DIRECTORATE OF FORESTRY
NAMIBIA-FINLAND FORESTRY PROGRAMME
P.O. BOX 23930
WINDHOEK, NAMIBIA
Tel. +264-61-221 478 Fax +264-61-222 830

TECHNICAL REVIEW OF THE INTEGRATED FOREST FIRE MANAGEMENT COMPONENT

OF THE

NAMIBIA-FINLAND FORESTRY PROGRAMME

W.S.W Trollope & L.A. Trollope
Department of Livestock and Pasture Science
Faculty of Agriculture
University of Fort Hare
Republic of South Africa

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INTRODUCTION

Arising from an invitation from the Namibian Directorate of Forestry, we visited Namibia from the 30th June to 30th July, 1999 to conduct a technical review of the Integrated Forest Fire Management (IFFM) component of the Namibian-Finland Forestry Programme (NFFP). The terms of reference for the technical review were:

- Prepare an in-depth analysis of the positive and negative impacts of controlling forest fires; Assess the specific viability of the present IFFM model;
- Provide recommendations on how to adjust or improve the present model in view of its expansion to other regions in northern Namibia considering the socio-cultural and economic realities of each area;
- Identify the pyro-technical (long term fire management) modifications needed for the potential improved model;
- Provide recommendations for the prescribed burning schedules based on different land-use categories;
- Draft an outline on what sections on Forest Fire Control should be included in the National Fire Policy of Namibia.

The technical review comprised interviewing members of the Directorate of Forestry, members of other government departments and relevant members of the public in Windhoek and the Caprivi region. On site inspections were also made of the different major land types inhabited by the rural communities in East Caprivi. A detailed list of the people interviewed and the itinerary for the review are presented in Appendices 1 and 2.

The IFFM component of the NFFP was motivated by both local and international considerations. At the local level there is the perception that excessive burning is having a highly significant negative effect on the woodland ecosystems in the northern areas of Namibia, particularly in the East Caprivi region. As a result of the rapidly increasing human population fire is being used more extensively for converting wooded areas into croplands, maintaining grazing lands and for facilitating activities like hunting and robbing wild bee hives for collecting honey. It is concluded that this is causing serious ecological damage as indicated by a decline in the biodiversity of these areas. Excessive burning is also resulting in considerable economic losses through damage to valuable timber and non-timber resources, loss of grazing and consequent increased livestock mortalities, all of which are to the detriment of the local human population (Goldammer, 1998). The current extent of burning in East Caprivi and the surrounding neighbouring countries has recorded by satellite between April and October, 1996 and the resultant fire scars indicate that this region is subjected to extensive annual burning (Mendelsohn & Roberts, 1997).

The concern at the international level is that large scale burning is contributing directly to the anthropogenic greenhouse effect and thereby influencing global climatic change. It is argued that widespread fires in the wooded areas are reducing the overall phytomass of the vegetation thereby causing a nett release of radiatively active trace gases and aerosols into the regional and global atmosphere. As a consequence Namibia is a signatory to the United Nations Convention on Climate Change and the International Decade on Natural Disaster Reduction. The Government is therefore obliged to submit reports on matters pertaining to the development of a national fire policy and the management of fires (Goldammer, 1998). These concerns provide the motivation and justification for the IFFM component of the NFFP.

However, before conducting the technical review of the IFFM programme there is a fundamental key question that needs to be answered viz. what is the effect of the current fire regime on the different

woodland ecosystems in East Caprivi relative to the different types of land use being applied? The answer to this question will provide an objective basis to the technical review. The review will also be based on the recognition that fire has been occurring since time immemorial and is a natural and essential component of savanna ecosystems in Africa (West, 1965; Trollope, 1984; van Wilgen et al, 1997). Therefore as part of the assessment of the IFFM programme emphasis has been given to developing and using objective methods for assessing the condition of the vegetation as effected by fire and relative to the different forms of land use that are practised in East Caprivi. Such techniques are also necessary for addressing the term of reference related to providing recommendations for prescribed burning for different land-use categories. A brief overview of the soils, climate, vegetation and land use pertaining to the East Caprivi region will be presented before focusing attention on the assessment of the condition of the vegetation.

CLIMATE, SOILS, VEGETATION & LAND-USE IN EAST CAPRIVI

East Caprivi is situated in the north east of Namibia and is bounded by Botswana to the south, Angola and Zambia to the north and Zimbabwe to the east. It covers an area of 12 000 km^2 and comprises a flat landscape approximately 1000 metres above sea level. It receives summer rainfall from approximately October/November to March/April with the mean annual rainfall varying from ±750 mm in the north east to approximately ±500 mm in the south west. The vegetation is influenced by three main factors, namely, soils, flooding and fire. The soils vary from Kalahari sand to hydromorphic and organic clay soils in areas that are regularly flooded by the Zambezi, Chobe, Linyanti and Kwando river systems (Mendelsohn & Roberts, 1997). This has resulted in the formation of six broad vegetation communities or land types.
These major vegetation communities have been further sub-divided into 36 more detailed vegetation units (Mendelsohn & Roberts, 1997). However, for management purposes these six vegetation communities are best suited for assessing the overall effects of fire and providing management recommendations for the different systems of land use. Of the six communities the major vegetation types are the Kalahari Woodlands (± 26%) growing on Kalahari sands, the Mopane Woodlands (± 40%) on light to heavy clay soils and the Floodplains (± 31%) dominated by grasslands occurring on hydromorphic and organic clay soils (Mendelsohn & Roberts, 1997).

There are four types of land-tenure in East Caprivi and their respective proportions are presented in Figure 1.

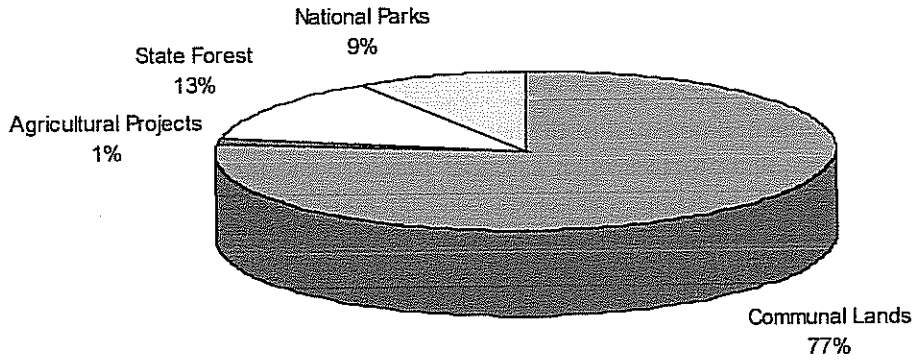

Figure 1: The proportions of land designated as Communal Land, State Forest, National Parks and Agricultural Projects in the East Caprivi region of Namibia (adapted from Mendelsohn & Roberts, 1997).

The major portion of East Caprivi is communal land (± 77%) and is inhabited by rural communities practising subsistence agriculture. Of this area the greater portion is utilized for stock farming which is dominated by cattle and which are kept for draught power, milk, meat and as a source of cash income. Cattle also have a great social value providing security, land rights and status to their owners. Other types of livestock include goats, pigs and horses but these constitute less than one per cent of the total livestock population. Crop farming is the other important agricultural activity in the communal lands and extensive areas have and are being cleared of trees and shrubs for this purpose (Mendelsohn & Roberts, 1997). Another emerging and economically promising form of land use in certain areas are community wildlife conservancies e.g. the Salambala Conservancy in the Ibbu community. These are aimed at improving the

economic circumstances of rural communities through ecotourism based on wildlife. Nevertheless the majority of the area in the communal lands is used primarily for grazing cattle.

Another significant area is the State Forest (± 13%), its status is currently unclear because no legislation has been passed to make it a protected reserve. Timber (presumably *Pterocarpus angolensis* (Kiaat) and *Baikiaea plurijuga* (Zambezi Teak) (Coates Palgrave, 1977; van Wyk, *et al*, 1997)) was extensively harvested in the past but currently no formal or commercial logging is allowed (Mendelsohn & Roberts, 1997). The area is presently very lightly stocked with domestic and wild ungulates primarily as a result of a lack of water and presumably its unclear legal status.

The remaining significant area are the Mudumu and Mamili National Parks (± 9%). Both these parks are currently very lightly stocked with wild ungulate species primarily as a result of the non-flooding of the Kwando and Linyanti rivers during recent years due to low rainfall. Poaching has also apparently been a significant contributory factor.

Finally the majority of the areas designated as agricultural projects (± 1%) are used for cattle grazing in the form of the Sachinga Cattle Breeding Station and the Quarantine Camp.

From the aforegoing description of the different types of land use in East Caprivi it can be concluded that the majority of the area is used for stock farming with cattle and that the vegetation is used primarily for grazing. Therefore when assessing the condition of the vegetation in relation to the effects of fire the effect of burning on the forage production potential of the herbaceous and woody vegetation must be of primary consideration. The vegetation also provides other essential products and services to the rural population e.g. building materials, firewood, thatching, medicines, basketry and food (Anonymous, 1999a; Ashley & LaFranchi, 1997). Therefore these must be considered as far as possible when assessing the condition of the vegetation in relation to the effects of fire.

TECHNIQUES FOR ASSESSING THE CONDITION OF THE VEGETATION

As mentioned earlier attention was focused on developing techniques for assessing the condition of the vegetation. In the previous section it was concluded that the major primary use of the vegetation in East Caprivi is grazing for cattle. This led to the development of two preliminary techniques for assessing the condition of the grass sward in order to be able to determine the current condition of the vegetation and the necessity for controlled burning. The first technique involves determining the botanical composition and basal cover of the grass sward and the second technique comprises estimating the standing crop of grass. A simple technique was also developed to determine the impact of fire on trees and shrubs and involved determining the density, structure and phytomass of the woody vegetation.

