

**MINISTRY OF ENVIRONMENT AND TOURISM  
Directorate of Forestry**



**WOODY RECOURCES  
INVENTORY REPORT ON EHIROVIPUKA CONSERVANCY  
FOREST**



**NAMIBIA - FINLAND FORESTRY PROGRAMME**

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## 1. INTRODUCTION AND MISSION OF FORESTRY

The Directorate of Forestry (DoF) under the Ministry of Environment and Tourism has a mission to carry out woody resources assessments in Namibia. In this task, the Government of Finland has supported this program since 1995. The aim was to build up the capacity of the Directorate of Forestry to carry out regional forest inventories. Throughout the years, an increasing number of local level inventories have also been carried out to fulfill specific requests by projects and forest managers. The support from the Government of Finland today through NFFP Phase II aims more at strengthening the capacity of Directorate of Forestry to serve the needs for local level forest management planning.

Another component of NFFP, which is the Participatory Integrated Forest Management (PIFM) in North West, is directly working with the community of Ehirovipuka Conservancy. They deemed it is necessary to determine the amount of resources available in the area in order to compile a sound forest management plan. In addition, the component is encouraging community to participate in the management of their forest and forest products. More income generating activities for sustainable development are thought of in the near future as the community will be familiarized with the concept of community forestry.

The conservancy was divided into two parts. The Southern part was zoned for hunting, while Northern part was reserved as a community forest to generate income from forest products.

The NFI team carried out the inventory in Ehirovipuka Conservancy Forest in December 2003. The total area of the Conservancy was 198607,509 hectares, while the area inventoried was 78,510 hectares only.

## 2. GENERAL DESCRIPTION OF THE AREA

The proposed Ehirovipuka Conservancy Forest is located in the Kunene region. This area is part of the Kalahari and Namib sand. Inventory area covers 78,510 hectares northwest of the conservancy. The proposed conservancy forest is bordering the Etosha National Park in the east. Common tree species found in the area are *Colophospermum mopane*, *Baikiaea plurijuga*, *Commiphora angolensis* and *Commiphora glandulosa*. According to the Atlas of Namibia vegetation map, the area falls in Trees and Shrub savanna vegetation type and the soil is classified as sandy soil. The annual rainfall is between 300-350 mm (see Atlas of Namibia, 2002).

