Floristic characteristics of riparian pan vegetation from the ndumo game reserve, South Africa

Article *in* Journal of Animal and Plant Sciences · April 2016

CITATION
1

READS
114

3 authors:

Madel Whittington
Tshwane University of Technology
3 PUBLICATIONS **19** CITATIONS
SEE PROFILE

Michael David Panagos
Tshwane University of Technology
35 PUBLICATIONS **148** CITATIONS
SEE PROFILE

Gerard Malan
Tshwane University of Technology
53 PUBLICATIONS **329** CITATIONS
SEE PROFILE

The Journal of Animal & Plant Sciences, 26(2): 2016, Page: 445-456
ISSN: 1018-7081

FLORISTIC CHARACTERISTICS OF RIPARIAN PAN VEGETATION FROM THE NDUMO GAME RESERVE, SOUTH AFRICA

M. Whittington[1], M.D. Panagos[*] and G. Malan

Department of Nature Conservation, Tshwane University of Technology, PB X680, Pretoria 0001, South Africa
[1]Present address: Ai Ai's Richtersveld Transfrontier Park, PO Box 406, Alexander Bay, 8290, South Africa
[*]Corresponding author email: panagosmd@tut.ac.za

ABSTRACT

The aim of this study was to identify habitat types according to plant communities that surround the Banzi, Shokwe and Nyamithi pans located in the Ndumo Game Reserve. This hydrophytic vegetation thrives on stream and riverbanks, and thus plays a direct role in the functioning of both river systems and the flanking terrestrial landscape. Banzi, Shokwe and Nyamithi pans were classified into two different wetland systems. Banzi and Shokwe pan as a Riverine system and Nyamithi Pan as a Lacustrine system. Around the pans, 14 sampling sites were positioned and 34 quadrats or belts were sampled within these sites. Eighty-six plant species were identified around the three pans, where the dominant growth form was mostly trees. The four floristic units obtained via a classifications process were conformed into three habitat types, the Mudflat, Beach and Reedbed (MBR) Habitat Type, Riparian Forest Habitat Type and the Fringe Terrestrial Habitat Type. Due to their uniqueness, the pans add value to the Reserve and thus need to be conserved and monitored. This study provided a baseline data set by which future changes in the specific floristic characteristics (species composition, structure, cover and density) of the riparian vegetation surrounding the pans can be monitored.

Key words: Ndumo Game Reserve, pan, riverine, lacustrine, floristics, riparian, wetland.

INTRODUCTION

Riparian wetlands, deltas and estuaries are normally seen as highly productive systems that harbour a high number of plant species (Nilsson and Berggren, 2000). Riparian vegetation is an ubiquitous feature of riverine landscapes that provides habitat and food sources, as well as some degree of erosion control (Darby, 1999). The vegetation also promotes geomorphic stability by means of increased flow resistance, increases the strength of bank materials via e.g. buttressing, and reduces soil moisture content through enhanced evapotranspiration and reduced infiltration (Darby, 1999). These ecosystems thus warrant special attention since their positioning in the landscape ensures that they play a direct role in the functioning of both river systems and the terrestrial landscape and are one of the major centres of biodiversity in the global context (Rogers, 1995).

Riparian ecosystems have been defined simply as the corridor of hydrophytic vegetation growing on the banks of streams and rivers and having an annual evapotranspiration level that influences surface and groundwater hydrology (Wissmar and Beschta, 1998). Such a definition though, overlooks the important edaphic and other influences of nearby terrestrial vegetation, such as shade and microclimate, plant species invasions, litter-fall, large woody debris recruitment and nutrient cycling (Wissmar and Beschta, 1998). The fringes of rivers or streams, better defined as riparian zones, are also the interface between aquatic and terrestrial ecosystems (Richardson, *et al.* 2006). These zones belong to the most diverse, productive and dynamic systems in the world (Nilsson and Berggren, 2000). The vegetation types in riparian zones are determined by the regional climate, the regional pool of species, and the hydrological, geo-morphological, and the disturbance regime (Richardson, *et al.* 2006). Rivers and streams are dynamic, non-equilibrium ecosystems subject to frequent disturbance events that have a strong influence on the biotic characteristics of riparian assemblages. The fluvial erosion-deposition process creates a new habitat for plant colonization, while the hydrology influences the vegetation through floods, drought and water table fluctuations (Richardson, *et al.* 2006). Therefore, change happens continuously.

