Ministry of Environment and Tourism
Directorate of Forestry

Forest Inventory Report

WOODY RESOURCES OF EAST AND SOUTH TSUMKWE, OTJINENE AND OKAKARARA DISTRICTS

National Forest Inventory Project
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1. BACKGROUND

The forest inventory area covers the eastern and southern parts of Tsumkwe district, the northern parts of Otjinene district and the eastern parts of Okakarara districts.

The woody resources were estimated using stratified systematic plot sampling. Vegetation Maps produced by the Directorate of Forestry were used to stratify the area into Forest land and bushland/savanna. Plots were located on 21 randomly selected vegetation mapsheets at a scale of 1:50 000. A number of plots were located on each one of these map sheets according to vegetation strata. A total of 117 plots were measured.

All trees, at least 5 cm DBH, inside the circular plot were measured. The plot consisted of three circles. The size of the plot depended on the size of the tree so that the radius of the plot is 30 m for trees with breast height diameter (DBH) more than 45 cm; 20 m for trees with 20 < DBH < 45 cm; and 10 m for trees with 5 < DBH < 20 cm. Diameter, location, species, crown class, quality, length and quality of possible saw log were measured. Height, diameter of canopy, crown height, damages and phenology were recorded for each tree in the plot.

Additionally, shrubs and regeneration were measured using two 3.99 m radius circular plots. Woody plants with diameter at breast height less than 5 cm were recorded on the shrub and regeneration field form and bigger woody plants on the sample tree field forms. Several variables describing the site, soil and tree cover were observed for each plot. Coverage of grasses and herbs were measured, also. All the measurements are described in more detail in the field instructions (Field Instructions Western Bushmanland 1996).

(An additional data of felled sample trees were collected for constructing volume and biomass functions for Burkea africana, Combretum collinum, Lonchocarpus nelsii, Pterocarpus angolensis and Terminalia sericea (Field Instructions: Collection of...). For other species (that were not so abundant in the data) one of these functions was applied for estimating volumes and biomass. The estimated volume and biomass functions are in Appendix 2) All the felled sample trees were collected in Inventory area No. 1: West Bushmanland. No trees were felled in East and South Tsumkwe, Otjinene and Okakarara districts.

2. GENERAL DESCRIPTION OF THE AREA

The area belongs to the Forest Savanna and Woodland and Camelthorn Savanna vegetation zones in the classification of

Giess (National Atlas of South West Africa). Soil is always sandy. The following land forms are present: dunes, dune valleys, dry river beds and sandy substrates. Annual rainfall is 300 – 400 mm. Elevation is 1100 – 1300 m over sea level.

The total land area is 8 212 447 ha. According to the Vegetation Maps (Directorate of Forestry) 591 521 ha is classified as forest (trees higher than 5 m), 7 598 346 ha as savanna (trees less than 5 m), 22 580 ha as grassland, cultivated land etc. The area for forest and savanna is 7 189 867 ha.

3. INVENTORY RESULTS
3.1 Measured data

A total of 117 plots were measured. According to the vegetation maps, 40 of the plots were on the Forest stratum and 77 on the Savanna/Bushland stratum. Thus, each plot in the Forest stratum represents 14 788.03 ha and each plot in the Savanna/Bushland stratum represents 98 679.82 ha. A total of 375 trees with diameter at least 5 cm were measured on the plots. The number of measured trees by species is shown in Table 1.

Table 1: Number of measured trees by species

Species	No. of all trees	% of all trees
Acacia mellifera	116	30.93
Terminalia sericea	72	19.20
Terminalia prunioides	32	8.53
Combretum psidioides (dinteri)	24	6.40
Acacia karroo	19	5.07
Burkea africana	18	4.80
Acacia hebeclada (hebeclada)	18	4.80
Acacia erioloba	18	4.80
Lonchocarpus nelsii	7	1.87
Acacia fleckii	7	1.87
Schinziophyton rautanenii	6	1.60
Guibourtia coleosperma	6	1.60
Combretum collinum	6	1.60
Acacia reficiens (reficiens)	6	1.60
Pterocarpus angolensis	4	1.07
Combretum zeyheri	3	0.80
Albizia anthelmintica	3	0.80
Ochna pulchra	2	0.53
Boscia albitrunca	2	0.53
Acacia tortilis (heteracantha)	2	0.53
Ozoroa paniculosa	1	0.27
Croton gratismus (subgratismus)	1	0.27
Commiphora africana	1	0.27
Acacia senegal	1	0.27
Total	**375**	**100.00**

The most frequent species in the data set were Acacia mellifera116, Terminalia sericea 72, Terminalia prunioides 32, Combretum psidioides (dinteri) 24, Acacia karroo 19, Acacia erioloba 18, Acacia hebeclada (hebeclada)18, and Burkea africana

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18. There was very little Pterocarpus angolensis, only 4 trees.