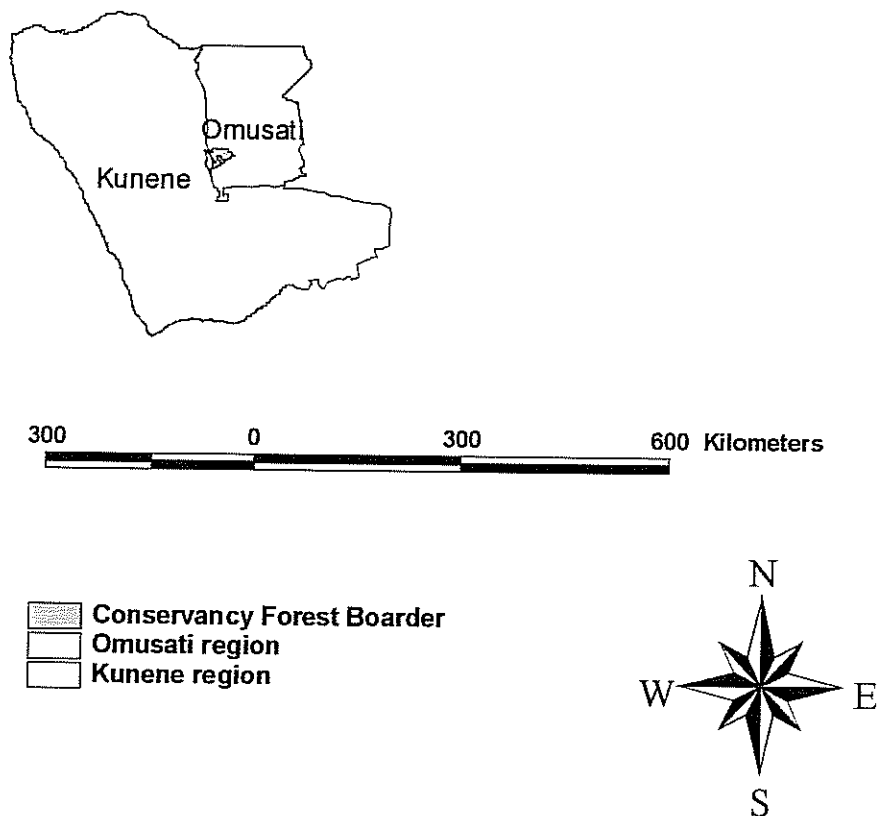


Figure 1: Location of Ehirovipuka Conservancy Forest

### 3. INVENTORY DESIGN

#### 3.1 Sampling method

The stratification was based on the Mountainous Conservancy Map produced by the National Remote Sensing Center. First, the maximum number of plots possible to measure was determined using the resources available (time, staff and money) as the limiting factor. A total of 284 plots were distributed on the area. No specific system was used for the allocation of plots; the decision was based on previous experience.

All mountainous areas were left out from the sample in order to improve efficiency of the field work. A uniform grid (plot distance according to the number of plots allocated) was then laid on the land units included in the sample. The plots were then digitized in order to obtain their coordinates.

Finally, a large land unit with a high expected tree cover was sampled. The number of plots measured in the area is given in the table below:

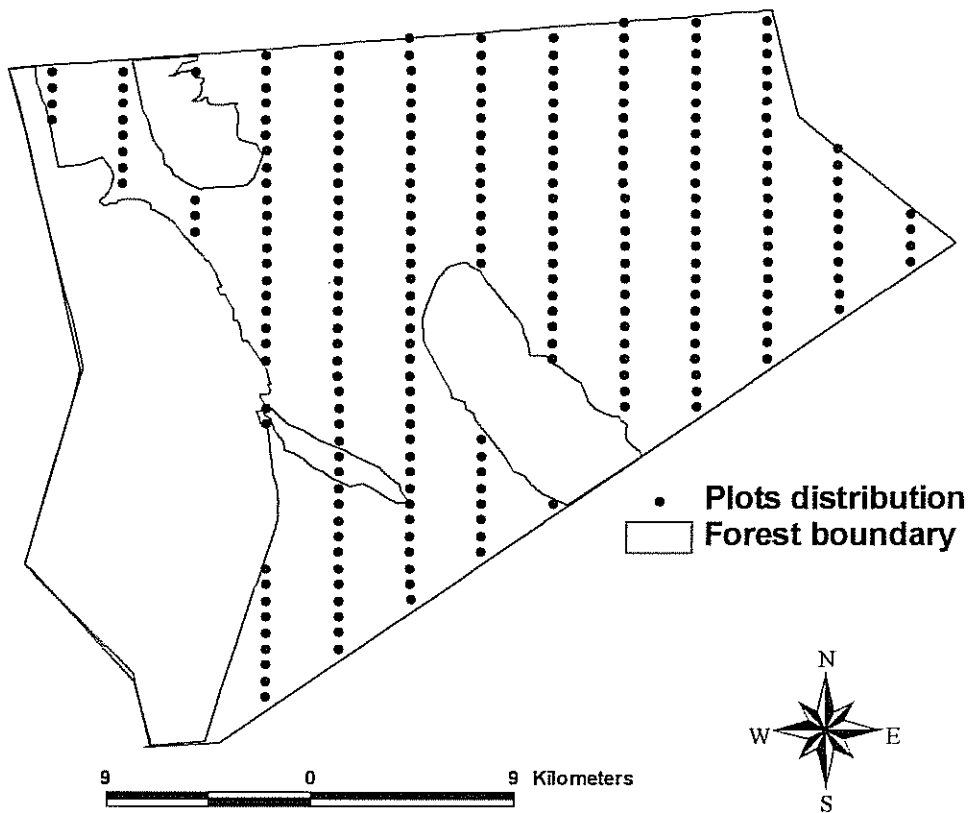
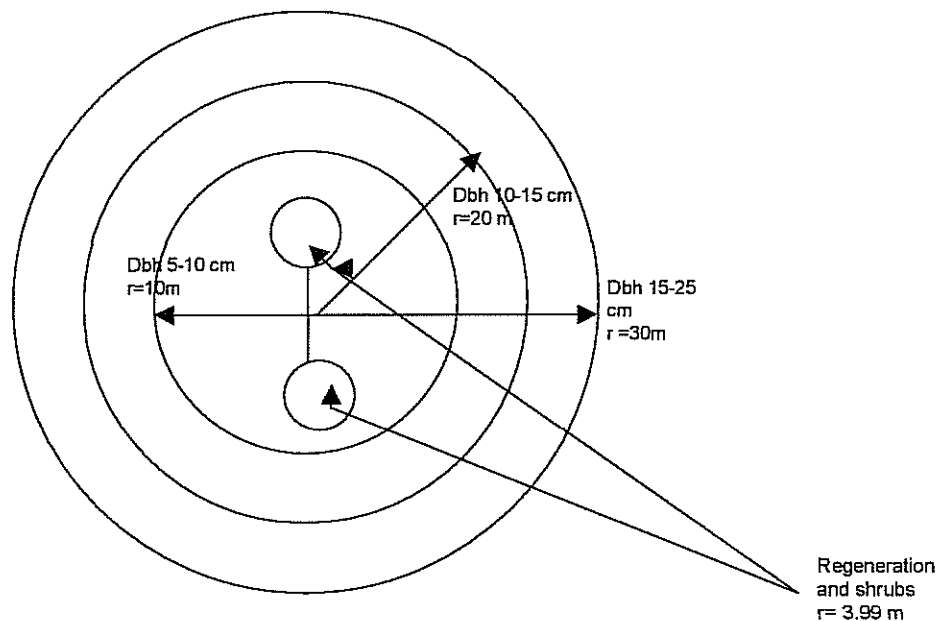


