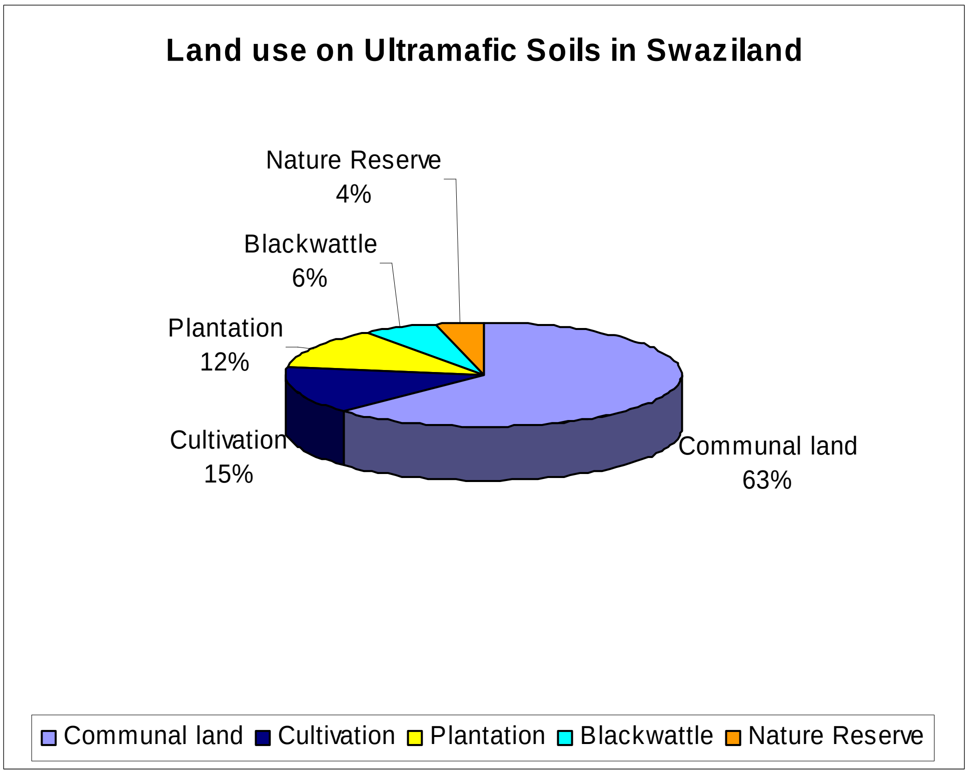

Figure 4.2. Land use for ultramafic soils in Swaziland

Figure 4.3. Map showing land use on ultramafic soils in Swaziland. Compiled from Directorate of Overseas Surveys, United Kingdom 1:50 000 geological series edition 1 1979; 2531 CC (Sheet 1), 2631AA & part of 2630BB (Sheet 5); 1: 50 000 geological series edition 2 1980; 2531CD & part of 2531CB (Sheet 2); Geologial Survey and Mines Department, Swaziland 1:25 000 geological series; Sheet 1 1968, Sheet 2 1969, Sheet 3 1970, Sheet 4 1971; Surveyor General, Swaziland 1:50 000 1992, aerial photography 1989; 2531 CC (Sheet 1), 2531 CD & part of 2531CB (Sheet 2), 2631 AA & part of 2630 BB (Sheet 5), 2631 AC (Sheet 11); Chief Director of Surveys and Mapping, South Africa1:50 000; 2630 BD Bell's Kop second edition 1985.

Table 4.1. Land use for study area and ultramafic soils.

	Study area		Ultramafic area	
	Area (km^2)	%	Area (km^2)	%
Communal farming	702.72	50.41	35.92	62.51
Cultivation	157.80	11.27	8.56	14.90
Plantations	351.90	25.24	7.16	12.46
Black wattle	9.86	0.71	3.56	6.20
Nature Reserves	172.44	12.37	2.26	3.93
Totals	1394.00	100.00	57.46	100.00

Communal land

Swazi Nation Land or communal land is the largest class of land use on ultramafic rocks and in the study area. In this land use a family typically has a living area with a number of buildings in a cleared yard, sometimes with fruit trees in the yard, surrounded by cultivated fields with natural grassland beyond this where cattle graze (Figure 4.4).

Figure 4.4. A typical family settlement on Motjane ultramafic with a wattle thicket in the background.

This type of land use has the least impact on plant diversity but at present levels already poses a threat to some taxa. The mixture of cultivated lands and grassland and the protection afforded by hills and mountains probably puts few species at risk. It is possible to see succession on abandoned lands, with weeds being replaced by grasses and forbs until the only clue that the area was once cultivated is the remnants of ridges and furrows under the vegetation cover. *Cymbopogon excavatus* is often associated with old fields indicating that secondary grassland may differ in species composition from primary grassland, but given the close proximity of uncultivated areas as a source of seeds it is likely that given enough time a similar species composition will be attained. Grazing has been identified as a major threat for *Kniphofia umbrina,* a critically endangered ultramafic endemic (Witkowski *et al*., 2001).

Commercial cultivation

These are orchards and farms particularly in the northern area. Intensive farming of the land leaves the only remaining natural vegetation in the road reserve. The northern site of about 18 km^2, near Hhohho, is the largest area of ultramafic soils in Swaziland, but is entirely covered by commercial cultivation (Figure 4.3). If any endemic plants occurred, they have almost certainly been lost.

Plantations

Plantations are the third largest land use on serpentine soils in Swaziland. They are mainly *Pinus* species, but there are also some *Eucalyptus* plantations. The plantations are devoid of any remnants of natural vegetation and even the fire breaks are kept clear. Figure 4.5 shows the contrast between the natural grassland and the plantation. The plantations host weeds such as *Solanum mauritanium* Scop., *Lantana camara* L. and *Passiflora edulis* Sims which have potential to spread into the

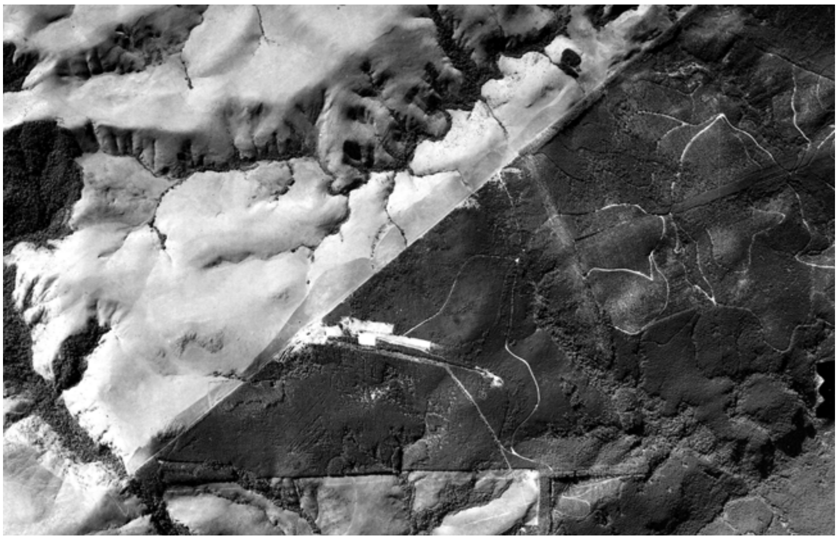

Figure 4.5. Aerial photograph showing the contrast between natural grassland and plantation.