3.2 Area estimates

The Vegetation Structural Type were derived for each vegetation unit from measured sample plots. The derivation of the Vegetation Structural Type is based on the measured tree height, shrub and grass cover and on measured coverage of each of these layers (Edwards 1983). The criteria are listed in Appendix 3.

Table 2. Area by Vegetation Structure Types

Vegetation Structure Type	Area in hectares	Area in %
Low Bushland	1239587.05	15.1
Tall Closed Shrubland	1198676.66	14.6
Low Closed Shrubland	972708.98	11.9
Low Open Woodland	822158.24	10.0
Low Open Shrubland	622333.55	7.6
Low Closed Woodland	567544.18	6.9
Short Open Woodland	487329.80	6.0
Short Closed Woodland	462101.31	5.6
Short Thicket	442390.58	5.4
Tall Open Shrubland	310726.30	3.8
Low Thicket	258717.07	3.2
Short Bushland	217786.92	2.7
Bare land	214815.73	2.6
High Closed Shrubland	151632.28	1.9
Short Closed Grassland	148385.79	1.8
Tall Closed Woodland	26284.10	0.3
High Open Shrubland	22950.00	0.3
Herbland	11869.25	0.1
Tall Closed Grassland	11869.25	0.1
Total	8189867.05	100.0

The area and percentage of different Vegetation Structural Types are in Table 2. Low Bushland (definition: Shrub cover > 10% and > 1 m high, and tree cover < 10%, and tree height < 5 m) covers 15.1% of the forest and savanna/bushland area. Tall Closed Shrubland (definition: Tree cover < 0.1% and shrub cover > 0.1% and Shrub height 1-2 m) covers 14.6%. Low Closed Shrubland (definition: Tree cover <0.1%, shrub cover > 10% and shrub height < 1 m) covers 11.9%. Low Open Woodland (definition: Tree cover 1-10%, and tree height < 5 m) covers 10%.

Low Bushland, Tall Closed Shrubland and Low Closed Shrubland together cover about 41.6% of the area.

The crown coverage of each species was calculated for each plot. The dominant and second dominant species were derived from these crown coverage estimates. Table 3 shows the areas and percentages of dominant species. Terminalia sericea is the most common dominant species. It is found on 1655158 ha or 20.2% of the area followed by Acacia mellifera as the second most common species on 679 145 ha or 8.3% of the area.

Table 3: Area (in ha and %) by dominant species

Species Name	Area in hectares	Area in %
No trees	3665967.80	44.8
Terminalia sericea	1655158.24	20.2
Acacia mellifera	679145.16	8.3
Burkea africana	436022.47	5.3
Combretum psidioides (dinteri)	316897.36	3.9
Terminalia prunioides	312105.78	3.8
Lonchocarpus nelsii	310726.30	3.8
Acacia fleckii	164485.03	2.0
Acacia reficiens (reficiens)	151595.95	1.9
Acacia karroo	146371.95	1.8
Combretum collinum	131664.28	1.6
Acacia erioloba	98895.28	1.2
Acacia hebeclada (hebeclada)	44744.92	0.5
Boscia albitrunca	31020.00	0.4
Acacia tortilis (heteracantha)	29234.92	0.4
Guibourtia coleosperma	13744.92	0.2
Pterocarpus angolensis	1043.35	0.0
Schinziophyton rautanenii	1043.35	0.0
Total	8189867.05	100.0

Table 4 shows the occurrence of second dominant species for each dominant species. For example, if Acacia hebeclada is the dominant species most often the second species is Acacia erioloba and vice versa. When A. Hebeclada is the dominant species then A. Erioloba is the second dominant species in 65% of the A. Hebeclada dominated forest and savanna. But, when A. Erioloba is the dominant species then A. Karroo is the second dominant species in 63% of cases.

When B. africana is the dominant species then C. psidioides/C. zeyheri are the second dominant species

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in 30% of the B. africana dominated forest and savanna.
And, when C. psidioides is the dominant species then B.
africana is the second dominant species in 49% of
cases.