GRASS SWARD

Estimating The Botanical Composition And Basal Cover Of The Grass Sward

Research experience gained in the Eastern Cape Province and Kruger National Park in South Africa (Trollope, 1986; Trollope, 1990) and in the central highlands of Kenya (Trollope *et al*, 1996) indicate that the technique for assessing the condition of the grass sward can be rapidly developed using a tested procedure and the following definition of range condition viz. *Range Condition is the condition of the vegetation in relation to some functional characteristic* (Trollope, Trollope & Bosch, 1990). The functional characteristics of the grass sward in East Caprivi are to produce forage for grazing animals, provide grass fuel to support a fire to maintain the optimum balance between grass and woody vegetation and to resist soil erosion. After interviewing several rural communities it was also decided to include the potential of the grass sward to produce thatching material. This component of the herbaceous vegetation is of fundamental importance and has become a very lucrative source of cash income to many of the communities in East Caprivi.

The procedure used for developing the first technique was:

Step 1: Identify all common grass species occurring in the range type being investigated.

Step 2: Based on careful observations in the field and consultations with local biological scientists and land users, subjectively classify the common grass species into decreaser and increaser species according to their reaction to a grazing gradient i.e. from high to low grazing intensities as follows:

DECREASER SPECIES - Grass & herbaceous species which decrease when rangeland is under or over grazed;

INCREASER I SPECIES - Grass & herbaceous species which increase when rangeland is under grazed or selectively grazed

INCREASER II SPECIES - Grass & herbaceous species which increase when rangeland is over grazed.

Step 3: Based on experience, observation and consultation subjectively allocate forage, fuel and thatching factors on a scale of 0-10 according to the potential of the different grass species to produce forage for bulk grazers, fuel for supporting a surface fire and good quality thatching material. These parameters are used to assess the potential of the grass sward to perform functions pertinent to the form of land use that the rangeland is being used for viz. producing forage for grazing animals, using fire as a range management practice and producing thatching material. This procedure was used because it conforms to the concept

of range condition being the condition of the vegetation in relation to some functional characteristics and in this case the potential to produce grass forage, fuel and thatching.

Step 4: Develop a technique for assessing the condition of the grass sward based on the aforementioned classification of the grass species into decreaser and increaser species together with their respective forage, fuel and thatching factors.

Step 5: Test the technique by conducting grass surveys over the widest range of grassland in different conditions possible and subjectively evaluate the results according to the experience of local, co-operating participants in East Caprivi.

The technique was developed in collaboration with Mr C. Hines, a botanical consultant from Windhoek who was responsible for classifying the vegetation of the Caprivi region in the publication "An Environmental Profile And Atlas Of Capriivi (Mendelsohn & Roberts, 1997). Mr Hines has an exceptional taxonomic and ecological knowledge of the vegetation in the Caprivi region and his co-operation proved invaluable and was highly appreciated.

Assistance with the identification of the grasses occurring in East Caprivi was provided by Mr Hines. The classification of the grasses into decreaser and increaser species and the allocation of forage, fuel and thatch factors were conducted by Mr Hines and the authors based on field observations and experience. Reference was also made to the publications by Gibbs-Russel (1990), Muller (1984) and van Oudtshoorn (1999). The results of the classification are presented in Table 1.

Table 1: The Forage, Fuel and Thatch Factors that have been estimated for the different grass species commonly occurring in the East Caprivi region of Namibia.

NO	SPECIES	CATEGORY	FORAGE FACTOR	FUEL FACTOR	THATCH FACTOR
1	*Brachiaria nigropedata*	D	7	7	0
2	*Cenchrus ciliaris*	D	5	6	0
3	*Chloris gayana*	D	7	7	0
4	*Digitaria brazzae*	D	4	4	0
5	*Digitaria eriantha*	D	7	7	0
6	*Digitaria milanjiana*	D	7	7	0
7	*Digitaria seriata*	D	7	7	0
8	*Eragrostis rigidior*	D	3	4	0
9	*Eragrostis stapfii*	D	6	6	0
10	*Panicum coloratum*	D	7	7	0
11	*Panicum maximum*	D	10	8	0
12	*Schmidtia pappophoroides*	D	6	6	0
13	*Setaria sphacellata*	D	6	7	0
14	*Sporobolus fimbriatus*	D	7	7	0
15	*Stipagrostis uniplumis*	D	6	6	0
16	*Themeda triandra*	D	10	10	0
17	*Triraphis schinzii*	D	7	7	0
18	*Andropogon gayanus*	I	1	10	0
19	*Andropogon huillensis*	I	1	10	10
20	*Andropogon schirensis*	I	1	8	0
21	*Aristida meridionalis*	I	1	4	0
22	*Aristida pilgerii*	I	1	2	0

23	*Aristida stipitata subsp. graciliflora*	I	1	8	0
24	*Aristida stipitata subsp stipitata*	I	1	8	8
25	*Bothriochloa bladhii*	I	1	3	0
26	*Brachiaria dura*	I	5	5	0
27	*Cymbopogon excavatus*	I	3	10	10
28	*Dicanthium annulatum*	I	2	6	0
29	*Diplachne fusca*	I	2	2	0
30	*Echinochloa colona*	I	2	2	0
31	*Echinochloa stagnina*	I	10	10	0
32	*Elionurus muticus*	I	1	5	0
33	*Eragrostis cimicina*	I	4	4	0
34	*Eragrostis inamoena*	I	4	6	0
35	*Eragrostis pallens*	I	2	8	10
36	*Eragrostis viscosa*	I	0	0	0
37	*Hyparrhenia filipendula*	I	4	10	10
38	*Hyparrhenia rufa*	I	4	10	10
39	*Hyperthelia dissoluta*	I	4	10	10
40	*Imperata cylindrica*	I	2	8	0
41	*Leersia hexandra*	I	5	5	0
42	*Miscanthus junceus*	I	4	10	10
43	*Oryza longistaminata*	I	4	4	0
44	*Oryzidium barnardii*	I	4	4	0
45	*Panicum fluviicola*	I	2	2	0
46	*Panicum kalaharense*	I	2	8	0
47	*Paspalidium obtusifolium*	I	2	2	0
48	*Pennisetum glaucocladum*	I	2	10	10
49	*Perotis patens*	I	0	0	0
50	*Phragmites australis*	I	0	10	10
51	*Sacciolepsis typhura*	I	2	10	0
52	*Schizachyrium exile*	I	2	7	0
53	*Sorghum bicolor*	I	5	7	0
54	*Tristachya superba*	I	3	6	0
55	*Vetivaria nigritana*	I	0	10	10
56	*Vossia cuspidata*	I	0	10	0
57	*Aristida adscensionis*	II	2	2	0
58	*Aristida rhiniochloa*	II	1	2	0
59	*Aristida congesta subsp. congesta*	II	2	2	0
60	*Aristida effusa*	II	1	2	0
61	*Aristida hordeacea*	II	1	2	0
62	BARE GROUND	II	0	0	0
63	*Bothriochloa insculpta*	II	2	3	0
64	*Bracharia eruciformis*	II	2	2	0
65	*Chloris virgata*	II	1	2	0
66	*Cynodon dactylon*	II	2	2	0
67	*Dactyloctenium aegyptium*	II	2	2	0
68	*Dactyloctenium giganteum*	II	4	5	0
69	*Elytrophorus globularis*	II	0	0	0
70	*Enneapogon desvauxii*	II	2	2	0
71	*Eragrostis aspera*	II	0	0	0
72	*Eragrostis dinteri*	II	1	1	0

73	*Eragrostis lehmanniana*	II	4	5	0
74	*Eragrostis superba*	II	2	4	0
75	*Eragrostis tricophora*	II	1	2	0
76	FORBS	II	2	2	0
77	*Heteropogon contortus*	II	3	6	0
78	*Megaloprotachne albescens*	II	2	2	0
79	*Melinis repens*	II	1	2	0
80	*Pogonarthria fleckii*	II	1	2	0
81	*Pogonarthria squarrosa*	II	1	3	0
82	*Schmidtia kalihariensis*	II	3	3	0
83	*Setaria verticillata*	II	3	4	0
84	*Sporobolus coromandelianus*	II	1	1	0
85	*Sporobolus ioclados*	II	1	1	0
86	*Tragus berteronianus*	II	0	0	0
87	*Tragus racemosa*	II	0	0	0
88	*Tricholaena monachne*	II	2	3	0
89	*Urochloa brachyura*	II	4	4	0
90	*Urochloa mosambicensis*	II	4	4	0
91	*Willkommia sarmentosa*	II	2	2	0

Note: D = Decreaser; I = Increaser I; II = Increaser II.

Based on this initial classification grass surveys were conducted over a wide range of plant communities in different conditions in the Kalahari and Mopane Woodlands. Using the grass species that were identified in these surveys the following preliminary technique was developed for assessing range condition in these two major vegetation communities in East Caprivi (see Table 2).

Table 2: Grass species technique for assessing the condition of the grass sward in the Kalahari and Mopane Woodland communities in the East Caprivi Region.

ASSESSMENT RANGE CONDITION - GRASS SWARD
Caprivi Region - Namibia

Land Type:..... **Sample Site:**.....**Date:**.....
Soil Type:..... **GPS:**.....