wooded valleys, and do spread into the surroundings to a small extent. Tree seeds also spread from the plantations into surroundings and can pose a threat to biodiversity particularly in favoured microclimates such as those provided by stream valleys. There is evidence

that plantations have resulted in the loss of a considerable area of former habitat for an endangered plant, *Syncolostemon comptonii* Codd. This species is known only from four collections, one of which, Komati Pass, is now under plantation.

Blackwattle

There are plantations and large spreading thickets of blackwattle, *Acacia mearnsii* De Wild., in the Forbes Reef and Motjane areas. The wattle is used for building and fire wood but only larger trees and saplings are harvested. Encroachment by seedlings, which will shade out the natural vegetation by the time they are used, and invasion of watercourses is a real danger to plant diversity. Blackwattle in Swaziland is both an asset and a liability from an environmental perspective. The availability of this species for fuel and timber probably reduces the pressure on other woody species, but the wattle patches replace other vegetation and decrease the area available for grazing and subsistence farming.

Conserved areas

Figure 4.6. Malolotja Nature Reserve, looking northwards across ultramafic site. The greener area beyond the fence is grazed grass outside the reserve.

A very small area of ultramafic soil is found in Hawane Nature Reserve near Hawane Dam (Figure 4.7). The map (Figure 4.3) shows that only a small area of the reserve around the borders is ultramafic soil. This is the only protected ultramafic area at higher altitude. The endangered ultramafic endemic *Kniphofia umbrina* Codd occurs in this area. Most of the conserved ultramafic area is in Malolotja Nature Reserve (Figure 4.6), north of the Komati River.

Conserved areas of ultramafic soils total 2.26 km^2, about 4% of the total area and the smallest land use category.

Figure 4.7. Hawane Dam near Hawane Nature Reserve.

Endemics and Red Data Species

Endemics

Of the probable ultramafic endemics identified in Swaziland, five are limited to Swaziland, three from the low altitude sites at Malolotja and two from higher altitude at Forbes Reef and Motjane. One species occurs only on ultramafic soils in Swaziland, but occurs on other soil types elsewhere in its distribution. Three species are also found on ultramafic sites in South Africa (Table 4.2). Descriptions of the probable endemics follow with Red Data status and recommended status.

Table 4.2. Ultramafic endemics or probable endemics in Swaziland - Swaziland localities in bold.

	Family	Localities	Notes
Berkheya rehmannii Thell. var. *rogersiana* Thell.	Asteraceae	Dunbar, Groenvaly, Kaapshehoop, Nelshoogte, **Malolotja.**	Ni hyperaccumulator
Helichrysum nudifolia var. nov.	Asteraceae	**Malolotja**	Possibly an ultramafic endemic. Collected on ultramafic soil in this study. No specimens at PRE.
Kniphofia umbrina Codd	Asphodelaceae	**Forbes Reef**	Continuing decline in population (Witkowski *et al.*, 2001)
Ocimum motjaneanum McCallum & K. Balkwill	Lamiaceae	**Forbes Reef**, **Motjane**	
Oxalis davyana R. Knuth	Oxalidaceae	**Malolotja**	Few collections some combination of rarity and narrow distribution.
Sartidia sp. nov.	Poaceae	Agnes Mine, Dunbar, Geluk, Groenvaly, Goudgenoeg, Kaapsehoop, Kromdraai, Kortbegrip, **Malolotja**, Onverwacht	
Siphonoglossa sp. nov.	Acanthaceae	**Malolotja**	Only one specimen found. Specimens also collected in same area by P. Phillipson.
Syncolostemon comptonii Codd	Lamiaceae	**Malolotja**	An ultramafic endemic. The few collections that have been made can be shown to have been on ultramafic soil.
Xerophyta villosa (Baker) L.B. Sm. & Ayensu	Velloziaceae	Dunbar, **Malolotja**	Confined to ultramafic soil in Swaziland, but may occur on other soils in South Africa, Zimbabwe or Zambia.

1. *Berkheya rehmannii* Thell. var. *rogersiana* Thell.

Figure 4.8. *Berkheya rehmannii* var. *rogersiana* flowers and foliage.

Description: A bright green multi-stemmed, shrublet to about 70 cm tall; stems soft, green and glabrous. *Leaves* green above and pale to white below, linear lanceolate, about 9 x 1 cm; margin with well spaced ciliate teeth; clasping stem at base. *Inflorescences* single terminal heads, bright yellow, 6 – 8 cm across with several series of narrow involucral bracts with long ciliate teeth (Figure 4.8).

Distribution: Collected at Dunbar, Groenvaly, Kaapshehoop, Nelshoogte and Malolotja.

Discussion: This is one of two hyperaccumulators of Ni in Swaziland. Williamson *et al*. (1997) found evidence that *Berkheya rehmannii* var. *rehmannii,* a taxon with a completely different appearance because of much narrower leaves, was the most closely related taxon to var. *rogersiana* and that the genetic difference between these taxa was not very great. The two varieties are conspecific and they concluded that var. *rogersiana* probably diverged from var. *rehmannii* in recent times and hence is a neoendemic.

IUCN Red List Assessment

This taxon is not currently listed in the southern African Red Data Lists 2002. Williamson and Balkwill, paper in prep., recommend a status of VU D1+2 for South Africa, afforestation being the greatest threat.

2. *Helichrysum nudifolium* (L.) Less. var. *roseum* McCallum var. nov.

Figure 4.9. Herbarium specimen of *H. nudifolium* var. *roseum* showing dark pink involucral bracts.

Description: Perennial herb with leaves in a basal rosette and flowering stems up to about 50 cm tall. Basal leaves lanceolate, 4 – 16 x 1.0 – 2.5 cm with 3 main veins impressed above, raised below; pseudopetioles up to 13 cm long. Cauline leaves similar to basal leaves but soon sessile and stem-clasping, becoming distant elongate bracts towards the tips. Heads campanulate, 4 x 4 mm; involucral bracts in about 4 ranks, imbricate, deep pink or red, bases white woolly, tips ovate to sub-acute. Flowers red; pappus scabrid, dark pink at the base becoming paler towards tips (Figure 4.9)..