Table 5 shows the distribution of crown cover classes
by dominant species. Terminalia sericea dominated areas
are most often in the cover classes 0-5%, 5-10%, 10-15%
and 15-20%. Most of the Acacia mellifera dominated
areas are in cover classes 5-10%, 10-15%, 15-20%, 20-
25%, 40-45% and 45-50%. For other dominant species the
crown cover is in most cases markedly lower, less than
20-25%.

Table 4: Occurrence (in %) of the first dominant and second dominant species. Figures in the table are percentages of the area of the first dominant species.

Second Dominant Species

First Dominant Species	A. erioloba	A. karroo	A. mellifera	A. reficiens (reficiens)	A. senegal	A. anthelmintica	B. africana	C. collinum	C. psidioides (dinteri)	C. zeyheri	G. coleosperma	L. nelsii	No trees	S. rautanenii	T. sericea	Total %
Acacia erioloba		63		30									3		4	100
Acacia fleckii	65	35											18			100
Acacia hebeclada (hebeclada)						80			2				18			100
Acacia karroo			10										90			100
Acacia mellifera	23												77			100
Acacia reficiens (reficiens)			87										13			100
Acacia tortilis (heteracantha)												100				100
Boscia albitrunca			50										50			100
Burkea africana									30	30			36		3	100
Combretum collinum													100			100
Combretum psidioides (dinteri)							49				1		50			100
Guibourtia coleosperma									100							100
Lonchocarpus nelsii													100			100
No trees													100			100
Pterocarpus angolensis														100		100
Schinziophyton rautanenii							100									100
Terminalia prunioides			50		42								8			100

Terminalia sericea	16	0	9	9	1	64	100

Table 5: Percentage of crown cover by dominant species

Species	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55+
Acacia erioloba		96				4						
Acacia fleckii	18	2	80									
Acacia hebeclada (hebeclada)				65				35				
Acacia karroo			90			10						
Acacia mellifera		2	1	9	23				46	19		
Acacia reficiens (reficiens)	100											
Acacia tortilis (heteracantha)	100											
Boscia albitrunca	100											
Burkea africana	67	3	30									
Combretum collinum		100										
Combretum psidioides (dinteri)	46	50	4									
Guibourtia coleosperma					100							
Lonchocarpus nelsii	100											
No trees	100											
Pterocarpus angolensis							100					
Schinziophyton rautanenii								100				
Terminalia prunioides	42	40	14	4								
Terminalia sericea									42		8	50

Crown cover class in % by species

3.3 Volumes and number of stems

Total volumes, mean volumes, total number of stems and average number of stems per hectare for the whole area by species are in Table 6. Only living trees are included in the table. The most common species is Acacia mellifera with an average of 44.27 trees per ha followed by Terminalia sericea with 19.83 trees per ha, Terminalia prunioides with 8.47 trees per ha and Combretum psidioides (dinteri) 7.75 trees per ha.

Acacia mellifera has also the highest mean volume of 1 m3/ha and total volume of 8174.24 m3. The second highest mean volume is for Terminalia prunioides (0.77 m3/ha) followed by Terminalia sericea (0.56 m3/ha). Totally, there are more than 826 million trees in the inventory area.

Table 6: Number of stems and volume per hectare and for the whole area by species

Species	Total vol (1000 m3)	mean vol (m3/ha)	No. of trees (1000)	No. of trees/ha
Acacia mellifera	8174.24	1.00	362597.61	44.27
Terminalia prunioides	6334.27	0.77	69342.90	8.47
Terminalia sericea	4573.76	0.56	162391.54	19.83
Burkea africana	3039.89	0.37	30231.83	3.69
Combretum psidioides (dinteri)	2757.32	0.34	63472.80	7.75
Lonchocarpus nelsii	2452.99	0.30	22347.50	2.73
Albizia anthelmintica	1317.65	0.16	12573.02	1.54
Acacia karroo	1308.16	0.16	26166.90	3.20
Acacia erioloba	1088.89	0.13	10100.20	1.23
Acacia fleckii	1082.92	0.13	6283.44	0.77
Acacia senegal	499.15	0.06	4191.01	0.51
Ochna pulchra	432.46	0.05	5382.88	0.66
Acacia hebeclada (hebeclada)	296.76	0.04	14129.11	1.73
Guibourtia coleosperma	278.17	0.03	609.79	0.07
Acacia reficiens (reficiens)	266.79	0.03	14074.55	1.72
Combretum zeyheri	210.49	0.03	9169.58	1.12
Boscia albitrunca	152.37	0.02	617.12	0.08
Combretum collinum	133.00	0.02	10579.61	1.29
Schinziophyton rautanenii	59.00	0.01	49.82	0.01
Acacia tortilis (heteracantha)	44.48	0.01	1861.15	0.23
Pterocarpus angolensis	14.88	0.00	53.51	0.01
Commiphora africana	8.01	0.00	3.69	0.00
Ozoroa paniculosa	0.56	0.00	33.21	0.00
Total	34526.21	4.22	826262.78	100.89