CATEGORY	SPECIES	FREQUENCY %	FORAGE FACTOR	FORAGE SCORE	FUEL FACTOR	FUEL SCORE	THATCH FACTOR	THATCH SCORE
DECREASER SPECIES	*Bracharia nigropedata*		7		7		0	
	Digitaria eriantha		7		7		0	
	Eragrostis rigidior		3		4		0	
	Panicum maximum		10		8		0	
	Stipagrostis uniplumis		6		6		0	
	Themeda triandra		10		10		0	
DECREASER TOTAL								
INCREASER I SPECIES	*Aristida meridionalis*		1		4		0	
	Aristida stipitata		1		8		8	
	Cymbopogon excavatus		3		10		10	
	Eragrostis pallens		2		8		10	
	Hyperthelia dissoluta		4		10		10	
INCREASER I TOTAL								
INCREASER II SPECIES	*Aristida congesta*		2		2		0	
	Aristida adscensionis		2		2		0	
	Chloris virgata		1		2		0	
	Cynodon dactylon		2		2		0	
	Dactyloctenium giganteum		4		5		0	
	Eragrostis dinteri		1		1		0	
	FORB		2		2		0	
	Megalotrachne sp		2		2		0	
	Pogonarthria squarrosa		1		3		0	
	Urochloa brachyura		4		4		0	
	Urochloa mosambicensis		4		4		0	
INCREASER II TOTAL			FORAGE		FUEL		THATCH	
TOTAL		100.0	SCORE		SCORE		SCORE	

CONCLUSIONS

FORAGE/ FUEL POTENTIAL

POTENTIAL	FORAGE/ FUEL SCORE	FORAGE: FUEL Tick	
VERY HIGH	> 500		
HIGH	401 - 500		
MEDIUM	301 - 400		
LOW	200 - 300		
VERY LOW	< 200		

THATCH POTENTIAL

POTENTIAL	THATCH SCORE	THATCH Tick
VERY HIGH	>800	
HIGH	701 - 800	
MEDIUM	601 - 700	
LOW	500 - 600	
VERY LOW	<500	

TREND

CATEGORY	%	GRAZING	Tick
DECREASER SPP.		MODERATE	
INCREASER I SPP		UNDER	
INCREASER I SPP		SELECTIVE	
INCREASER II SPP		OVER	

SOIL EROSION

FACTOR	POTENTIAL FOR EROSION		
TUFT DISTANCE	LOW	MOD	HIGH
	<10 cm	10-15 cm	>15 cm
Distance = cm			
GRASS STD CROP	LOW	HIGH	
	≥500 kg/ha	<500 kg/ha	
kg/ha =			
OVERALL SOIL EROSION POTENTIAL			

CONTROLLED BURNING

BOTANICAL COMPOSITION	%	BURN	
		YES	NO
DECREASER SPECIES			
INCREASER I SPECIES			
INCREASER II SPECIES			
FUEL LOAD - kg/ha			
OVERALL DECISION TO BURN			

The conclusions that are drawn from the grass species technique presented in Table 2 are based on the following assumptions:

Trend: This refers to whether the rangeland is being moderately grazed, under grazed, selectively grazed or over grazed. The criteria used for deciding the intensity of grazing is that if the rangeland is dominated by decreaser grass species then it is being moderately grazed. If it is dominated by Increaser I grass species then it is being under grazed. If it is dominated by Increaser II grass species then it is being over grazed. Finally if it is dominated by both Increaser I and Increaser II grass species it is being selectively grazed.

Soil Erosion: The effect of the herbaceous vegetation on soil erosion depends upon the basal and canopy cover of the grass sward. If the basal and canopy covers are high then the potential for soil erosion is low and *vice versa.* Simple indices have been identified for these two parameters. Basal cover is satisfactorily described by recording the distance from a measuring point to the edge of the nearest grass tuft and is easily measured in the field. The standing crop of grass is an excellent index of the canopy cover of the grass sward and is readily measured in the field with a disc pasture meter which will be dealt with in the next section. The different values that have been assigned to these parameters have been subjectively determined based on field experience but can be refined through adaptive management as the need arises.

Controlled Burning: The necessity for rangeland to be burnt or not depends upon its ecological status and physical condition. In order to maintain the potential of the grass sward to produce forage controlled burning should not be applied if it is in a pioneer condition dominated by Increaser II grass species caused by overgrazing. Burning should not be applied when rangeland is in this condition in order to allow it to develop to a more productive stage dominated by Decreaser grass species. Conversely when the grass sward is in an undergrazed condition dominated by Increaser I species, it needs to be burnt to increase the better fire adapted and more productive Decreaser grass species. Finally controlled burning is also necessary when the grass sward has become overgrown and moribund as a result of excessive self-shading. When in this condition it is necessary to remove this old unpalatable grass material to restore the vigour of the grass sward and allow new nutritious regrowth to occur. Field experience indicates that when the standing crop of grass exceeds 4000 kg/ha in southern African savannas then the grass sward has become moribund and needs to be defoliated by burning or any other means.

The procedure used for conducting the grass survey to determine the botanical composition and basal cover of the grass sward comprises locating the sample site in a representative area of the vegetation community being investigated. The survey involves recording the nearest rooted herbaceous plant to a point quadrat located at two metre intervals along two transects 100 metres long, parallel to one another and 25 metres apart i.e. 100 points per survey.

Estimating The Standing Crop Of Grass

The second technique involved using the *Disc Pasture Meter* as a means of estimating the standing crop of grass. This information is used for determining what areas should be considered for burning based on the degree to which the grass sward has become moribund and needs to be burnt to restore its palatability, nutritive value and vigour. The *Disc Pasture Meter* was developed by Bransby & Tainton (1977) and involves relating the settling height of an aluminium disc dropped onto a grass sward to the standing crop of grass holding up the disc, expressed in kilograms per hectare. The technique was calibrated for use in the savanna areas of the Kruger National Park in South Africa by Trollope & Potgieter (1986). This calibration has subsequently been successfully tested in the central highlands of Kenya and shown to be the most reliable and practical means of estimating the standing crop of grass in savanna vegetation. Time did not permit testing the calibration quantitatively in East Caprivi but field experience indicated that estimates obtained over a wide range of conditions were a realistic estimation of the standing crop of grass. Therefore it is recommended that this calibration can be used in East Caprivi. The calibration equation and the relationship between the settling height of the disc and the standing crop of grass are presented in Table 3.

Table 3: Calibration for the Disc Pasture Meter developed for the Kruger National Park and recommended for use in estimating the standing crop of grass in the East Caprivi region of Namibia.

X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
cm	kg/ha	cm	kg/ha	cm	kg/ha	cm	kg/ha	cm	kg/ha	cm	kg/ha	cm	kg/ha	cm	kg/ha
2.0	177	6.0	2517	10.0	4128	14.0	5437	18.0	6569	22.0	7581	26.0	8505	30.0	9360
2.1	256	6.1	2563	10.1	4163	14.1	5467	18.1	6596	22.1	7605	26.1	8527	30.1	9380
2.2	333	6.2	2608	10.2	4199	14.2	5497	18.2	6622	22.2	7629	26.2	8549	30.2	9401
2.3	408	6.3	2654	10.3	4234	14.3	5527	18.3	6649	22.3	7653	26.3	8571	30.3	9421
2.4	482	6.4	2698	10.4	4269	14.4	5557	18.4	6675	22.4	7677	26.4	8593	30.4	9442
2.5	554	6.5	2743	10.5	4304	14.5	5587	18.5	6702	22.5	7701	26.5	8615	30.5	9462
2.6	625	6.6	2787	10.6	4339	14.6	5616	18.6	6728	22.6	7725	26.6	8637	30.6	9483
2.7	695	6.7	2831	10.7	4374	14.7	5646	18.7	6754	22.7	7749	26.7	8659	30.7	9503
2.8	763	6.8	2874	10.8	4408	14.8	5675	18.8	6780	22.8	7772	26.8	8681	30.8	9523
2.9	830	6.9	2918	10.9	4442	14.9	5705	18.9	6806	22.9	7796	26.9	8703	30.9	9544
3.0	895	7.0	2960	11.0	4477	15.0	5734	19.0	6832	23.0	7820	27.0	8724	31.0	9564
3.1	960	7.1	3003	11.1	4511	15.1	5763	19.1	6858	23.1	7843	27.1	8746	31.1	9584
3.2	1024	7.2	3045	11.2	4544	15.2	5792	19.2	6884	23.2	7867	27.2	8768	31.2	9605
3.3	1086	7.3	3087	11.3	4578	15.3	5821	19.3	6910	23.3	7890	27.3	8789	31.3	9625
3.4	1148	7.4	3129	11.4	4612	15.4	5850	19.4	6935	23.4	7913	27.4	8811	31.4	9645
3.5	1209	7.5	3170	11.5	4645	15.5	5879	19.5	6961	23.5	7937	27.5	8833	31.5	9665
3.6	1269	7.6	3211	11.6	4678	15.6	5907	19.6	6986	23.6	7960	27.6	8854	31.6	9685
3.7	1328	7.7	3252	11.7	4711	15.7	5936	19.7	7012	23.7	7983	27.7	8876		
3.8	1387	7.8	3293	11.8	4744	15.8	5964	19.8	7037	23.8	8006	27.8	8897		
3.9	1444	7.9	3333	11.9	4777	15.9	5993	19.9	7063	23.9	8030	27.9	8918		
4.0	1501	8.0	3373	12.0	4810	16.0	6021	20.0	7088	24.0	8053	28.0	8940		
4.1	1557	8.1	3413	12.1	4842	16.1	6049	20.1	7113	24.1	8076	28.1	8961		
4.2	1613	8.2	3453	12.2	4875	16.2	6077	20.2	7138	24.2	8099	28.2	8982		
4.3	1667	8.3	3492	12.3	4907	16.3	6105	20.3	7164	24.3	8122	28.3	9004		
4.4	1722	8.4	3531	12.4	4939	16.4	6133	20.4	7189	24.4	8145	28.4	9025		
4.5	1775	8.5	3570	12.5	4971	16.5	6161	20.5	7214	24.5	8167	28.5	9046		
4.6	1828	8.6	3609	12.6	5003	16.6	6189	20.6	7239	24.6	8190	28.6	9067		
4.7	1881	8.7	3647	12.7	5035	16.7	6217	20.7	7263	24.7	8213	28.7	9088		
4.8	1932	8.8	3685	12.8	5067	16.8	6244	20.8	7288	24.8	8236	28.8	9109		
4.9	1984	8.9	3723	12.9	5098	16.9	6272	20.9	7313	24.9	8258	28.9	9130		
5.0	2035	9.0	3761	13.0	5130	17.0	6299	21.0	7338	25.0	8281	29.0	9151		
5.1	2085	9.1	3799	13.1	5161	17.1	6327	21.1	7362	25.1	8304	29.1	9172		
5.2	2135	9.2	3836	13.2	5192	17.2	6354	21.2	7387	25.2	8326	29.2	9193		
5.3	2184	9.3	3873	13.3	5223	17.3	6381	21.3	7411	25.3	8349	29.3	9214		
5.4	2233	9.4	3910	13.4	5254	17.4	6408	21.4	7436	25.4	8371	29.4	9235		
5.5	2281	9.5	3947	13.5	5285	17.5	6435	21.5	7460	25.5	8393	29.5	9256		
5.6	2329	9.6	3983	13.6	5315	17.6	6462	21.6	7485	25.6	8416	29.6	9277		
5.7	2377	9.7	4020	13.7	5346	17.7	6489	21.7	7509	25.7	8438	29.7	9297		
5.8	2424	9.8	4056	13.8	5377	17.8	6516	21.8	7533	25.8	8460	29.8	9318		
5.9	2471	9.9	4092	13.9	5407	17.9	6543	21.9	7557	25.9	8483	29.9	9339		

Note: The data in Table 3 are based on the calibration $Y = -3019 + 2260 (\sqrt{X})$, where X is the mean disc height of 100 readings and Y = kg/ha (Trollope & Potgieter, 1986).