Extensive historical and on-going modification of riparian corridors and floodplains for flood management, water diversion, land reclamation, commerce and other developments are leading to losses in the natural physical and biological integrity in river catchments. These modifications often fragment riparian corridors and lead to losses in complexity and connectivity between the riparian channel and floodplain habitats to which aquatic communities are adapted (Wissmar and Beschta, 1998).

Ndumo Game Reserve is appreciably richer in species if compared to other protected areas in South Africa, and is a RAMSAR site due to its unique wetlands and biological diversity (Naguran, 2002). The riverine or fringing forest found within the Reserve plays an

important role in the stabilisation of stream banks, the creation of protected breeding areas for fish, birds and other animals and helps in the weakening of devastating floods (Naguran, 2002). Finally, the wetlands of Ndumo Game Reserve function as a reservoir and a nursery for fish on which the rest of the Pongola and Rio Maputo (in Mozambique) wetland system depends on for restocking (Naguran, 2002).

The aim of this study was to identify habitat types according to plant communities, which would be sampled and classified. This has not been done before on the riparian vegetation due to its variability. To do so will enable one to monitor future changes in riparian vegetation and therefore manage this vegetation type accordingly.

MATERIALS AND METHODS

Study area: Ndumo Game Reserve (26°53' S; 32°18' E) is situated in north-eastern Zululand, east of the Lebombo Mountains and north of Jozini. It is 10 117 ha in extent and approximately 70 km from the KwaZulu-Natal north coast. Natal Parks Board proclaimed the Reserve in 1924 (Anon, 1993), primarily as a Hippopotami (*Hippopotamus amphibious*) sanctuary. RAMSAR status was awarded in 1997, as a Wetland of International Importance (Anon, 1993; http://www.ramsar.org).

Classification of pans: Dini, *et al.* (1998) used a classification system for Wetlands that consists of six different categories: Estuarine, Riverine, Lacustrine, Palustrine and Endorheic. This system was used to classify the three major pans in Ndumo Game Reserve (NGR).

Sampling sites and vegetation analysis: Aerial photographs of each pan (1:10 000) were used to stratify the different habitat types that are found around each pan. Dia-positives of these images were obtained from the Department of Land Affairs in Cape Town. Negatives were made from the Dia-positives and prints were obtained, which were scanned at a resolution of 300 dots per inch (dpi), and saved in a jpeg image format. The images were then imported into ArcGIS (ESRI, 2008) for further analysis.

The most recent aerial photos (2002) were employed for the stratification of the habitat units around the pans. A set of three images (one for each pan) were printed on an A3 sheet of paper (1:10 000) and the hardcopies were used subjectively to stratify the different habitats that occur around the pans by visual differentiation of greyscales and texture. Habitat units were subjectively and visually selected in the field around each pan along an elevational gradient from the water's edge moving higher up and away from the water.

The vegetation survey of the habitats was carried out in June 2008. The reason for conducting the survey in winter was that water levels are low and habitat types proximal to the water's edge were accessible and visible. Fourteen sampling sites were subjectively positioned around the three pans. Within each of these sites, each habitat type was sampled using a 200 m² sampling unit; either a 10 m x 20 m quadrat or a 2 m x 100 m belt transect. Belt transects were used in the narrower (MBR) habitat types and in the broader (Riparian Forest and Fringe Terrestrial) a standard 10 m x 20 m quadrat was employed.