Distinguishing features: Despite the large variation in most features of *H. nudifolium*, involucral bracts are never pink as in the new variety. They range from yellow and greenish to brown except in the case of specimens of var. *oxyphyllum* (DC.) Beentjie which may be almost white with the outer bracts tinged pinkish or reddish, but in that variety the florets are cream-yellow, not red as in the new variety.

Habitat: Mountain grassland among rocks.

Distribution: Collected in the northern part of Malolotja Nature Reserve in the area closest to Luhhumanani School. No other sites known.

Flowering season: Flowering plants collected in November.

Discussion: *Helichrysum nudifolium* (L.) Less. is a widespread and very variable species occurring from Sierra Leone and Nigeria to Sudan and Ethiopia and south to Angola and South Africa as well as in Yemen. An indication of the variability of this species is that in a revision, Beentjie (2000) reduces *H. pilosellum* (L.f.) Less., a species that is quite distinct in southern Africa, to a variety of *H. nudifolium* because of almost continuous variation of features between these taxa over the entire distribution range. Plants of the new variety differ from the typical variety only in the colour of the involucral bracts and there is no geographical separation of the varieties, so the new variety is likely to be a neoendemic.

IUCN Red List assessment

No specimens matching the new variety were found in the National Herbarium (PRE). Collecting intensity in Swaziland has been greatest in protected areas and Malolotja Nature Reserve has been well surveyed (Dlamini & Dlamini, 2002). This suggests that the new variety is likely to be either uncommon or restricted in occurrence. During the present study a single locality was found, although at the time the plant was not recognized as a new discovery and consequently efforts were not made to find additional populations. Present knowledge would give a rating of DD - Data Deficient.

3. *Kniphofia umbrina* Codd

Description: Perennial herbs with rosettes of leaves arising from thickened rhizomes, flowering plants 70 – 90 cm tall. *Leaves* 7 – 9 per peduncle, mid-green, v-shaped in section, up to 70 x 2 cm; margin smooth; apex blunt. *Inflorescence* tapering slightly towards apex, 7 – 15 x 1.5 – 2 cm, very dense. Flowers purplish-brown in bud opening reddish-brown, slightly scented; stamens exserted (Codd, 1969) (Figure 4.10).

Figure 4.10. Photogaph of *K. umbrina* infructescence (courtesy E. Witkowski).

Distribution: Forbes Reef area.

Discussion: Codd (1969) lists the similarities between *K. umbrina* and *K. typhoides* Codd in his account, thereby suggesting the latter species as the most closely related to *K. umbrina*. This species has a distribution that partially surrounds the area where *K. umbrina* occurs, but at a considerable distance. The geographic separation between closely related species may be interpreted in various ways. The species may share a common ancestor which would have had a contiguous distribution, *K. umbrina* may have arisen from *K. typhoides* at a time when the distributions were contiguous or the distribution is a result of a long distance dispersal event. The first two possibilities would imply a long passage of time has elapsed. There are also a number of differences between the two taxa, which suggest a long period of divergence pointing to this species being palaeoendemic rather than neoendemic.

IUCN Red List assessment

This species is listed as Critically Endangered. CR B1B2c(iv) (Witkowski *et al*., 2001)

4. *Ocimum motjaneanum* McCallum & K. Balkwill– Appendix 4.

Figure 4.11. *Ocimum motjaneanum* McCallum & K. Balkwill, showing prostrate habit, almost glabrous leaves and the manner in which flowers open in each verticel.

Description: Procumbent branched perennial; stems annual, about 15 cm long at first flowering and 35 cm or more at the end of the growing season, spreading along the ground, 3 cm tall, becoming upright and 8 – 12 cm tall at the inflorescences, square, grooved down each face, sparsely hairy; rootstock a woody caudex, narrowly conical, 9 – 15 × 2.0 – 3.5 cm, with the stems arising around the edge. *Leaves* bright green, elliptic or obovate, 9 – 17 × 20 – 32 mm, glabrous above and below, main and secondary veins translucent, raised above and below; apex acute or obtuse; margin entire or with 2 or 3 small teeth on each side in the apical half; petiole short, (0 –) 1 – 2 (– 4) mm long. *Inflorescences*: 2 – 6 verticels of opposite 3-flowered cymes. All three flowers in a cyme usually open simultaneously. Corolla white or tinged mauve (Figure 4.11).

Distribution: Forbes Reef and Motjane ultramafic sites.

Discussion: *Ocimum motjaneanum* most closely resembles *O. obovatum* E. Mey. ex Benth var. *hians* Benth., which occurs in the same area. Differences between these taxa are: the prostrate habit, the raised veins on the upper surface and the bright green glabrous or almost glabrous leaves. The leaves of *O. obovatum* var. *hians* are a duller green due to a denser covering of sessile glands and usually trichomes on the veins and at least a few scattered between veins. The leaf shape is also different, the leaves of *O. obovatum* var. *hians* are mostly relatively narrower, usually around twice as long as broad compared to somewhat less than twice as long as broad in *O. motjaneanum*. Another difference is *O. obovatum* var. *hians* usually has at least one flower that is out of phase with the rest. The many differences between taxa suggest a long separation, but the lack of geographic separation suggests a more recent origin.

IUCN Red List assessment
Critically Endangered (CR B1a+b(iii)) or CR B2 a + b(iii)

5. *Oxalis davyana* R. Knuth

Description: Perennial herb to 30 cm tall with few leaves arising from the base; rootstock a small succulent taproot, bulb unknown. *Leaves* palmately compound with 3 ovate to rhomboid lealets, green above, greyish green below, 2 – 5 x 2 – 4 cm; petiolules short; petioles 6 – 27 cm long. *Inflorescences* umbels of up to 10 flowers; pedicels up to 2 cm long; peduncles as long or longer than petioles. *Flowers*: corolla bright pink, 2 cm across (Figure 4.13).

Distribution and habitat: Figure 4.12 shows the distribution in the Komati Valley and Havelock Concession area. Plants occur in afromontane grassland.

Discussion: Specimens quoted in Salter (1944) and the distribution based on specimens housed at the National Herbarium (PRE), are consistent with this species being endemic to ultramafic soils. The relatively small area of ultramafic soils could be part of the explanation for the paucity of specimens. This is the only species in sub-section Goetzii, so is not considered closely related to any other species of *Oxalis*. This suggests the species may be palaeoendemic.