As mentioned in the previous section in Table 2 estimates of the standing crop of grass with the *Disc Pasture Meter* play a dual role in assessing the condition of the rangeland. viz. indicating the potential for soil erosion as influenced by the grass canopy and whether the grass sward is moribund or not indicating the necessity or otherwise for controlled burning.

The procedure for estimating the standing crop of grass with the *Disc Pasture Meter* is that the survey must be conducted simultaneously with the survey for determining the botanical composition and basal cover of the grass sward. The survey involves recording the settling height of the disc located at two metre intervals along two transects 100 metres long, parallel to one another and 25 metres apart i.e. 100 readings per survey.

WOODY VEGETATION

The simple technique for assessing the condition of the trees and shrubs comprised an adaptation of the point centre quadrat technique. It involves recording the distance from a central point of the nearest rooted woody plant in each quarter together with its height. In order to ensure an adequate spread of trees and shrubs in different height classes the first two quarters are used to record the nearest woody plant less than two metres in height and the remaining two quarters the nearest woody plant greater than two metres in height. It was found that this procedure adequately sampled trees less than six metres in height but not taller trees. Therefore to cater for the larger trees the distance between the nearest neighbouring trees greater than 6 metres are recorded together with their height and the average distance between trees calculated. The recording points for the shorter trees are located approximately 10 metres apart but this distance can be varied according to the density of the woody vegetation as long as care is taken to avoid double sampling of the trees. An adequate sample size for the small trees and shrubs was 10 - 15 recording points and for the taller vegetation recording the distance between 10 large trees proved adequate. These data are used to calculate the overall density and structure of the woody vegetation in the sample area. An index of the phytomass of the woody vegetation is also calculated and expressed as the number of tree equivalents per unit area. A tree equivalent is defined as a tree or shrub that is 1.5 m high and is calculated by determining the total height of the trees recorded in the survey and dividing it by a standard height of 1.5m (Teague, *et al*, 1981). This latter parameter has proven to be a very conceptually meaningful and efficient means of quantitatively describing the phytomass of woody vegetation in a single figure.

ASSESSMENT OF THE INTEGRATED FIRE MANAGEMENT PROGRAMME ACCORDING TO THE TERMS OF REFERENCE

IN-DEPTH ANALYSIS OF THE POSITIVE AND NEGATIVE IMPACTS OF CONTROLLING FOREST FIRES

Using the quantitative techniques developed to assess the condition of the vegetation, field surveys were conducted on the grass sward and woody vegetation in the three major vegetation communities in East Caprivi.

GRASS SWARD

A total of 22 grass surveys were conducted in the three major vegetation communities in East Caprivi i.e. the Kalahari Woodlands, Mopane Woodlands and the Floodplains. These surveys were sited in areas that were deemed to be representative of the condition of the rangelands in the general area. On the basis of these results the
following general conclusions were made about the ecological status of the vegetation and whether the rangelands need to be burnt or not.

Kalahari Woodlands

In both the communal lands and the State Forest the surveys indicated that generally the rangelands did not require to be burnt in their current condition. The overall results of the surveys are presented in Table 4.

Table 4: The condition of the grass sward at representative sites in the State Forest and communal lands occurring in Kalahari Woodlands, indicating the dominant grass species, the grass fuel load and whether controlled burning is necessary or not.

NO	PLOT	SITE	LAND TYPE	DOMINANT GRASS SPECIES	GRASS FUEL KG/HA	BURN YES/ NO
1	20	State Forest	Kalahari Woodland	*Schmidtia pappophoroides* (D)	2135	No
2	21	State Forest	Kalahari Woodland	*Schmidtia pappophoroides* (D)	830	No
3	22	State Forest	Kalahari Woodland	*Megalotrachne sp* (II)	333	No
4	3	Liselo Community	Kalahari Woodland	*Digitaria eriantha* (D)	2184	No
5	16	Choi Community	Kalahari Woodland	*Aristida stipitata* (I)	1881	No

The results indicate that generally the grass sward is either dominated by Decreaser or Increaser 1 grass species. This indicates that the vegetation has an ecological status that will not be harmed by fire but the grass sward is currently not in a moribund condition i.e. < 4000 kg/ha, and therefore does not need to be burnt.

Mopane Woodlands

This plant community is found almost entirely in the communal lands except for Mudumu National Park. The surveys indicated that generally the rangelands in this type of vegetation did not require to be burnt in their current condition. The overall results of the surveys are presented in Table 5.

Table 5: The condition of the grass sward at representative sites in the communal lands occurring in Mopane Woodlands, indicating the dominant grass species, the grass fuel load and whether controlled burning is necessary or not.

NO	PLOT	SITE	LAND TYPE	DOMINANT GRASS SPECIES	GRASS FUEL KG/HA	BURN YES/ NO
14	4	Muyako Community	Mopane Woodlands	*Urochloa brachyura* (II)	± 700	No
15	6	Salambala Camp Site	Mopane Woodlands	*Urochloa brachyura* (II)	1667	No
16	12	Sachona Community	Mopane Woodlands	*Eragrostis rigidior* (D)	333	No
17	13	Sachona Community	Mopane Woodlands	*Eragrostis rigidior* (D)	2035	No

The ecological status of the grass sward in this plant community varied considerably from being dominated by productive Decreaser grass species in some areas to pioneer Increase II species in others, indicating that controlled burning could be considered, if necessary, in certain areas. However, overall the grass sward was dominated by pioneer Increaser II species and was not moribund being either overgrazed or well grazed, neither of which needed burning.

Floodplains

This plant community is also found almost entirely in the communal lands except for Mamili National Park. The surveys indicated that a differentiation should be made between the wetter Zambezi Floodplains and the drier Kwando/Linyanti/Chobe Floodplains. The overall results of surveys conducted in these two areas are presented in Table 6.

Table 6: The condition of the grass sward at representative sites in the communal lands occurring in the Floodplains, indicating the dominant grass species, the grass fuel load and whether controlled burning is necessary or not.

NO	PLOT	SITE	LAND TYPE	DOMINANT GRASS SPECIES	GRASS FUEL KG/HA	BURN YES/ NO
1	8a	Isize Community	Zambezi Floodplains	Tall Climax Species (I)	7677	Yes
2	14	Malengalenga Community	Kwando/Linyanti/ Chobe Floodplains	*Urochloa brachyura* (II)	554	No
3	15	Malengalenga Community	Kwando/Linyanti/ Chobe Floodplains	*Urochloa brachyura* (II)	1828	No
4	15	Malengalenga Community	Kwando/Linyanti/ Chobe Floodplains	*Urochloa brachyura* (II)	1828	No
3	7	Ibbu Community	Kwando/Linyanti/ Chobe Floodplains	*Cymbopogon excavatus* (I)	5675	Yes

Generally the Zambezi Floodplains are flooded annually resulting in the accumulation of very high grass fuel loads as recorded in Table 6. Unfortunately it was not possible to identify the dominant grass species in this area in the time available but it was obvious that the grass sward was dominated by tall growing Increaser I species. Therefore both in terms of ecological status and the standing crop of grass these grasslands require frequent burning which is apparently occurring. An added advantage of burning these moist floodplains is that according to Veterinary Services in Katima Mulilo, burning possibly reduces the incidence of ticks that parasitise cattle. Fires are also used to remove excess plant material just prior to the rainy season so as to facilitate the preparation of land for cultivation when the flood waters recede and prevent snagging of fishing nets during the flood period.

Conversely the Kwando/Linyanti/Chobe Floodplains are much drier because in recent years flooding has not been occurring and consequently the production of grass has been significantly less. These areas are heavily grazed with cattle and excluding the reed beds, the grass sward is generally dominated by pioneer Increaser II grass species in the Malengalenga community area as illustrated in Table 6. Therefore both in terms of ecological status and standing crop of grass these floodplains generally do not require burning in their present condition. The exception are areas dominated by thatch grass e.g. *Cymbopogon excavatus,* in the Ibbu community. This is a climax Increaser I species that accumulates considerable grass fuel loads if not harvested for thatching material and therefore needs to be burnt when in an overgrown condition.

An unusual fire phenomenon occurring in these drier foodplains are ground fires that have developed in the deep layers of organic peat material that characterise the swampy areas and which have been ignited by surface fires burning during the current dry period. These affected areas can be very dangerous to both humans and grazing animals but the solution to this problem will probably only occur when these floodplains are again inundated by flood waters.