A total of 34 quadrats or belts were surveyed. At Banzi Pan, four belt transects were sampled in the MBR Habitat Type, four in the Riparian Forest Habitat Type and two quadrats in the Fringe Terrestrial Habitat Type. At Shokwe Pan, five belt transects were sampled in the MBR Habitat Type, four quadrats in the Riparian Forest Habitat Type and none in the Fringe Terrestrial Habitat Type. At Nyamithi Pan, eight belt transects were sampled in the MBR Habitat Type, three quadrats in the Riparian Forest Habitat Type and four quadrats in the Fringe Terrestrial Habitat Type.

The following floristic parameters were recorded within each of the 34 quadrats/belt transects: (1) all plant taxa, identifiable at the time of sampling, rooted in the stand, (2) a growth form (tree, shrub, dwarf shrub, grass and forb) was assigned to each species recorded following Westfall (1992), (3) the mean canopy diameter for each species recorded, and (4) the projected canopy cover for each species recorded, using the Plant-Number Scale technique of Westfall and Panagos (1988).

All of these floristic parameters were used in the PHYTOTAB-PC programme to classify the sampled vegetation into plant communities (Westfall, 1992; Westfall *et al*., 1996).

RESULTS

Pan classification: Banzi and Shokwe pans were classified as a Riverine system. Banzi Pan (Fig. 1) has an inflow and an outflow from the Usuthu River. Shokwe Pan (Fig. 2) also receives water from the Usuthu River but only when in flood. Nyamithi Pan (Fig. 3) was classified as a Lacustrine system. This pan is directly affected by the Pongola river system.

Habitats: Habitat names delineated were the Mudflat, Beach and Reedbed Habitat Type (MBR), Riparian Forest Habitat Type (RF) and Fringe Terrestrial Habitat Type (FT).

Description of the habitat types of the three different pans: A total of 86 plant species were recorded in the 34 sampling units placed around all three pans on NGR. The initial classification of the vegetation around all three pans, by and large indicated a floristic relationship

with three main habitat types, namely a MBR Habitat (Habitat Type 1), a RF Habitat (Habitat Types 2 and 4 – see below) and a FT Habitat (Habitat Type 3). The RF Habitat could be subdivided into habitats dominated by *Trichilia emetica/Ficus sycomorus* (at Shokwe Pan) and *Vachellia xanthophloea/Cynodon dactylon* (at Nyamithi and Banzi pans). However, floristic variations within the MBR Habitat Type and the other two Habitat Types were evident and this confused the classification. Subsequently it was decided to provide a classification for each pan to clarify the relationship between the habitats identified using the floristic classification as a guideline. It is realized that by taking this approach, two of the three pans (Banzi with only 12 sampling units and Shokwe with only nine sampling units) have been under-sampled. Nevertheless, the floristic delineation of the habitats around the three pans is clearer than would have been the case using the overall classification as described above.

Each pan on NGR and their associated habitat types is depicted using a phytosociological table (Tables 1, 6 and 9). Thereafter, each Habitat Type occurring at that pan is briefly described using quantitative data drawn from the data collected.

Banzi Pan: The floristic association with habitat types for Banzi Pan produced a classification (Table 1) comprising 37 plant species found in three Habitat Types. Only the main two Habitat Types are described due to the third being a combination of the two (non-diagnostic).

Phragmites mauritianus-Ficus capreifolia **MBR Habitat Type 1:** Species group *a* (Table 1) is diagnostic and characteristic for this Habitat Type. The dominant species (in terms of cover and frequency) included *Phragmites mauritianus, Helitrophium sp., Ficus capreifolia, Phragmites australis, Solanum seaforthianum, Schoenoplectus littoralis, Solanum incanum, Cyperus fastigiatus, Flaveria bidentis* and *Euphorbia prostrata* (Table 2). The total cover for Habitat Type 1 was high at 98% (Table 3). The cover percentages were divided as follows: Forbs 28.8 %, Grass 63.4 % and Shrubs 7.53 %.

