water & forestry

Department:
Water Affairs & Forestry
REPUBLIC OF SOUTH AFRICA

Sustainable Resource Use

2005

RAMBØLL

Funded by Danida

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List of Abbreviations

Danida	Danish International Development Assistance
DBH	Diamter at Breat Height
DWAF	Department of Water Affairs and Forestry
FMU	Forest Management Unit
GIS	Geographic Information System
GPS	Global Positioning System
IDP	Integrated Development Plan
IUCN	International Union for Conservation of Nature & Natural Resources
NWFP	Non-Wood Forest Product
PFM	Participatory Forest Management
PSP	Permanent Sample Plot
RRA	Rapid Rural Appraisal
PRA	Participatory Rural Appraisal
SANParks	South African National Parks

1. Introduction

The Department of Water Affairs and Forestry (DWAF) has adopted Participatory Forest Management (PFM) as a general approach to all its activities. PFM seeks to ensure that there is a shared responsibility of forest management between key stakeholders and the state, and that there is a sustainable flow of benefits to key stakeholders. Through PFM, DWAF thus strives to consider local people's forest-based needs, their role in forest management and their involvement in decision-making processes.

Incorporating stakeholder's needs into forest management is a recent practice in South Africa and many parts of the world. As a result, few management agencies or local rural communities are experienced in doing forest resource assessments, developing sustainable harvesting practices and implementing regulatory mechanisms, while taking into account the needs of those who use the forest.

This PFM Guideline explains the technical part of the resource management process. To establish sustainable harvesting levels data is needed on the spatial distribution of resources, its size, species composition and productivity.

Once the harvest levels have been determined, harvesting practices can be developed to ensure that the impacts on the resources are within the tolerance limits. This information is essential for:

- Development of policy;
- Long-term planning;
- Development of sustainable resource harvesting practices;
- Decisions on alternative land-uses.

This Guideline is part of the PFM Guidelines developed during the DWAF/Danida PFM Project (2001-2005). The PFM Guidelines aim to empower DWAF staff, the new custodians of the State forests, and partners at local level to implement the new DWAF Forestry Vision in accordance with the DWAF Criteria, Indicators and Standards for Sustainable Forest Management.

2. About this Guideline

2.1 Aim and Objectives

This Guideline aims to provide an understanding of the concepts, methods and implementation of sustainable forest resource use and looks in detail at forest resource inventories. It also provides guidance regarding the mechanisms for the regulation of sustainable forest use as well as alternative use practices.

Since every situation is unique, the procedure, methods and examples included here are fairly simple and generic in their approach and can be adapted to each specific situation. The Guideline presents approaches which take into account that often very little or no data is available regarding the particular forest area.

The objectives of this Guideline are to provide an understanding of:

- Combining participatory approaches with high-technological methods to develop sustainable harvesting and regulatory systems;
- Resource use and its impacts, including the identification of target species and/or products;
- Conducting a forest resource inventory to assess the status, potential and constraints of a targeted forest resource;
- Developing sustainable harvesting practices.

2.2 Who is this Guideline for?

The target groups of this Guideline are PFM practitioners and stakeholders responsible for forest management. This includes researchers and scientists of forest management organisations (DWAF, SANParks, Provincial Nature Conservation Departments, etc,) and other management personnel such as PFM Forum or Committee members, NGOs, development organisations, etc.

It has also been developed in such a way that it can reach practitioners with different levels of expertise in forest management.

2.3 How to Use this Guideline

Chapter 3 explains the relevant concepts of indigenous forest ecology and management as well as forest resource inventories and development of sustainable resource use systems.

Chapter 4 gives a step-by-step description of procedures for sustainable use practices.

Annexes 1 - 11 provide more information for the forestry scientists on concepts and processes mentioned in Chapters 3 and 4.

Annex 12 provides a glossary, which explains words and terms used in the text.

Annex 13 presents an extensive list of references used in the text as well as other useful documents and guidelines.

Annex 14 gives an overview of the PFM Guidelines produced by DWAF.

This Guideline has been produced as a practical resource document as well as for training purposes. Sections of the Guideline can be easily copied for discussions, presentations and other training and development purposes.

3. Aspects of Sustainable Resource Use

3.1 Forest Characteristics

A forest is a multi-layered vegetation unit dominated by trees (largely evergreen or semi-deciduous) which have combined strata of overlapping crowns, except at the fringes, and which rarely has grass species in the floor cover.

Functional characteristics represent the adaptations of individual species to present and past abiotic and biotic environments.

Structural characteristics represent the spatial organization of the biomass of species populations or stands, such as height, crown cover, stand density and stem diameter.

Growth or life forms of plants are both functional and structural characteristics, and they include plants with woody and non-woody (herbaceous) stems[1].

3.2 Forest Types

The functional-structural characteristics combined with the dominant species can be used to describe a specific forest and distinguish one type of forest from another. There are eight different indigenous forest groups in South Africa and in total 20 different forest types within these groups. Most of them are Afrotemperate in character and represent the richest forests of the global Warm-Temperate Forest Biome. The box below lists the different forest groups and types[2].

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1 Refer to Annex 1 for details of forest characteristics

2 Refer to DWAF: *Classification System for South African Indigenous Forests* (2003) for details of each forest type

South African Natural Forest Groups and Types

Forest Group:	Forest Type:	
I: Southern Afrotemperate Group	I1:	Western Cape Talus Forests
	I2:	Western Cape Afrotemperate Forests
	I3:	Southern Cape Afrotemperate Forests
II: Northern Afrotemperate Group	II1:	Marakele Afromontane Forests
	II2:	Northern Highveld Forests
	II3:	Drakensberg Montane Forests
	II4:	Northern KwaZulu-Natal Mistbelt Forests
III: Northern Mistbelt Group	III1:	Limpopo Mistbelt Forests
	III2:	Mpumalanga Mistbelt Forests
IV: Southern Mistbelt Group	IV1:	Eastern Mistbelt Forests
	IV2:	Transkei Mistbelt Forests
	IV3:	Amatole Mistbelt Forests
V: Scarp Group	V1:	Eastern Scarp
	V2:	Pondoland Scarp Forests
	V3:	Transkei Mistbelt Forests
VI: Northern Coastal Group	VI1:	KwaZulu-Natal Coastal Forests
	VI2:	KwaZulu-Natal Dune Forests
VII: Southern Coastal Group	VII1:	Eastern Cape Dune Forests
	VII2:	Albany Coastal Forests
	VII3:	Western Cape Milkwood Forests
Azonal Forest Types	A1:	Lowveld Riverine Forests
	A2:	Swamp Forests
	A3:	Mangrove Forests
	A4:	Licuati Sand Forests

3.3 Biodiversity

Biodiversity or biological diversity is '*the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems' (from Article 2, Convention on Biological Diversity, 1992).*

Biodiversity is evident at three levels:

(i) Ecosystems;
(ii) Species;
(iii) Genetics.

Of these, practical forest management usually concentrates on ***ecosystems*** and ***species***. Ecosystems may, for simplicity, be considered as the different forest habitats or forest types.

3.4 Conservation of Forests

DWAF has a national and international obligation to protect tree species under threat and which appear in the Red Data List of South African plants. The Red Data List is the IUCN system of allocating categories to plants according to their probability of becoming extinct in the near future[3].

Besides the Red Data species, all natural forests are protected under the National Forests Act of 1998. In addition, DWAF has developed a National List of Protected Trees, which has recently been gazetted[4].

The IUCN has also developed broad protected area management categories which are internationally recognised and which offer various levels of protection to natural areas[5]. Within South African forestry too, indigenous forests are usually divided into different management classes/zones, which protect forest areas, or categories that may be fragile or of high biodiversity value.

3.5 Forest Products and Services

The forest habitat provides benefits in terms of goods and services and often supports flora, fauna and people in important and unique ways. In many areas, it is also part of a significant tourism industry. Forest trees provide fuel and other goods essential to meeting basic needs at the rural household and community level. Forests and forest lands provide food and the environmental stability (such as the maintenance of water quality and soil erosion prevention) necessary for continued food production. Also, forests and forest products can generate income and employment in the rural community.

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3 Refer to Annex 2
4 Refer to Annex 3
5 Refer to Annex 4

3.5.1 Wood Products

Forests are an important source of wood products, including fuelwood, poles and timber. Fuelwood is almost the only domestic fuel used, not only in the rural areas but in some urbanized areas as well. Wood is also an important construction material.

3.5.2 Non-wood Products

Many trees and shrubs yield Non-Wood Forest Products (NWFPs), which are important for everyday use by rural commmunities, as well as for industry and for export. These products include fruit and seeds; foliage and fodder for livestock; plant material for medicine, gums, resins and tannins; flowers/foliage for the essential oil and florist trade; honey and other beekeeping products; sap for beverages.

A key factor in the success of non-wood forest products is local processing to preserve them, reduced post-harvest losses, and reaching distant markets, all of which add significantly to the value of the resource. These products are important for populations with little or no access to inputs and resources.

3.5.3 Wildlife

Wildlife in forest habitats is intimately involved with creating and maintaining the forest environment. Animals fulfil vital ecological roles, which include:

- Pollination (birds, bats, bees and other insects);
- Decomposition (vultures, dung beetles, earthworms and other insects);
- Seed dispersal (birds, monkeys, rodents, fish, ants);
- Seed predation (rodents, birds, beetles);
- Herbivory or plant-eating (insects, mammals);
- Predation or hunting of other animals (insects, mammals, reptiles, birds).

Through these roles, animals influence forest composition and structure of vegetation. They also influence the reproductive success of plants, contribute to soil fertility and serve as regulators of pest populations.

Wildlife found in or near forests is used by people to cover a variety of basic needs including food, skins and hides, handicraft and ceremonial material. It is also the focus for sport hunting and stock sources for domestication or improvement.

3.5.4 Main Environmental Services

The numerous ecosystem services provided by forests include reduced erosion by water and wind; maintenance of soil fertility; providing shade and shelter; maintaining water quality and harbouring biological diversity.

Without maintaining the integrity of forest ecosystems, livelihoods for both rural and urban people would be seriously threatened.

3.6 Ecological Processes of Disturbance and Recovery

Plants and animals have become adapted to a particular range of disturbance-recovery regimes. The human interferences caused when resources are harvested from the forests, or when forests are cleared for cultivating other crops, are severe or mild replicates of the natural disturbance processes. The impact of a particular resource use practice can be a disaster; or it can be within the adaptations and tolerance limits of the forest; or it can be a non-event and have no effect on the natural disturbance and recovery processes of forests. This assessment is necessary to determine whether immediate action is necessary, or whether there is no cause for concern.

Bark Use and the Disturbance Processes

For example, harvesting of bark from an *Ocotea bullata* tree may be a disaster at the level of an individual tree, as the tree may die; or it may be within the tolerance level of the population e.g. if bark is sustainably removed in narrow vertical strips from some trees; or it is a non-event at the level of the broader forest community if the forest as a whole is not affected.

Scale of disturbance required by the dominant species is indicated by the relationship between the composition of species in the canopy with the same species in the regenerating layer of a particular forest. This relationship is also known as the grain of the forest.

With regard to disturbance and recovery, specific forest conditions, such as forest margin condition, canopy condition, biogeography and nutrient cycling, can serve as indicators of ecological processes and thus whether a forest is being degraded or not[6].

3.7 Sustainability

Sustainability constitutes the basic framework for forest management. Sustainable resource use has four key components:

- **Ecologically** the biophysical components and processes of the resource must be sustained to ensure the functioning of the ecosystem;
- **Socially** it is essential to satisfy the cultural and livelihood needs of the people who depend directly and indirectly on those resources and their products;
- **Economically** it is necessary to provide viable businesses and industries to ensure economic activities;
- **Legally** it is necessary to develop initiatives within a legal framework and effective institutional structures[7].

[6] Refer to Annex 5

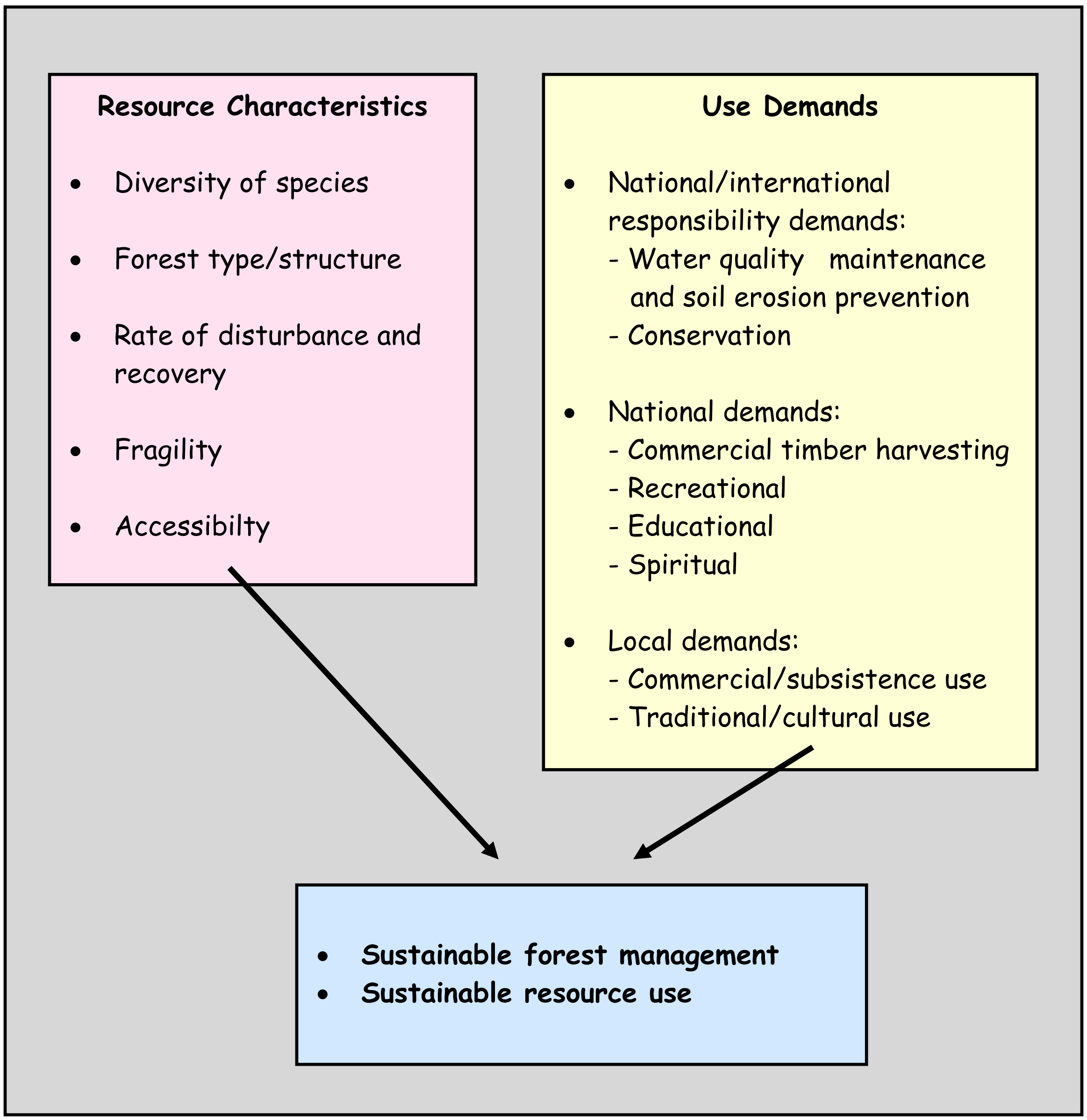
[7] Refer to DWAF/Danida PFM Guideline: Legal Options for Community Partnerships with DWAF Forestry (2005)

3.8 Matching Forest Resources with Use Demands

Forest uses, public demands and management practices have to adequately match the available forest resources and take into account the forest characteristics, including its constraints and dynamics. This is the basis of sustainable forest management policies, strategies and practices and thus sustainable forest resource use.

This is illustrated in Figure 1.

Figure 1: Matching Forest Resources with Demands from Users



Socio-economic changes (such as urbanisation, increased wealth, increased education) require continuous adaptation of resource management systems to ensure sustainable resource use and sustainable development.

3.9 Forest Resource Inventory or Survey

To develop sustainable harvesting systems, the forest characteristics as well as the resource use requirements must be known. This is done through an assessment of the resource by conducting an inventory of the forest and a survey of the forest uses. These forest inventories/surveys will provide information to adequately match the needs of the resource users with the available resources.

An ***inventory*** is basically a list of items and often includes details about those items. In the context of forestry, these items would include tree species and products with details being stem numbers, size, diameter distribution, appearance, condition, etc.

A ***survey*** is a detailed investigation or study of an item(s) or resource and its value, condition, etc, or a detailed investigation of peoples' opinions, needs, behaviour, etc.

Forest resource assessments can be done at various levels:

Resource Assessment Levels

i) National Inventories
- Map scale: 1:500 000 or smaller;
- Indicates distribution and area of broad vegetation types;
- Gives species composition of major types – by species lists and index of importance.

ii) Regional or Provincial inventories
- Map scale: 1:250 000;
- Indicates extent (distribution and area) and composition of major forest types and local variations;
- Gives growing stock potential.

iii) Management Plan Inventories (the level of focus for this guideline)
- Map scale: 1:10 000 to 1:2000;
- Indicates selected areas of high resource use, forest degradation and ability to recover;
- Allows sub-sampling of high-value, low density species;
- Gives detailed information for intensive management.

3.9.1 User Needs Survey

The user determines the market demand of a product. The kind of product used determines the probable harvesting technique and eventual impact on the resource.

The purpose of a user needs survey is to determine what species and parts of the species people are using from the natural forests, how much and when, and from which forest areas. During the survey the following information should be collected:

- Whether the products are harvested for subsistence or commercial use. These factors determine the quality and amounts of the products harvested as well as the time when the product is required.

- An exact description of the product, such as species, size of poles, size of logs, size and sex of animals, size and quality of fern leaves, etc.

The kind of product required determines the likely harvesting technique and eventual impact on the resource. For example, harvesting of poles has an impact on the intermediate tree sizes in the forest; and harvesting fern leaves has a very different impact on the resource than harvesting fern plants.

3.9.2 Resource Use Area

The resource use areas of different interest groups may overlap, which may result in conflicts of interest amongst the users. Also, the area of use is often influenced by activities in the surrounding area. A map is therefore necessary to delineate resource use areas of different users (subsistence and commercial users), to serve as reference in discussions and as record of changes in resource use areas.

3.9.3 Resource Use Impacts

The resource impacts relate to the species used and the way in which the resources are harvested. The intensity of the impact of harvesting is determined from the way in which the remaining target population responds, the population of the target species, the structure of the forest, and condition of the habitat after harvesting. For example, trees that do not coppice or sprout (regrow vegetatively) have to regrow from seed within the system. These have to be replaced by the existing seedlings within the stand, or have to be planted in the stand.

If a tree regrows vegetatively, then it would be necessary to determine under what conditions of harvesting the tree will regrow successfully, at what rate, and when a future crop can be harvested again.

The harvesting of bark or roots has diverse impacts on the survival of a tree, depending on the species harvested, and the conditions under which the products are harvested. It is therefore necessary to obtain information from the resource users, and to observe carefully what happens to a plant shortly and long after the product has been harvested. Such information should be recorded during the inventory of the resource[8].

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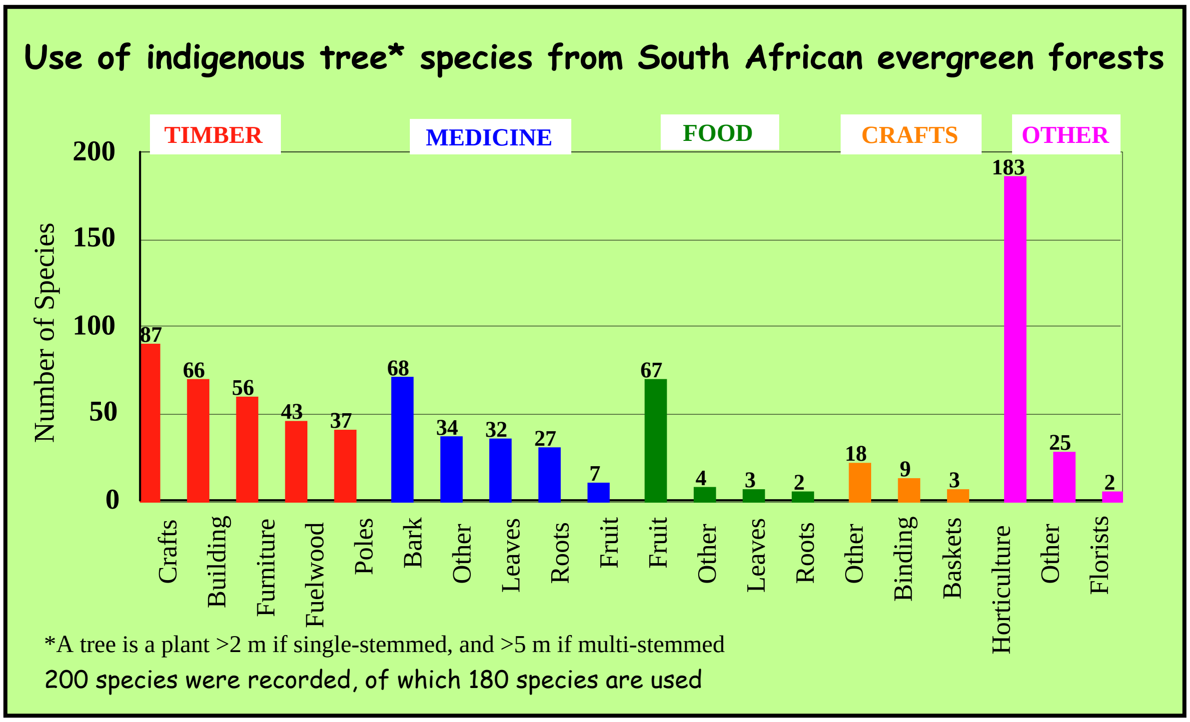
8 Refer to Chapter 4

3.9.4 Selection of Species

Some species are used for many different products as indicated in Figure 2. However, the development of sustainable resource use practices for particular products should be based on a few selected target species.