WOODY VEGETATION The impact of fire on the woody vegetation was most marked in the Kalahari Woodlands and consequently efforts were concentrated in this vegetation community. Contrasting examples of the effects of different fire regimes on the density, structure and phytomass of trees in this vegetation type were found in the State Forest and the Sachinga Cattle Breeding Station and are presented in Figure 2

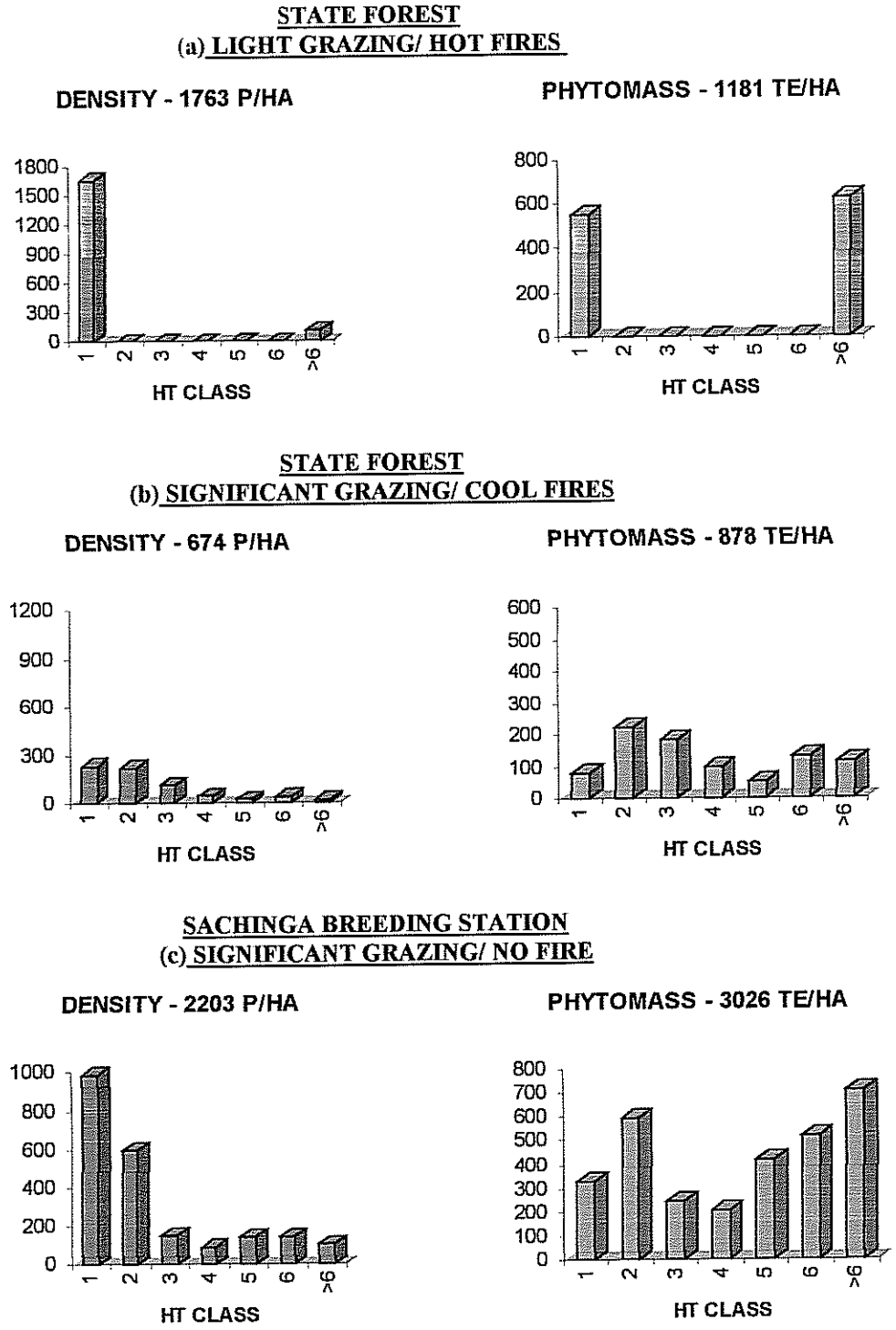

Figure 2: Effect of grazing and fire intensity on the density and phytomass of woody vegetation in different height classes in the Kalahari Woodlands in the East Caprivi region of Namibia. Height classes expressed in metres.

The three different structures of woody vegetation presented in Figure 2 are interpreted as being primarily the result of differences in fire intensity. Grass fuel loads of up to 4269 kg/ha were recorded in areas of the State Forest represented in Figure 2 (a), these were located away from human settlements and where clearly very light grazing occurred. Thus intense hot fires occur in these areas resulting in a two layered structure of woody vegetation characterised by a high density and phytomass of short coppicing shrubs and a scattering of a few large trees. Conversely grass fuel loads of as low as 177 kg/ha were recorded in areas of the State Forest represented in Figure 2 (b). These were located close to human settlements where there were physical signs of significant grazing by cattle. Thus fires would be much cooler in this type of situation and would result in a more equitable development of woody vegetation both in terms of density and size in all height classes. Finally, on the Sachinga Cattle Breeding Station, where fires have been actively suppressed since 1980 (Figure 2 (c)), there is a significantly higher overall phytomass and density of woody plants. This area has become severely encroached by bush to the significant detriment of the grazing capacity of the rangeland and is a clear demonstration of the negative effects of fire suppression on the grazing potential of Kalahari Woodland.

These three situations would suggest that in terms of both maintaining and promoting the grazing and forestry potential of Kalahari Woodland, significant levels of grazing are necessary. This will reduce the accumulation rate of highly flammable grass fuel loads thereby decreasing both the intensity and frequency of fires in this plant community. It is believed that such a scenario would still permit fires to occur that would prevent bush encroachment but the resultant cool and less frequent burns would allow the recruitment and development of trees thereby increasing the forestry potential of the area. Such a fire regime would also maintain the grass sward in a palatable and nutritious condition for grazing animals.

CONCLUSIONS

From the in-depth assessment of the effects of the current fire regime on the vegetation of East Caprivi the following conclusions can be drawn:

- It is clear from an assessment of the condition of the vegetation that generally East Caprivi has been subjected to too frequent, indiscriminate wildfires that have been ignited for apparently no valid ecological reasons. Therefore controlling indiscriminate wildfires will have a beneficial effect on the condition of the grass sward and the woody vegetation. However, the IFFM component of the NFFP must also actively include the implementation of controlled burning based on regular assessments of the condition of the vegetation using the techniques that have been developed.

  Indiscriminate wildfires would appear to be a particular problem in the Kalahari Woodlands where the grass sward is generally not in a moribund condition in the communal lands and therefore does not require controlled burning at present. However the exclusion of fire for extended periods will gradually result in the grass sward becoming unpalatable to grazing animals because of the accumulation of old dead non-nutritious grass material. Controlled burning will therefore be necessary periodically to remove the old moribund grass in order to promote the growth of new high quality forage.

  The indiscriminate wildfires are also negatively impacting the woody vegetation which generally comprises a layer of short coppicing shrubs interspersed by scattered large trees over extensive areas in the Kalahari Woodlands. This is a problem, especially in the State Forest, which is being subjected to too frequent intense

fires as a result of excessive grass fuel loads continually accumulating in the absence of significant levels of grazing. Thus controlling indiscriminate wildfires will initially benefit the trees and shrubs in this vegetation community but controlled burning will have to be periodically applied to prevent bush encroachment as has occurred on the Sachinga Cattle Breeding Station.

- The Mopane Woodlands are dominated by pioneer grass species but the sparse nature of the grass sward would suggest that they do not burn that frequently and their current condition is primarily the result of a high grazing pressure. This conclusion is also supported by referring to the Caprivi Atlas where the satellite images for 1996 indicate that this type of vegetation was subjected to less burning during that year (Mendelsohn & Roberts, 1997). Thus controlling indiscriminate wildfires will benefit the grass and woody vegetation as in the previous vegetation community but again controlled burning will be necessary to remove moribund grass material when and if it accumulates. Bush encroachment is also a potential problem in the Mopane Woodlands both in the form of *Colophospermum mopane* and *Terminalia sericea* and will necessitate controlled burning when deemed necessary.

- The Zambezi floodplains are apparently subjected to frequent fires (annual or biennial) which would appear to be ecologically acceptable. With the abundant moisture provided by the annual flooding of the flat terrain, excessively high fuel loads of grass are produced that have limited value for grazing and constitute a serious fire hazard if not removed regularly. Thus controlling fires in these floodplains would have a highly negative effect. Firstly, with the rapid accumulation of extremely high grass fuel loads accidental ignitions would result in devastating high intensity fires. These would be a serious threat to humans, livestock and the slightly elevated islands of forest that are scattered over these tall growing grasslands. Secondly, the excessive control of fires would also result in a significant decline in the quality of the grazing to the severe detriment of the livestock population in these areas.

  Indiscriminate wildfires are a problem in the Chobe, Linyanti and Kwando Floodplains where the rainfall is lower and where normal flooding of the areas has not occurred for a decade or more. These wildfires originate primarily from Botswana and/or from ground fires that have developed in the deep layers of organic peat material that characterise the swampy areas and which have been ignited by surface fires during the current dry period. Controlling indiscriminate wildfires will generally have a highly beneficial effect in these areas. It will prevent the unnecessary burning off of valuable forage for grazing animals and should also limit the development of ground fires in the layers of peat in the swampy areas. However, if these areas are again flooded in the future then controlled burning will become necessary as is the case in the Zambezi floodplains.

- A situation where controlled burning is currently very necessary are the areas adjacent to the floodplains where thatching material is harvested from dominant stands of *Cymbopogon excavatus, Eragrostis pallens, Hyperthelia dissoluta, Hyparrhenia filipendula* or *Aristida stipitata* grass species. These are all climax Increaser I grass species that need to be burnt periodically to maintain them in a non-moribund condition best suited to producing thatching material and grazing. Thus while indiscriminate fires could be deleterious in these situations and should be controlled, it must be recognised that controlled burning is a key management practice for the successful production of high quality thatching material.

A factor that was assessed but not found to be a serious problem associated with indiscriminate wildfires was the occurrence of widespread soil erosion as mentioned in some reports (Siljander, 1996). None of the grass surveys conducted in the Kalahari Woodlands, Mopane Woodlands or the Floodplains indicated that there was an overall serious soil erosion problem in East Caprivi. Areas that were denuded and where accelerated soil erosion was undoubtedly occurring were in the vicinity of rural villages and at livestock drinking troughs.

Fortunately the terrain in East Caprivi is very flat and combined with widely occurring sandy soils even in these denuded areas soil erosion does not occur at the alarming rate it does in other parts of southern Africa characterised by steep topography and highly erodible soils e.g. Lesotho and Transkei.

ASSESSMENT OF THE SPECIFIC VIABILITY OF THE PRESENT IFFM MODEL

As illustrated in Figure 1 and established in the previous section, the occurrence of indiscriminate wildfires are a major ecological problem in East Caprivi in particular, and in this region of southern Africa in general. From an inspection of the IFFM program in the field and a review of the relevant literature the following conclusions can be drawn about the viability of the present IFFM model.

- The IFFM program has apparently had a highly significant positive impact on reducing the area burnt by indiscriminate wild fires in East Caprivi which is both commendable and ecologically desirable. Progress in this regard is illustrated by the areas that were burned, managed and protected during the period 1995 to 1998 (see Table 7).