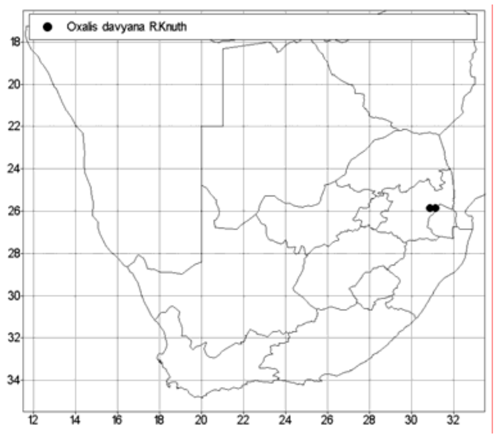

Figure 4.12. Distribution of *Oxalis davyana*.

Figure 4.13. Herbarium specimen of *Oxalis davyana*.

IUCN Red List assessment

A limited distribution and very few collections in over sixty years suggest this species is likely to be in one of the threatened categories.

6. *Sartidia* sp. nov.

Description: Perennial clump forming grass, 0.4 – 1 m tall. *Leaves* narrow, 2 mm broad. Inflorescences spreading, on leafless stalks, glumes cernuous (Figure 4.14).

Distinguishing features

The new species and *S. jucunda* De Winter have smaller spikelets than the other two species. Some differences between the new species and *S. jucunda* are: leaf sheath pallid or pale green and lower leaf blade glabrous in the new species rather than leaf sheath rusty brown and lower leaf blade with rough hairs. The new species also has a broader panicle than the other three species (Balkwill *et al.*, paper in prep.).

Distribution and habitat: This species has been collected in rocky afromontane grassland on ultramafic soils.

Flowering season: Mainly December to April.

Discussion: De Winter (1965) determined that three species of *Aristida* with differences in their fruit also had a very different leaf anatomy, and he placed these species in a new genus *Sartidia*. In 1972 P.J. Muller collected a species of *Sartidia* in the Cythna Letty Nature Reserve in Mpumalanga which did not the match existing species. It was subsequently collected by K. Balkwill and co-workers in many more localities and by K. Braun in Malolotja Nature Reserve (Balkwill *et al.*, paper in prep.).

IUCN Red List assessment

This species is classified as DD- Data Deficient- for Swaziland in the 2002 Red data list. Williamson and Balkwill, paper in prep, recommend a category of Lower Risk for this species in South Africa.

Figure 4.14. Herbarium specimen of *Sartidia* sp. nov. Note the broadly spreading inflorescence.

6. Siphonoglossa sp. nov.

Description: Herb to 40 cm tall; stems square. *Leaves* dark green, lanceolate 6.5 × 1.2 cm; apex tapering to an acute point; margin entire; petiole short. *Inflorescence*: compact terminal inflorescence; bracts prominent; primary narrow, to 3 cm long. *Flowers* bright pink; tube 2.5 cm long with lobes spreading to 1 cm across (Figure 4.15).

Distribution: Known from this collection and collections by P. Phillipson in the same general area.

Discussion: Only one plant was collected in this study despite a search for additional plants. The specimen was found close to the border between ultramafic and non-ultramafic soil near Malolotja Nature Reserve, and the soil may not have been ultramafic.

Figure 4.15. ***Siphonoglossa*** **sp. nov., a possible ultramafic endemic.**

IUCN Red List assessment

New species, no existing assessment, would be rated as DD- Data Deficient.

7. *Syncolostemon comptonii* Codd

Description: Shrub to 160 cm tall; stems slender, shortly hairy. *Leaves* appear clustered at nodes, oblanceolate to narrowly elliptic, 2 – 3.5 x 0.3 – 0.6 cm; apex acute; margin entire; petiole short. *Inflorescences* compact with 2-flowered verticillasters spaced 2 – 3 mm apart. *Corolla* white, 9 – 10 mm long (Figure 4.16).

Distribution: This species is known only from one area in Swaziland. The type was collected near Komati bridge in 1959 (Codd, 1976). By the time the name was published a new shorter road had been built to Piggs Peak, and the new Komati bridge was 2 km downstream from the old bridge. The old bridge is near an ultramafic site, and the old road crosses ultramafic rock on the ascent out

Figure 4.16. Herbarium specimen of *Syncolostemon comptonii*. Note the compact inflorescences with verticels 2 – 3 mm apart.

of the Komati valley on the way to Piggs Peak while the new road is on granite for the entire transit of the valley. Superimposing the geological map on the map of the old road and marking positions of the three specimens at the National Herbarium (PRE) and the one collected in the present study it is found that all specimens were collected on ultramafic soils (Figure 4.17). This taxon is probably uncommon in the localities where it occurs. Added to this the serpentine sites are small in extent and remote from the present road so little if any collecting is likely to have occurred at these localities. Anyone wanting to relocate populations of the plant could easily have searched in vain near the present road. The paucity of vouchers for this taxon is probably due to a combination of the very localised distribution and probably small populations.