Figure 2: Diverse Resource Use from Forests



The initial selection focuses on species that are in demand, which cause the greatest impact through use, for which information is available and which offer the best chances of achieving a sustainable and acceptable harvesting system. Gradually other species can be included in the development, based on the interests of community members, diverse market needs and optimal resource use.

3.10 Yield Regulation

Yield regulation is the process of ensuring that environmental, social and economic sustainability is maintained into the future by making certain that resource demand never surpasses resource supply. Yield regulation relates to the *production rate* of the resource and the production rate determines how much of a resource can be used on a sustainable basis[9]. Yield regulation has three components:

a) ***Periodic harvest level***. The yield or regular harvest (off-take) at periodic intervals relate to the growth or production rate of the resource. This periodic harvest rate can be compared to taking the interest on invested capital - if more than the interest rate is taken, the capital erodes. If less is taken, there may be other constraints on the growth, such as mortality of trees through competition under high stand density.

   The periodic harvest, also known as the *annual allowable harvest* is fixed for a particular type of forest or specific species with a specific growing stock and growth rate. This is regulated through the harvesting cycle.

b) ***Harvesting cycle***. This is the interval between two successive harvests from the same area. It is determined by:

   (i) **Ecological requirements** of the target species for in-growth or recruitment (e.g. small gaps for shade-tolerant species and large gaps for light-demanding species);
   (ii) **Economic considerations** – long cycles result in harvesting periodic allowable off-take in relatively small areas with lower costs, while short cycles result in harvesting of larger areas with higher operating costs but less ecological impact;
   (iii) **Socio-cultural considerations** - trying to maintain control over long cycles is often more difficult and more costly than shorter cycles.

[9] Production rate is detailed in section 4.2.1

c) ***Harvesting or silvicultural systems***. This indicates the method and rate of harvesting to ensure recovery of the resource during the harvesting cycle. These systems are developed through understanding the ecological processes operating in each type of forest.

3.11 Planning for Forest Resource Management

With respect to natural resources, and forestry in particular, important planning documents are:

i. **Strategies and policies** (10-20 years; national and regional; long-term plans with overall goals, principles and guidelines);
ii. **Management Plans** (5-10 years; districts; specific setting);
iii. **Annual Operational Plans** (translates the Management Plan to real actions);
iv. **Work Plans** (Months/Weeks/days; site specific).

A ***Forest Management Plan*** is usually compiled for a Forest Management Unit (FMU), which is a forested area with mainly geographic features as boundaries. An FMU is usually subdivided into blocks and compartments, which are more homogenous in terms of species, stand development, biophysical conditions, etc.

A Forest Management Plan should provide practical, realistic guidance in sustainable forest management of the FMU and include management maps indicating the blocks and compartments, and zones for different uses or management classes. Management Plans also relate management practices to national/provincial biodiversity objectives; PFM and other policies and principles; national Criteria, Indicators and Standards (C,I and S's); local land use planning (such as IDP's); and other local and provincial department/organisation co-operation.

The Forest Management Plan period may cover ten years or less depending on available information on management practices, and financial implications. Also, forest circumstances may change thus requiring re-planning.

Monitoring and evaluation of the Forest Management Plan is ongoing and assisted by assessing the Annual Operational Plans and Work Plans as well as new information/research data that may become available.

3.12 Participatory Approaches

Consultations and participation are viewed internationally as central to sustainable forest management. Local stakeholders and users groups can provide knowledge, skills and resources in management, and carry out tasks for which they are uniquely suited. For example, local resource users usually have detailed knowledge of local biodiversity, past and existing management practices. They can thus be useful in monitoring and making inputs in how to best manage the forest resource locally.

Participation of this kind is likely to result in improved long-term forest management and greater sustainability of all operations, as well as reduced conflicts[10].

The participatory approach to forest management, plus limited resources and data, will often dictate the use of Participatory Rural Appraisal (PRA) or Rapid Rural Appraisal (RRA). Techniques applied include interviews, transect walks, participatory mapping, etc. in conjunction with more technical/scientific forest assessment techniques such as remote sensing, Geographic Information Systems (GIS), comprehensive forest inventory, etc.

[10] Refer to DWAF/Danida PFM Guideline: Stakeholder Participation (2005) for participatory procedures and techniques

4. Sustainable Resource Use Practices

Information on the spatial distribution of the forest, its size, species composition and productivity will help determine sustainable harvesting levels. When the harvesting level has been determined, the harvesting practices have to be developed. The impact of these practices on the forest should be within the tolerance limits of the resource.

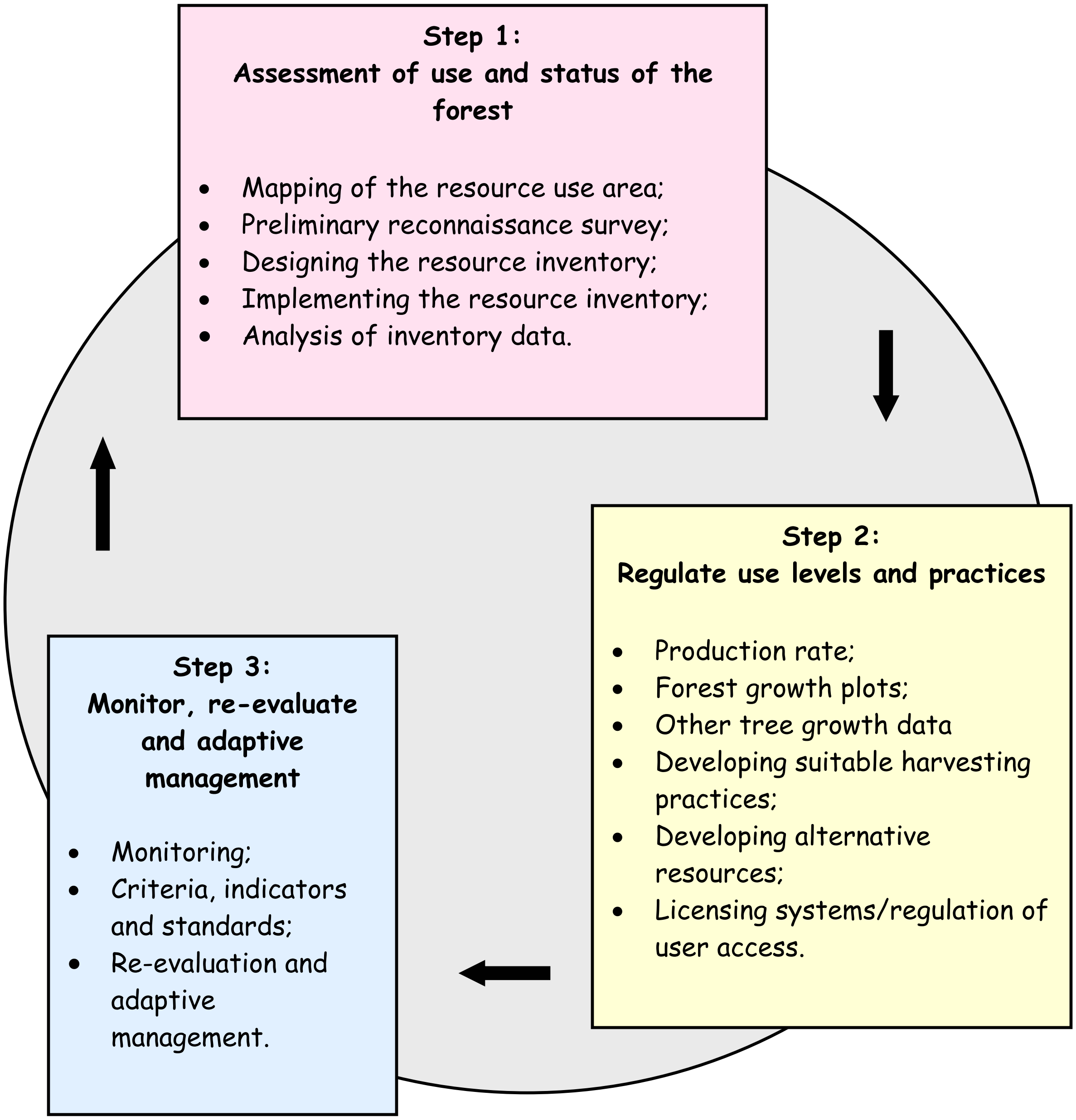
Developing sustainable resource use practices involves three steps:

1. Assessment of use and status of the forest;
2. Regulation of use levels and practices;
3. Monitoring, re-evaluation and adaptive management.

These steps form a cycle over time with monitoring, re-evaluation and adaptive management leading to a second round of product and species identification, as indicated in Figure 3.

Some of the steps and activities can take place in sequence or be carried out simultaneously. Some activities may be of short duration, while others may continue over a long period, but with variable intensity at different stages. An interactive and integrative approach will thus enable efficient management of sustainable resource harvesting and create confidence and cooperation amongst the resource users.

Figure 3: Process for the Development of Sustainable Resource Use Practices



4.1 Step 1: Assessment of Use and Status of the Forest

The assessment of forest resources is done through the following activities:

1. Mapping of the resource use area;
2. Preliminary reconnaissance survey;
3. Designing the resource inventory;
4. Implementing the resource inventory;
5. Analysis of inventory data.

4.1.1 Mapping of Resource Use Area

The purpose of a map is:

- To serve as basis for the reconnaissance survey.

- A basis for zoning of the area into vegetation units and management classes. For example, the area could be mapped according to units suitable for the harvesting of timber, firewood, poles, medicinal material, areas for grazing, areas to be protected, etc.

- To indicate identified important and/or critical environmental features that must be considered, such as rivers and streams, easily erodable substrates, drainage lines that could be blocked, fire hazards, cliffs, etc.

- To indicate features important to the local people and other stakeholders such as villages, roads and footpaths, power and telephone lines, and historical and cultural sites.

- A basis for designing a sampling strategy.

- A reference for different resource uses and other management activities.

The mapping of a forest area can be divided into:

a) Development of a Base Map

Provision of a suitable base map is essential. An orthophoto-based map, with contour lines superimposed over it and with a grid in degrees and minutes, provides the most suitable basis for management planning. It should be of a suitable scale (1:5000 to 1:2000). Topographical maps can also be used but are normally of a broader scale (1:50 000)[11].

Satellite imagery is useful for larger forest complexes such as the Southern Cape Forests and the Amatole Forests, but generally is not of much value for smaller forests or use at the level of management planning for most South African evergreen forests.

b) Annotation of Base Map

Annotation is the drawing in and labelling/describing of the various elements on the map, which are of relevance, such as streams, roads state forest boundaries, dwellings, etc. The initial base map should be annotated in the field, initially during the reconnaissance survey (described below), and later during the resource inventory process. These annotations, and the results from the resource inventory, are used to map the forest into vegetation types and forest management classes/use zones.

4.1.2 Preliminary Reconnaissance Survey

The purpose of a preliminary reconnaissance survey is to:

- *Assess what species are used for what products;*
- Locate and assess the potential of the resource areas to facilitate effective resource-use planning;
- Provide a broad assessment of the impacts of resource use on the species harvested and on the forest condition and structure.

All or some of the following methods described on the next page should be used when conducting the preliminary reconnaissance survey. A minimum of a) and b) should be carried out, while methods c) and d) may not always be possible,

[11] Refer to Annex 7 for map request form

a) Use of a Topographic Map, Aerial Photographs or Orthophotos

With a good base map (preferably with an orthophoto as a background), local resource users can indicate their forest areas through orientating themselves with features they can associate with, such as:

- Infrastructure (roads, powerlines, villages, dams, etc);
- Forest and other vegetation types;
- Orientation with sunrise and sunset.

b) Traversing on Foot

Transect walks[12] by resource users through key parts of the resource area can provide essential information on resources and harvesting practices used. Resource use information (such as bark-stripping, pole-cutting), the impacts on the species harvested, the responses of species to harvesting impacts, and the different conditions where species regenerate and with what vigour, can also be obtained. For example, during a walk through the forest, the canopy condition, the condition of the forest floor[13] and the presence of regeneration of target light-demanding species can be observed.

These observations should be recorded and indicated on the map of the particular forest.

A photographic record of different parts of the forest area, the species and products used, harvesting impacts and responses of different species to harvesting practices, is also a useful way of documenting observations.

To add inforamtion transect walks can be complemented by:

1) Literature reviews of available reports on resource use in the area;
2) RRA and PRA techniques such as interviews, workshops, and participatory mapping, etc.

c) Observations from High-lying Points Observations from view points over-looking the forest area can provide broad information on condition of the canopy, level of degradation, surrounding vegetation types, etc.

[12] Refer to DWAF/Danida PFM Guideline: Stakeholder Participation (2005)

[13] Refer for Annex 5 for details of canopy and forest floor condition

d) Low-level Flying

Low-level flying by helicopter or fixed-wing aircraft, particularly in larger forest complexes, is a useful way of putting the resource area in context of the surrounding vegetation types and land use activities as well as observing the overall condition of the forest.

During the reconnaissance survey a ***species list*** of those species occurring in the forest should be compiled. This list should be expanded during later resource inventories. Such a list should be updated continuously, with inputs from staff and stakeholders.

Information to be Included in a Species List

- Botanical name and Family;
- Local name(s);
- Growth or life form (tree, shrub, climber, fern, etc.);
- Conservation status (endemism, threatened or Red Data Book listing);
- Uses;
- Whether the species is abundant, rare, clustered, etc;
- Comments (for example, recovery response to key disturbance factors such as resprouting behaviour, reseeding, seed banks, relative shade tolerance, bark regrowth, etc).

The preliminary reconnaissance survey will provide:

- A broad-based map with an indication of:
  - i) The forest type or composition and the condition of the forest in different parts;
  - ii) Potential resource use areas;
  - iii) Areas indicated by resource users to be important for cultural, spiritual or household/commercial purposes;
  - iv) Other important features that should be considered in the planning (streams, roads, tracks, dwellings, etc).
- A list of the species used, with some indication for each species of use preference, how it is used and how the species responds to harvesting impacts.

- A set of pictures of species used, products, forest condition, good and bad practices that could be used for discussion with different stakeholders.

4.1.3 Designing the Resource Inventory

Designing an inventory includes establishing a sampling strategy, which will provide for a statistically acceptable estimate of growing stock, which can then be used to determine sustainable harvesting levels.

The sampling intensity (or the percentage of the resource that is sampled) is determined by:

- The number and heterogeneity (variation) of different vegetation or local forest types/characteristics;
- The required accuracy and reliability of the estimates;
- The time available for the survey.

Scientifically sound sampling strategies are designed according to each use option and target species, using the base map of broad vegetation or forest types. The sampling area should be representative of the area under investigation and of the different identified forest types/characteristics.

Designing an appropriate inventory is a specialized task and it may be necessary to obtain advice from a specialist in this field, particularly when dealing with a species with an unusual distribution pattern, or with many NWFPs. The sampling for NWFPs obtained from trees should follow the same design as for trees. A sampling strategy includes:

a) Spatial distribution of sampling points;
b) Location of sample units at a sampling point;
c) The size and shape of a sample unit.

a) Spatial Distribution of Sampling Points

A sampling design should ensure a reliable, cost-effective estimate of the available resources. Different strategies should be used to distribute sampling points in resource areas of differing vegetation composition[14].

[14] Refer to Annex 8 for more detail of these different sampling strategies

For example:

i) For large areas of different forest types, a random selection of sampling points from a grid overlay could be used;
ii) For a single/uniform forest type with high use activities, a more regular, uniform sampling strategy can be used;
iii) For specific high-value, low-density species, such as a species along a meandering river, or in scattered clumps, appropriate sampling designs should be used.

b) Location of Sample Units at a Sampling Point
Each sampling point can be sampled with either one of the following:

- One sample unit (called a plot, relevé, or transect);
- A cluster of two or more sample units.

For a forest inventory, only one sample unit is usually measured per sampling point. However, over large areas with difficult access (sandy areas, areas with high density of streams, or areas with no roads), clustered sample units are used to make the effort to get to a sampling point more time and cost effective.

c) Size and Shape of a Sample Unit
Circular plots of a particular size (usually 11.3m in radius or 0.04ha/400 m^2) are generally used for trees, and smaller sub-plots for tree regeneration and understorey vegetation in the South African forests.

Procedure to Measure Out a Circular Plot

1. Use a piece of soft but tough rope.
2. Tie one end of the rope to a wire peg, and tie a knot in the rope at 11.3 m from the peg – this will be the radius of the plot.
3. Insert the peg all the way into the ground – this will be the mid-point of the plot.
4. Pull the rope, as horizontal as possible, preferably in the uphill direction, and make a mark on the ground at the knot in the rope to mark the plot boundary. Record the trees in a logical sequence[15].
5. Whenever a tree occurs near the edge of the plot, pull the rope in a straight line from the plot centre to the relevant tree. If the end of the rope reaches the centre of the tree on the boundary, or beyond the centre of the tree, the tree should be recorded. If it reaches to less than the centre of the tree, the tree is excluded from measurement.

In some cases, an area has many trees in some plots and fewer trees in other plots. In terms of cost-efficiency and reliability of the sampling estimate, it is preferable that a variable plot size be used in such cases. This means that a set number of trees above a minimum size limit (usually 25) are measured instead of a set plot size. In dense forests a smaller area will thus be covered to record the 25 trees and in more open forests a larger area will be covered[16].

4.1.4 Implementing the Resource Inventory

4.1.4.1 Team and Equipment

A resource inventory has to be well prepared. A good team should be gathered and equipped to work effectively in the forest. An inventory team can consist of:

[15] Refer to Annex 8 for explanation of a measuring sequence
[16] Refer to Annex 8 for more details on variable plots

- A team leader who would be responsible for recording the data;
- Two measurers;
- Two general assistants for laying out and cutting survey lines open where a transect is to be used and the undergrowth is thick.

Relevant training for an inventory team:

- Species identification;
- Correct measuring techniques;
- The importance of accuracy in measuring and recording data;
- Data management.

Equipment Needed by the Inventory Team

- Diameter tapes;
- Tape measure (30 m);
- Suunto hypsometer for measurement of heights (m) and slope;
- Compass (Silva 54);
- GPS;
- Digital camera;
- Binoculars for tree identification;
- Pruning shears/catapult to collect leaves from trees for identification;
- Pocket knife for identifying bark for tree identification;
- Plastic bags and tags for sampling plant specimens.
- Small saw (blade closes like a pocket knife);
- Aluminium poles of 1.5m length with upper 30 cm painted with yellow road-marking paint;
- Thin rope (3-4 mm) for measuring the radius of the plot (11.3 m between peg and end knot);
- Thick rope (6-8 mm) for measuring survey line, at least 40 m long, with knots indiating the 0 m, 10 m, 20 m, 30 m and 40 m marks (a measuring tape can be used, but it is often too thin and more difficult to work with);
- Slashers.

4.1.4.2 Data Collection

The data to be collected will be determined by the reconnaissance survey, but should at least include the target species, other species of relevant growth forms as well as species that could be used as alternatives or substitutes.

Diameter at breast height (DBH), taken at 1.3m from ground level, is the easiest tree measurement and is used in the calculation of stand density (number of stems per unit area), mean stem diameter per stand or species, and stem diameter distribution[17]. Height is generally used to measure saplings.

This data should be recorded on appropriate field forms. If existing field forms do not exist, these should be designed to suit the purpose of the inventory[18].