Table 7 shows the number of plots, variance of vol/ha, standard deviation and mean vol/ha by sampling stratum. Out of 117 plots 25 were in T. sericea dominated

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bushlands, 13 in A. mellifera bushlands and 11 in mixed forest stratum. Average vol/ha is highest in Fgu stratum, due to the huge size of G. coleosperma trees, followed by Fbu and Ftp strata respectively.

Table 7: Number of plots, variance, standard deviation and mean volume by stratum

Sampling stratum	No. of clusters	Var Of vha	Std	Avg vha
FAc	3	31.53	5.61	7.10
FAe	5	63.90	7.99	8.38
FAf	4	1.60	1.26	0.63
FAt	3	0.11	0.33	0.19
FBu	4	173.39	13.17	13.25
FGu	2	5.72	2.39	45.59
FMx	11	9.67	3.11	2.42
FTp	4	92.72	9.63	11.81
FTs	4	23.11	4.81	5.47
SAf	3	0.00	0.00	0.00
SAh	2	0.00	0.00	0.00
SAm	13	5.07	2.25	1.79
SAt-Ae	3	71.56	8.46	7.17
SBp	2	0.00	0.00	0.00
SCa	2	0.00	0.00	0.00
SDc	4	0.00	0.00	0.00
SMx-Ac	21	47.86	6.92	4.51
STp	2	39.42	6.28	4.44
STs	25	41.45	6.44	3.92
Total	117			

Table 8: Maximum diameter by species

Species	Max_Diam
Acacia erioloba	67.2
Guibourtia coleosperma	52.0
Commiphora africana	51.4
Acacia karroo	49.6
Pterocarpus angolensis	48.3
Schinziophyton rautanenii	48.2
Combretum psidioides (dinteri)	38.7
Terminalia prunioides	34.4
Burkea africana	33.4
Terminalia sericea	32.0
Boscia albitrunca	27.7
Lonchocarpus nelsii	27.2
Acacia fleckii	25.7

Acacia reficiens (reficiens)	21.9
Ochna pulchra	17.6
Albizia anthelmintica	16.5
Acacia mellifera	14.6
Acacia senegal	14.2
Acacia hebeclada (hebeclada)	14.1
Combretum zeyheri	10.7
Combretum collinum	10.0
Acacia tortilis (heteracantha)	9.9
Croton gratismus (subgratismus)	7.7
Ozoroa paniculosa	6.7

Table 8 shows the maximum diameter measured for each species. The biggest tree diameters occurred in A. erioloba, G. coleosperma, C. africana, A. karroo, P. angolensis and C. psidioides (dinteri) species. However, the number of trees per hectare (Table 6) for each one of these species is 1.23, 0.07, 0.00, 3.20, 0.01, and 7.75 respectively. Except for C. psidioides (dinteri) there are very, very few large trees of theses species in the area.

3.4 Damages

Damages were recorded both at stand level (for the sampled vegetation unit) and at tree level (for the measured sample trees). There is no damage observed on 76.72% of the area. Mild fire damage is about 1.61% of the area. Most of the damages were mild caused by mammals on 15.44% of the area.

Damage_1	No damage	Mild	Moderate	Total %
No damage observed	76.72			76.72
Forest fire		1.61	0.36	1.97
Mammals		15.44	5.87	21.31
				100.00

Table 9: Distribution of trees in damage classes

3.5. Species diversity

Tables 3 and 4 describe the occurrence of dominant species and also give an idea about the mixture of species. Table 6 gives a figure on the frequency of different species on the inventory area. An other measure for species diversity is the number of plots where each species was found. Table 10 shows this result for both trees less than 5 cm in diameter (including shrubs) and trees larger than 5 cm. Totally, 24 different species were recorded on the tree field form and 41 species on the regeneration and shrub field form. For trees greater than 5 m in height, Terminalia sericea, Acacia mellifera, Combretum psidioides (dinteri) and Burkea africana were recorded on 19.6%, 10.2%, 9.4% and 8.5% of the 117 plots respectively. There are several species, like Acacia senegal, Acacia tortilis (heteracantha), Combretum zeyheri, Croton gratismus (subgratismus), and Ozoroa paniculosa, that were found only on 1 plot each.