Figure 2: Plots distribution

### 3.2 Plot design

A total of 284 sample plots were measured in Ehrovipuka. All trees with at least 5 cm breast height diameter (Dbh) within the plots. Circular sample plots were used. The plots were further divided into 3 radius to give concentric circles at radius of 10, 20 and 30 meters radius respectively (see Figure 3). Trees with breast height diameter (dbh) 5 – 10 cm, dbh 10 – 15 cm and 15 – 25 cm were measured at 10, 20 and 30 meter radiuses respectively.

The parameters recorded in each were, dbh, location, species, crown class, height, and quality. Regeneration was recorded on two sub-plots of 3.99 m radius, south and north. Several variables describing the site, soil and tree cover were observed for each plot. All measurements are described in more detail in the Manual for Woody Resource Inventories by the Directorate of Forestry 2001. Coordinates for the measured plots are available from the Inventory Section in Windhoek.



**Figure 3:** Plot design

## 4. INVENTORY RESULTS

### 4.1 Measured data

A total of 284 plots were measured on an area of 78,510 hectares. A total of 1005 trees with a diameter of at least 5 cm were measured on the plots. Table 1 shows the total number of measured trees by species found in the forest area.

**Table 1:** Number of measured trees by species

Species	Total No. of measured trees	% of measured trees
<i>Acacia erioloba</i>	1	0.1
<i>Acacia fleckii</i>	13	1.3
<i>Acacia hebeclada</i> (hebeclada)	4	0.4
<i>Acacia luederitzii</i>	1	0.1
<i>Albizia anthelmintica</i>	11	1.1
<i>Berchimia discolor</i>	3	0.3
<i>Boscia albitrunca</i>	3	0.3
<i>Boscia foetida</i>	10	1.0
<i>Colophospermum mopane</i>	404	40.2
<i>Combretum apiculatum</i> (apiculatum)	20	2.0
<i>Combretum hereroense</i>	6	0.6
<i>Combretum imberbe</i>	4	0.4
<i>Commiphora angolensis</i>	45	4.5
<i>Commiphora glandulosa</i>	1	0.1
<i>Rhigoszum brevispinosum</i>	3	0.3
<i>Sesamothamnus guerichii</i>	348	34.6
<i>Terminalia prunioides</i>	128	12.7
<b>Total</b>	<b>1005</b>	<b>100.0</b>

The four most frequent tree species in the area were *Colophospermum mopane* (40%), *Sesamothamnus guerichii* (34.6%), *Terminalia prunioides* (12.7%) and *Combretum apiculatum* (2%). Other amounts of species are less than 2%, which are not common compared to other areas.