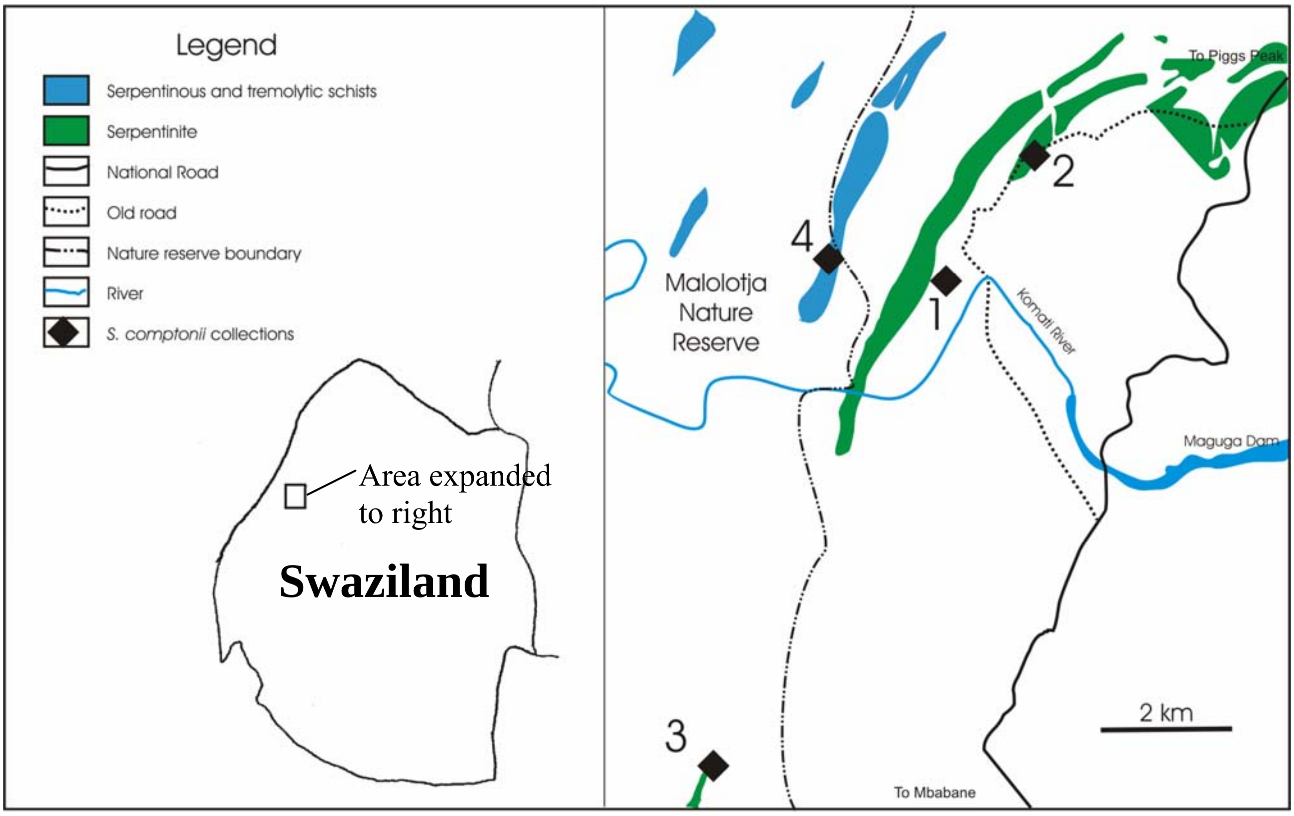

Figure 4.17. Map showing positions of old and new roads, ultramafic areas and sites where *S. comptonii* has been collected. The vouchers marked are: 1. Compton 28839 (PRE), May 1959, Near Komati Bridge. 2. Compton 31513 (PRE), May 1962, Komati Pass. 3. Heath 480 (PRE) South of Nkomati South camp, April 1986. 4. McCallum 916 (J) Malolotja.

Discussion: This species closely resembles *S. parviflorus* E. Mey. ex Benth. which also occurs in the area. D. Otieno (pers. comm.) considers the species to be so close that *S. comptonii* should perhaps be recognised as a variety of *S. parviflorus* rather than at species level. The close resemblance and presence in the same area suggest neoendemism.

IUCN Red List assessment

The infrequent collection of this species can be explained by:

1. The limited extent of possible habitat.
2. The change of route of the road which probably occurred before or shortly after the species was described in 1976.
3. An extensive area where it was previously collected (Komati Pass) is now under plantation.
4. It being uncommon where it does occur.

The present classification in Golding (2002) is critically endangered (CR A1cB1B2a) but that classification is partly based on incorrect information. The Maguga Dam threatens the area around the Komati bridge on the present Mbabane – Piggs Peak road, not the area where the plant was actually collected at the previous Komati bridge, upstream of the dam (Figure 4.17).

Local endemic

1. *Xerophyta villosa* (Baker) L.B. Sm. & Ayensu

Description: low plant with pseudo-stems of dry persistent leaf bases with leaves emerging at apex; pseudo-stems up to 50 cm tall. *Leaves* elongate, densely hairy. *Flowers* purplish blue (Figure 4.18).

Figure 4.18. Leaves and flowers of *Xerophyta villosa*.

Distribution: This species occurs in Swaziland, Mpumalanga in South Africa, Zimbabwe and Zambia. In Malolotja Nature Reserve a different species, *Xerophyta retinervis* Baker, occurs on non-ultramafic rocks being replaced by *X. villosa* on ultramafic soils. The association with ultramafic soils was a useful indicator of ultramafic soils. *Xerophyta villosa* occurs on ultramafic soil at Dunbar valley and at the Sawmill outcrop in Queens River valley, but possibly occurs on non- ultramafic soils elsewhere in South Africa (Figure 4.19) and in Zimbabwe, Zambia and at the Swaziland-Mozambique border.

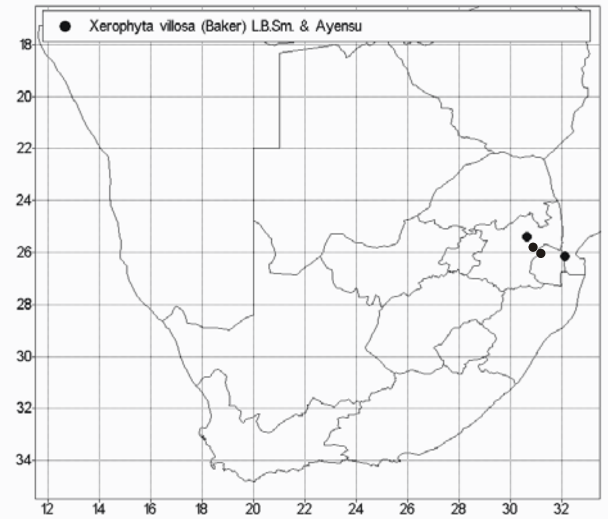

Figure 4.19. Distribution of *X. villosa* in South Africa and Swaziland.

Discussion: This species seems to be locally endemic to ultramafic soil. If there is no gene flow between populations on and off ultramafic soils speciation may occur in time. Three species considered endemic to ultramafic soils in South Africa occur on non-ultramafic soils in Swaziland.

IUCN Red List assessment

This species has been classified as vulnerable in Golding (2002), VU D2 by reason of the small localised distribution.

Conservation status of ultramafic endemics

Of the 9 ultramafic endemics in Swaziland 4 need to be added to the red data list and using the IUCN assessment criteria *Xerophyta villosa* should be rated as endangered rather than vulnerable. *Syncolostemon comptonii* remains critically endangered but the criteria are different, as the threat posed by the Maguga Dam was based on an erroneous interpretation of locality information. Four species are data deficient but are likely to be threatened as there are few specimens of these taxa in herbaria, suggesting small or localised populations. Table 4.3 gives the information for making assessments, the present assessment, if any, and the recommended assessment. Appendix 3 is the summary of the categories.

Table 4.3. Information required for determining conservation status for plants endemic to ultramafic soils in Swaziland, current status and recommended status (see Appendix 3 for summary of categories).