The data set could be used to evaluate the regeneration status and dynamics of the stand, or to calculate basal area and/or timber volume. Collection of this data set should involve:

- Measuring all stems ≥5cm DBH (or ≥10cm depending on what data is being collected) with the species and DBH recorded – each recording should be numbered;
- Measuring each stem of multi-stemmed trees, but giving each stem the same number to indicate that they belong to the same tree;
- Counting the stems of 1 to 4.9cm DBH (or 5 to 9.9cm DBH depending on size measured) and recording the number per species, and if necessary, their height.

Besides measuring the trees, the optimum data set should also include a complete list of all species of the other growth forms (shrubs, climbers, ferns, grasses, geophytes, epiphytes, herbs etc), that occur within the plot.

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17 Refer to Annex 1 for details on stem diameter distributions
18 Examples of field forms are included in Annex 9

Also, crown cover is used to express the importance of those functional characteristics of a forest that cannot be measured accurately, and should be measured by estimating the approximate projection of the crown cover onto the ground within each plot[19].

Key issues on species identification are:

- Correct botanical names are more reliable than local names:
  - One local name may represent different species in different areas.
  - One botanical name may have different local names depending on use.
- Closely related species may differ in habitat requirements.
- If the team is unsure about a species, a specimen should be collected in triplicate for proper identification elsewhere.
- The unknown plant should be given a collection number and/or a unique name combination and this number/name should be used whenever plants similar to the collected specimen are recorded. For example, use '*Rhus* sp1' and '*Rhus* sp2', and not 'unknown', or 'Rhus spp.' Once the specimen has been identified, the data in the master file should be updated.
- Make one interested person responsible for plant name coordination.

4.1.4.3 Assessment of Resource Use and Impact

Information gathered during the reconnaissance survey will guide what data is to be collected to assess and monitor the impact and response to resource use practices of different species.

Data collected for all forest products should include variables that could help to assess the status of the resource. This will include crown condition, re-sprouting vigour, amount of regeneration, etc.

[19] Refer to Annex 1 for crown cover classes

Examples of Assessment of Resource Use

For fern harvesting, information recorded could include number of clusters of plants per area, number of plants per cluster, and number of fronds (leaves) in different development stages per plant.

In the case of bark harvesting, the species and the amount of bark harvested per tree should be measured, and information gathered on how and if the stripped area healed, the crown condition (percentage healthy crown) and sprouting ability of any trees that were harvested.

For trees cut for poles or timber, the species and height of the remaining stump should be recorded, and the numbers of resprout clusters and their height measured.

4.1.4.4 Data Management

Data management is important both during data collection in the field and in organising the data in the office.

Wrong measurement of trees, or measuring of stem thickness in circumference rather than diameter can happen, depending on the kind of equipment used. If callipers, diameter tapes and ordinary measuring tapes are used within a team, it must be ensured that all stem diameters are recorded in diameter and not in girth (circumference). If a girth of a large tree has to be measured, ensure that a note is made of this.

Inventory data should be entered into the computerized data files in standardized format, such as:

- Column width, alignment, font type or size, normal or bold, grid lines;
- Sequence of columns;
- One file for forest versus one file per plot.

Once all data per forest or plot have been entered, the data is sorted in sequence to check missing values, correct spelling (particularly species names), extreme values, etc.

A master file will ultimately contain the confirmed data. If corrections have to be made at a later stage to the master file, a note should be made in a separate comments column to indicate that a correction was made, what was changed, why, and when.

Never do analyses on the master file. Make a copy of the master file for data analyses.

4.1.5 Analysis of Inventory Data

The analysis of data may require specialist input from an expert. From data analysis, relationships between the vegetation types/populations can be established, as well as scale of disturbance of the forest and regeneration patterns of the target tree species, using indicators These indicators could include ***size class distributions, forest canopy condition, species population status*** and ***importance value***[20]. Below is a brief explanation of these different indicators.

Size class distribution of all trees should be determined for the forest area using the data obtained from each plot. Various size measurements can be used to indicate size class distributions. These include diameter, which is the easiest and most common measurement, height and even crown cover.

The size class distribution of important species is then compared amongst the populations/plots/forest areas.

Forest canopy condition is an indicator of habitat level processes. Canopy condition determines the internal forest microclimate (light, temperature, humidity, wind speed). This is the first external indicator of forest degradation and warns if something is wrong internally.

Species population status is an indicator of the population structure. It is represented by numbers of juvenile, growing, mature and old individuals - a viable species population has individuals in all age classes.

[20] Annex 5 and Annex 6 provide details of these indicators

The rates at which ingrowth (recruitment) and mortality occur indicate whether the level of disturbance caused by management activities (or natural activities) allows or prevents the target species to maintain a viable population.

The Importance Value Index (IVI) indicates the varying importance that different species have in different forest types. This, together with size class distribution patterns of a species in different site conditions, provide useful information on the ecology of the species.

For the results of the analysis to be meaningful, both the forest type and the ecological response of the target species are taken into account.

Also, from the preliminary reconnaissance survey, further analysis may be needed on the forest margin, nutrient layer on the forest floor and the biogeography of the forest area.[21]

Such analysis can provide:

- A reliable classification and description of the forest area;
- Species diversity patterns;
- Description of the main stand types in terms of species composition and growing stock.
- The resource potential of different forest stands for different uses;
- Knowledge of the resource status of commercial timber or other target species, i.e. the spatial distribution and the ratio of immature and mature individuals of each species, or the spatial distribution and cover density of targeted understorey species;
- Volume estimates by timber species for specific forest stands;
- The dynamics and management requirements of important timber species and non-timber species;
- Which forest areas could be managed intensively, and which areas should receive special conservation measures.

[21] Refer to Annex 5 for more details

4.2 Step 2: Regulate Use Levels and Practices

4.2.1 Production Rate

The production rate determines how much of a resource can be used on a sustainable basis. Nett growth of a population of trees/plants is the end result of:

- The growth of individual plants or trees;
- The ingrowth or recruitment into the lowest diameter class of plants or stems from below the lower limit (e.g. 10cm DBH for trees);
- The mortality of plants or trees in sizes above the lower limit (e.g. 10cm DBH for trees), during the harvesting cycle.

Limited information is available on the production rates for most products from natural areas. However, long-living woody plants, such as trees, enable regular measurement of stem diameter, tree height or shoot growth, to provide information on production rates over long periods. This is generally done using Permanent Sample Plots (PSPs).

Different variables should be measured for herbaceous plants or plants of other growth forms, such as climbers, that function in different cycles.

4.2.1.1 Permanent Sample Plots

The establishment and maintenance of Permanent Sample Plots (***PSPs)*** for measurement of tree growth and stand change is essential to provide information that can be used to develop sustainable use levels.

PSPs are expensive to establish and maintain and thus be carefully thought through. They should be representative of the important vegetation types as well as their development stages, nationally, provincially and locally to enable extrapolation of the growth rates from the study sites to other areas.

Several PSPs exist in the South African forests where data has been accumulated on ingrowth, diameter growth, mortality, and the components of forest change and essential elements of forest yield regulation over periods of at least 10 years[22].

They were selected, established and maintained according to the following considerations:

- Fewer, larger and well-maintained PSPs are better than a large number of small plots that cannot be maintained properly.
- The plots should be representative of the main environmental and disturbance gradients between and within the main vegetation types to enable forest growth modelling.
- Square plots of minimum size 80m x 80m should be used, with subdivisions of 10m x 10m, rather than long narrow rectangles. The grid reference for each tree should be determined which will enable the analysis of stand dynamics by assessing impacts of neighbouring trees, and inter and intra species relationships.
- Local security of the PSPs should be ensured through development of good relations with the neighbouring communities, and involving them in the maintenance of the PSPs.
- Measurement should take place at least every 5 years to ensure security of the plots, correct initial measurement and species identification, and recording of new trees into the lower size category (recruitment or ingrowth) and of dead and dying trees (mortality).
- Analysis of the growth data should take place at least every 10 years because trees grow relatively slowly.

[22] Refer to Annex 10

General Results from PSP Studies

- Diameter growth of individual trees varies enormously according to species, tree size, crown position and site conditions.
- From 10% to 15% of all trees in a stand show zero or even negative growth over a 10-year period.
- Most trees in a stand grow between 0.1 and 1.0cm/10 years, and very few trees grow more than 3cm/10 years.
- Trees with crowns locked underneath the canopy grow very slowly, but trees with a large part of the crown exposed to full overhead light grow much faster. Stand manipulation can therefore be used to focus growth on selected trees.
- Basal area growth increases with increasing basal area of a stand.
- Ingrowth from young trees and tree mortality contributes to continuous change in a stand and must be considered in the calculation of nett growth in the forest.
- Nett changes in the stand growing stock, measured as number of stems or basal area (m^2) per ha in relatively undisturbed forest, are very small and fluctuate around zero (positively and negatively).
- Individual species vary much in their mean growth rates, as well as their growth relationship with tree size.

4.2.1.2 Other Long-term Tree Growth Data

Very often, reliable long-term growth data is not readily available for areas from where resources are to be harvested or for target species that are utilised. Various approaches to gather this type of data are discussed below.

For target species that are not well covered by the set of PSPs, the following can be measured:

a) Measurement and Calculation of Diameter Increment of Trees

1. Within a specific site, select 5 to 10 trees per tree species and diameter class, in each of the following diameter classes: <5cm; 6-10cm; 11-15cm; etc up to at least 65-70cm depending on the species.

2. Select the trees in groups within the specific site (no plots are laid out). This will facilitate the relocation of the trees during the second and third measurements.
3. Within such a group, all the trees belonging to a species group should be measured irrespective of the quality of the tree.
4. Paint a horizontal line on the tree at 1.3m above ground level, as well as a unique number. Measure the diameter (DBH) at the painted line to the nearest mm.
5. Note the crown and stem condition of each tree.
6. Record the grid reference (with GPS) of each group and show this on a map.
7. Regeneration (see below) should also be measured in the group.
8. The stem density for each tree must be determined by measuring the distance from the tree to the centre of the stem of the second nearest tree from the measured tree.
9. Measurements should be done on the painted band every 5 years, preferably during winter (when there is minimum fluctuation in diameter), together with measurements of the regeneration.
10. The measurements must be repeated at least twice after the first measurement.

b) Height Growth of Regeneration Starting from Seed

Regeneration of the most important species in the vicinity of the trees measured for diameter growth, must be marked for regular height measurements. This will determine the development period from after germination to the established stage of the seedling, and further until the pole stage.

At least 10 to 20 plants per species per locality should be measured in each of the following height classes:

<20 cm;
21-50 cm;
51-100 cm;
101-150 cm;
151-200 cm;
201-300 cm;
>300 cm.

Up to 200 cm the heights should be measured to the nearest cm, and for larger plants to the nearest 5cm. The heights must be measured annually for at least 5 years. The plants should be measured after the main growing season. Measurements should include descriptions such as surrounding understorey vegetation, number of shoots, effects of browsing, etc.

d) Height Growth of Coppice Shoots on Cut Stems

1. After cutting, a stump should be marked and its species, diameter and month of cutting recorded.

2. The heights of the coppice shoots should be measured annually for at least 5 years.

3. The plants should be measured after the main growing season.

Each resource use area should have sites for measuring these different components within the harvested areas as well as in undisturbed areas as a means of monitoring resource use impacts. This will provide information for yield regulation and the harvesting rate for individual species and specific stands.

4.2.2 Developing Suitable Harvesting Practices

Suitable resource use practices can be developed for particular species and products based on observations during the reconnaissance survey and the information obtained during the resource inventory and long-term growth measurements.

Traditional harvesting practices may not suit a particular species, or may only suit certain conditions. Therefore, alternative harvesting methods may have to be developed for specific species or certain conditions.

Examples of Suitable Bark Harvesting Practices

In the case of species harvested for their bark, the practice of ring-barking the tree when removing bark will almost certainly kill the tree, however, harvesting bark in narrow, vertical strips can be sustainable for species in which the bark recovers through edge or sheet growth.

For species that can regrow vegetatively, dying trees (from ring-barking) can be cut to ensure their survival through vigorous coppice regrowth.

For species of which the bark does not recover no matter what harvesting technique is used, it may be better to cut a few selected trees periodically to harvest all bark from a tree instead of taking small strips from many trees that eventually may die.

The adopted harvesting practice must be within the tolerance limits of the species and of the site. In focus should then be characteristics of the species (such as ability to regrow bark or not) and its regeneration requirements (from seed or from vegetative regrowth), as well as the substrate conditions of the site. The reasons for adopting the particular harvesting practice, compared to previously used practices, should be discussed with the relevant resource users during the testing and implementation of the harvesting practice.

The individual resource users record the amounts of a particular product harvested over a specified period (week, month, quarter), from a specific forest. A simple system will facilitate involvement of users in the data-gathering process and in this way check that harvesting levels are being adhered to.

For example, the following can be recorded:

- The name of the user (indicate male, female and approximate age);
- The user group;
- Category of use (e.g. bark for medicine, poles for specific type of use, timber, firewood, fruit);
- Species used for each product;

- Amounts used (e.g. number of bags of bark, bundles of firewood, containers with fruit; bundles of thatch grass, number of poles);
- Where collection took place – preferably indicated on a map.

This information will ensure participatory monitoring and can be incorporated into a database for the forest area inquestion.

4.2.3 Developing Alternative Resources

For some species that are rare, or for species in high demand, the amount of resources within the forest may not be adequate to meet the demand. For such species it may be essential to find alternative species that provide a similar product.

For example, in the case of *Ocotea bullata*, other species of the family, such as *Cryptocarya* species or the introduced *Cinnamomum camphora* can be (and are traditionally) used as substitutes.

For several of the bark-harvested species, it has been determined that the active chemical compounds important for healing are also present in the leaves, but in smaller concentrations. It may thus be much more productive and less destructive to grow the trees specifically for leaf harvesting production systems (e.g. low hedges as in the production and harvesting of tea).

In the case of the *Rumohra* fern, the cultivation of the plant in the understorey of pine stands or under shade-cloth is much more productive than harvesting the fern fronds from indigenous forests.

Alternative resources might be indentified in conjunction with forest rehabilitation[23].

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23 Refer to Annex 11

4.2.4 Regulation of User Access

The National Forests Act of 1998 makes provision for harvesting resources for commercial use through the issuing of licences. When there is a large demand for the resources, however, it may be difficult to control the level of resource use through many licences issued. In such cases it is better to issue two or more licences to groups or concessionaires and to control the off-take through them. Forest guards can be used to observe the harvesting activities in the forest. They can control the amount removed by recording the bundles/bags, etc collected or monitoring what the users themselves record.

4.3 Step 3: Monitoring, Re-evaluation and Adaptive Management

4.3.1 Monitoring

A monitoring system is used to assess how the management objectives are achieved through the management practices. The monitoring system can therefore give reliable measurements to be analysed easily and quickly.

Design of a monitoring system will be influenced by:

- What management activities or practices must be assessed?
- What are the management objectives for these activities or practices?
- What information is needed to assess these objectives?
- What methods should be used and what should be measured?
- How frequently should measurements be taken?
- How should the data be analysed?
- What are the relevant indicators and criteria, which should be evaluated? Are there standards that should be met[24]?
- Will the system be simple, easy to implement, and cost-effective?

[24] Refer to DWAF: Draft Principles, Criteria, Indicators and Standards for Sustainable Forest Managements of Natural Forests and Plantations in South Africa (2002)

It is common in the management of indigenous forests that not all information is always available to set clear management objectives or systems (such as sustainable harvesting levels). Monitoring in such cases will thus provide baseline information to develop management objectives and harvesting systems and adapt existing ones.

While the national Criteria, Indicators and Standards (C,I & S's) for sustainable forest management should be used when monitoring and evaluating forestry practices, locally developed criteria and indicators can also be developed which would be appropriate for local users/stakeholders to use. This would enable the users themselves to measure changes in the status of the forest resources and contribute to, and understand management decisions.

The data is to be collected at regular, realistic intervals, and analysed, Permanent sample plots, fixed points or other repeatable techniques (described in sections 4.2.1.1. and 4.2.1.2), can be used to provide a continuous record of the harvest of forest products and its impact on the resource.

Example of Monitoring Frequency

Monitoring of fern harvesting can be done both on a daily basis by forest guards in the harvested areas, to provide a check on the condition of the fern; and at regular intervals during the year by the forester on permanent plots whose locations are unknown to the fern pickers.

4.3.2 Re-evaluation and Adaptive Management

Where there are many unknown factors regarding forest management, some logical assumptions and decisions will have to be made, and conservative harvesting practices implemented. During this process, parallel studies and monitoring procedures should be undertaken.

These management assumptions, decisions and harvesting practices should then be re-evaluated and adapted according to monitoring data and new research results that become available.

Active adaptive management (also known as action research or learning by doing) is useful, particularly when the forest users and other relevant stakeholders are involved in monitoring and re-evaluation of management practices. This will develop the understanding, knowledge and confidence of forest management staff, local users and any other stakeholders who are involved in the process.

Annex 1: Characteristics of a Forest

1. Growth Forms

Growth or life forms of plants are both functional and structural characteristics, and they include plants with woody and non-woody (herbaceous) stems:

Woody Plants

- <u>Tree:</u> Self-supporting with DBH ≥10 mm and height ≥3 m if single-stemmed or ≥5 m if multi-stemmed. This category excludes special woody growth forms (see the next page).

- <u>Shrub:</u> Self-supporting (sometimes half-woody) with height <3 m if single-stemmed or <5 m if multi-stemmed.

- <u>Liane:</u> Not self-supporting with DBH ≥10 mm, winding, sprawling or climbing. This category excludes stilt roots of stranglers (e.g. *Ficus* species).

Non-woody/Herbacaeous Plants (Rooted in the ground)

- <u>Vine:</u> Not self-supporting with DBH <10 mm, winding, sprawling or climbing.

- <u>Graminoid:</u> Grass-like tufted erect plant <2 m tall of the families Poaceae, Cyperaceae, Juncaceae and Restionaceae.

- <u>Geophyte:</u> Non-graminoid monocotyledon with underground storage organs.

- <u>Fern:</u> Non-flowering vascular plant, tufted or crawling. Climbing ferns are included in liane/vine category, and epiphytic ferns in epiphyte category.

- <u>Bryophyte:</u> Non-vascular plant, <250 mm tall.

- Lichen: Non-vascular fungal-algal plant, <250 mm tall.
- Forb: Angiosperm plants <2 m tall, excluding graminoids, geophytes and vines.

Epiphytes

Special type of aerially supported herbaceous plants attached by surface roots to tree stems, branches, leaves and rocks (e.g. lichens, bryophytes, ferns and flowering plants).

Special Woody Growth Forms

These include Palms, Tree ferns, Cycads, Aloes, Bamboos and other apparently woody plants.

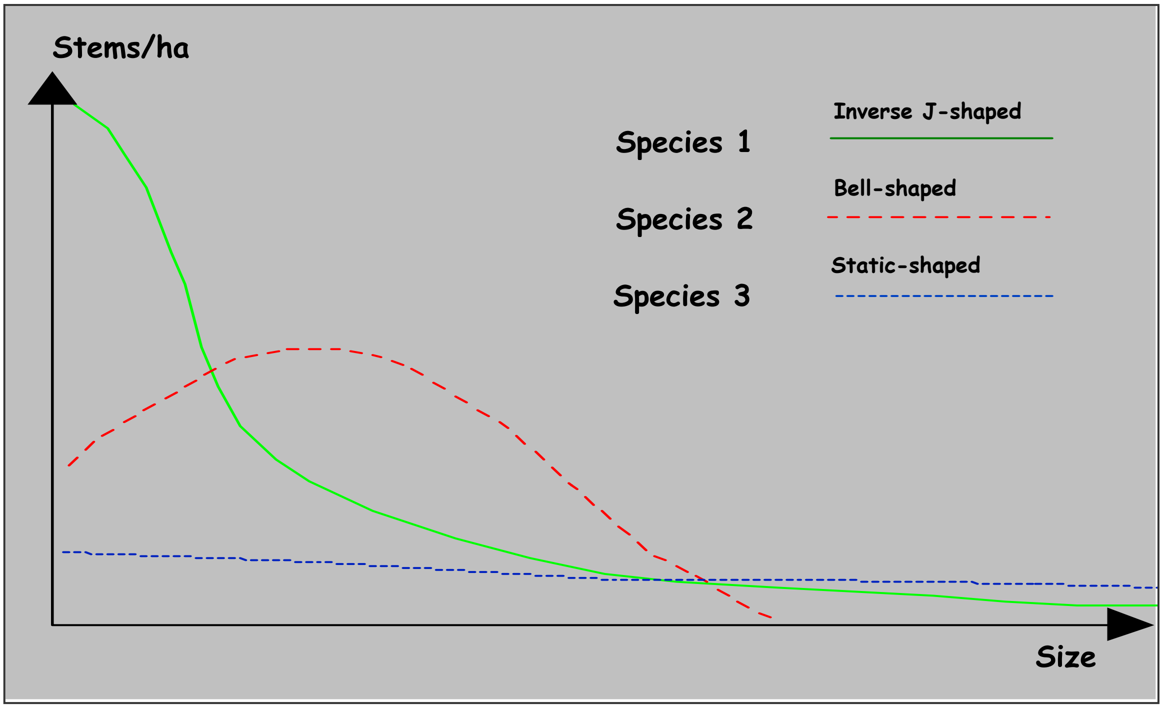
2. Structure

There are four variables used individually and in combination to describe stand structure:

- The stand density, which is the number of stems per unit area.
- The shape of the stem diameter distribution of a species or stand (described below);
- The ratio of small to large trees is used as an index of forest complexity;
- The regeneration status of a stand and a species.