## 4.2 Average and maximum height by species

Table 2: Average and maximum height by species found

Species	Average height (m)	Maximum height (m)
<i>Acacia erioloba</i>	6.83	11.3
<i>Acacia tortillis</i>	5.10	5.1
<i>Baikiaea plurijuga</i>	7.68	19
<i>Boscia albitrunca</i>	4.80	4.8
<i>Burkea africana</i>	5.53	6.5
<i>Colophospermum mopane</i>	5.57	9.3
<i>Combretum apiculatum (apiculatum)</i>	4.65	8.4
<i>Combretum collinum</i>	4.50	6.7
<i>Combretum imberbe</i>	5.48	6.3
<i>Combretum molle</i>	5.11	9.3
<i>Commiphora angolensis</i>	4.59	8.4
<i>Commiphora glandulosa</i>	3.96	5.2
<i>Commiphora mollis</i>	5.47	14.3
<i>Dichrostachys cinerea (Setulosa)</i>	3.96	5.3
<i>Lonchocarpus nelsii</i>	6.42	10.7
<i>Terminalia prunioides</i>	5.21	7.8
<i>Terminalia sericea</i>	5.02	8.5

The highest tree measured was *Commiphora mollis*, with 14.3 m. The second highest tree species is *Acacia erioloba* and *Lonchocarpus nelsii*, with 11.3 m and 10.7 m respectively.

## 4.3 Species diversity

A simple measure of species diversity is to express the number of species found in the area and the number of plots where each species was found. Table 3 shows the number of plots where each species was found for both trees (dbh  $\geq$  5 cm) and shrubs (dbh < 5 cm).



**Table 3: Species diversity by the number of plots where each species was found**

Species	No. of plots dbh < 5 cm	No. of plots dbh > 5 cm
<i>Acacia ataxacantha</i>	2	
<i>Acacia erioloba</i>	38	1
<i>Acacia fleckii</i>	8	3
<i>Acacia hebeclada</i> (hebeclada)		4
<i>Acacia karroo</i>	2	
<i>Acacia luederitzii</i>	5	1
<i>Acacia mellifera</i>	16	
<i>Acacia nebrownii</i>	5	
<i>Acacia nilotica</i>	1	
<i>Albizia anthelmintica</i>	3	3
<i>Berchemia discolor</i>		1
<i>Boscia albitrunca</i>	2	3
<i>Boscia foetida</i>	9	8
<i>Colophospermum mopane</i>	172	112
<i>Combretum apiculatum</i> (apiculatum)	31	7
<i>Combretum engleri</i>	1	
<i>Combretum hereroense</i>	23	3
<i>Combretum imberbe</i>		1
<i>Commiphora africana</i>	1	
<i>Commiphora angolensis</i>	75	24
<i>Commiphora glandulosa</i>	20	1
<i>Dichapetalum cymosum</i>	11	
<i>Dichrostachys cinerea</i> (Setulosa)	7	
<i>Elephantorrhiza goetzei</i>	21	
<i>Elephantorrhiza elephantina</i>	29	
<i>Grewia bicolor</i>	6	
<i>Grewia flava</i>	16	
<i>Grewia retinervis</i>	1	
<i>Lonchocarpus nelsii</i>	2	
<i>Mundulea sericea</i>	6	
<i>Rhigoszum brevispinosum</i>	27	1
<i>Sesamothamnus guerichii</i>	8	42
<i>Terminalia prunioides</i>	43	35
<i>Terminalia sericea</i>	10	

A total of 34 woody species were recorded in Ehirovipuka. 17 species are occurring as trees while 31 species are found in the shrub layer. 14 species were found both in the tree and shrub layer.