Taxon	Estimated population size	Estimated future or past decline (%)	Threats and potential threats	Extent of occurrence (EOO) (km^2)	Area of occupancy (AOO) (km^2)	Number of sub-populations	Current status For Swaziland	Recommended status (if different)
Berkheya rehmannii Thell. var. *rogersiana* Thell.	100 – 250	0	Change in status of Malolotja N.R.	0.1	0.1	1	Not listed	EN D
Helichrysum nudifolia var. nov.	unknown	unknown	Change in status of Malolotja N.R.	unknown	unknown	unknown	Not listed	DD
♦*Kniphofia umbrina* Codd	357	92	Grazing, cultivation	4	0.2	13	CR A1, B1,2,3	
Ocimum motjaneanum McCallum & K. Balkwill	1000 – 1500	20	Grazing, encroachment by trees, settlement	22	1	4	CR B2 a+b(iii)	
Oxalis davyana R. Knuth	Probably under 10 000	unknown	Change in status of Malolotja N.R.	unknown	unknown	Possibly 3	Not listed	DD
Sartidia sp. nov.	unknown	unknown	Change in status of Malolotja N.R.	unknown	unknown	1 known	DD	
Siphonoglossa sp. nov.	unknown	unknown	unknown	unknown	unknown	unknown	Not listed	DD
Syncolostemon comptonii Codd	unknown	30	settlement, afforestation	20	5	3 known	CR A1cB1B2a	CR B1,2 a+b(iii)
Xerophyta villosa (Baker) L.B. Sm. &Ayensu	100 – 250	0	unknown.	0.1	0.1	1	VU D2	EN D1

Possible additional ultramafic endemics.

Two taxa are insufficiently known, but merit further investigation as possible ultramafic endemics.

1. ***Alepidea longifolia* E. Mey. var. *lancifolia* Weim.** appears to have a distribution in the Barberton mountain lands. This variety has been placed in synonymy with the typical variety which has a more widespread distribution. The material and distribution should be examined, as an ultramafic distribution together with morphological differences would justify a re-evaluation of the taxonomic status of these specimens.

2. ***Hermannia antonii* Verdoorn** has been collected in Swaziland and the Barberton area. The C.E. Moss Herbarium has a number of vouchers from the Barberton area from both ultramafic and other soils. All the Swaziland material so far has been on ultramafic soils or from localities that could be ultramafic. There is a small possibility that *H. antonii* could be locally endemic to ultramafic soils in Swaziland, and this should be investigated further.

Species not considered ultramafic endemics in Swaziland.

Four species listed as endemic to ultramafic soils in Changwe & Balkwill (2003) and Balkwill & Balkwill (1999) were collected in this study, two on ultramafic sites and the other on banded ironstone. Herbarium collections indicate that these species also occur on soils in Swaziland not known to be ultramafic. A fourth species listed in Williamson and Balkwill (In edit.) occurred both on and off ultramafic soil in Swaziland.

1. *Berkheya nivea* N.E. Br.

The type specimen was collected near Barberton (Brown, 1901). Distribution is listed as Mpumalanga in Germishuizen and Meyer (2003). A specimen was collected on banded ironstone in this study. The high iron content in this soil is likely to be limiting for many plant species and possibly the collection of *B. nivea* on this soil type is more an indication of soil similarities than an indication of plant versatility.

2. *Cyphia bolusii* E. Phillips

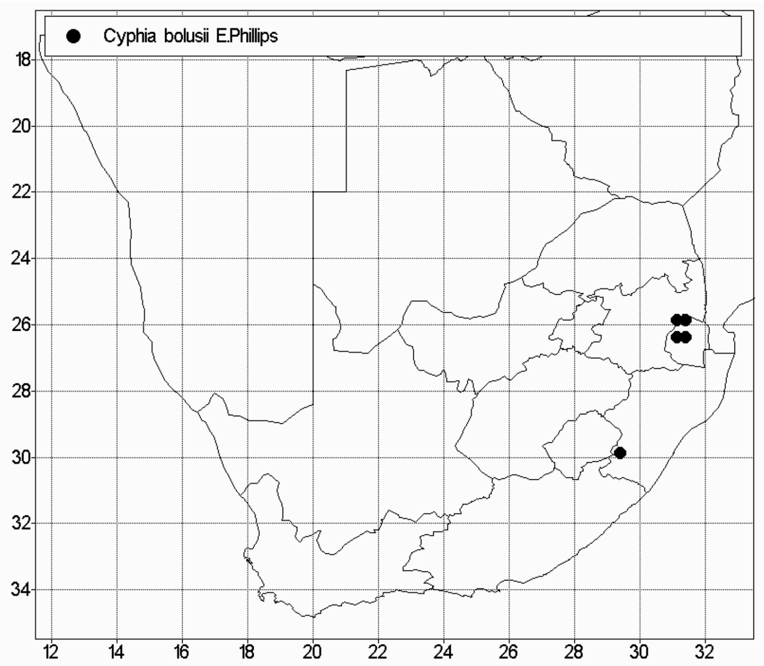

Figure 3.20 Distribution map for *Cyphia bolusii*.

This species, listed as an ultramafic endemic by Changwe and Balkwill (2003) and Williamson and Balkwill (in edit) is recorded from highveld grassland in Swaziland. There were three vouchers at the National Herbarium (PRE) from the Mbabane area that were not on soils known to be ultramafic. Part of the collection was out on loan. Plants were collected on ultramafic soils in the Mbabane area in this study, but this species appears to be tolerant of ultramafic soils rather than endemic to them in Swaziland. The collection from near Lesotho is very unlikely to be on ultramafic soil (Figure 4.20).

3. *Indigofera crebra* N.E. Br.

The type specimen for this species is from Hlatikulu, Swaziland (N.E. Brown, 1925), a site not known to be ultramafic. In this study it was collected on ultramafic soils and at one non-ultramafic site. The species has been collected only in Swaziland and Mpumalanga (Germishuizen and Meyer, 2003).

4. *Salpinctium hirsutum* T.J. Edwards

When this species was described in 1989 it was known only from two collections, Stegi and Hlatikulu in Swaziland. Neither locality is known to be ultramafic. Balkwill and Balkwill (1999) list it as a serpentine (ultramafic) endemic found on 2 sites in the Barberton Greenstone Belt, one of which, Diepgezet, is near the Swaziland border. Changwe and Balkwill (2003) and Williamson and Balkwill (in edit.) also list it as an ultramafic endemic. In the present study it was collected on the Motjane ultramafic site in the same degree square as Hlatikulu. This species appears to be tolerant of, rather than endemic to, ultramafic soils in Swaziland.

Endemism on ultramafic soils in southern Africa.

The percentage endemism for the Swaziland sites is lower than that of most southern African sites (Table 4.4).

Table 4.4. Number of endemics, percentage endemism and area of ultramafic sites in southern Africa. The sites are: Agnes Mine(AM), Diepgezet (DG), Dunbar Valley (DV), Forbes Reef (FR), Great Dyke (GD), Kaapsehoop (KH), Malolotja (Ma), Motjane (Mo). Figures in brackets include possible additional endemics. Bold sites this study.