Different species have typical ***stem diameter distributions***, which may vary between major forest areas. As indicated in the diameter distribution graph in Figure 1a there are three main shapes:

Figure 1a: Generalized Stem Diameter Distributions



Inverse J-shaped: In the natural evergreen forest the shade-tolerant canopy species, such as *Podocarpus latifolius*, typically have this stem diameter distribution because they continuously regenerate under the canopy. They thus have many small stems and few large stems with a sharp decline in number of stems in the first few stem diameter class sizes and a very small decline in stem numbers in the larger diameter class size.
Bell shaped: The shade-intolerant canopy species, such as *Ocotea bullata*, and invader plant species such as *Acacia melanoxylon,* typically have the bell-shaped stem diameter distributions because they cannot regenerate in the shade. The numbers of the medium size trees decrease rapidly – these species need a large gat to become established
Static shape: This indicates that there is no regeneration but existing trees increase in diameter size.

A high ***stand density*** usually represents a smaller mean stem diameter than a low stand density.

Plant height is arbitrarily used to define different layers within a forest stand, and is also used to calculate biomass or volume. In general, it is better to record actual height, but for descriptive purposes four height classes are generally used.

Box A1. Height Classes

Name	Trees	Shrubs	Grasses & Herbs
High	>20 m	2-5 m	>2 m
Tall	10-20 m	1-2 m	1-2 m
Short	5-10 m	0.5-1 m	0.5-1 m
Low	2- 5 m	<0.5 m	<0.5 m

3. Crown Cover

Crown cover can be measured in terms of the area covered by that species within a 400 m^2 plot. It is expressed in cover classes according to the Braun-Blanquet (BB) as depicted below. For example, if the projection of the crowns of all the plants of a particular species will cover 15 m^2 on the 400 m^2plot, then the percentage crown cover for that species will be in the crown cover category 1 – 5% with a Braun-Blanquet cover-abundance code of 1.

Crown Cover Classes

Symbol	% Crown cover	Cover on 400 m^2 plot
r	rare	<0,01 m^2
+	present by <1%	<4 m^2
1	1 - 5%	4 - 20 m^2
2a	6 - 12%	21 - 50 m^2
2b	13 - 25%	51 - 100 m^2
3	26 - 50%	101 - 200 m^2
4	51 - 75%	201 - 300 m^2
5	76 - 100%	301 - 400 m^2

Annex 2: Red Data List Categories

The Red Data List of South African plants includes all the plant species that have been assessed according to their probability of becoming extinct in the near future, using the IUCN Red Data List Criteria (www.redlist.org). The latest IUCN Red Data List categories are given below.

IUCN Red Data List Categories (Version 3.1)

EXTINCT (EX): Exhaustive surveys in known and/or expected habitat throughout its historic range have failed to record an individual.

EXTINCT IN THE WILD (EW): The taxon only survives in cultivation, in captivity or as a naturalized population (or populations) well outside the past range, after exhaustive surveys in known and/or expected habitat throughout its historic range have failed to record an individual.

CRITICALLY ENDANGERED (CR): The taxon is facing an extremely high risk of extinction in the wild.

ENDANGERED (EN): The taxon is facing a very high risk of extinction in the wild.

VULNERABLE (VU): The taxon is facing a high risk of extinction in the wild.

NEAR THREATENED (NT): With evaluation the taxon does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

LEAST CONCERN (LC): With evaluation the taxon does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.

DATA DEFICIENT (DD): There is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. Such a taxon may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. It is not a threat category.

NOT EVALUATED (NE): The taxon has not yet been evaluated against the criteria.

Annex 3: National List of Protected Tree Species

The list of protected tree species below is a relatively limited list, as there are many other species that are in need of protection, however, their protection can be managed using other legal or appropriate measures.

Botanical Name	English Common Names	Other Common Names Afrikaans (A), Northern Sotho (NS), Southern Sotho (S), Tswana (T), Venda (V), Xhosa (X), Zulu (Z)	National Tree Number
Acacia erioloba	Camel thorn	Kameeldoring (A) / Mogohlo (NS) / Mogôtlhô (T)	168
Acacia haematoxylon	Grey camel thorn	Vaalkameeldoring (A) / Mokholo (T)	169
Adansonia digitata	Baobab	Kremetart (A) /Seboi (NS)/ Mowana (T)	467
Afzelia quanzensis	Pod mahogany	Peulmahonie (A) / Mutokota (V) / Inkehli (Z)	207
Balanites subsp. *maughamii*	Torchwood	Groendoring (A) / Ugobandlovu (Z)	251
Barringtonia racemosa	Powder-puff tree	Poeierkwasboom (A) / Iboqo (Z)	524
Boscia albitrunca	Shepherd's tree	Witgat (A) / Mohlôpi (NS)/Motlhôpi (T)/ Muvhombwe (V) / Umgqomogqomo (X) / Umvithi (Z)	122
Brachystegia spiciformis	Msasa	Msasa (A)	198.1
Breonadia salicina	Matumi	Mingerhout (A) /Mohlomê (NS) / Mutu-lume (V) / Umfomfo (Z)	684
Bruguiera gymnorrhiza	Black mangrove	Swart-wortelboom (A) / Isikhangati (X) / Isihlobane (Z)	527
Cassipourea swaziensis	Swazi onionwood	Swazi-uiehout (A)	531.1
Catha edulis	Bushman's tea	Boesmanstee (A) / Mohlatse (NS) / Igqwaka (X) / Umhlwazi (Z)	404

eriops tagal	Indian mangrove	Indiese wortelboom (A) / Isinkaha (Z)	525
Cleistanthus schlechteri var. *schlechteri*	False tamboti	Vals-tambotie (A) / Umzithi (Z)	320
Colubrina nicholsonii	Pondo weeping thorn	Pondo-treurdoring (A)	453.8
Combretum imberbe	Leadwood	Hardekool (A) / Mohwelere-tšhipi (NS) / Motswiri (T) / Impondondlovu (Z)	539
Curtisia dentata	Assegai	Assegaai (A) / Umgxina (X) / Umagunda (Z)	570
Elaeodendron transvaalensis	Bushveld saffron	Bosveld-saffraan (A) / Monomane (T) / Ingwavuma (Z)	416
Erythrophysa transvaalensis	Bushveld red balloon	Bosveld-rooiklapperbos (A) / Mofalatsane (T)	436.2
Euclea pseudebenus	Ebony guarri	Ebbehout -ghwarrie (A)	598
Ficus trichopoda	Swamp fig	Moerasvy (A) / Umvubu (Z)	54
Leucadendron argenteum	Silver tree	Silwerboom (A)	77
Lumnitzera racemosa var. *racemosa*	Tonga mangrove	Tonga-wortelboom (A) / Isikhaha-esibomvu (Z)	552
Lydenburgia abottii	Pondo bushman's Tea	Pondo-boesmanstee (A)	407
Lydenburgia cassinoides	Sekhukhuni bushman's tea	Sekhukhuni-boesmanstee (A)	406
Mimusops caffra	Coastal red milkwood	Kusrooimelkhout (A) / Umthunzi (X) / Umkhakhayi (Z)	583
Newtonia hildebrandtii var. *hildebrandtii*	Lebombo wattle	Lebombo-wattel (A) /Umfomothi (Z)	191
Ocotea bullata	Stinkwood	Stinkhout (A) / Umhlungulu (X) / Umnukane (Z)	118
Ozoroa namaquensis	Gariep resin tree	Gariep-harpuisboom (A)	373.2

Philenoptera violacea	Apple-leaf	Appelblaar (A) / Mphata (NS) / Mohata (T) / Isihomohomo (Z)	238
Pittosporum viridiflorum	Cheesewood	Kasuur (A) / Kgalagangwe (NS) / Umkhwenkwe (X) / Umfusamvu (Z)	139
Podocarpus elongatus	Breede River yellowwood	Breederivier-geelhout (A)	15
Podocarpus falcatus	Outeniqua yellowwood	Outniekwa-geelhout (A)/ Mogôbagôba (NS)/ Umkhoba (X)/ Umsonti (Z)	16
Podocarpus henkelii	Henkel's yellowwood	Henkel-se-geelhout (A) / Umsonti (X) / Umsonti (Z)	17
Podocarpus latifolius	Real yellowwood	Opregte-geelhout (A) / Mogôbagôba (NS)/ Umcheya (X) / Umkhoba (Z)	18
Protea comptonii	Saddleback sugarbush	Barberton-suikerbos (A)	88
Protea curvata	Serpentine sugarbush	Serpentynsuikerbos (A)	88.1
Prunus africana	Red stinkwood	Rooi-stinkhout (A) / Umkhakhase (X) / Umdumezulu (Z)	147
Pterocarpus angolensis	Wild teak	Kiaat (A) / Morôtô (NS) / Mokwa (T) / Mutondo (V) Umvangazi (Z)	236
Rhizophora mucronata	Red mangrove	Rooi-wortelboom (A) / Isikhangathi (X)/ Umhlume (Z)	526
Sclerocarya birrea subsp. *Caffra*	Marula	Maroela (A) / Morula (NS) / Morula (T) / Umganu (Z)	360
Securidaca longiped-unculata	Violet tree	Krinkhout (A) / Mmaba (T)	303
Sideroxylon inerme subsp. *inerme*	White milkwood	Wit-melkhout (A) / Ximafana (X) / Umakhwelafingqane (Z)	579
Tephrosia pondoensis	Pondo poison pea	Pondo-gifertjie (A)	226.1
Warburgia salutaris	Pepper-bark tree	Peperbasboom (A)/ Molaka (NS)/ Mulanga (V)/ Isibaha (Z)	488
Widdringtonia cedarbergensis	Clanwilliam cedar	Clanwilliam-seder (A)	19
Widdringtonia schwarzii	Willowmore cedar	Baviaanskloof-seder (A)	21

Annex 4: IUCN Protected Areas Management Categories

Category I. Strict Nature Reserve/Wilderness Area:
Protected area managed mainly for science or wilderness protection.

Category 1a: Strict Nature Reserve:
Protected area with some outstanding or representative ecosystems and/or species, available primarily for scientific research and/or environmental monitoring.

Category 1b: Wilderness Area:
Protected largely unmodified or slightly modified area, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed to preserve its natural condition.

Category II. National Park:
Protected natural area designated to a) protect the ecological integrity of one or more ecosystems for present and future generations, b) exclude exploitation or occupation harmful to the purposes of designation of the area, and c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Category III. Natural Monument:
Protected area containing some (one or more) specific natural or natural/cultural features of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

Category IV. Habitat/Species Management Area:
Protected area subject to active management intervention to ensure the maintenance of habitats and/or to meet the requirements of specific species.

Category V. Protected Landscape:
Protected area of land (with coast/sea where relevant) to safeguard the traditional interaction of people and nature over time that produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity, and to provide recreation.

Category VI. Managed Resource Protected Area:
Protected area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Annex 5: Forest Disturbance and Recovery

Specific forest conditions can serve as indicators of ecological processes and thus health of the forest. These are detailed below and should be considered in the development of sustainable harvesting practices.

a) ***Forest Margin Condition.*** This is an indicator of landscape level processes and forest ecotone dynamics. The large ratio of forest margin to forest area makes natural forests particularly sensitive to management practices on adjacent land, such as fire and cultivation.

A soft natural forest margin maintains the transitional vegetation (ecotone) between natural forest and adjacent vegetation such as woodland, shrubland and grassland. It also contains species adapted to an intermediate disturbance regime. This margin can be wide if the habitat (e.g. aspect, slope, moisture conditions) inside and outside the forest is very similar, but is narrow when there are sudden habitat changes.

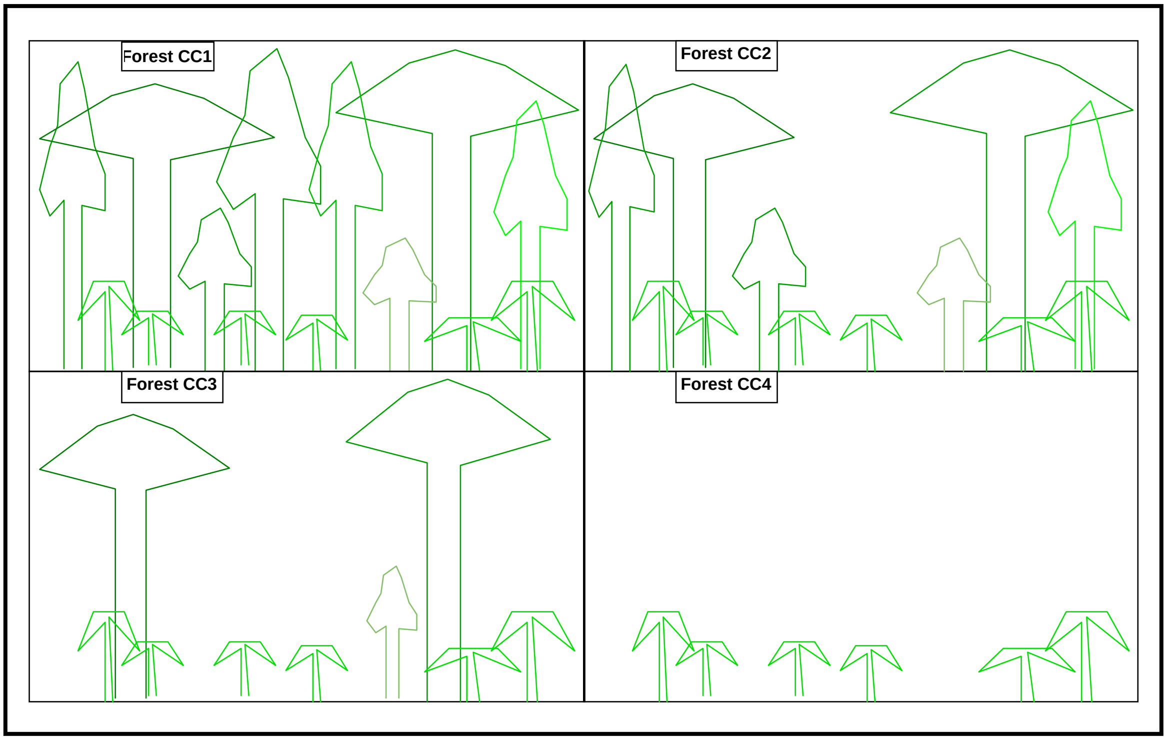
A hard (abrupt and open) natural forest margin has no natural ecotone vegetation, is open and exposes the forest interior to strong wind, light and fire to which the forest interior vegetation is not adapted.

Definition of a forest margin as soft or hard will depend on the surrounding natural vegetation type.

b) ***Forest Canopy Condition***. This is an indicator of habitat level processes. Canopy condition determines the internal forest microclimate such as light, temperature, humidity and wind speed. Canopy condition categories need to be defined for different forest types, but in general, canopy condition categories can be defined as (illustrated in Figure 5a):

- Condition 1: canopy intact.
- Condition 2: scattered small gaps.
- Condition 3: large gaps, many emergent trees and general canopy lowered.
- Condition 4: tree layer removed.
- Condition 5: forest cleared (such as for cultivation).

Figure 5a: Forest Canopy Condition Categories



Forest canopies are generally smooth to slightly undulating (wavey), with occasional emergent trees. Tall forests generally have a rougher canopy than lower forests or regrowth forests. Forests in categories 1 and 2 reflect low impact disturbance by management practices.

Occasional extreme natural disturbances (strong wind, fire, snow, flooding, large animals such as elephant) and some types of human resource use (uncontrolled tree cutting, shifting cultivation) may damage the forest canopy or create large gaps.

Excessive canopy gaps affect survival of light-sensitive species, increase alien invasions and retard forest recovery. Local inspection will indicate whether canopy condition deterioration resulted from natural disturbances or resource use practices, and what actions will be required.

c) ***Species Population Status.*** This indicates the population dynamics or species level processes. It applies equally to life forms of plants other than trees, as well as animals. Species vary in their requirements for germination, establishment and growth, and their tolerance to factors such as shade, moisture and predation.

Resource use practices should facilitate natural regeneration of the target species whether reproductive and/or vegetative, and should not cause excessive mortality in the remaining resource (target species or the stand as a whole).

d) ***Biogeography***. Landscape dynamics or gene flow processes are maintained by dispersal through natural vegetation types (corridors, i.e. areas of similar habitat). Small forest patches (<0,5 ha) provide stepping-stones between larger forest patches. Plantations are relatively good corridors for natural forest species.

The condition of and distance between natural forest patches should maintain the movement of dependent animals and the facilitation of dispersal of relevant plants. The patches will depend on maintenance of the relevant disturbance regime such as gap size in forests and conditions within and between the different parts of the system. The condition of the mosaic of natural forest habitats and the connectivity between them determine the vitality and maintenance of species diversity in these areas. Loss of forest patches will increase the average distance between forest patches.

On the other hand, certain management practices (such as reduced fire frequency) have facilitated the development of natural forest patches and the spread of alien invader plants into grassland, shrubland and woodland, and reduced the vitality and biodiversity of these fire-prone vegetation types.

e) ***Nutrient Cycling on Forest Floor***: Standing litter, i.e. the litter on the ground in various stages of decomposition, is an important, easily observable component of nutrient cycling in a forest ecosystem and of the maintenance of soil fertility. Loss of litter may indicate soil compaction and erosion.

Depth of litter on the forest floor (or condition, or mass per unit area) may vary from site to site, but the comparison between the affected site and an undisturbed forest provides a useful information irrespective of different forest types. Nutrient dynamics and their periodic replenishment should be managed on a scientific, site-specific basis to maintain the nutrient status of the site.

Annex 6: Importance Values of Species

With respect to individual tree species the importance of the species may be assessed by referring to its *abundance*, *frequency*, *dominance* and *relative importance value*.

The Importance Value Index (IVI), or simply Importance Value (IV) is calculated, using relative density, relative frequency and relative basal area (biomass).

The IV of each tree species for stems within the different size classes (starting from 5cm) is calculated as:

IV = (RF + RD + RBA)/3 where:

- ***RF = Relative Frequency***, calculated as the percentage of plots in a community in which the species was present (100 x number of plots in which species was present ÷ total number of plots recorded);

- ***RD = Relative Density***, calculated as the recorded stems (density) of a species in a community expressed as a percentage of all stems of all species in the community (100 x number of stems recorded for the species ÷ number of all stems recorded for all species);

- ***RBA = Relative Basal Area***, calculated as the basal area of a species in a community and expressed as a percentage of total basal area of all species in the community.

- ***Basal area = horizontal surface area*** of a stem at 1.3 m above ground level (expressed in m^2, calculated as $\Pi x(DBH)^2/40000$, if DBH is measured in cm, with Π (pi) = 22/7.

For woody stems of smaller DBH (1 to 5cm) such as regeneration, the importance value is calculated as IV = (RF + RD)/2. For ground flora, the importance value is calculated as IV = (RF + mean crown cover as %)/2.

Annex 7: Maps

Example of a map request form:

SUBDIRECTORATE: GIS DATA MANAGEMENT				FILE NO.	TASK NO.
				18/7/1	GE….../04
A. CLIENT INFORMATION					
CLIENT NAME					
DIRECTORATE / INSTITUTION					
ADDRESS				TEL	
				FAX	
				ROOM NO.	
				DATE	
B. TASK INFORMATION					
MAP DESCRIPTION					
	Upper left corner		Bottom right corner		
GEOGRAPHICAL EXTENT	° . 'S	° . 'E	° . 'S	° . 'E	
SCALE					
DIGITAL FORMAT (e.g. Arc/Info)			MEDIA (e.g. stiffy/CD)		
HARDCOPY FORMAT (e.g. A3 paper)					
DEADLINE (date and time)					
C. CLIENT ACCEPTANCE					
COMMENTS					
SIGNATURE			DATE		
DATE COMPLETED			NO. OF FILES		

Maps can be obtained from:

The Assistant Director: Spatial Information,
DWAF,
Pretoria

Tel: 012 336 - 6754
Fax: 012 336 - 8847

When requesting maps it is important to indicate what type of map is required (orthophoto, topographical, etc), the approximate location of the resource area by mentioning the names of important forests and the magisterial district, and purpose the map would be used for.

Often a map, orthophoto or aerial photograph of a smaller forest is not available, and a GIS facility is not present. A forest can still be mapped, using a GPS or a compass and measuring tape. While fairly labour-intensive, it is a simple process. Get advice and guidance from someone with knowledge and experience in this field.