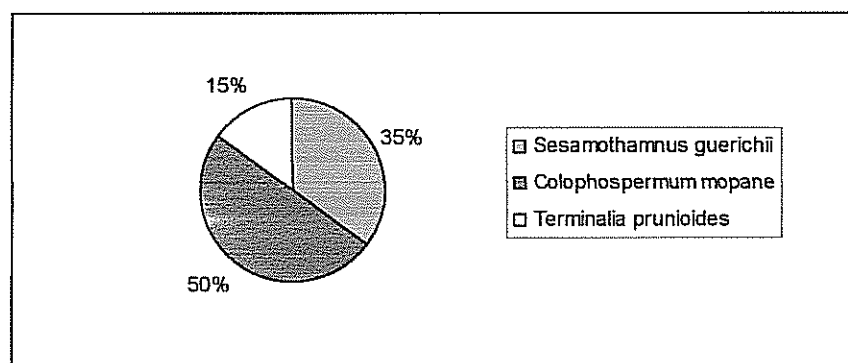
## 4.4 Tree volumes and number of stems

### Live trees

**Table 4:** Volume and number of stems for live trees

Species	Total No. of stems	Stems per ha	Total tree volume, m <sup>3</sup>	Mean volume m <sup>3</sup> /ha
<i>Acacia erioloba</i>	3911		246	
<i>Acacia fleckii</i>	65508	0.8	1168	
<i>Acacia hebeclada</i> (hebeclada)	15644	0.2	992	
<i>Acacia luederitzii</i>	8800	0.1	125	
<i>Albizia anthelmintica</i>	77240	1.0	2181	
<i>Berchimia discolor</i>	16621	0.2	1522	
<i>Boscia albitrunca</i>	8800	0.1	2226	
<i>Boscia foetida</i>	70396	0.9	5911	0.1
<i>Colophospermum mopane</i>	2938063	37.4	60498	0.8
<i>Combretum apiculatum</i> (apiculatum)	152525	1.9	3349	
<i>Commiphora angolensis</i>	230743	2.9	20154	0.3
<i>Commiphora glandulosa</i>	8800	0.1	67	
<i>Combretum hereroense</i>	52797	0.7	708	
<i>Combretum imberbe</i>	7822	0.1	456	
<i>Rhigoszum brevispinosum</i>	26399	0.3	418	
<i>Sesamothamnus guerichii</i>	2074732	26.4	165391	2.1
<i>Terminalia prunioides</i>	862353	11.0	20480	0.3
<b>Total</b>	<b>6621151</b>	<b>84.3</b>	<b>285892</b>	<b>3.6</b>

Table 4 above shows that there are 6,621,151 stems in total, which are 84 stems per ha. The biggest share of stems is of *Colophospermum mopane* (37 stems/ha) and *Sesamothamnus guerichii* (26 stems/ha) followed by *Terminalia prunioides* with 11 stems per ha. The mean volume of all species is 3.6 m<sup>3</sup>/ha. The amount is less, compared to other similar areas.



**Figure 4:** The volume of the most common live tree species expressed in % of the total volume of species (285,892m<sup>3</sup>)

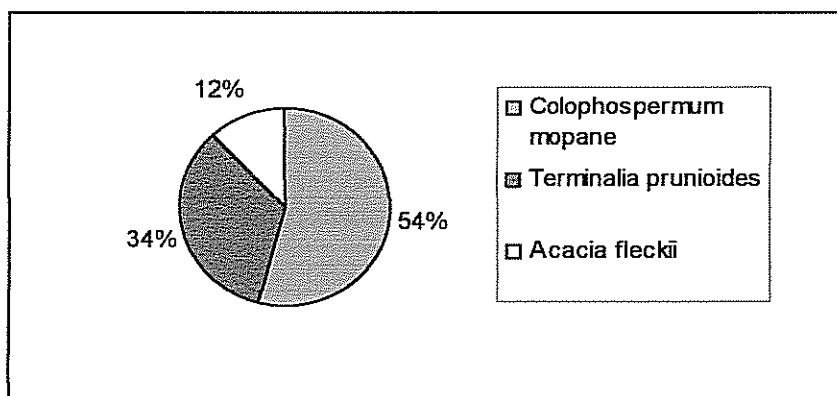
The total volume of all live trees is 285,892 m<sup>3</sup>. The total volume of *Colophospermum mopane* is 60,498 m<sup>3</sup>, for *Sesamothamnus guerichii* is 165,391 m<sup>3</sup> and the total volume for *Terminalia prunioides* is 20,480 m<sup>3</sup>.

#### Dead trees

The most common dead trees in Ehrovipuka Conservancy Forest woodlot are *Acacia fleckii* (1,061m<sup>3</sup>), *Colophospermum mopane* (4,740m<sup>3</sup>), *Combretum apiculatum* (162m<sup>3</sup>), *Combretum imberbe* (390m<sup>3</sup>) and *Terminalia prunioides* (2,984m<sup>3</sup>) total volumes respectively. *Colophospermum mopane* has the high volume total followed by *Terminalia prunioides* (see table 5).