Ultramafic sites										
	AM	GD	MC	KH	GV	DG	DV	**Ma**	**Mo**	**FR**
Endemics	14	20	6	9	5	5	5	7	1	2(4)
% Endemism	6.9	6.2	5.8	5.3	3	2.4	2	3.3	1.4	1.2(2.4)
Size of site (km^2)	6.75	3263	8.5	5.3	3	2.4	3	2.5	4	

Red Data Species

A number of the taxa collected during this study are listed as red data species for Swaziland in Golding (2002). Five of the threatened taxa are serpentine endemics. Of the remaining seven taxa, six were collected only on ultramafic soil (Table 4.5). Much of the difference in the total number of species and infraspecific taxa collected on ultramafic soils compared to the total number collected on non-ultramafic soils is probably due to additional collecting on the ultramafic sites. If the assumption is made that this is the only reason for the difference it may be expected that the number of threatened taxa collected would be proportional to the total number of taxa collected for each soil type.

Table 4.5. Threatened species and sites where collected. U = ultramafic, N = non-ultramafic.

THREATENED	Forbes		Motjane		Malolotja	
	U	N	U	N	U	N
Aloe chortolirioides Berger var. *chortolirioides*	✓					
Aloe minima Baker	✓					
Asclepias eminens (Harv.) Schltr.			✓			
Dianthus mooiensis F.N. Williams ssp. *kirkii* (Burtt-Davy) Hooper			✓			
Helichrysum milleri Hilliard					✓	
Hemizygia stalmansii A.J. Paton					✓	
Kniphofia umbrina Codd	✓					
Ocimum motjaneanum McCallum & K.Balkwill	✓		✓			
Protea parvula Beard*		✓				
Sartidia sp. Nov.					✓	
Syncolostemon comptonii Codd					✓	
Xerophyta villosa (Baker) Smith & Ayensu					✓	

* *Protea parvula* is not threatened in South Africa according to Interim Red Data List. No Swaziland update available.

Table 4.6. Species at lower risk and sites where collected. U = ultramafic, N = non-ultramafic.

LOWER RISK	Forbes		Motjane		Malolotja	
	U	N	U	N	U	N
Aristida transvaalensis Henr.	✓					
Begonia sonderana Irmsch.					✓	
Cephalaria pungens Szabo	✓				✓	
Crassula acinaciformis Schinz						
Cyphia bolusii Phill.	✓				✓	
Diospyros galpinii (Hiern) De Winter						✓
Erica cerinthoides L. var. *barbertona* (Galpin) Bolus						✓
Eriosema ellipticifolium Schinz		✓				✓
Eriosema transvaalense C.H. Stirton		✓				
Hemizygia albiflora (N.E. Br.) Ashby					✓	
Hemizygia modesta Codd	✓	✓		✓	✓	✓
Heteropyxis canescens Oliv.					✓	
Senecio mlilwanensis Compton					✓	
Tephrosia cordata Hutch. & Burtt Davy			✓			
Tinnea barbata Vollesen					✓	

Table 4.7. Data deficient species and sites where collected. U = ultramafic, N = non-ultramafic.

DATA DEFICIENT	Forbes		Motjane		Malolotja	
	U	N	U	N	U	N
Aloe cooperi Baker ssp. *cooperi*					✓	
Annesorhiza flagellifolia Burt Davy						
Asclepias cultriformis Harv. ex Schltr.			✓			
Crassula alba Forssk. var. *parvisepala* (Schönland) Tölken	✓	✓				
Gladiolus ferrugineus Goldblatt & Manning		✓				
Helichrysum argyrolepis MacOwan	✓	✓		✓		
Helichrysum athrixiifolium (O. Kuntze) Moeser			✓			
Helichrysum chrysargyrum Moeser	✓					
Helichrysum difficile Hilliard			✓			
Helichrysum mixtum (Kuntze) Moeser var. *grandiceps* Hilliard					✓	
Helichrysum petraeum Hilliard						✓
Helichrysum truncatum Burtt Davy	✓	✓	✓	✓		✓
Indigofera hilaris Eckl. & Zeyh.	✓					
Phymaspermum argenteum Brusse						
Polygala nodiflora Chod.						
Rhus pondoensis Schönland		✓			✓	
Salpinctium hirsutum T.J. Edwards				✓		
Schoenoxiphium lehmannii (Nees) Steud.					✓	
Sebaea erosa Schinz					✓	
Senecio mbuluzensis Compton					✓	
Stachys aethiopica L.					✓	
Streptocarpus cyaneus S. Moore ssp. *cyaneus*					✓	
Streptocarpus pentherianus Fritsch			✓		✓	
Thesium gracilentum N.E. Br.	✓					

The number of species in Swaziland quoted by Dlamini & Dlamini (2002) is 3400 and the number of threatened species is 66. One might then expect ≈ 12 (11.6) in a sample of 598 and ≈ 6 (5.83) threatened species in a sample of 301. The number of threatened species for ultramafic soils (12) is as would be expected but the number for non-ultramafic soil (1), is lower than expected (Table 4.8). The observed values for data deficient and lower risk categories (Tables 4.6 and 4.7) are very close to those expected (Table 4.8).

Table 4.8. Number of threatened, lower risk and data deficient species collected in this study together with expected values. The threatened category includes 5 ultramafic endemics recorded. Bold figure has probability less than 0.05 (Chi-squared test) if the chance of collecting a threatened plant is the same as the chance of collecting any other plant.

Total #	Soil type	Threatened		Lower risk		Data deficient	
		Actual	Expected	Actual	Expected	Actual	Expected
598	ultra	12	11.61	13	14.63	17	17.29
301	non-ultra	**1**	5.84	8	7.36	9	8.7

Threatened species usually have a more restricted distribution, and when sampling a small area one would expect to have a lower chance of collecting them as opposed to more widely distributed non-threatened taxa. Collecting the expected number of threatened taxa based on the unlikely assumption that threatened taxa are as likely to be collected as non-threatened taxa indicates an increased proportion of threatened taxa on ultramafic soils. The significant under recovery for non-ultramafic soils and the expected recovery for lower risk categories confirm this suggestion of increased proportion or occurrence of threatened plants on ultramafic soils.

Ni hyperaccumulators

Two Ni hyperaccumulators occur on the Malolotja ultramafic site. *Berkheya rehmannii* Thell.var. *rogersiana* Thell. has already been discussed under the heading 'Endemics'. The other hyperaccumulator is *Senecio coronatus* (Thunb.) Harv. No hyperaccumulators were found on the Forbes Reef or Motjane sites.

***Senecio coronatus* (Thunb.) Harv.**

This species is widely distributed in southern Africa (Figure 4.21). Plants on ultramafic soils may hyperacumulate Ni, as was the case for plants collected in Malolotja N.R., or may have Ni concentrations similar to non-accumulating plants. This species thus shows within species biochemical diversity. Mesjasz-Przybylowicz *et al.* (1997) used the National Accelerator Centre nuclear microprobe to determine where various elements were situated in stems and found concentrations of Ni, Zn and Fe around the edge of stems in accumulating plants. Non-accumulating plants had a concentration of Ca in this outer layer of the stem. Processes occurring in the stems of hyperaccumulators are clearly different from those in non-accumulating plants.