On the other hand for trees less than 5 m height, Terminalia sericea, Bauhinia petersiana, Grewia avellana, Commiphora

angolensis and Acacia mellifera were recorded on 41%, 28.2%, 26.5%, 23.1% and 12% respectively.

Table 11 shows the plot number and number of species recorded per plot. The number of species ranged from 0 – 13.

SpeciesName	DBH < 5 cm	DBH > 5 cm
Acacia ataxacantha	13	
Acacia erioloba	5	6
Acacia fleckii	16	3
Acacia hebeclada (hebeclada)	5	2
Acacia hebeclada (tristis)	1	
Acacia karroo		5
Acacia mellifera	14	12
Acacia reficiens (reficiens)	1	4
Acacia senegal		1
Acacia tortilis (heteracantha)	1	1
Acacia tortilis (spirocarpa)	1	
Albizia anthelmintica		2
Baphia massaiensis	18	
Bauhia petersiana	33	
Boscia albitrunca	11	2
Burkea africana	15	10
Catophractes alexandri	2	
Combretum collinum	1	3
Combretum engleri	5	
Combretum psidioides (dinteri)	17	11
Combretum psidioides (psidioides)	1	
Combretum zeyheri	14	3
Commiphora africana	15	1
Commiphora angolensis	27	
Croton gratismus (subgratismus)	13	1
Dichapetalum cymosum	15	
Dichrostachys cinerea	4	
Dichrostachys cinerea (setulosa)	10	
Grewia avellana	31	
Grewia bicolor	9	
Grewia retinervis	28	
Guibourtia coleosperma	1	2
Lonchocarpus nelsii	22	4
Mundulea sericea	6	
Ochna pulchra	15	2
Ozoroa paniculosa	3	1
Pterocarpus angolensis	2	2
Rhigoszum brevispinosum	4	
Rhus tenuinervis	2	
Schinziophyton rautanenii	1	2
Tarchonanthus camphoratus	1	
Terminalia prunioides	1	4
Terminalia sericea	48	23
Ziziphus mucronata	5	

Table 10: Number of plots in which a species was found

4. RELIABILITY OF THE 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 used for e.g. volume estimation.

In this work, specific attention was paid to guarantee good quality of the field data. Field personnel were trained for measurements and plant identification. Specimens were taken and checked by late Dr. Müller for all found tree and shrub species. Several cross checkings were done to find out possible errors and inconsistences in the data. Data processing programs were carefully designed and double checked.

The applied volume functions are probably the main source of errors. The size of the material collected for constructing the functions was moderate. These error sources affect the volume estimates but not, for example, the estimates of stem numbers and size class distributions.

The magnitude of sampling error was estimated with the formula of stratified random sampling using sample plots as sampling units. The applied sampling method was not random but the formula should be more or less valid since the distance between plots was high. Probably the formula over estimates the sampling error.

For the mean volume estimate of all species the sampling error was 0.799 m³/ha (i.e. 20.32 %). This means that the true mean volume is between 3.1 and 4.7 m³/ha with the probability of 68%.

5. CONCLUSIONS FOR MANAGEMENT PLANNING AND RESEARCH

The inventory data indicate that there is no commercial timber resources in this area. Most of the area is dominated by Terminalia sericea, Acacia mellifera, Burkea africana, Combretum psidioides (dinteri), Terminalia prunioides and Lonchocarpus nelsii (Table 4). Where ever commercial trees such as P. angolensis occur in this area, they must be left standing. For commercial forestry the area does not contain a significant amount of exploitable timber. But, It would be wise to conserve the Savanna/bushlands for various purposes such as building materials, carbon sequestration, prevension of soil erosion and animal fodder.

The inventory project will continue in the other parts of Namibia. The data to be collected will give unique possibilities for further studies on the Namibian woodland and savanna ecosystems. Information on the species composition (such as Table 4) on different sites as well as on the species diversity will be easily obtained by analysing the data.

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List of appendices

1. Biomass and volume functions
2. Vegetation Structural Types
3. Location of mapsheets sampled

Appendix 1. Biomass and volume functions.