**Table 5:** Volume and total number of stems for dead trees

Species	Total no. of stems	Stems per ha	Total tree volume, m <sup>3</sup>
<i>Acacia fleckii</i>	24443		1061
<i>Colophospermum mopane</i>	107550	1	4740
<i>Combretum apiculatum</i> (apiculatum)	8800		162
<i>Combretum imberbe</i>	12710		390
<i>Terminalia prunioides</i>	138837	2	2984
<b>Total</b>	<b>292340</b>	<b>3</b>	<b>9338</b>



**Figure 5:** The volumes of the most common dead trees expressed in % of the total volume of species (9,338 m<sup>3</sup>)

## 4.5 Diameter distribution

### Live trees

Appendix 1 shows the diameter distribution of live trees. The bulk of the trees are in small and medium sized diameter classes. The distribution also gives indications on which tree species have a potential to grow into big size trees in the area. The biggest live trees are *Colophospermum mopane*, *Sesamothamnus guerichii* and

*Terminalia prunioides* trees. Their diameter distribution is also good in the sense that the majority of the stems are in lower diameter classes. The number of small size of *Colophospermum mopane* is very high, compared to other species.

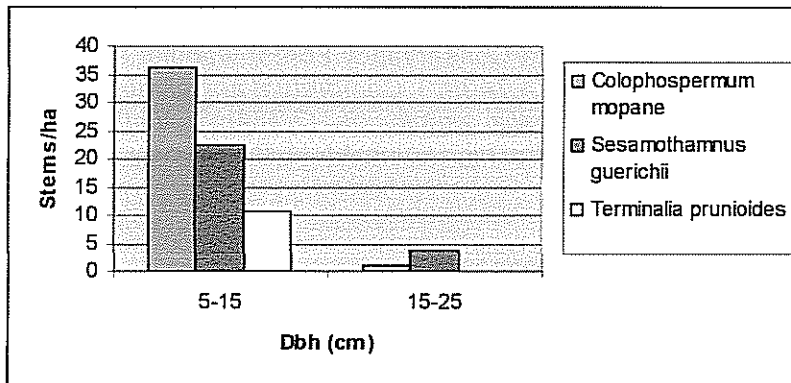


Figure 6: Live wood diameter distribution for most common species

Dead trees

Figure 7 and Appendix 2 show that most of dead stems are from *Colophospermum mopane* and *Terminalia prunioides*. They are mainly found in small size, which is a diameter less than 15 cm at breast height. That means trees are dying in younger age.

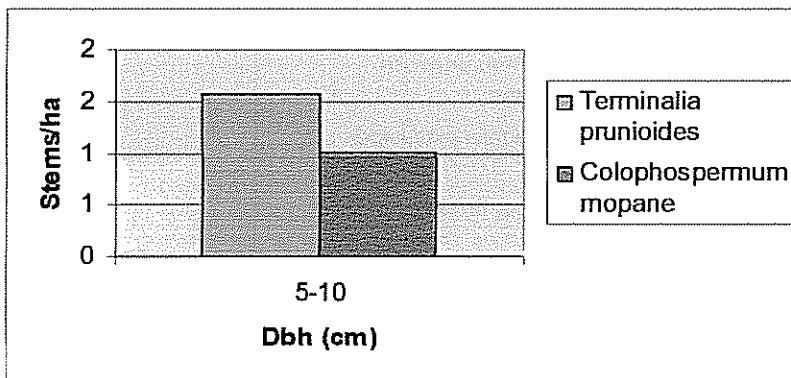


Figure 7: Dead wood diameter distribution for most common species

#### 4.6 Number of stems by quality classes

A specific tree quality classification designed for Ehrovipuka Conservancy was used as follows:

- 1 = Timber: tree stems with dbh >25 cm and upward quality good enough for timber.
- 2 = Pole for house: good quality tree stems with dbh 15 cm to 25 cm.
- 3 = Pole for fence: good quality tree stems with dbh 10 cm to 15 cm.
- 4 = Pole for *kraal*: good quality tree stems with dbh 5 cm to 10 cm.
- 5 = Firewood: dead trees.
- 6 = Other than above.

From the table below, it can be seen that there are 900,000 tree stems with a quality good enough for housing. There are no timber trees at all. There are about 338,292 trees stems suitable for fence or *kraal*.