Table 7: The progress achieved through the application of the IFFM model in terms of the area burned, managed and protected during the period 1995 to 1998 (Anonymous, 1999b)

YEAR	AREA BURNED ha	AREA MANAGED ha	AREA PROTECTED	
			AREA - ha	%
1995	840 000	10 000	0	0
1996	790 000	112 000	50 000	6
1997	638 000	396 000	202 000	24
1998	354 000	636 000	450 000	54

Unfortunately it was not possible to verify these data presented in Table 7 on the ground or otherwise during the visit to East Caprivi. There is no reason why these estimates should not be accepted since the impression gained during the technical review is that the IFFM model is being implemented with absolute sincerity, commitment and obvious enthusiasm by the Directorate of Forestry, both in Windhoek and Katima Mulilo. Furthermore, the impression gained from interviews with traditional leaders and members of the rural communities, together with general members of the public in Katima Mulilo, was that there was consensus on a significant reduction in the incidence of fires since the initiation of IFFM in 1996. These views are supported by Trigg (1998) who concluded from satellite data that there had been a decrease of 7 % in the area burnt in East Caprivi in 1997 compared to 1996. This was in contrast to the Caprivi region as a whole where there had been an 8 % increase in the area burned. Therefore for the purposes of this report it is accepted and concluded that the IFFM model has successfully reduced the incidence of indiscriminate wildfires in East Caprivi since its implementation in 1996. Nevertheless it is strongly recommended that satellite images be used to test the data presented in Table 7 and to monitor the areas burned annually in the future.

- The effectiveness of the IFFM would appear to have been achieved by the successful large-scale public awareness campaign that has been conducted via roadside billboards, local radio bulletins, pamphlets, village meetings and drama presentations. Emphasis has been given to focusing the campaign on school children who have been very successful in transmitting fire awareness to their parents and the rural communities in general. A particularly powerful extension tool have been the dramas presented at schools and rural communities by the Caprivi Theatre Group. We had the privilege of attending a presentation by this theatre group at a school in

Katima Mulilo and were struck by the professionalism of the actors and the enthusiastic response and participation by the school children in the drama. The construction of cutlines (firebreaks) in the different rural communities would also appear to have contributed to the public awareness campaign concerning fires in East Caprivi. This is because both the local community leaders and members of the contract teams constructing the cutlines were very well informed about the necessity for controlling fires and the role cutlines played in achieving this objective.

- As there are no maps available indicating the location of the cutlines in the different communities it was difficult to ascertain to what extent the cutlines, which have been constructed by participating communities to limit the spread of fires, have physically reduced the area burnt by indiscriminate wildfires. In discussions with Mr Simon Trigg, a remote sensing specialist, it transpired that the effectiveness of the cutlines in controlling wildfires could be determined on a regional scale using satellite images. Suffice it to say that the cutline system does provide a potentially effective means of combating wildfires when active steps are being taken to control fires under extreme atmospheric conditions. They also provide the practical means of reducing the risk of applying controlled burns when and if it is necessary in the different rural communities.

- The physical dimensions (10-15m wide) and construction of the cutlines (two cleared strips and a burnt central portion) were found to be satisfactory both as a means of applying backfires when controlling wildfires and in the application of controlled burns. The progress made in the construction of cutlines is most impressive having increased by 100 km in 1995 to 1832 km in 1998 (Anonymous, 1999b). However, it is doubtful whether the construction of cutlines by the different village communities that have requested participation in the IFFM program will be sustainable if payment to the contract workers by the Namibian Government is discontinued at the end of the program in 2001. This was the general view expressed by contract cutline workers and rural dwellers at all the communities that were visited. The probable reason for this is the commonly held view in communal areas that positive efforts made by individual persons in a community do not have an immediate and direct effect on the well-being of the majority of persons in the community.

- It has not been possible to determine the ecological effects of the IFFM program on the woody and herbaceous vegetation in East Caprivi. This is because of the absence of a comprehensive monitoring program that describes all components of the vegetation in a functional manner i.e. both trees and grass vegetation.

RECOMMENDATIONS ON HOW TO ADJUST AND IMPROVE THE PRESENT MODEL

A most striking and highly pertinent factor that emerged during the conducting of the technical review of the IFFM of the NFFP were the different perspectives people and agencies had on fire and its ecological role in African savannas. This is believed to be highly pertinent to the adjustment and improvement of the present IFFM model. Ideally when conducting a public awareness and action programme there should be consensus on all aspects of the programme amongst the participating and affected members of the community. The following opinions and perspectives emerged from interviews conducted with members of relevant organizations involved in and affected by the IFFM programme.

DIRECTORATE OF FORESTRY

There are two distinct perspectives on fire in the Directorate of Forestry. Firstly at the headquarters in Windhoek interviews with senior officials from Namibia and Finland indicated that there is a clear general recognition that fire is a natural factor of the environment in African savannas. It is also recognised that controlled burning is an ecologically necessary management practice under certain ecological circumstances and is an integral part of IFFM in East Caprivi. In contrast interviews with the District Forest Officer and his staff at Katima Mulilo in the

Caprivi region indicated that at the district level fire is not regarded as a natural factor of the environment in African savannas. It is believed that total fire suppression is necessary and is the primary objective of IFFM.

TRADITIONAL COMMUNITIES

Interviews with traditional leaders and rural dwellers indicated that there is a dichotomy in attitudes towards fire. At the official level traditional communities support a policy of total fire suppression. However, at an individual level amongst the older generation there is generally a well developed traditional understanding of the role fire plays in the management of the herbaceous and woody vegetation in the different plant communities. This traditional knowledge was found to be both practical and scientifically acceptable. Of particular interest was the use of fire in the management of tall growing grass species that are harvested for thatching material.

MINISTRY OF AGRICULTURE

Interviews with agricultural officials in Katima Mulilo led to the conclusion that there is a complete lack of understanding and appreciation of the ecological role of fire in African savannas and its use in range management for livestock production.

DIRECTORATE OF NATURE CONSERVATION

During interviews with the senior nature conservation officer in Katima Mulilo there was a recognition of the ecological role of fire in African savannas and an appreciation for its role and necessity as a range management tool in nature conservation areas. However, it was felt that the current widespread occurrence of indiscriminate wildfires precluded the ability and necessity of applying controlled burning in the National Parks in East Caprivi under present circumstances.

INTEGRATED RURAL DEVELOPMENT NATURE CONSERVATION (IRDNC)

Interviews with members of the IRDNC at all levels and from attending meetings of this organization with some traditional communities from East and West Caprivi, indicated that there is a clear recognition of the necessity for including controlled burning as a range management practice in savanna areas.

As a consequence of these differing perceptions on the ecological role and use of fire in East Caprivi together with other considerations the following recommendations are made to adjust and improve the current IFFM model:

- regarding the ecological role and use of fire in East Caprivi viz. that fire is a natural factor of the environment in African savannas and that controlled burning is an ecologically necessary management practice under certain ecological circumstances and is an integral part of IFFM in East Caprivi. It is imperative that IFFM be changed from a fire suppression program at the district level to a fire management program in which controlled burning is recognised as being ecologically necessary under certain circumstances. Such a change in attitude can be achieved through local district forestry personnel attending training programs in fire ecology and controlled burning relevant to the different forms of land-use practised in East Caprivi.

- It is also recommended that the current public awareness program be adapted to differentiate between the harmful effects indiscriminate fires are having on the vegetation and the ecological necessity of using controlled burning when it is necessary. Such an adaptation to the public awareness program will help to restore the credibility of traditional knowledge developed over millennia regarding the ecologically acceptable use of fire in

managing the natural vegetation resources of East Caprivi. This will also overcome the anomaly that has developed where some communities are now requesting authority to apply ecologically acceptable controlled burns despite the public awareness campaign of preventing all fires contained in the highly visible notices in public buildings and along roadsides.

- It is recommended that an integrated approach be adopted in the implementation of IFFM that will involve all government and non-government agencies affected by the program. For example the apparent lack of knowledge and involvement in IFFM of the range management and livestock sections in the Ministry of Agriculture is most unfortunate as the implementation of the programme has a direct bearing on the availability of grazing and the performance of livestock. The involvement of the Directorate of Nature Conservation and the IRDNC is also essential because once again IFFM directly effects the maintenance and development of suitable habitat for wildlife. Close liaison must also be maintained with the Ministry of Regional, Local Government and Housing who have been made responsible for the implementation of IFFM in the long term. This integrated approach could be co-ordinated by reviving the Regional Committee that was formed to perform this function but which is currently dormant. While recognising the difficulties of involving other parties in IFFM it is also very clear that unless this is successfully achieved it is difficult to see how IFFM will be sustainable in the long term once the current active project phase has come to an end.

  It is recommended that the current view projected by the IFFM program that the most important use of the natural resources in East Caprivi is the production of forest products be adapted. Recognition must be given to the fact that the major form of land use in the region is livestock and crop production (87%) where livestock contribute 85% of the agricultural cash income (Keulder & Werner, 1997). For example in the mid-term review of the IFFM program it is stated that of the 1.2 million hectares comprising East Caprivi, 780000 hectares are managed forests whereas the State Forest comprises only 160000 hectares (13%) (Anon., 1999a). Ofcourse the natural vegetation is also used for harvesting thatch grass, timber for constructing buildings and kraals and plant products for food and medicinal purposes. However, the major use of the natural vegetation is for grazing of livestock and the most important factor in this regard is the condition of the grass sward in the rangelands occurring in the different vegetation communities. Unfortunately for all practical purposes range management for livestock production is currently being virtually totally ignored by the Directorate of Forestry and the livestock section in the Ministry of Agriculture.

- It is recommended that a program be developed and implemented for monitoring the condition of the vegetation in the different plant communities as a practical means of implementing IFFM in the future. The techniques that have been developed for assessing range condition can be used as the basis for such a monitoring program together with appropriate methods used in the current forest inventory program. However, it is also recommended that a simplified technique based on the identification key grass species be developed for assessing and monitoring the condition of the grass sward. This has proven to be extremely successful in the implementation of a program for monitoring range condition in the Kruger National Park which is 1.9 million hectares in extent. It is neither appropriate nor practical to go into the details of such a monitoring program and suffice it to say that monitoring should be an integral part of a management program like IFFM.