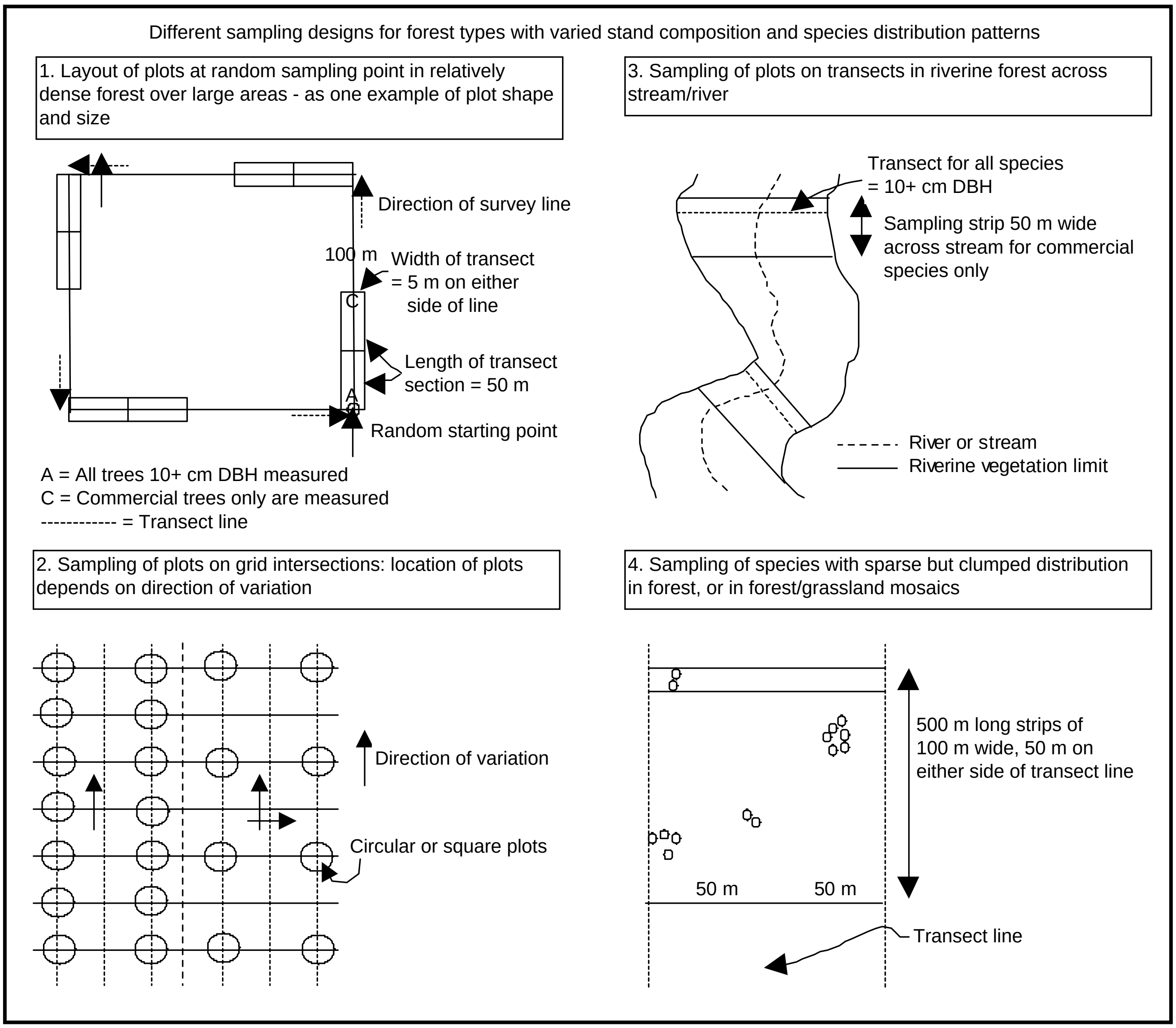
Annex 8: Sampling Design

Sampling design is the distribution of sampling points in the forest in order to collect certain data on status of the forest from a plot/cluster of plots at the sampling point.

1. Layout of Sampling Points

Figure 8a below depicts different sampling designs for forest/vegetation types with varied stand composition and species distribution patterns.

Figure 8a: Types of Sampling Designs for Different Forest Situations



For acceptable representation of the vegetation types/forest categories in the plots to be sampled, the following steps should be implemented (using Figure 8b as an example):

1. Superimpose a grid over the map of the vegetation types (four in Figure 8b) and the blocks (A and B).

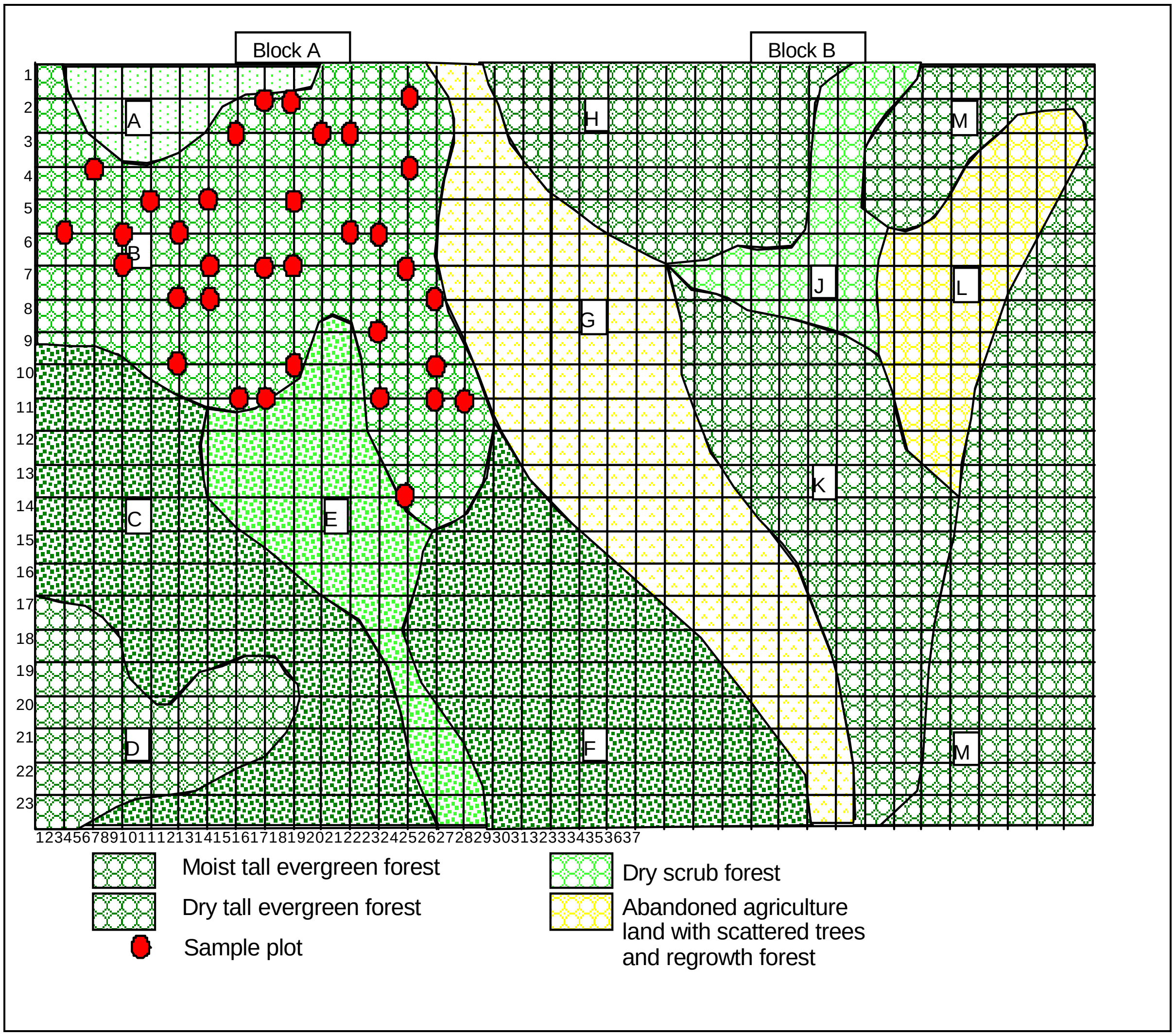
2. The scale of the grid should be smaller than the natural pattern in the landscape so that important features are not left out.

3. A grid could also have grid lines spaced differently in one direction than in the perpendicular direction. For example, in steep gradients in the environment such as mountains, the spacing of lines should be wider along the contour, and narrower up the slope. Rather have too many grid intersections than too few.

4. Each point of the grid intersection should be considered a potential point for sampling a plot (cluster of plots for large monitoring area). In Figure 8b a total of 731 potential points were counted, however, in this example, it was decided that because of time and cost constraints, only 200 plots would be sampled.

5. These 200 points should be proportionally distributed over the different vegetation types, i.e. the larger vegetation types should have more sample plots. For each vegetation type, the allocated number of plots should then be randomly selected – in this case 34 for the first vegetation type (moist tall evergreen forest) in Block A.

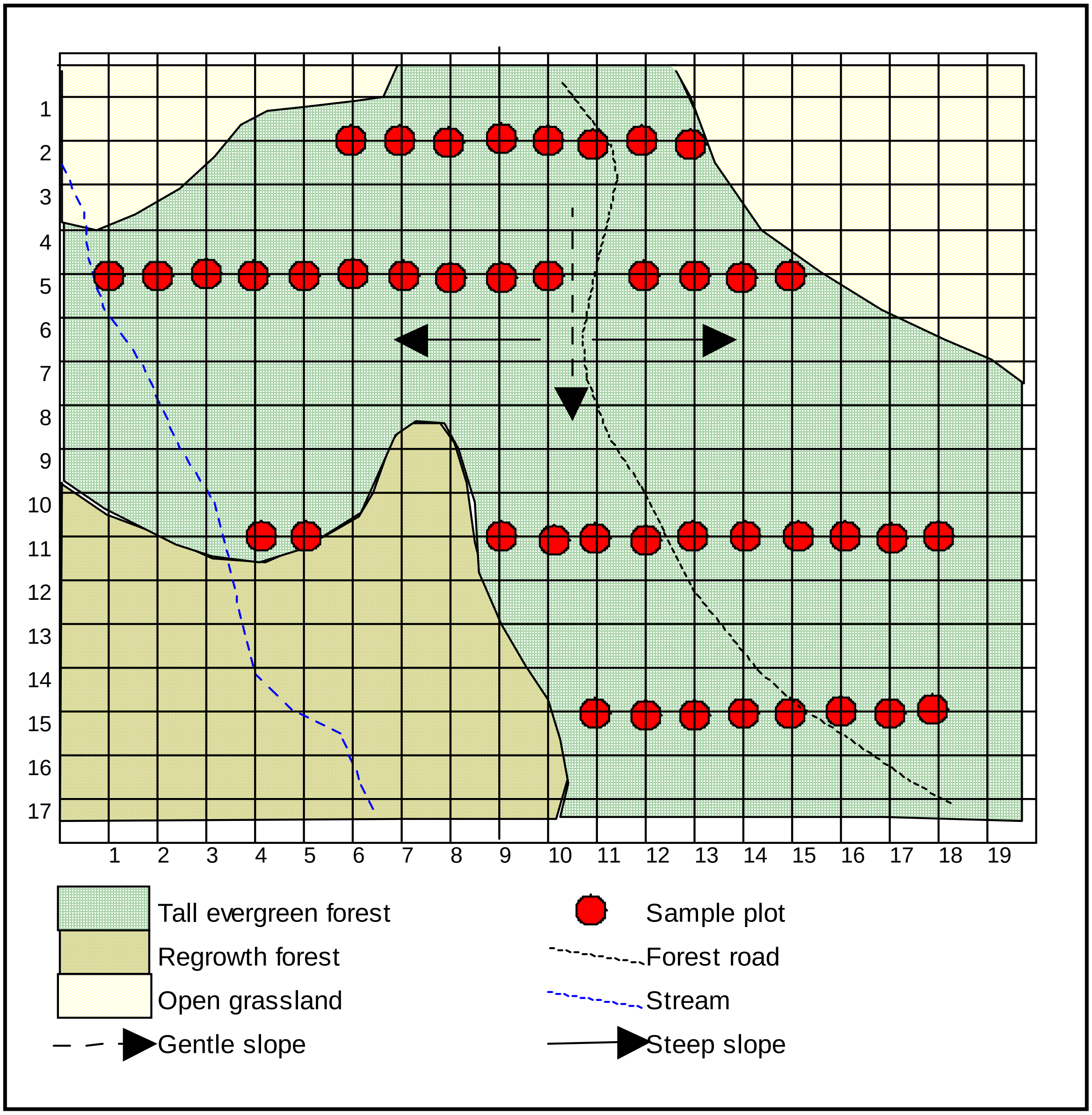
Figure 8b: Map of Different Vegetation/Forest Types to be sampled



A different sampling design for one forest area of a uniform vegetation/forest type is shown in Figure 8c on the following page. This can be used, for example, where there is a high concentration of forest utlisation in the area, or where a target species occurs that needs to be measured.

As depicted here, it is important that plots are layed out in such a way that they best capture the local variation (streams, road, steep slopes, etc) within the forest area.

Figure 8c: Sampling Design for One Vegetation/Forest Type



2. The Sample Units or Plots

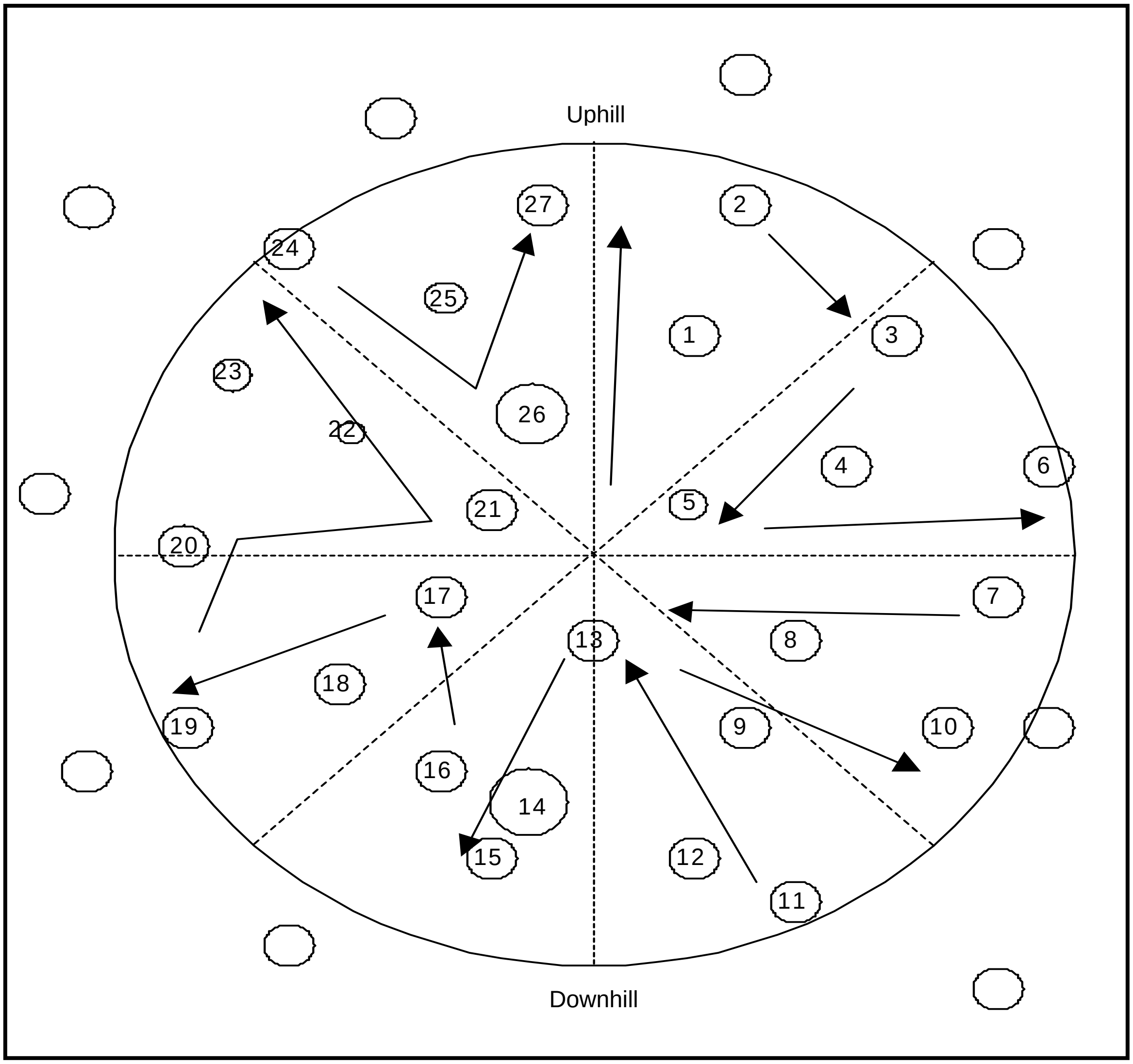
a) Circular Plots of Fixed Size

Once the sampling design has been completed and the plots layed out (usally 0.04ha in size), the trees/resources have to be measured within each plot.

Figure 8d depicts the sequence in which trees within a circular plot can be measured.

The dotted lines in Figure 8d show the hypothetical subdivision of the plot into sections for an orderly measurement of trees (1 to 27) along the direction of the arrows.

Figure 8d: Sampling of a Circular Plot



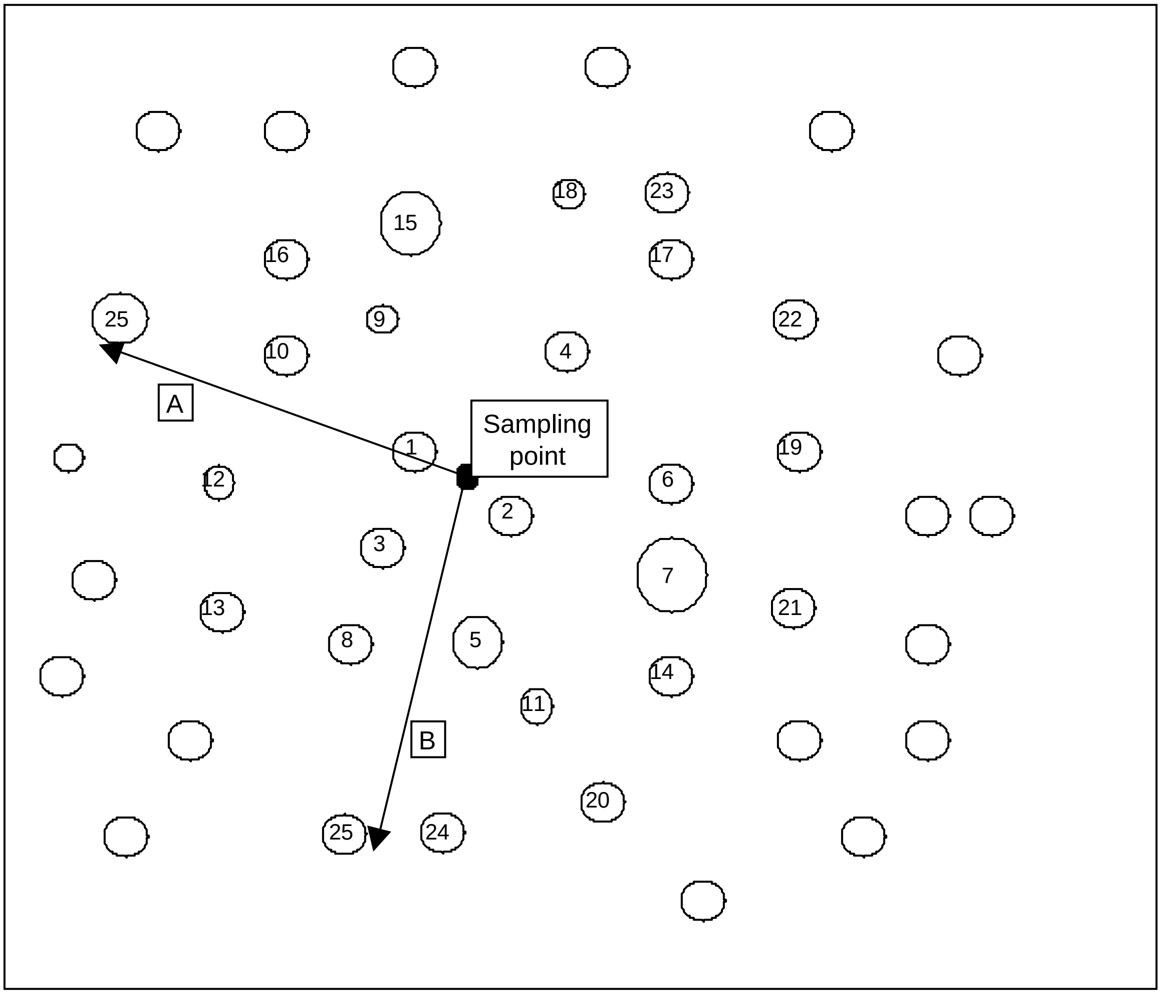
b) Variable Plot Size

If a variable plot size is used, a fixed number of trees are chosen – usually 25 trees. The 25 trees to be measured are those that are the closest to the sampling point as indicated in Figure 8e. Tree number 1 is the closest to the sampling point, tree number 2 the second closest, etc. It may be difficult to determine which is the 25th closest tree and thus the distances will need to be measured from the centre to the 20th to 27th trees (lines A and B in Figure 8e). In this way it can be determined which is the 25th closest tree.