**Table 6: Utilizable tree species according to quality classes**

Species	Quality	No. of stems per ha	Total No. of stems	% of utilizable stems
Colophospermum mopane	2	11	830088	12.0
Combretum hereroens	2	1	8800	0.1
Terminalia sericea	2	1	44975	0.7
Acacia hebeclada	3		11733	0.2
Colophospermum mopane	3	4	317761	4.6
Colophospermum mopane	4		8800	0.1
Albicia anthelmintica	5		3911	0.1
Colophospermum mopane	5	18	1403035	20.3
Commiphora angolensis	5		4889	0.1
Terminalia sericea	5	1	73329	1.1
Acacia erioloba	6		3911	0.1
Acacia fleckii	6	1	89951	1.3
Acacia hebeclada	6		3911	0.1
Acacia luederitzii	6		8800	0.1
Albicia anthelmintica	6	1	73329	1.1
Berchemia discolor	6		16621	0.2
Boscia albitrunca	6		8800	0.1
Boscia foetida	6	1	70396	1.0
Colophospermum mopane	6	6	485929	7.0
Combretum apiculatum	6	2	161325	2.3
Commiphora angolensis	6	3	225854	3.3
Commiphora glandulosa	6		8800	0.1
Combretum hereroens	6	1	43998	0.6
Combretum imberbe	6		20532	0.3
Rhigozum brevispinosum	6		26399	0.4
Sesamothanmus gueritzii	6	26	2074732	30.0
Terminalia sericea	6	11	882885	12.8
<b>Total</b>		<b>88</b>	<b>6913491</b>	<b>100</b>

#### 4.7 Damage to the woody vegetation

No fire damage on trees was observed in the area. Severe human activities in form of cutting were observed in the community forest. Young regeneration of *Colophospermum mopane* was removed for fencing and constructing *kraal*.

#### 4.8 Regeneration of the trees and shrub layer

There is a good regeneration potential of *Colophospermum mopane* with 457 seedlings per hectare. Other tree species have much less regeneration. The number of seedlings of all species is 640 per hectare. The number of saplings per hectare of all tree species is shown in Table 7 below.

**Table 7: Number of tree seedling per hectare by height classes**

Species	0-25	26-50	51-100	101-150	151-200	201-250	251-300	300+	Total	% of total
<i>Acacia ataxacantha</i>				1					1	0.2
<i>Acacia erioloba</i>	3	9	8	7	6	2	1		36	5.6
<i>Acacia fleckii</i>	1	1	3		1				5	0.8
<i>Acacia mellifera</i>		1	4	3	3	1		1	13	2.0
<i>Albizia anthelmintica</i>								1	1	0.2
<i>Boscia albitrunca</i>									1	0.1
<i>Boscia foetida</i>	1	1	1	1					4	0.6
<i>Colophospermum mopane</i>	22	82	95	115	78	22	12	31	457	71.4
<i>Combretum engleri</i>										0.1
<i>Commiphora africana</i>								1	1	0.1
<i>Commiphora angolensis</i>	5	31	23	7	3	1		1	71	11.1
<i>Dichapetalum cymosum</i>		1	1	2	1			1	6	0.9
<i>Dichrostachys cinerea</i> ( <i>Setulosa</i> )			1		1				3	0.4
<i>Lonchocarpus nelsii</i>	1								1	0.1
<i>Terminalia prunioides</i>	1	4	3	7	10	4	4	4	36	5.7
<i>Terminalia sericea</i>	1		1		1	1			5	0.8
<b>Total</b>	<b>35</b>	<b>130</b>	<b>140</b>	<b>143</b>	<b>104</b>	<b>31</b>	<b>18</b>	<b>40</b>	<b>640</b>	<b>100</b>

**Table 8: Number of shrubs per hectare by height classes**

Species	0-25	26-50	51-100	101-150	151-200	201-250	251-300	300+	Total	% of total
<i>Acacia nilotica</i>										
<i>Combretum apiculatum</i> ( <i>apiculatum</i> )		2	3	5	6	6	4	1	27	30
<i>Grewia bicolor</i>		1			1				3	3.5
<i>Grewia flava</i>		2	6	1	1				11	12.2
<i>Grewia retinervis</i>										
<i>Mundulea sericea</i>			1	1	3				5	5.1
<i>Rhigoszum brevispinosum</i>	15	16	4	3	4	1	1		44	48.6
<b>Total</b>	<b>15</b>	<b>20</b>	<b>15</b>	<b>11</b>	<b>16</b>	<b>7</b>	<b>4</b>	<b>2</b>	<b>90</b>	<b>100</b>

Table 8 shows the number of seedlings for shrub species. There is on average 90 shrubs per hectare in the shrub layer. *Rhigozum brevispinosa* is dominating in the shrub layer with 44 shrubs per hectare.