- It is not possible to make detailed recommendations on the possible adjustment and improvement of the present IFFM model for expansion to other regions in northern Namibia in view of not having visited these areas and become familiar with their individual physiographic characteristics. However, it is believed that if the currently recommended modifications are made to the IFFM model being used in East Caprivi they will assist in making the model generally applicable anywhere in northern Namibia.

PYRO-TECHNICAL MODIFICATIONS NEEDED FOR THE POTENTIALLY IMPROVED MODEL

The field visit to east Caprivi and a review of the provided literature led to the following conclusions and recommendations.

- No adaptations need to be made to the physical construction of the cutlines as generally in all the areas that were visited the cutlines had been efficiently constructed. The one exception to this was the cutline in the State Forest located on the border with Zambia. The physical dimensions of the cutlines (10-15 m wide) are such that they would be effective in controlling wildfires in the form of backfires burning against the wind and low to moderately intense head fires burning with the wind. They would not be able to contain high intensity head fires but would provide ideal conditions for setting precautionary backfires as a means of stopping rapidly advancing intense wildfires. The contract workers constructing the cutlines were equipped with appropriate clothing and field tools to be able to execute their duties effectively and efficiently.

- Assuming that controlled burning will become part of the field operations of IFFM then a highly necessary modification that will be necessary in the IFFM model will be the training of field staff in the safe application of controlled burning. It is therefore strongly recommended that key personnel receive training in practical fire ecology and fire management. Such courses are presented at the Southern African Wildlife College in South Africa depending upon demand but an even more viable alternative would be to have such a course presented on site in East Caprivi

RECOMMENDATIONS FOR PRESCRIBED BURNING SCHEDULES FOR DIFFERENT LAND-USE CATEGORIES

The main types of land-use in East Caprivi relevant to prescribed burning are:

- Livestock farming (cattle) in the Communal Lands, Sachinga Cattle Breeding Station and the Quarantine Farm;
- Nature conservation in the two National Parks and emerging community wildlife conservancies in the Communal Lands;
- Forestry in the State Forest;
- Production of thatching material in the Communal Lands.

The use of fire in the construction and preparation of crop lands is not included in this list because it is a "once off" type of operation that is not practised on a continuous basis on the same area and will therefore not be considered. The use of fire for other activities like hunting and robbing of bees will also not be considered as they are peripheral activities to the main forms of land-use that have been listed.

In formulating a prescribed burning program the most important factors to consider are the reasons for burning and the appropriate fire regime to be applied. This will be done with respect to the aforementioned different types of land-use.

LIVESTOCK FARMING

Reasons For Burning

The permissible reasons for burning rangeland for livestock farming are:

- to remove moribund and/or unacceptable grass material;
- to control and/or prevent the encroachment of undesirable plants (Trollope, 1989).

An often quoted reason for burning rangeland is to stimulate an out of season *green bite*. This is often done during late autumn or late winter to provide green grazing for livestock. This practice is completely unacceptable for the following reasons:

- it reduces the vigour of the grass sward;
- it reduces the canopy and basal cover of the grass sward;
- it increases the runoff of rain water;
- it can result in increased soil erosion (Trollope, 1989).

In order to decide objectively whether controlled burning needs to be applied or not, the condition of the rangeland needs to be assessed using the grass survey technique presented in Table 2 together with a survey with the *Disc Pasture Meter* to determine the standing crop of grass. If, as mentioned earlier, the grass sward is dominated by either Decreaser or Increaser I grass species and the standing crop of grass exceeds 4000 kg/ha then it is in a moribund condition and needs to be burnt. If the condition of the grass sward does not fulfill these requirements then controlled burning is not necessary.

Burning to remove old moribund and/or unacceptable grass material is applicable to all the different vegetation communities in East Caprivi but is of particular relevance to the Zambezi Floodplains which are subjected to frequent flooding.

In the context of East Caprivi burning to control and/or prevent the encroachment of undesirable plants refers to controlling or preventing bush encroachment. This problem is especially applicable to the Kalahari Woodlands where the Sachinga Cattle Breeding Station is a good example of what can happen with bush encroachment if controlled burning is not applied timeously. Unfortunately quantitative criteria are not available for East Caprivi to decide objectively at what stage burning needs to be considered to prevent bush encroachment. The preliminary results obtained in East Caprivi during the technical review suggest that if the phytomass of bush exceeds 1200 tree equivalents per hectare then bush encroachment is becoming a problem and controlled burning needs to be applied for this reason. It is therefore recommended that this criteria be used at this stage and modified using adaptive management if necessary. There is also a potential for bush encroachment occurring in the Mopane Woodlands, but less than in the Kalahari Woodlands because of lower rainfall. As mentioned earlier *Colophospermum mopane* and *Terminalia sericea* are potential encroaches in this vegetation community.

Fire Regime

The fire regime to be used in controlled burning refers to the type and intensity of fire and the season and frequency of burning.

i) Type of fire

There are three broad types of fires based on the layers in which the vegetation burns, viz., ground, surface and crown fires (Brown and Davis, 1973; Luke and McArthur, 1978):

- a *ground fire* is a fire that burns below the surface of the ground in deep layers of organic material (Brown and Davis, 1973; Luke and McArthur, 1978) and plant debris;
- a *surface fire* is a fire that burns in the herbaceous surface vegetation (Brown and Davis, 1973; Luke and McArthur, 1978). Besides the afore-mentioned types of fires, a further subdivision can be made into fires burning with and against the wind. Trollope (1978) referred to these as *head* and *back fires* respectively;
- *crown fires* occur only as head fires and burn the fine fuels in the crowns of trees and shrubs.

Ground fires do occur in East Caprivi particularly in the Chobe, Linyanti and Kwando Floodplains where ground fires develop in the deep layers of organic peat material that characterise the swampy areas. However, surface fires are the most common type of fire and in tree and shrub vegetation can develop into crown fires when the foliage ignites and carries the fire above the surface of the ground. In savanna communities crown fires only develop when the tree foliage is very dry and atmospheric conditions are characterised by high winds, high air temperatures and low relative humidities.

It is recommended that head fires be used in controlled burning because they cause least damage to the grass sward but can cause maximum damage to woody vegetation if necessary (Trollope, 1989). This can be achieved by applying controlled fires as block burns where the area to be burnt has a fire break around the perimeter. The block is then ignited around the perimeter, firstly against the wind on the leeward side for safety reasons, then along the windward side to ensure that the majority of the area is burnt as a head fire.

ii) Fire Intensity

Research on fire behaviour in the Eastern Cape and Kruger National Park has shown that fire can be classified into the following categories according to fire intensity (Trollope, 1983; Trollope and Potgieter, 1985).

FIRE INTENSITY kJ/s/m	DESCRIPTION
<500	Very cool
501 - 1000	Cool
1001 - 2000	Moderately hot
2001 - 3000	Hot
> 3000	Extremely hot

When burning to remove moribund and/or unacceptable grass material a cool or low intensity fire of < 1000 kJ/s/m is recommended. This can be achieved by burning when the air temperature is < 20°C and the relative humidity > 40%. These conditions occur in the late afternoon and evening and it is recommended that controlled burning be preferably applied at this time, if possible, because fires burning into the night are easier to control.

When burning to control undesirable plants like encroaching bush, a high intensity fire of > 2000 kJ/s/m is necessary. This can be achieved when the grass fuel load is > 4000 kg/ha, the air temperature is 25 - 30°C and the relative humidity < 30%. This will cause a significant topkill of stems and branches of bush species up to a height of 3 m. In all cases the wind speed should not exceed 20 km/h. Great care should be taken when applying these control burns because they have to be applied under extreme atmospheric conditions which are dangerous.

iii) Season of burning

Research in South Africa has shown that the least damage is caused to the grass sward if burning is applied when the grass is dormant (Tainton, *et al*, 1977; Trollope, 1989). Therefore it is recommended in East Caprivi that burning both to remove moribund and/or unacceptable grass material and to control encroaching plants burning should be applied during the latter half of the dry season (August/September) before it becomes too hot. Delaying burning to the late dry season also reduces the risk of running out of grazing in the latter half of the dry season. A decision not to burn can still be made at this stage if it becomes clear that there is a shortage in the amount of grazing available before the spring growing period commences.

iv) Frequency of burning

When burning to remove moribund and/or unacceptable grass material the frequency of burning will depend upon the accumulation rate of excess grass litter (Trollope, 1989). Field experience indicates that this should not exceed 4000 kg/ha and therefore the frequency of burning should be based on the rate at which this phytomass of grass material accumulates. This approach has the advantage that the frequency of burning is related to the stocking rate of grazers and to the amount of rainfall the area receives.

The frequency of burning can not be prescribed when using fire to control bush encroachment because it will depend upon the particular circumstances existing in the affected area.

Range Management After Burning

In order to minimise the problem of excessively heavy, continuous grazing after an area is burnt in Communal Land where there are no fences, care must be taken not to burn small areas at any one time. Relatively large areas ($\geq$ 200 ha) should be burnt to minimise this problem. Conversely, this is not a problem in the Sachinga Cattle Breeding Station and the Quarantine Farm which are fenced into camps. It is recommended that in these situations burnt camps should not be grazed for longer than two weeks at a time during the first growing season after the burn.

NATURE CONSERVATION

Reasons For Burning

The permissible reasons for burning rangeland in nature conservation areas are:

- to remove moribund and/or unacceptable grass material;
- to control and/or prevent the encroachment of undesirable plants (Trollope, 1989).
- to encourage wildlife to move to less preferred areas in order to minimise the overgrazing of preferred areas. Such burns are normally co-ordinated with the two preceding reasons if possible.

Fire Regime

i) Type of Fire

In order to maximise structural diversity and therefore habitat diversity in the vegetation, fires are preferably ignited as point ignitions in wildlife areas. This results in the area being burnt by a mosaic of head and backfires thereby promoting structural diversity in the vegetation to the benefit of different types of wildlife having different habitat requirements.

ii) Fire Intensity

The same guidelines as for livestock farming apply in wildlife areas.

iii) Season of Burning

It is also recommended in wildlife areas that burning be applied when the grass is dormant during the dry season. However, in this case the burning window is extended to include the entire dry season from early winter to late winter/ spring as a strategy to maximise habitat diversity and different types of wildlife.

iv) Frequency of Burning

The same guidelines as for livestock farming apply in wildlife areas.