The size of the area sampled is determined by measuring the distance from the sampling point centre to the mid-point of the stem of the 25th tree. The number of trees in the plot with this radius is 24.5 trees.

Separate data sets could be recorded for the tree component and the regeneration component.

Figure 8e: Variable Plot



Annex 9: Examples of Field Sheets

Field sheets or forms need to adequately capture the relevant data. The first example is for data of all plant species and allows for the capture of information on the resource characteristics and status of the different species. The second example is for an inventory of bark-harvested trees, to assess the amount of bark harvested per tree.

Example 1. Field Form: Forest Characteristics and Status

Forest name: ……………………………………………

Date of Assessment: ………………………………..

Assessed by: ……………………………………………

a) General Description of Location and Environment

This data set describes the environmental details of the forest area being measured.

Grid reference:	**Altitude, m:**		**Landscape Profile:**		
GEOMORPHOLOGY	Streams/gullies				
Mountain ridge	Mountain gully/valley	Upperslope	GEOLOGY:		
Mountain plateau	Foothill	Middleslope			
Mountain scarp	River	Footslope			
Mountain slope	Plain	Valley bottom			
Substrate condition	Rocky	Boulders	Deep soil	Wetland	

b) Specific Description of Stand

This data set should include a general description of each plot in terms of:

- *Vertical layering: height range, Braun-Blanguet (BB) crown cover abundance and dominant species of each layer;*
- *Observed disturbances.*

i) Stand structure: Canopy and crown condition, and vertical layering:

General height: ……… m

Canopy surface: Smooth Uneven Rough Broken

Presence of gaps: None Small Large

Causes: …………………………………………………..

Vertical layering:

Stratum*	**Height**		**BB**	**Dominant species**
	Upper	**Lower**		
Emergent				
Canopy				
Sub-canopy 1				
Sub-canopy 2				
Sub-canopy 3				
Shrub 1				
Shrub 2				
Herb 1				
Herb 2				

* Only complete when layer is present

ii) Observed disturbances: General comments.

c) Floristic Sampling: Growth Forms

The data recorded includes the different species in each growth form and Braun-Blanquet (BB) crown cover within 400 m^2 plots.

Forest .... Transect .... Plot ....

Interior/Margin: Slope .... Aspect ....

Trees

Species	BB	Species	BB	Species	BB

Shrubs & Climbers (this could include saplings)

Species	BB	Species	BB	Species	BB

Vines

Species	BB	Species	BB	Species	BB

Ferns

Species	BB	Species	BB	Species	BB

Graminoids

Species	BB	Species	BB	Species	BB

Epiphytes

Species	BB	Species	BB	Species	BB

Other herbs

Species	BB	Species	BB	Species	BB

d) Floristic Sampling: Diameter

This data set includes the DBH of stems ≥5 cm (or ≥10 cm depending on inventory requirements) by species on 400 m^2 plots.

Forest .... Transect .... Plot ....

Interior/Margin: Slope .... Aspect ....

No.	Species	DBH cm	Stems* 1-5 (10)	No.	Species	DBH cm	Stems* 1-5 (10)

* Count stems of trees of 1 – 4,9 cm DBH (or 1 – 9,9 cm DBH, if measuring trees ≥10 cm DBH)

Example 2. Resource Assessment of Selected Areas for Bark Harvesting

The data to be recorded here is the amount of bark used from different species and how the trees responded in terms of crown condition (percentage healthy crown) and sprouting ability.

Describe the starting point or paint a mark on a tree, or, if a GPS is available, take a GPS reading.

Forest:		**Date:**		**Recorder:**				**Measurers:**					
Transect:		Starting Point (GPS):						Compass Direction:					
Plot Number:		m to m		Canopy height, m:					Slope: d/u				
Tree	Species	DBH cm	SL m	Bark stripping					Sprouting				
				H_l	H_u	W	%	Cc	n	Ht	Br	Dd	Note

Notes:

Explanation of symbols used:

d/u = down or up

SL = length of stem to first main branches

H_l = height from ground level to bottom end of bark wound

H_u = height from ground level to upper end of bark wound

W = width of wound at widest part of wound

% = percentage of bark removed from the cylinder of bark between the bottom and top margins of the scar

Cc = crown condition category, see box below

Sprouting: n = number of sprouting clusters

Ht = height of tallest coppice shoot

Br = have sprouts been browsed or not? (Y or N)

Dd = number of dead sprout clusters

Notes = general notes about clusters

Description of crown condition categories for assessing impact of bark harvesting:

Crown condition category	**Percentage living crown**	**Description**
0	0	Tree dead.
1	1-20	Few leaves, only present near bole & stems of crown.
2	21-40	Leaves present on branches closest to bole of the tree.
3	41-60	Leaves present on branches.
4	61-80	Tips of terminal shoots without leaves while the rest of the tree appears healthy.
5	81-100	Crown densely covered with leaves with no apparent die-back.

Annex 10: Description of Permanent Sample Plots (PSPs) In South Africa

These plots are long-term study sites for diameter growth, ingrowth and mortality in mixed, evergreen forest in South Africa.

(See next page)

Grid reference	Altitude m	Rainfall mm Season	Geology	Aspect & slope	Forest description	Plot size, ha	Date	
							Established	Re-measured
Orange Kloof-, Cape Peninsula, W.Cape (Geldenhuys & Rathogwa 1995a; Geldenhuys 1999b)								
Orangekloof 34°00'S, 18°24'E	150	1350 Winter	Granite	Gentle, southerly	Species poor (14 tree species), regrowth forest, dominated by *Cassine peragua, Olinia ventosa, Olea capensis* subsp. *capensis, Canthium inerme, Rapanea melanophloeos, Diospyros whyteana* and *Olea europaea* subsp. *africana.* Open understorey. Canopy 12 to 18 m high.	0.52	12/1988	12/1993 01/1999
Diepwalle - Knysna, W.Cape (Geldenhuys1993b, Van Wyk 1998)								
Diepwalle 33°56'S, 23°09'E	300	1220 All-year	Quartzite	Gentle, northerly	Mixed forest (27 tree species), dominated by *Olea capensis* subsp. *macrocarpa, Podocarpus latifolius* and *Curtisia dentata* in the canopy, and *Gonioma kamassi* and *Cassine papillosa* in the sub-canopy. Dense, 4 m high understorey of *Trichocladus crinitus.* Canopy 18 to 22 m high.	2.86	05/1987	09/1992 11/1997
Koomansbos & Witelsbos, Tsitsikamma, E.Cape (Geldenhuys1994a, 1998c)								
Koomansbos 34°01'S, 24°03'E	190	1030 All-year	Shale	Flat, plateau	Mixed forest (33 tree species), dominated by *Olea capensis* subsp. *macrocarpa, Podocarpus latifolius, Brachylaena glabra, Pterocelastrus tricuspidatus, Olea capensis* subsp. *capensis* and *Apodytes dimidiata* in the canopy, and *Gonioma kamassi* and *Burchellia bubalina* in the sub-canopy. Sparse, 4 m high understorey of *Trichocladus crinitus.* Canopy 18 to 22 m high.	0.65	08/1988	08/1993 09/1998

Grid reference	Altitude m	Rainfall mm Season	Geology	Aspect & slope	Forest description	Plot size, ha	Date	
							Established	Re-measured
Pirie, Isidenge, Sandile Kop & Kologha - Amatole, E.Cape (Geldenhuys & Rathogwa 1995b, 1997)								
Pirie 32°44'S, 27°17'E	580	890 Summer	Mudstone shale & sandstone with dolorite intrusions	Flat, valley bottom	Mixed forest (43 tree species), dominated by *Olea capensis* subsp. *macrocarpa, Podocarpus falcatus, Mimusops obovata* and *Nuxia floribunda* in the canopy, and *Trichocladus ellipticus* and *Canthium inerme* in the sub-canopy. Open understorey. Canopy 17 to 22 m high.	0.64	02/1987	10/1991 10/1996
Isidenge 32°40'S, 27°16'E	920	1035 Summer		Flat, valley bottom	Mixed forest (37 tree species), dominated by *Rhus chirindensis, Olea capensis* subsp. *macrocarpa* and *Xymalos monospora* in the canopy, and *Trichocladus ellipticus* and *Diospyros whyteana* in the sub-canopy. Open understorey. Canopy 20 to 25 m high.	0.64	02/1987	10/1991 10/1996
Sandile Kop 32°38'S, 27°16'E	1160	1100 Summer		Gentle, ridge top	Mixed forest (38 tree species), dominated by *Olea capensis* subsp. *macrocarpa, Scolopia mundii, Xymalos monospora* and *Podocarpus latifolius* in the canopy, and *Trichocladus ellipticus, Diospyros whyteana* and *Maytenus heterophylla* in the sub-canopy. Grassy understorey. Canopy 20 to 25 m high.	0.46	02/1987	10/1991 10/1996
Kologha 32°32'S, 27°21'E	990	965 Summer		Gentle, southerly	Mixed forest (36 tree species), dominated by *Olea capensis* subsp. *macrocarpa, Rapanea melanophloeos* and *Vepris undulata* in the canopy and *Trichocladus ellipticus, Diospyros whyteana* and *Maytenus heterophylla* in the sub-canopy. Open understorey. Canopy 18 to 25 m high.	0.80	02/1987	10/1991 10/1996

Grid reference	Altitude m	Rainfall mm Season	Geology	Aspect & slope	Forest description	Plot size, ha	Date	
							Established	Re-measured
Manubi - Transkei coast, E.Cape (Geldenhuys & Rathogwa 1995c)								
Manubi 32°25'S, 28°30'E	275	1220 Summer	Dolorite	Gentle, southerly	Mixed forest (44 tree species) dominated by *Chionanthus pegleriae, Strychnos mitis, Drypetes gerrardii, Olea capensis* subsp. *macrocarpa, Vepris lanceolata* and *Syzygium guinieense* subsp. *gerrardii* in the canopy. Subcanopy is dominated by *Bequartiodendron natalensis, Allophylus dregeana, Diospyros natalensis* and *Tricalysia lanceolata. Trichocladus crinitus* forms the major component of the sparse to dense shrub understorey.	0,64	10/1988	10/1995 10/2000
Mpesheni & Ngeli near Kokstad, & Ngome near Vryheid, KwaZulu-Natal (Geldenhuys 1999a)								
Mpesheni 30°38'S 29°39'E		1200 Summer	Dolorite	Gentle, southerly	Mixed forest (24 tree species) dominated by *Podocarpus henkelii* and *Ocotea bullata* in the canopy, with *Eugenia zuluensis*, *Casearia gladiiformis*, *Cassipourea gummiflua* and *Syzygium gerrardii* common understorey trees.	0,64	10/1998	Oct 2003
Ngeli 30°32'S, 29°42'E		1200 Summer	Shale	Gentle, southerly	Mixed forest (39 species) dominated by *Xymalos monospora, Cryptocarya myrtifolia* (evergreen species), *Celtis africana, Vepris lanceolata* and *Kiggelaria africana* (deciduous species) in the canopy. *Trichocladus ellipticus* (sub-canopy) and *Eugenia zuluensis* dominate the understorey. Many lianes of several species are present.	0,64	10/1998	Oct 2003

Grid reference	Altitude m	Rainfall mm Season	Geology	Aspect & slope	Forest description	Plot size, ha	Date	
							Established	Re-measured
Ngome 27°49'S, 31°25'E	1100	1524 Summer	Shale	Gentle, southerly	Mixed forest (37 species) dominated by *Syzygium gerrardii, Xymalos monospora* and *Rapanea melanophloeos* in the canopy. *Psychotria capensis, Oxyanthus speciosus* (forming almost pure stands in places), *Rinorea angustifolia*, *Eugenia zuluensis*, *Eugenia natalitia* and *Peddiea africana* are common understorey trees.	0,64	10/1998	Oct 2004
Patatasbos, Hellschebos & Grootbos in Magoebaskloof and Matiwabos in Soutpansberg, Limpopo Province (Geldenhuys 1994b, 1999c, 2000)								
Patatasbos 23°51'S, 30°00'E	1480	1215 Summer	Granite-gneiss	Gentle, easterly	Mixed forest (28 tree species), dominated by *Syzygium guineense* subsp. *gerrardii, Xymalos monospora, Cryptocarya liebertiana* and *Cassipourea malosana* in the canopy, and *Tricalysia capensis* in the sub-canopy. Open understorey, with scattered clumps of bamboo *Prosphytochloa prehensilis*. Canopy is 20 to 24 m high.	0.64	07/1989	07/1994 08/1999
Hellschebos 23°48'S, 30°00'E	1350	1695 Summer		Steep, easterly	Mixed forest (25 tree species), dominated by *Xymalos monospora, Cassipourea malosana, Combretum kraussii, Cryptocarya liebertiana* and *Ficus craterostoma* in the canopy, and *Rinorea angustifolia, Rothmannia capensis* and *Ochna arborea* subsp. *oconnorii* in the sub-canopy. Open understorey. Canopy 15 to 25 m high with gaps.	0.64	07/1989	07/1994 08/1999

Grid reference	Altitude m	Rainfall mm Season	Geology	Aspect & slope	Forest description	Plot size, ha	Date	
							Established	Re-measured
Grootbos 23°44'S, 30°02'E	1580	1780 Summer		Gentle, easterly, ridge top	Mixed forest (26 tree species), dominated by *Xymalos monospora, Cassipourea malosana, Syzygium guineense* subsp. *gerrardii* and *Nuxia congesta* in the canopy, and *Oxyanthus gerrardii, Ochna arborea* subsp. *oconnorii, Dovyalis lucida* and *Peddiea africana* in the sub-canopy. Open understorey. Canopy 18 to 24 m high with gaps.	0.64	07/1989	07/1994 08/1999
Matiwabos 22°59'S, 30°17'E	1380	1960 Summer	Quartzite	Gentle, easterly, ridge top	Mixed forest (33 tree species), dominated by *Xymalos monospora, Cassipourea malosana* and *Olea capensis* subsp. *macrocarpa* in the canopy, and *Chionanthus foveolata* subsp. *major, Rothmannia capensis* and *Pavetta lanceolata* in the sub-canopy. Dense, 2 to 3 m high understorey of multi-stemmed shrub *Mackaya bella*. Canopy 20 to 26 m high.	0.64	07/1989	07/1994 08/1999

Annex 11: Development of Alternative Resources

1. Forest Rehabilitation

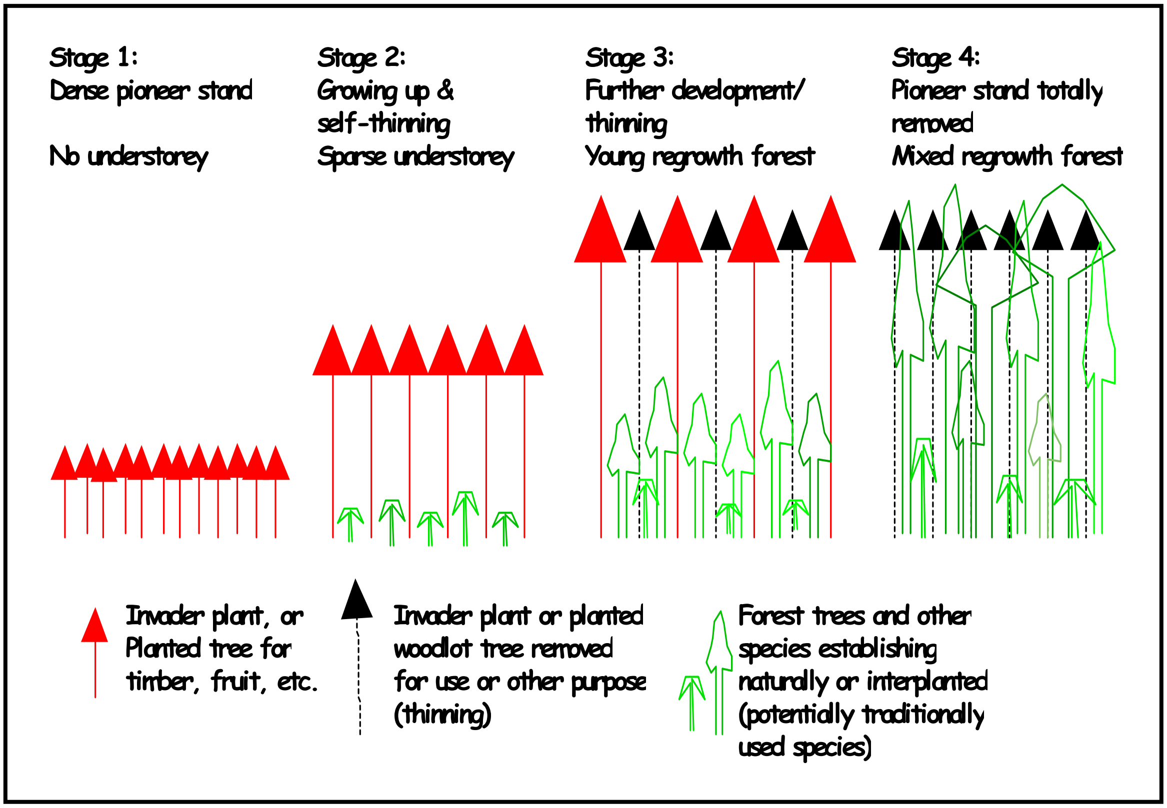
The recovery of a forest stand include vegetative regrowth of surviving plants in the disturbed site, regeneration and establishment of plants from seed banks existing on the site and seed dispersed into the site from neighbouring vegetation, and restoration of the nutrient cycle. Cost-effective mechanisms are needed to facilitate and direct the recovery processes.

a) Manipulation of Nurse Stands

The Concept

Several studies have shown that plantations and invader plant stands facilitate or nurse natural forest development. The initial plantation, invader plant or indigenous pioneer stands are generally dense, pure stands or thickets and they inhibit establishment of natural forest species. Over time such stands undergo natural thinning and become less dense. They are gradually colonized and 'enriched' by shade-tolerant indigenous forest species of middle to late successional stages as depicted in Figure 11a.

Figure 11a: Succession through Tree Stands



The Practice

1. The nurse stands (indigenous or introduced; planted or naturalised) should be selectively thinned to facilitate the establishment and growth of forest species. Trees to be removed, which would result in allowing more light to establishing forest species, should be carefully selected.
2. Ring-barking, poisoning or hand-pulling the trees to be thinned will favour gradual canopy release (reduce stand density) with minimal damage to the establishing indigenous species.
3. Too much canopy opening will favour invader species.
4. Litter accumulation in the stages after disturbance restores the nutrient cycling. This would determine the rate of colonisation and recovery.

This process can be managed to be a benefit rather than a cost burden for the land manager on the forestry estate, agricultural land, nature conservancy or in the rural community.

This approach of converting stands of alien species will have the additional advantage that fuelwood and other products obtained from the invader plant stands will be more sustainable over a longer period. Useful secondary crops could be grown in the understorey to supplement resource use and income, such as ferns for the florist industry, plants used for traditional medicines and special food crops.

b) Planting Indigenous Trees for Rehabilitation

Selected species should be planted in systems that will favour cost-effective harvesting of products. These systems should create conditions that attract birds and mammals that disperse seed of indigenous plants, and that are also favourable for the establishment of those species. Appropriate soil and crop cultivation practices should be applied to facilitate indigenous tree regeneration.

Planting trees for rehabilitation can be expensive but it provides a basis to:
i) Grow selected, traditionally-used forest species faster in mixed-species stands;
ii) Add value to products harvested from planted stands through small businesses;
iii) Reduce pressure on the existing natural forests;
iv) Restore forests, consolidate fragmented forest patches or protect riparian zones.