## 5. RELIABILITY OF RESULTS

The following error sources are always present in sampling based forest inventories: sampling error, measurement error including coding error, errors in data processing and errors in models for volume estimation. In this work, data were handled carefully to maintain good quality of the field data. Several cross checking were done to find out possible errors and inconsistencies in the data. The applied volume functions are probably the main source of errors. The functions in this report are from previous inventory results of similar vegetation type.

## 6. INVENTORY COSTS

All inventories require financial inputs which are either direct or indirect costs. The design of the inventory determines the financial implications that will be incurred during the inventory activities on the ground. National Forest Inventory team (NFI) carried out inventory in Ehrovipuka and Omatendeka Conservancies in December 2003.

One field trip was undertaken for 25 days, and six people did the actual fieldwork. In the calculation, a cost for a man-day includes the salary plus the daily subsistence costs, calculated at a fixed rate for fieldwork. Three motor vehicles, from Windhoek via Opuwo to respective Conservancy were used, and four ATV's for moving from one plot to another at a fixed distance of 700 meters, between plots and two bikes per group of three people. The cost for fuel is more or less real. This calculation only includes immediate costs of the fuel during the actual fieldwork period.

**Table 9:** Inventory costs

Item	Unit	Cost/unit, \$	Total cost, \$
Field Equipment			2,000.00
Fieldwork	10 days X 6 people	150	9,000.00
Fuel	300 litres	4.03	1,209.00
Report printing			1,000.00
<b>Total</b>			<b>13,209.00</b>

## 7. CONCLUSION

The majority of people depend on the forest resources for fuel wood and poles for homestead construction. Other plants are also used for nutrition and medicinal purposes. Domestic animals and game also depend on the forest resources for fodder and shelter. Hence, there is need to manage and maintain the forest bio-diversity of the area. The most common utilizable tree species found in Ehirovipuka Conservancy Forest were *Colophospermum mopane* and *Terminalia prunioides*. Straight stems of *Colophospermum mopane* and *Terminalia prunioides* are used for household construction, fuel wood, poles for fencing and construction of *kraal*. There are two types of *Commiphoras* in this area, *Commiphora angolensis* and *Commiphora glandulosa*; both species are used for carving.

The area inventoried has very good potential for management by the local community. The information in this report creates now a sound basis for forest management planning.

## 8. ACKNOWLEDGEMENTS

The inventory of the Ehirovipuka forest area was carried out by the NFI-team of the Directorate of Forestry. The key personnel in the inventory were:

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## APPENDIX 1

Diameter distribution of the total number of stems per hectare by species for live trees (1000<sup>s</sup>)

Species	5-15	15-25	Total	% of total
Colophospermum mopane	36	1	37	45
Sesamothamnus guerichii	22	4	26	31
Terminalia prunioides	11		11	14
Commiphora angolensis	2	1	3	3
Combretum apiculatum (apiculatum)	2		2	2
Albizia anthelmintica	1		1	1
Boscia foetida	1		1	1
Acacia fleckii	1		1	1
Combretum hereroense	1		1	1
Rhigoszum brevispinosum				
Berchimia discolor				
Acacia hebeclada (hebeclada)				
Boscia albitrunca				
Acacia luederitzii				
Commiphora glandulosa				
Combretum imberbe				
Acacia erioloba				
<b>Total</b>	<b>77</b>	<b>6</b>	<b>83</b>	<b>100</b>

## APPENDIX 2

Diameter distribution of the total number of stems per hectare by species for dead trees (1000<sup>s</sup>)

Species	5-10	Total	% of total
Acacia fleckii			9
Colophospermum mopane	1	1	34
Combretum apiculatum (apiculatum)			3
Combretum imberbe			5
Terminalia prunioides	2	2	49
<b>Total</b>	<b>3</b>	<b>3</b>	<b>100</b>