Range Management After Burning

In order to minimise the problem of excessively heavy, continuous grazing occurring after burning care must be taken not to burn small areas at any one time. Relatively large areas ($\geq$ 200 ha) should be burnt at any one time.

FORESTRY (STATE FOREST)

Reasons For Burning

The primary reason for controlled burning in the State Forest will be to reduce fuel loads in order to reduce fire intensity thereby reducing the negative effect of fires on the recruitment and development of valuable timber species like *Baikiaea plurijuga* (Teak) and *Pterocarpus angolensis* (Kiaat).

Fire Regime

i) Type of Fire

It is recommended that point ignitions be used in the State Forest to allow the development of a mosaic of head and backfires thereby promoting structural diversity in the tree and shrub vegetation.

ii) Fire Intensity

In order to promote the development of valuable tree timber species it is recommended that only cool fires (< 1000 kJ/s/m) be applied by burning whenever the grass fuel load accumulates to $\pm$ 3000 kg/ha and when the air temperature is < 20°C, the relative humidity > 40% and the wind speed less than 20 km/h. These conditions occur in the late afternoon and evening and it is recommended that controlled burning be applied at this time and on into the night so as to ensure the application of low intensity fires.

iii) Season of Burning

It is also recommended that burning be applied when the grass is dormant during the dry season in order to minimise damage to the herbaceous grass layer. The burning window can also be extended to include the entire dry season from early winter to late winter/spring so as to increase the opportunities for applying cool controlled burns under mild atmospheric conditions.

iv) Frequency of Burning

The frequency of burning will be determined by the period it takes for a grass fuel load of ± 3000 kg/ha to accumulate. This rate of accumulation can also be reduced by encouraging grazing by cattle and wildlife where practicable.

Range Management After Burning

While realising that grazing is not a major factor in the State Forest care must also be taken to minimise the problem of excessively heavy continuous grazing occurring after burning. Therefore relatively large areas (≥ 200 ha) should be burnt during the application of controlled burns.

PRODUCTION OF THATCHING MATERIAL

Reasons For Burning

The primary reason for controlled burning is to remove old dead thatching material that has accumulated after harvesting so as to ensure the production of new high quality material.

Fire Regime

i) Type of Fire

It is recommended that the thatch areas be burnt with the wind as head fires so as to ensure a clean burn and minimise damage to the grass plants.

ii) Fire Intensity

It is recommended that cool fires be applied by burning in the late afternoon when the air temperature is < 20°C and the relative humidity > 40% and the wind speed less than 20 km/h.

iii) Season of Burning

It is recommended that burning only be applied when the grass is dormant during the dry season so as to minimise damage to the herbaceous grass layer. This will normally occur in the late winter after the thatching material has been harvested.

iv) Frequency of Burning

The frequency of burning will be determined by the period it takes for a grass fuel load of ≥ 4000 kg/ha to accumulate. However, burning of thatching areas must not be more frequent than once every two years (biennial) so as to maintain the density and vigour of the grass sward.

OUTLINE SECTIONS ON FOREST FIRE CONTROL TO BE INCLUDED IN THE NATIONAL FIRE POLICY OF NAMIBIA

After consulting with Dr Kojwang, the Director of Forestry, on the precise requirements for this term of reference it was decided by him to omit this point.

ACKNOWLEDGEMENTS

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APPENDICES

Appendix 1: List of persons interviewed during the technical review of the *Integrated Fire Management* component of the *Namibia-Finland Forestry Programme* in East Caprivi, Namibia.

PERSON	WHERE INTERVIEWED	AGENCY
Kojwang Dr H.	Windhoek	Director, Directorate of Forestry (DoF), MET, Windhoek
Jurvélius M.	Windhoek	Forest Fire Control Specialist, Namibia-Finland Forestry Program, Katima Mulilo
Seppanen H.	Windhoek	Consultant Team Leader, Namibia-Finland Forestry Program, Windhoek
Chakanga M.	Windhoek	National Program Co-ordinator, DoF, MET, Windhoek
Hailwa J.	Windhoek	Chief Forester, DoF, MET, Windhoek
Bainga F.	Caprivi	District Forest Officer, Directorate of Forestry, Katima Mulilo
Diggle R.	Caprivi	Integrated Rural Development & Nature Conservation (NGO), Katima Mulilo
Chilinda A.	Caprivi	Chief Animal Health Inspector, Veterinary Services, MAWRD, Katima Mulilo
Flexmore R.	Caprivi	Retired manager of saw-mill, Katima Mulilo
Jacobsohn Dr M.	Caprivi	Director, Integrated Rural Development & Nature Conservation (NGO), Katima Mulilo
Hines C.	Caprivi	Plant-ecologist/ consultant, Windhoek
Kambinda M.	Caprivi	Chief Officer, Directorate of Extension and Information Services, MAWRD, Katima Mulilo
Kamwi A,	Caprivi	Fire extensionist, Integrated Forest Fire Management Program, NFFP
Kawana J.	Caprivi	Fire extensionist, Namibia-Finland Forestry Program, Katima Mulilo
Kwenani R.	Caprivi	Vice-chairman Salambala Conservancy Management Committee, Ibbu
Libongani C.	Caprivi	Senior Foreman, Sachinga Cattle Breeding Station, Sachinga
Mandyaao O.	Caprivi	Fire extensionist, Integrated Forest Fire Management Program, NFFP
Matota J.	Caprivi	Resource monitor, IRDNC, Kongola
Chief Mayuni	Caprivi	Mashi Traditional Authority, Mashi
Mukwata L.	Caprivi	Environmental Awareness & Outreach, IRDNC, Kongola
Munyaza A.	Caprivi	Induna forestry, Masubia Tribal Authority, Bukalo
Musiyalela A.	Caprivi	Director Caprivi Community Theatre Group, Katima Mulilo
Mutwa, George	Caprivi	Councillor, Bukalo Khuta, Bukalo
Owen-Smith G.	Caprivi	Director, IRDNC, Katima Mulilo
Rosset K.	Caprivi	Facilitator Natural Resource Monitors, IRDNC, Katima Mulilo
Scheepers L.	Caprivi	Conservation Scientist, Directorate of Resource Management, MET
Sikabongo D.	Caprivi	Fire Chief, Integrated Forest Fire Management, Katima Mulilo
Sikopo A.	Caprivi	Northern Livestock Development Program, Katima Mulilo
Sinyambo R.	Caprivi	Vice-secretary Salambala Conservancy Management Committee
Mayes S.	Caprivi	IRDNC, Susuwe, West Caprivi
Symons A.	Caprivi	IRDNC, Susuwe, West Caprivi
Thompson, R.	Caprivi	River Transport Services, Katima Mulilo
Trigg S.	Caprivi	Remote Sensing & GIS Specialist, Oshakati, Namibia
Viitanen J.	Caprivi	Environmental Forestry Specialist, Namibia-Finland Forestry Program

Appendix 2: Itinerary for the technical review of the *Integrated Fire Management* component of the *Namibia-Finland Forestry Programme* in East Caprivi, Namibia during the period 1st - 30th JULY, 1999.

DATE	DAY	ACTIVITIES
1st	THURSDAY	Orientation & discussions - Windhoek.
2nd	FRIDAY	Orientation & discussions - Windhoek.
3rd	SATURDAY	
4th	SUNDAY	Departed Windhoek for Caprivi.
5th	MONDAY	Discussions and planning activities - District Forest Office, Katima Mulilo.
6th	TUESDAY	Visited State Forest and forested area in the Liselo Community.
7th	WEDNESDAY	Visited Bukalo Khuta and Lake Liambesi in the Muyako Community.
8th	THURSDAY	Visited Integrated Rural Development Nature Conservation (IRDNC) headquarters in Katima Mulilo.
9th	FRIDAY	Visited Salambala Wildlife Conservancy and Chobe floodplains in the Ibbu community. Discussed burning of thatch grass with Induna James.
10th	SATURDAY	
11th	SUNDAY	
12th	MONDAY	Inspected cutlines in the Mubiza Community and visited the Zambezi floodplains with Mr R. Thompson and Mr R. Flexmore.
13th	TUESDAY	Inspected cutlines in the Masokotwani Community.
14th	WEDNESDAY	Inspected cutlines in the Sachona Community.
15th	THURSDAY	Visited the Mamili National Park and inspected the peat fires in the Linyanti floodplain in the Malengalenga Community. Had discussions over supper with IRDNC and Chief Mayuni at Kabuyana Camp site.
16th	FRIDAY	Attended IRDNC meeting involving applications for community wildlife conservancies and conducted discussions on controlled burning of thatch grass.
17th	SATURDAY	
18th	SUNDAY	
19th	MONDAY	Conducted vegetation surveys in the State Forest near Katima Mulilo.
20th	TUESDAY	Held discussions with Evelien Kamminga on review process and attended open air theatre display of public awareness campaign at Katima Mulilo.
21st	WEDNESDAY	Conducted vegetation surveys on the Sachinga Livestock Breeding Station.
22nd	THURSDAY	Conducted vegetation surveys on the western cutline of the State Forest in the Kongola area.
23rd	FRIDAY	Inspected vegetation sites in the State Forest near Katima Mulilo with Mr Chris Hines and discussed the fire ecology of the Caprivi region.
24th	SATURDAY	Conducted vegetation surveys on the Sachinga Livestock Breeding Station.
25th	SUNDAY	Participated in a botanising expedition to the Zambezi floodplains.
26th	MONDAY	Conducted vegetation surveys in the State Forest at Katima Mulilo and held discussions with Mr Simon Trigg on satellite monitoring of fire scars in the Caprivi region.
27th	TUESDAY	Held a preliminary report back meeting with Dr Kojwang at Katima Mulilo and conducted vegetation surveys on satellite monitoring sites at Kongola with Mr Simon Trigg.
28th	WEDNESDAY	Estimated forage, fuel and thatch factors for different grass species in Caprivi with Mr Chris Hines and flew to Windhoek for final discussions.
29th	THURSDAY	Held discussions with Dr Kojwang in Windhoek and was interviewed on NBC radio about the Integrated Fire Management programme.
30th	FRIDAY	Returned to South Africa.