Species Selection
Useful, fast-growing commercial or domestic tree species (used for timber, fuelwood, building poles, medicine and fruit) should be selected to initiate establishment of nurse stands. The first choice should be suitable, fast-growing natural forest tree species, such as:

- Typical pioneer species: *Acacia karroo, Virgilia divaricata* and *Trema orientalis;*
- Other semi-pioneer trees: *Cunonia capensis, Halleria lucida, Millettia grandis* and *Rapanea melanophloeos;*
- Useful timber/bark/pole species: *Podocarpus falcatus, Prunus africana, Ptaeroxylon obliquum, Ilex mitis* and *Ocotea bullata.*

An alternative choice could be introduced species according to the following criteria:

- Select species which are fast-growing, particularly shade-intolerant, and dependent on disturbance for establishment;
- Avoid species which show aggressive invasion tendencies, are shade-tolerant and have wind-dispersed seeds or hard-coated long-living seeds;
- Avoid species, which would compete with indigenous species in any way.

Planting Stock

Plant material for the cultivation of alternative resources should be carefully selected. As a precautionary approach to maintain genetic integrity and as a general rule, cultivation of a species from the wild, in the wild, should be done with material obtained from that particular area and not imported. One option is to collect the targeted tree seedlings in the understorey of mature plantation stands on the forest margin, or outside the boundary of the forest margin. These seedlings should be planted directly in the forest gaps or on the forest margin.

If seedlings of the targeted species cannot be found, seed should be collected and placed on moist soil in a box placed in a larger box covered with white or translucent plastic, thus creating a small greenhouse. It must be possible to lift the lid of the box to occasionally water the seed tray, or to remove the germinated seedlings for transplanting. The lid should fit relatively tightly to maintain a high humidity inside (but not wet conditions). This greenhouse box should be placed in the shade.

Development of a nursery for forest rehabilitation purposes should be avoided. Establishment and maintenance of a nursery is expensive. If a nursery is not properly and hygienically managed, diseases are easily cultivated and then introduced into the forest. Small nurseries should be established only under exceptional circumstances, for example for species with a poor seed source and seed viability, or if vegetative material must be propagated.

Planting Sites

Planting sites should be outside the typical fire path-ways and not be in conflict with grazing and other land use practices. Minimum preparation of the soil should be carried out and fire should never be used in site preparation.

Several site options could be considered for planting:

- Degraded forest gaps and forest margins for forest rehabilitation. The planted seedlings should be covered with branches to prevent browsing by antelope and livestock.

- Establishing mixed stands of species that are in high demand. These could be close to the villages or home gardens (as live fences) without impacting on existing grazing and crop land. Alternatively they could be within small open areas, mainly in riparian zones, within timber plantations or other productive land use systems.

- Managing planted trees to harvest the leaves instead of the bark. Harvesting leaves is less destructive and reduces the period between planting and resource harvesting.

Annex 12: Glossary

Abiotic environment
The physical environment, including the climatic features (such as temperature, humidity, rainfall, wind) and substrate features (such as geology, soils, moisture status)

Adaptive management
Also known as action research or learning by doing. In the forestry context it is the approach followed by making logical assumptions when there are many unknown aspects that may be important, implementing conservative harvesting practices along with parallel studies and monitoring procedures, and adapting the procedures as new information becomes available.

Annotation of maps
Adding labels and identification to describe the different elements on the base map.

Basal area
The horizontal surface area of a stem, usually at standard height of 1.3m above ground level.

Biotic environment
The biological environment, including the plants (of different growth forms) and animals (of different groups such as invertebrates, e.g. insects, and vertebrates, e.g. birds, mammals, reptiles, amphibians and fishes) and their combinations in different communities.

Braun-Blanquet (BB) scale
A qualitative sliding scale used in vegetation sampling to assess importance (cover or dominance) of a species or group of species (growth forms) or vegetation layer.

Canopy
This refers to the different top layers of a forest (the tree crowns).

Coppice
Shoots that grow on the cut stump or on various parts of the stem (also called vegetative regrowth).

Criteria
Management objectives that are set in order to achieve broad management goals.

Crown
Refers to the foliage (leaf) distribution of a tree.

Dominant species
Species that dominate the stand either in terms of very tall trees, or prominence in the canopy or understorey.

Ecotone
Also known as the forest margin, this is the transitional vegetation between natural forest and adjacent vegetation (such as woodland, shrubland and grassland).

Forest rehabilitation
The action of improving the condition or status of a degraded forest through removing the cause of degradation and assisting or facilitating the recovery process. Restoration is the end point of the rehabilitation when all components and processes of the system have been restored.

Forest Types
Units of similar vegetation in the classification of the South African forests, and are the main units of forest management at the national level. Each forest type is composed of sub-types and communities representing different levels of habitat differentiation.

Global Positioning System (GPS)
This is a piece of equipment used to take the latitude and longitude (X, Y) co-ordinates at a particular point.

Habitat
The abiotic and biotic environment (home) of a species or group of species.

Harvest
The amount of a specific product taken from the forest during one harvesting period (also called off-take).

Indicators (C,I and S context)
Tools for measuring whether the objectives set in the criteria are being achieved.

Indicators (forest assessment context)
Measurements that can be used to assess the forest or resource status (or other aspects) when analysing inventory data.

Management classes
A process of allocating a system of management classification or zonation to a forest according to the properties/characteristics of the forest as well the user needs.

Natural disturbances
A disturbance is any relatively discrete event in time that disrupts ecosystem, community or population structure and changes resources, substrate availability, or the physical environment. Natural disturbances are caused by natural factors, such as fire, wind, tree falls, floods, landslides, lightning, hail, browsing by animals, or any similar event.

Participatory Rural Appraisal (PRA)
An approach using local knowledge and uses group dynamics and exercises, suh as participatory mapping, ranking, easonal calendars, etc, to facilitate information gathering, sharing and learning among stakeholders.

Rapid Survey
Recording relevant information through general observation and qualitative assessment over a relatively short period of time.

Rapid Rural Appraisal (RRA)
The collection of data, mainly done through general observation, semi-structured interviews and transect walks.

Resource
A supply or source of items/services provided, in this context, by forests and forest areas.

Ring-barking
When the bark is removed horizontally around the total circumference of a tree, often in a narrow band or ring which normally results in the death of the tree.

Sampling design
This indicates how the resource will be sampled, i.e. how many plots of what shape and size, and how the sampling units will be distributed over the resource area to give statistically reliable information.

Sampling estimate
The approxiation or estimation of the forest (usually the growing stock and it's status) which is obtained during the inventory.

Sampling intensity
Percentage of the forest that is sampled.

Sampling point
The place or location where sampling is to take place when conducting a forestry inventory. It is at this point that the sample unit(s) is layed out.

Sample unit
A plot, relevé, or transect which is layed out at the sampling point. For a forest inventory only one sample unit is usually measured per sampling point. However, over large areas with difficult access, clustered sampling units may be used.

Scale of disturbance (or grain)
The relationship between the composition of species in the canopy with the same species in the regenerating layer of a particular forest.

Target species
Species in high demand, threatened species, or other forest dependent species, particularly where there is active resource use practised.

Taxon
Species, subspecies or variety (plural = taxa).

Transect
A type of sample unit, usually long narrow lines of about 40 – 50m wide with survey lines (cut lines) cleared on either side of the transect which demarcate the transect and is used for access.

Tolerance limits
Plant (and animal) species have adapted to tolerate particular disturbances and stresses, but vary in the limits of their tolerance. For example, some species can tolerate warmer conditions or more shade or lower moisture conditions, than others.

Annex 13: List of References

Acocks, J.P.H. 1988. Veld types of South Africa. 3rd Edition. *Memoirs of the Botanical Survey of South Africa* 57: 1-146.

Bailey, C. L., Shackleton, C.M., Geldenhuys, C.J., Moshe, D., Fleming, G., Vink, E.R., Rathogwa, N.R., and Cawe, S.G. 1999. Guide to, and summary of, the meta-database pertaining to selected attributes of South African natural forests and woodlands. ENV-P-C 99027, CSIR, Pretoria.

Bews, J.W. 1920. The plant ecology of the coast belt of Natal. *Ann. Natal Mus*. 4: 367-467.

Bredenkamp, G.J. & Theron, G.K. 1978. A synecological account of the Suikerbosrand Nature Reserve. I. The phytosociology of the Witwatersrand geological system. *Bothalia* 12: 513-529.

Bredenkamp, G.J. & Theron, G.K. 1980. A synecological account of the Suikerbosrand Nature Reserve. II. The phytosociology of the Ventersdorp Geological System. *Bothalia* 13: 199-216.

Breen, C.M. 1971. An account of the plant ecology of the dune forest at Lake Sibayi. *Transactions of the Royal Society of South Africa* 39: 223-235.

Bartholomew, R.L.C. 1989. A quantitative assessment of Henderson's Forest Sunwich Port, Natal. In: Gordon, I.G. (ed.) *Natal indigenous forests*, pp. 119-134. Natal Parks Board, Pietermaritzburg.

Burns, M.E.R. & Raal, P.A. 1993. Dune forests of the Eastern Cape. In: Van der Sijde (ed.) *South African forestry handbook,* pp. 639-646. Southern African Institute of Forestry, Pretoria.

Campbell, B. M. & Moll, E. J. 1977. The forest communities of Table Mountain, South Africa. *Vegetatio* 34: 105-115.

Cawe, S.G. 1990. A classification of the Coastal Forests of Transkei and an assessment of their timber potential. University of Transkei, Umtata.

Cawe, S.G. 1996. A floristic classification of the indigenous forests of Transkei, South Africa. In: Van der Maesen *et al.* (eds.) *The biodiversity of African plants* pp. 241-249. Kluwer, Dordrecht.

Cawe, S.G. & McKenzie, B. 1989. The afromontane forest of Transkei, Southern Africa. II: A floristic classification. *South African Journal of Botany* 55: 31-39.

Coetzee, B.J. 1974. A phytosociological classification of the vegetation of the Jack Scott Nature Reserve. *Bothalia* 11: 329-347.

Coetzee, B.J. 1975. A phytosociological classification of the Rustenburg Nature Reserve. *Bothalia* 11: 561-580.

Comins, D.M. 1962. The vegetation of the districts of East London and King William's Town, Cape Province. *Memoirs of the Botanical Survey of South Africa* 33: 1-32.

Cooper, K. H. 1985. The conservation status of indigenous forests in Transvaal, Natal and O.F.S., South Africa. Wildlife Society of South Africa, Durban.

Cooper, K.H. & Swart, W. 1992. *Transkei forest survey*. Wildlife Society of S.A., Durban.

CPWild 2003. Sustainable utilization, commercialization and domestication of products from indigenous forest and woodland ecosystems: Final report on Commercial Products from the Wild Innovation Fund Project. Commercial Products from the Wild Consortium, Department of Forest Science, Stellenbosch.

Deall, G.B., Scheepers, J.C. & Schutz, C.J. 1989a. The vegetation ecology of the Eastern Transvaal Escarpment in the Sabie area. 1. Physical environment. *Bothalia* 19: 53-67.

Deall, G.B., Theron, G.K. & Westfall, R.H. 1989b. The vegetation ecology of the Eastern Transvaal Escarpment in the Sabie area. 2. Floristic classification. *Bothalia* 19: 69-89.

Department of Water Affairs and Forestry. 2002. *Draft Principles, Criteria, Indicators and Standards for Sustainable Forest Managements of Natural Forests and Plantations in South Africa.* Pretoria.

Du Preez, P.J. & Bredenkamp, G.J. 1991a. The syntaxonomy and synecology of the forests in the eastern Orange Free State, South Africa. II. The *Pittosporetalea viridiflorum*. *South African Journal of Botany* 57: 207-212.

Du Preez, P.J., Bredenkamp, G.J. & Venter, H.J.T. 1991. The syntaxonomy and synecology of the forests in the eastern Orange Free State, South Africa. I. The *Podocarpetalia latifolii*. *South African Journal of Botany* 57: 198-206.

Eckhardt, H.C., van Rooyen, N. & Bredenkamp, G.J. 1993. The phytosociology of the thicket and woodland vegetation of the north-eastern Orange Free State. *South African Journal of Botany* 59: 401-409.

Eckhardt, H.C., van Rooyen, N. & Bredenkamp, G.J. 1997. Plant communities of the forests, woodlands and thickets in northern Kwazulu-Natal. *Koedoe* 40: 91-112.

Edwards, D. 1967. *A plant ecological survey of the Tugela river basin*. Town and Regional Planning Commission, Pietermaritzburg.

Ellery, W.N., Balkwill, K. & Ellery, K. Reddy, R.A. 2001. Conservation of the vegetation on the Melville Ridge, Johannesburg. *South African Journal of Botany* 67: 261-273.

Everard, D.A. 1986. The effects of fire on the *Podocarpus latifolius* forests of the Royal Natal National Park, Natal Drakensberg. *South African Journal of Botany* 52: 60-66.

Everard, D.A. 1992. On the feasibility of developing a functional classification as a decision support system for the management of the indigenous forests in Natal. Report FOR-DEA 458. Division of Forest Science and Technology, CSIR, Pretoria.

Everard, D. A. & Hardy, S. D. 1993. *Composition, structure and dynamics of the Amatole forests.* Report FOR-DEA 810, Division of Forest Science and Technology, CSIR, Pretoria.

Everard, D.A., Midgley, J.J. & van Wyk, G.F. 1995. Dynamics of some forests in KwaZulu-Natal, South Africa, based on ordinations and size-class distributions. *South African Journal of Botany* 61: 283-292.

Geldenhuys, C.J. 1991a. Distribution, size and ownership of the southern Cape forests. *South African Forestry Journal* 158: 51-66.

Geldenhuys, C.J. 1991b. Inventory of indigenous forest and woodland in southern Africa. *South African Forestry Journal* 158, 83-94.

Geldenhuys, C.J. 1992. Richness, composition and relationships of the floras of selected forests in southern Africa. *Bothalia* 22: 205-233.

Geldenhuys, C.J. 1993a. Growth and mortality patterns over stands and species in the Diepwalle FVC plots: Report on 1992 measurements. Report FOR-DEA 579, Division of Forest Science and Technology, CSIR, Pretoria. 15 pp.

Geldenhuys, C.J. 1993b. Composition and dynamics of plant communities in the Southern Cape forests. Report FOR-DEA 612. CSIR, Pretoria.

Geldenhuys, C.J. 1993c. Floristic composition of the southern Cape forests with an annotated check-list. *South African Journal of Botany* 59: 26-44.

Geldenhuys, C.J. 1993d. Observations of the effects of drought on evergreen and deciduous species in the Eastern Cape forests. *South African Journal of Botany* 59: 522-534.

Geldenhuys, C.J. 1993e. The use of diameter distributions in sustained use management of forests: examples from southern Africa. In: Piearce, G.D. & Gumbo, D.J. (eds). The ecology and management of indigenous forests in southern Africa. Proceedings of an International Symposium, Victoria Falls, Zimbabwe, 27-29 July 1992. Zimbabwe Forestry Commission & SAREC. p.154-167.

Geldenhuys, C.J. 1993f. Management of forestry plantations to become effective stepping stones and corridors for forest migration. In: Everard, D.A. (ed). The relevance of island biogeographic theory in commercial forestry. Environmental Forum Report, FRD, Pretoria. p.102-118.

Geldenhuys, C.J. 1994a. Bergwind fires and the location pattern of forest patches in the southern Cape landscape, South Africa. *Journal of Biogeography* 21: 49-62.

Geldenhuys, C.J. 1994b. Growth and mortality patterns over stands and species in the Tsitsikamma forest increment study sites at Koomansbos and Witelsbos: Report on 1993 measurements. Report FOR-DEA 706, Division of Forest Science and Technology, CSIR, Pretoria. 28 pp.

Geldenhuys, C.J. 1994c. Growth and mortality patterns over stands and species in the northern Transvaal forest increment study sites at Woodbush- De Hoek and Entabeni: Report on 1994 measurements. Report FOR-DEA 827, Division of Forest Science and Technology, CSIR, Pretoria. 21 pp.

Geldenhuys, C.J. 1994d. Growing useful indigenous species on the forest margin: potential and requirements. In: Everard, D.A. (ed). Dynamics, function and management of forest ecotones in the forest-plantation interface. Environmental Forum Report, Proceedings of Forestry Forum Research Meeting, Sabie, May 1994. p.104-113.

Geldenhuys, C.J. 1996. The Blackwood Group System: its relevance for sustainable forest management in the Southern Cape. *South African Forestry Journal* 177: 1 - 15.

Geldenhuys, C.J. 1997a. Composition and biogeography of forest patches on the inland mountains of the southern Cape. *Bothalia* 27: 57-74.

Geldenhuys, C.J. 1997b. Native forest regeneration in pine and eucalypt plantations in Northern Province, South Africa. *Forest Ecology and Management* 99: 101-115.

Geldenhuys, C.J. 1997c. Growth patterns and composition trends in mixed evergreen forests in South Africa. In: Foli, E.G., Vanclay, J.K. & Ofosu-Asiedu, A. (eds). Proceedings of IUFRO Conference on Growth studies in Tropical Moist Forests of Africa, Kumasi, Ghana. November 1996. p.79-92.

Geldenhuys, C.J. 1998a. Growth and mortality patterns over stands and species in the Tsitsikamma increment study sites at Koomansbos and Witelsbos: Report on 1998 measurements. Report No. FW-05/98, FORESTWOOD, Pretoria. 23 pp.

Geldenhuys, C.J. 1998b. Growth, ingrowth and mortality patterns over stands and species in the Groenkop forest study site, George. Report ENV/P/C 98001, Division of Water, Environment & Forestry Technology, CSIR, Pretoria. 58 pp.

Geldenhuys, C.J. 1998c. Long-term monitoring plots show trends in the composition, growth and mortality of mixed evergreen forest in South Africa. In: F. Dallmeier & J.A. Comiskey (eds). Forest Biodiversity Research, Monitoring and Modeling: Conceptual background and Old World Case Studies. Man and the Biosphere Series, Volume 20. UNESCO, Paris & Parthenon Publishing. p. 457-479.

Geldenhuys, C.J. 1999a. Growth and mortality patterns in the Orange Kloof forest growth study site, Cape Peninsula: Report on 1999 measurements. Report No. FW-02/99, FORESTWOOD, Pretoria. 25 pp.

Geldenhuys, C.J. 1999b. Growth, ingrowth and mortality patterns over stands and species in the forest growth study sites at Entabeni and Woodbush, Northern Province: Report on 1999 measurements. Report No. FW-03/99, FORESTWOOD, Pretoria. 29 pp.

Geldenhuys, C.J. 1999c. Plots for long-term monitoring of growth and mortality in Weza and Ngome indigenous forests, KwaZulu-Natal: Report on Plot establishment and First Measurement, 1998. Report No. FW-01/99, FORESTWOOD, Pretoria. 19 pp.

Geldenhuys, C.J. 1999d. Requirements for improved and sustainable use of forest biodiversity: examples of multiple use of forests in South Africa. In: Poker, J., Stein, I. & Werder, U. (eds). Proceedings Forum Biodiversity - Treasures in the World's Forests, 3 - 7 July 1998, Alfred Toepfer Akademie für Naturschutz, Schneverdingen, Germany. p. 72-82.

Geldenhuys, C.J. 2000a. The need for monitoring recruitment, growth and mortality in the indigenous forests: Examples from Northern Province. In: Seydack, A.H.W., Vermeulen, W.J. & Vermeulen, C. (eds). *Towards sustainable management based on scientific understanding of natural forests and woodlands. Proceedings: Natural Forests and Woodlands Symposium II*, pp. 17-28.

Geldenhuys, C.J. 2000b. Sustained yield determination of forest and woodland produce. In: Owen, D.L. & Vermeulen, W.J. (eds). South African Forestry Handbook 2000, Vol 2, The Southern African Institute of Forestry, Pretoria. p. 643-650.

Geldenhuys, C.J. 2002. Concepts and approach towards development of sustainable resource use of non-timber forest products: the example of bark harvesting for traditional medicine. In: Seydack, A.H.W., Vorster, T., Vermeulen, W.J. & Van der Merwe, I.J. (eds). Multiple use management of natural forests and savanna woodlands: Policy refinements and scientific progress. Proceedings of Natural Forests & Savanna Woodlands Symposium III, 6-9 May 2002, Berg-en-Dal, Kruger National Park. p.91-104.

Geldenhuys, C.J. 2004. Meeting the demand for *Ocotea bullata* bark: Implications for the conservation of high-value and medicinal tree species. In: Lawes, M.J., Eeley, H.A.C, Shackleton, C.M. & Geach, B.G.S. (eds). Indigenous forests and woodlands in South Africa: Policy, people and practice. University of KwaZulu-Natal Press, Scottsville, South Africa. p. 517-550.

Geldenhuys, C.J. & Murray, B. 1993. Floristic and structural composition of Hanglip forest in the Soutpansberg, Northern Transvaal. *South African Forestry Journal* 165: 9-20.

Geldenhuys, C.J. & Pieterse, F.J. 1993. Floristic and structural composition of Wonderwoud forest in the Wolkberg, north-eastern Transvaal. *South African Forestry Journal* 164: 9-19.

Geldenhuys, C.J. & Rathogwa, N.R. 1995a. Growth and mortality patterns over stand and species in the Orange Kloof forest increment study site on the Cape Peninsula: Report on 1993 measurements. Report FOR-DEA 883, Division of Forest Science and Technology, CSIR, Pretoria. 15 pp.