Figure 4.21. ***Senecio coronatus*, a plant which may hyperaccumulate Ni.**

Discussion

Conservation status of Ultramafic areas in Swaziland

Very little of the ultramafic area in Swaziland is conserved, significantly less than the overall area conserved in that part of Swaziland. There is a significantly greater percentage of ultramafic area lost to commercial farming and wattle infestation, although the percentage under wattle is low. In total nearly half the ultramafic area in Swaziland has been lost to commercial farming, plantations and wattle thickets. The northern-most ultramafic area, which differs in latitude, altitude and topography from the other areas, has been completely lost. The areas remaining have a high diversity in physical features and vegetation. Some endemics are limited to a single site. Ultramafic sites of the Barberton Greenstone Belt in South Africa also show great diversity between sites and often have endemics limited to one or a few sites (Balkwill *et al.*, 1992; Williamson, 1995; Williamson and Balkwill, in edit). It is likely that some endemic taxa would have occurred on the areas now under plantation and commercial agriculture. A search of herbaria for specimens from the lost areas might confirm that taxa have been lost.

A small ultramafic site just outside the fence of Malolotja Nature reserve could easily be incorporated in the reserve. This would incorporate one of the populations of *Ocimum motjaneanum*, a critically endangered ultramafic endemic, into the reserve. The remainder of the sites would be difficult to protect in this way. They are small, discontinuous and interspersed with other land uses. A practical solution would be to ensure that the sites currently on Swazi Nation Land remain part of communal land, with their use restricted to grazing. This use has allowed natural vegetation to persist, but there is evidence that even at present usage levels some species may be at risk. The Motjane ultramafic plots and non-ultramafic plots nearby had a low species richness which appears to be due to disturbance, as the climate and soils were similar to ultramafic and non-ultramafic soils of the richer, less disturbed Forbes Reef sites. Grazing pressure is given as the greatest threat to *Kniphofia umbrina* (Witkowski *et al.,* 2001).

With 80% of the population in Swaziland engaged in subsistence farming and 40 % living below the poverty line, overgrazing and soil depletion are already considered environmental threats. These problems are likely to worsen because 41.4% of the population is under 14 years old, and will be setting up their own homes when they are older, putting pressure on resources already strained. (population statistics from World fact book, 2003, http://www.cia.gov/cia/publications/factbook/geos/wz.html). Efforts would thus also need to be made to ensure that grazing is at sustainable levels. Wattle encroachment would also need to be prevented.

Should ultramafic areas in Swaziland be conserved?

Ultramafic areas in Swaziland should be conserved in some way for a number of reasons. The small area protected does not adequately cover the diversity of ultramafic sites. The ultramafic endemics and the increased presence of Red Data List species make some form of conservation an effective way to conserve plant biodiversity. Nickel hyperaccumulators are potentially useful for recovering Ni from soil and for cleaning Ni contaminated soil. These plants are also of interest to physiologists and biochemists interested in the metabolic aspects of metal uptake, translocation and safe storage within the plants.

Is the ultramafic flora likely to persist?

The ultramafic flora of the relatively small area within Malolotja Nature Reserve is likely to persist because the variety of different slopes and aspects will serve to ameliorate the possible effects of climate change. Vegetation at the higher altitude sites is threatened by an increase in intensity of use as communal land or unsustainable stocking rates and by likely changes in use from communal lands to commercial farming and forestry. They are also threatened by wattle encroachment, increasing soapstone quarrying and industrial and residential expansion. With many diverse threats this flora is unlikely to persist unless there is some level of formal protection.

Endemic taxa and Red Data species

There are nine probable ultramafic endemics in Swaziland (Table 4.2), one of which may occur on non-ultramafic soils elsewhere. Two taxa have been identified as possible endemics, one possibly restricted to ultramafics in Swaziland but collected on other soil types in South Africa. Three taxa endemic to ultramafic soils in South Africa are considered not to be ultramafic endemics in Swaziland, but should be located at the non-ultramafic sites to confirm that these areas are in fact not ultramafic. In North America the ferns *Aspidotis densa* and *Polystichum lemmonii* are considered ultramafic indicators in Washington State. They have a coastal distribution except on ultramafic soils where they occur at higher altitude (Kruckeberg 2004). In Lake, Napa and Yolo counties (California) there are four species considered to be indicators of ultramafic soils (Callizo, 1992). The species found in this study that either occur on other soils elsewhere but appear to be restricted to ultramafics in the study area, or are considered ultramafic endemics in South Africa and have been collected from other soils in Swaziland, fit in with these North American findings.

Most endemics are classified as endangered, vulnerable or data deficient in Swaziland, and the recommended classifications for those taxa not yet classified are also in these categories. *Kniphofia umbrina* Codd (, (Dlamini T.S., Dlamini G.**,** 2002), *Syncolostemon comptonii* Codd (Dlamini & Dlamini**,** 2002) and *Ocimum motjaneanum* McCallum & K. Balkwill (McCallum & K. Balkwill, 2004) are listed as Critically Endangered. *Xerophyta villosa* (Baker) L.B. Sm. & Ayensu is classified as vulnerable. *Sartidia* sp. nov. is rated as Data Deficient (Dlamini & Dlamini**,** 2002). *Helichrysum nudifolia* var. nov. and *Siphonoglossa* sp. nov. are insufficiently known and so would be classified as data deficient, but are likely to have a very restricted distribution as they have rarely been collected in an area of Swaziland considered to be well surveyed. *Berkheya rehmannii* Thell.

var. *rogersiana* Thell. does not have a Red Data list rating but a rating of Endangered is recommended (Table 4.3). The paucity of collections for *Oxalis davyana* R. Knuth suggest that it is either rare or has a very restricted area of occurrence which would make it endangered because of small population sizeor because of a very restricted area of occurrence. The small area of ultramafic soils in Swaziland means a small area of occupation, which is a risk factor for survival.

The percentage endemism, 3.3 % for Malolotja, is lower than that for the three richest Barberton Greenstone Belt sites in South Africa (Table 4.4), but the area is less than half that of those sites. In addition to the endemic species, a number of Red Data species were collected. Red Data species often have restricted ranges or small populations and the chance of collecting them is lower at a particular site than the chance for common species. Collecting the number of Red Data species on ultramafic soil that would be expected assuming Red Data species have the same chance of being collected as any other species indicates Red Data species are more common on ultramafic soils.. This increases the importance of these soils to the conservation of plant biodiversity and justifies restricting land use on ultramafics to those uses which preserve that plant cover.