Function (1) was found to describe well the relation between volume and diameter for Burkea africana and Terminalia sericea. For Combretum, Lonchocarpus and Pterocarpus, Function 2 was applied.

$$v = e\,(a_0 + a_1/d) \tag{1}$$

$$v/d^2 = a_0 + a_1{}^*d + a_2{}^*d^2 \tag{2}$$

where v = volume, dm^3
d = diameter at breast height, cm

The parameter estimates for the volume functions are as follows

Species	a_0	a_1	a_2
Burkea africana	8.607856	-58.71163	-
Combretum collinum	0.131382	0.0180767	-0.0000905
Lonchocarpus nelsii	0.396588	0.0077865	-
Pterocarpus angolensis	0.667061	-0.008408	0.0002143
Terminalia sericea	7.158742	-39.232256	-

The volume is converted to biomass by multiplying with the basic density. The measured basic densities varied according to tree species and stem diameter as follows.

Species	Basic density, kg/dm3	Basic density,kg/dm3
Burkea africana	0.805, if d < 30 cm,	0.770, otherwise
Combretum collinum	0.881, if d < 25 cm,	0.770, otherwise
Lonchocarpus nelsii	0.977, if d < 25 cm,	0.854, otherwise
Pterocarpus angolensis	0.598, if d < 30 cm,	0.525, otherwise
Terminalia sericea	0.754, if d < 20 cm,	0.616, otherwise

The biomass of branches is estimated with Function (3).

$$B5/B = a_0 + a_1/d \tag{3}$$

where B5 = biomass of branches less than 5 cm in diameter
B = total biomass
d = breast height diameter of the tree, cm

The parameter estimates are as follows.

Species	a_0	a_1
B. africana	0.0468932	2.9833058
C. collinum	0.0956231	1.3644359
L. nelsii	0.0713440	3.5334357
P. angolensis	0.0344962	2.9576978
T. sericea	0.1000000	4.5794900

The biomass of branches can be converted to volume by dividing it with following averaged basic densities of branches.

Species	Conversion factor
B. africana	0.7881
C. collinum	0.8366
L. nelsii	0.9229
P. Angolensis	0.6141
T. sericea	0.6627

Appendix 2. Vegetational Structural Types (Edwards 1983).

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1a Tree cover > 0.1%
   2a shrub cover < 10%, if > 1m high
   forest and woodland
      3a tree cover > 75%                                         forest
         4a tree height > 20m                                high forest
         4b tree height 11-20m
   tall forest
         4c tree height 5-10m
   short forest
         4d tree height < 5m                                   low forest
      3b tree cover 11 - 75%                             closed woodland
         5a tree height > 20m
   high closed woodland
         5b tree height 11-20m
   tall closed woodland
         5c tree height 5-10m
   short closed woodland
         5d tree height < 5m                        low closed woodland
      3c tree cover 1 - 10%                                open woodland
         6a tree height > 20m
   high open woodland
         6b tree height 11-20m
   tall open woodland
         6c tree height 5-10m
   short open woodland
         6d tree height < 5m                          low open woodland
      3d tree cover < 1%                                   sparse woodland
         5a tree height > 20m
   high sparse woodland
         5b tree height 11-20m
   tall sparse woodland
         5c tree height 5-10m
   short sparse woodland
         5d tree height < 5m                        low sparse woodland
   2b shrub cover > 10% and > 1 m high             thicket and bushland
         8a tree cover > 10%                                       thicket
            9a tree height > 5m
   short thicket
            9b tree height < 5m                                low thicket
         8b tree cover < 10%                                      bushland
            10a tree height > 5m
   short bushland
            10b tree height < 5m                              low bushland

1b Tree cover < 0.1%
   11a shrub cover >0.1%
   shrubland
      12a shrub cover > 10%                             closed shrubland
         13a shrub height > 2m                      high closed shrubland
         13b shrub height 1-2m
   tall closed shrubland
         13c shrub height < 1m
   low closed shrubland
      12b shrub cover 1 - 10%                            open shrubland
         14a shrub height > 2m                        high open shrubland
         14b shrub height 1-2m
   tall open shrubland
         14c shrub height < 1m
   low open shrubland
      12c shrub cover < 1%                                open shrubland
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      15a shrub height > 2m                              high sparse shrubland
      15b shrub height 1-2m
tall sparse shrubland
      15c shrub height < 1m
low sparse shrubland
11b shrub cover < 0.1 % · · · · · · · · ·   · · ·   · · · · · grassland and herbland
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Appendix 3: Acknowledgements

The successful completion of the Forest Inventory Exercise in East tsumkwe, Otjinene and Okakarara Districts was a result of the cooperative efforts of many individuals within the Directorate of Forestry and other institutions. The key personnel directly involved in the forest inventory consisted of Directorate of Forestry and Government of Finland staff.

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