Geldenhuys, C.J. & Rathogwa, N.R. 1995b. Growth and mortality patterns over stand and species in four Amatole forest increment study: Report on 1991 measurements. Report FOR-DEA 884, Division of Forest Science and Technology, CSIR, Pretoria. 19 pp.

Geldenhuys, C.J. & Rathogwa, N.R. 1995c. Growth and mortality patterns over stands and species in the Manubi forest increment study site: report on 1995 measurements. Report FOR-DEA 943, Division of Water, Environment and Forestry Technology, CSIR, Pretoria. 22 pp

Geldenhuys, C.J. & Rathogwa, N.R. 1997. Growth and mortality patterns over stands and species in four Amatole forest growth study sites: Report on 1996 measurements. Report ENV/P/C 97006, Division of Water, Environment and Forestry Technology, CSIR, Pretoria. 25 pp.

Geldenhuys, C.J. & Theron, J.M. 1994. Litterfall and nutrient cycling in mixed evergreen forest near George, South Africa. Report FOR-DEA 746, Division of Forest Science and Technology, CSIR, Pretoria. 28 pp.

Geldenhuys, C.J. & Venter, S.M. 2002a. Plant communities and biodiversity of indigenous forests on State Forestry land, Limpopo Province. Report FW-01/02, FORESTWOOD cc, Pretoria. 83 pp.

Geldenhuys, C.J. & Venter, S. 2002b. Plant communities and biodiversity of the Limpopo Province forests: relevance and management options. In: Seydack, A.H.W., Vorster, T., Vermeulen, W.J. & Van der Merwe, I.J. (eds). Multiple use management of natural forests and woodlands: Policy refinements and scientific progress. Proceedings of Natural Forests & Savanna Woodlands Symposium III, 6-9 May 2002, Berg-en-Dal, Kruger National Park. p.23-37.

Geldenhuys, C.J. & Van der Merwe, C.J. 1988. Population structure and growth of the fern *Rumohra adiantiformis* in relation to frond harvesting in the southern Cape forests. *South African Journal of Botany* 54: 351-362.

Geldenhuys, C.J. & Van Wyk, B.-E. 2002. Indigenous biological resources of Africa. In: Baijnath, H. & Singh, Y. (eds). Rebirth of Science in Africa: A shared vision for life and environmental sciences. Umdaus Press, Hatfield, Pretoria. pp. 116-132.

Geldenhuys, C.J. & Von Dem Bussche, G.H. 1997. Performance of *Podocarpus falcatus* provenances in South Africa. *Southern African Forestry Journal* 178: 15-24.

Geldenhuys, C.J., Kotze, D. & van der Merwe, C.J. 1988. Road building and the survival of indigenous forest in the southern Cape. *South African Forestry Journal* 145: 13-24.

Geldenhuys, C.J., Caplan, M. & Rau, D. 2001. *Forest resource inventory in the Umzimkulu District: Species composition and the status of bark-stripped species.* Unpublished Report, CP Wild Project, FORESTWOOD, Pretoria.

Geldenhuys, C.J., Knight, R.S., Russell, S. & Jarman, M.L. (eds). 1988. Dictionary of forest structural terminology. South African National Scientific Programmes Report No 147, FRD:CSIR, Pretoria. 70 pp.

Golding, J.S. 2002. Workshop Proceedings: Revision of the National List of Protected Trees as per Section 12, National Forests Act of 1998, 6-8 March 2002, Roodeplaat, Pretoria.

Hill, T.R. 1996. Description, classification and ordination of the dominant vegetation communities, Cathedral Peak, KwaZulu-Natal Drakensberg. *South African Journal of Botany* 62: 263-269.

Huntley, B. .1965. A preliminary account of the Ngoye Forest Reserve, Zululand. *South African Journal of Botany* 31: 177-205.

Killick, D.J.B. 1963. An account of plant ecology of the Cathedral Peak Area of the Natal Drakensberg. *Memoirs of the Botanical Survey of South Africa* 34: 1-146.

Kirkwood, D. & J.J. Midgley, J.J. 1999. The floristics of Sand Forest in northern KwaZulu-Natal, South Africa. *Bothalia* 29: 293-304.

Kleinn, C., Laamaren, R. & Malla, S.B. 1996. Integrating the assessment of non-wood forest products into the forest inventory of a large area: Experiences from Nepal. In: Domestication and commercialization of non-timber forest products in agroforestry systems. Proceedings of an International Conference held in Nairobi. FAO, Rome. p. 23-31.

Knight, R.S. 1989. Relationships between floristics and structure of southwestern Cape forest patches. In: Geldenhuys, C.J. (ed.) Biogeography of the mixed evergreen forests of southern Africa, pp. 194-205. Foundation for Research Development, Pretoria.

Lawes, M.J. 1990. The distribution of the samango monkey (Cercopithecus mitis erythrarchus Peters, 1852 and Cercopithecus mitis labiatus I. Geoffroy, 1843) and forest history in southern Africa. *Journal of Biogeography* 17:669-680.

Lawes, M.J., Eeley, H.A.C, Shackleton, C.M. & Geach, B.G.S. (eds). Indigenous forests and woodlands in South Africa: Policy, people and practice. University of KwaZulu-Natal Press, Scottsville, South Africa.

Lubbe, R.A. 1996. *Vegetation and flora of the Kosi Bay coastal forest reserve in Maputaland, northern KwaZulu-Natal, South Africa.* MSc. Thesis, University of Pretoria

Lubke, R.A. & de Villiers, G. 1991. The vegetation of the Joan Muirhead Nature Reserve, Kenton-on-Sea. *The Naturalist* 35: 21-30.

Lubke, R.A. & Strong, A. 1988. The vegetation of the proposed coastal National Botanic Garden, East London. *South African Journal of Botany* 54: 11-20.

MacDevette, D.R. 1993. The woody vegetation of the Zululand coastal dunes. In: van der Sijde (ed.) South African Forestry Handbook, pp. 633-637. Southern African Institute of Forestry, Pretoria.

MacDevette, D.R., MacDevette, D.K., Gordon, I.G. & Bartholomew, R.L.C. 1989. The floristics of the Natal indigenous forests. In: Gordon, I.G. (ed.) *Natal indigenous forests. A preliminary collection of reports on indigenous forests in Natal*, pp. 1-20. Natal Parks Board, Pietermaritzburg.

Masson, P. 1990. *The dynamics of the Afromontane forest remnants in the southwestern Cape*. MSc thesis, University of Cape Town, Rondebosch. 142 pp.

Masson, P. & McKenzie, B. 1989. Floristics of southwestern Cape forests. In: Geldenhuys, C.J. (ed.) Biogeography of the mixed evergreen forests of southern Africa, pp. 182-193. Foundation for Research Development, Pretoria.

Masson, P.H. & Moll, E.J. 1987. The factors affecting forest colonisation of fynbos in the absence of recurrent fire at Orange Kloof, Cape Province, South Africa. *South African Forestry Journal* 143: 5-10.

Matthews, W.S., Bredenkamp, G.J. & van Rooyen, N. 1992. The vegetation of the dry dolomitic regions of the north-eastern mountain sourveld of the Transvaal Escarpment, South Africa. *Phytocoenologia* 20: 467-488.

Matthews, W.S., van Wyk, A.E. & van Rooyen, N. 1999. Vegetation of the Sileza Nature Reserve and neighbouring areas, South Africa, and its importance in conserving the woody grasslands of the Maputaland Centre of Endemism. *Bothalia* 29: 151-167.

Matthews, W.S., van Wyk, A.E., van Rooyen, N. & Botha, G.A. 2001. Vegetation of the Tembe Elephant Park, Maputaland, South Africa. *South African Journal of Botany* 67: 573-594.

McCormack, A. 1998. *Guidelines for inventorying non-timber forest products*. M.Sc thesis, Oxford. 127 pp.

McKenzie, B. 1978. *A quantitative and qualitative study of the indigenous forests of the southwestern Cape.* MSc thesis, University of Cape Town.

McKenzie, B., Moll, E.J. & Campbell, B.M. 1977. A phytosociological study of Orange Kloof, Table Mountain, South Africa. *Vegetatio* 34: 1-53.

Moll, E.J. 1972. The current status of mistbelt mixed *Podocarpus* forest in Natal. *Bothalia* 10: 595-598.

Morgenthal, T.L. & Cilliers, S.S. 1999. Vegetation analysis of Pedlar's Bush, Mpumalanga, and its conservation. *South African Journal of Botany* 65: 270-280.

Morgenthal, T.L. & Cilliers, S.S. 2000. Species composition and phytogeographical significance of an afromontane forest fragment in the Mpumalanga Province, South Africa. *Southern African Forestry Journal* 189.

Nicholson, H.B. 1982. The forests of the Umtamvuna River Reserve. *Trees in South Africa* 34: 2-10.

Phillips, J.F.V. 1931. *Forest-succession and ecology in the Knysna region.* Botanical Survey of South Africa. Memoir No. 14. Government Printer, Pretoria.

Phillipson, P.B. 1987. A checklist of vascular plants of the Amatole Mountains, Eastern Cape Province/Ciskei. *Bothalia* 17: 237-256.

Phillipson, P. B. & Russell, S. 1988. Phytogeography of the Alexandria Forest (southeastern Cape Province). Monogr. Syst. Bot. Missouri Bot. Gard. 25: 661-670.

Robesson, R.A.J. 1998. *Phytosociology of north-western KwaZulu-Natal.* MSc thesis, Department of Botany, University of Pretoria, Pretoria.

Roberts, B. R. 1961. Preliminary notes on the vegetation of Thaba 'Nchu. *Journal of South African Botany* 27: 241-251.

Scheepers, J. C. 1978. Vegetation of Westfalia Estate on the north-eastern Transvaal Escarpment. *Memoirs of the Botanical Survey of South Africa* 42:1-230.

Schelpe, E.A.C.L.E. 1943. The plant ecology of the Cathedral Peak area. *J. Nat. Univ. Coll. Sci. Soc.* 3: 21-27.

Shackleton, C.M., Cawe, S.G., and Geldenhuys, C.J. 1999. Review of the definitions and classifications of South African indigenous forests and woodlands. ENV-P-C 99007, CSIR, Pretoria.

Siebert, S.J. 2001. *Vegetation of the ultramafic soils of the Sekhukhuneland Centre of Endemism.* PhD thesis, Dept. of Botany, Univ. of Pretoria.

Silander, J.A. Jr. 2001. Temperate rainforests. In:*Encyclopedia of Biodiversity,* Volume 5: 607-626. Academc Press, San Diego.

Smit, C.M., Bredenkamp, G.J. & van Rooyen, N. 1993. Woodland plant communities of the Fa land type in the Newcastle - Memel - Chelmsford Dam area. *South African Journal of Botany* 59: 14-20.

Stalmans, M., Robinson, E. R. & Balkwill, K. 1999. Ordination and classification of the vegetation of Songimvelo Game Reserve in the Barbeton Mountainland, South Africa for the assessment of wildlife habitat distribution and quality. *Bothalia* 29: 305-325.

Story, R. 1952. A botanical survey of the Keiskammahoek District. *Memoirs of the Botanical Survey of South Africa* 27: 1-184.

Taylor, H.C. 1955. Forest types and floral composition of Grootvadersbosch. *Journal of the South African Forestry Association* 26: 33-46.

Taylor, H.C. 1961. Ecological account of remnant coastal forest near Stanford, Cape Province. *Journal of South African Botany* 23: 153-165.

Taylor, H.C. 1996. *Cederberg vegetation and flora.* National Botanical Institute, Pretoria.

Van der Merwe, I. (1998). *The Knysna and Tsitsikamma forests: Their history, ecology and management.* Chief Directorate Forestry, Department of Water Affairs and Forestry, Pretoria.

Van der Merwe, C.V. 1976. *Die plantekologiese aspekte en bestuursprobleme van die Goukamma-Natuurreservaat.* MSc thesis, University of Pretoria, Pretoria.

Van der Meulen, F. 1979. Plant sociology of the western Transvaal Bushveld, South Africa: A syntaxonomic and synecological study. A. Gantner, Vaduz.

Van der Schijff, H. P. & Schoonraad, E. 1971. The flora of the Mariepskop complex. *Bothalia* 10: 461-500.

Van Rooyen, N., Theron, G.K. & Grobbelaar, N. 1981. A floristic description and structural analysis of the plant communities of the Punda Milia – Pafuri - Wambiya area in the Kruger National Park, Republic of South Africa: 2. The sandveld communities. *South African Journal of Botany* 47: 405-449.

Van Staden, P.J. 2002. *An ecological study of the plant communities of Marekele National Park.* MSc thesis, Centre for Wildlife Management, Univ. of Pretoria, Pretoria.

Van Vuuren, D.R.J. & van der Schijff, H.P. 1970. 'n Vergelykende ekologiese studie van die plantegroei van 'n noordelike en suidelike kloof van die Magaliesberg. *Tydskrif vir Natuurwetenskappe* 10: 16-75.

Van Wyk, A.E. 1989. Floristics of Natal/Pondoland sandstone forests. In: *Biogeography of mixed evergreen forests of Southern Africa.* Geldenhuys, C.J. (ed). Occasional Report 45, Ecosystems Programme, FRD, Pretoria. Pp. 145-157.

Van Wyk, G.F. 1998. Growth, ingrowth and mortality of indigenous evergreen forest in South Africa: Diepwalle FVC plots – results of 10 years of monitoring. Report ENV-P-C 98047, Environmentek, CSIR, Pretoria. 20 pp.

Van Wyk, G.F., Everard, D. A., Midgley, J. J. & Gordon, I.G. 1996. Classification and dynamics of a southern African subtropical coastal lowland forest. *South African Journal of Botany* 62: 133-142.

Van Zinderen Bakker Jr., E.M. 1973. Ecological investigations of forest communities in the eastern Orange Free State and the adjacent Natal Drakensberg. *Vegetatio* 28: 299-334.

Venter, H.J.T. 1972. *Die plantekologie van Richardsbaai, Natal.* DSc thesis, Dept. of Botany, Univ. of Pretoria.

Venter, S.M. 2000. Basket-making from *Secamone* climbers in the Northern Province forests: Can it be sustained? *South African Forestry Journal* 189: 103-107.

Vermeulen, W.J. 1993. Management of indigenous evergreen high forests with specific reference to the Southern Cape. In: van der Sijde, H.A. (ed.), *South African Forestry Handbook,* pp. 617-632. Southern African Institute of Forestry, Pretoria.

Von Breitenbach, F. 1974. *Southern Cape forests and trees.* Government Printer, Pretoria.

Von Breitenbach, F. 1990. *Reports on indigenous forests Part 1: Introduction and methods, Southeastern Transvaal forests, Kaapsehoop forests, Uitsoek forests.* Department of Environment Affairs, Forestry Branch, Pretoria.

Von Maltitz, G.P., van Wyk, G.F. & Everard, D.A. 1996. Successional pathways in disturbed coastal dune forest on the coastal dunes in north-east KwaZulu-Natal, South Africa. *South African Journal of Botany* 62: 188-195.

Von Maltitz, G., Mucina, L., Geldenhuys, C.J., Lawes, M.J., Eeley, H., Aidie, H., Vink, D., Fleming, G. & Bailey, C. 2003. *Classification system for South African Indigenous Forests*. An objective classification for the Department of Water Affairs and Forestry Unpublished report, No. ENV-P-C 2003-017, Environmentek, CSIR, Pretoria. 275 pp.

Ward, C.J. 1980. The plant ecology of the Isipingo beach area, Natal, South Africa. *Memoirs of the Botanical Survey of South Africa* 45: 1-147.

Ward, C.J. & Steinke, T.D. 1982. A note on the distribution and approximate areas of mangroves in South Africa. *South African Journal of Botany* 1: 51-53.

Ward, C.J., Steinke, T.D. & Ward, M.C. 1986. Mangroves of the Kosi System, South Africa: Their re-establishment since a mass mortality in 1965/66. *South African Journal of Botany* 52: 501-512.

Weisser, P.J. 1978. Conservation priorities in the dune area between Richards Bay and Mflozi Mouth based on vegetation survey. *Natal Town and Region. Plan. Rep.* 38: 1-64.

Weisser, P.J. 1980. The dune forest of Maputaland. In: Bruton, M.N. & Cooper, K.H. (eds.) *Studies on the ecology of Maputaland*, pp. 78-90. Rhodes University, Grahamstown & Natal Branch of the Wildlife Society of Southern Africa, Durban.

Weisser, P.J. 1987. *Dune vegetation between Richards Bay and Mlalazi Lagoon and its conservation priorities in relation to dune mining.* Town and Regional Planning Commission, Pietermaritzburg.

Weisser, P.J. & Ward, C.J. 1982. Destruction of the *Phoenix/Hibiscus* and *Barringtonia racemosa* communities at Richards Bay, Natal, South Africa. *Bothalia* 14: 123-125.

Weisser, P.J., Smith, E.C.A., Backer, A.P. & van Eeden, S. 1992. Flora and vegetation of the Mbonambi Beach Arcuate Scar on the Zululand dune barrier, Natal, South Africa. *Bothalia* 22: 289-294.

Weisser, P.J. & Cooper, K.H. 1993. Dry coastal ecosystems of the South African east coast. In: E. van der Maarel (ed.) *Ecosystems of the World 2B: Dry coastal ecosystems – Africa, America, Asia and Oceania*, pp. 109-128. Elsevier, Amsterdam.

Westfall, R.H., van Rooyen, N. & Theron, G.K. 1985. The plant ecology of the farm Groothoek, Thabazimbi District. II. Classification. *Bothalia* 15: 655-688.

Wessels, N. 1991. The Swamp Forests of Lake St. Lucia. *African Wildlife* 45: 256-263.

Whateley, A. & Porter, R. N. 1983. The woody vegetation communities of the Hluhluwe-Corridor-Umfolozi Game Reserve Complex. *Bothalia* 14: 745-758.

Wong, J.L.G., Thornber, K. & Baker, N. 2001. Resource assessment of non-wood forest products: experience and biometric principles. Non-wood forest products No. 13, FAO, Rome.

Wyatt, N.L. 1991. *A methodology for the evaluation of non-timber resources. Case study: the forest reserves of southern Ghana.* M.Sc thesis, Silsoe College, Cranfield Institute of Technology. 102 pp.

Websites: www.redlist.org

Annex 14: The PFM Guidelines

The eight PFM Guidelines were prepared as part of the DWAF/ Danida PFM Project (2001-2005). The PFM Guidelines aim to empower DWAF staff, the new custodians of the state forests and partners at local level to implement the new DWAF Forestry Vision. The PFM Guidelines are meant to support community upliftment in accordance with the DWAF Criteria, Indicators and Standards for Sustainable Forest Management.

Some Guidelines target local groupings, where limited capacity prevails.

The Guidelines are available from the Directorate: Participative Forestry in DWAF, Pretoria.

Description and Main Target Groups

Guideline	Description	Main Target Groups
Stakeholder Participation	How to mobilise stakeholders at local level and form partnerships and agreements with local user groups/communities	DWAF and the new custodians of state forests as well as other departments/ organisations pursuing participation in natural resource management
Legal Options for Community Partnerships with DWAF Forestry	Legal mechanisms/entities available for local groups to co-operate and form CFAs with DWAF and thus obtain licences to use forests and their products	DWAF and the new custodians of state forests as well as local groupings (PFM Committees, CBOs, NGOs, clubs, small enterprises, etc.)

Logical Framework Approach Project Planning	Planning and documenting a project and explaining what a project is, including the major projects funded by donors	DWAF and the new custodians of state forests and local groupings (NGOs, CBOs, Forest User Groups, etc.)
Sustainable Harvesting	Multiple use by stakeholders of indigenous forests through the development of sustainable harvesting systems	DWAF and the new custodians of state forests and local groupings (NGOs, CBOs, PFM Committees, Forest User Groups, etc)
Project Monitoring and Evaluation	A tool for monitoring and evaluating projects in line with DWAF's new monitoring and regulatory role	DWAF and the new custodians of state forests
Fund Raising for Projects	How to compile a funding proposal and where community structures and other local groupings can apply for funding for forest related and natural resource management projects – complements the PFM Guideline: LFA Project Planning	Local groupings (NGOs, CBOs, Forest User Groups, etc.)
Formation of PFM Forums and Committees	Aspects and procedures of developing local PFM structures and compiling a constitution in order that DWAF can liase and form partnerships with communities through local structures – supplements the PFM Guideline: Stakeholder Participation	DWAF and the new custodians of state forests and local groupings (NGOs, CBOs, Forest User Groups, etc.)
Financial Management of Projects	Simple aspects and processes of sound financial management of projects – many local groupings have limited capacity in this regard and can thus not apply for project funding	Local groupings (NGOs, CBOs, Forest User Groups, etc.)