Ficus sycomorus-Cynodon dactylon **RF Habitat Type 2:** Species group *b*'s diagnostic and characteristic species are *Cynodon dactylon* and *Ficus sycomorus* (Table 1). In terms of cover and frequency the dominant species for this habitat type include, *Vachellia xanthophloea, Ficus sycomorus, Rauvolfia caffra, Dactyloctenium australe, Evolvulus nummularius, Helitrophium* sp., *Cissus rotundifolia* var. *rotundifolia, Dovyalis caffra* and *Euphorbia prostrata*. The total cover for this habitat type is a moderate 62.85% (Tables 4 and 5). Tree cover was high at 78 %, Forbs at 11.35 %, Grass 7.94 % and Shrubs and Dwarf Shrubs were both 1 %.

Shokwe Pan: The floristic association with habitat types for Shokwe Pan produced a classification (Table 6) comprising 25 plant species found in two distinct Habitat Types (Habitat Types 1 and 4) with one anomalous sampling unit (number 20) classified as a FT but in fact is a grassed floodplain occurring on the western edge of Shokwe Pan and as such constitutes an outlier in this classification.

Phragmites mauritianus-Ficus capreifolia **MBR Habitat Type 1:** In Species group *a*, the dominant species that occur in Habitat Type 1 are *Cyperus fastigiatus, Phragmites mauritianus, Ageratum houstonianum, Euphorbia prostrata* and *Helitrophium* sp. The total cover for this habitat type is 59.74% (Tables 2 and 3). Grass cover was high cover at 70.43 %, Forbs at 28.72 % and Trees a low 0.85 %.

Ficus sycomorus-Trichilia emetica **RF Habitat Type 4:** In Species group *b* (Table 6), the dominant and characteristic species for this habitat type are *Ficus sycomorus, Trichilia emetica, T. dregeana, Tabernaemontana elegans* and *Gardenia cornuta* (Tables 7 and 8). The total cover for this habitat type is high at 84.18 %. Trees provided 99.1 % of the cover, Forbs 0.51 %, Shrubs 0.27 % and Dwarf Shrubs 0.12 %.

Nyamithi Pan: The floristic association with habitat types for Nyamithi Pan produced a classification (Table 9) comprising 62 plant species found in two distinct Habitat Types 1 and 3.

Phragmites australis-Cynodon dactylon **MBR Habitat Type 1:** In Species group *a* (Table 9) the diagnostic, characteristic and dominant species are *Cynodon dactylon* and *Phragmites australis* (Tables 2 and 3). Other dominant species were *Vachellia robusta* subsp. *robusta, V. xanthophloea, Sporobolus africanus, Schoenoplectus littoralis, Hemarthria altissima* and *Evolvulus nummularius*. The total cover for this habitat type is a moderate 37.8 %. Grass was at a high of 64.53 %, Trees at 28.66 %, Forbs at 6.56 % and Shrubs at 0.24 %.

Dactyloctenium australe-Vachellia ataxacantha **FT Habitat Type 3:** In Species group *b* (Table 9) the diagnostic, characteristic and dominant species are *Dactyloctenium australe, Senegalia ataxacantha, S. nigrescens, Vachellia xanthophloea, Albizia petersiana* subsp. *evansii, Gardenia cornuta, Spirostachys africana, Euclea schimperi* var.*schimperi, E. divinorum, Gymnosporia mossambicensis, G. buxifolia, Azima tetracantha, Euphorbia grandicornis* subsp. *grandicornis,* and *Solanum seaforthianum*. The total cover for this habitat type is a moderate 53.3 % (Tables 10 and 11).Shrubs were at a high of 54.93 %, Trees at 23.07 %, Grass at 9.13 %, Forbs at 7.85 % and Dwarf Shrubs at 5 %.

1**Figure 1: Banzi Pan is classified as a Riverine system. "A" indicates the inlet and "B" the outlet**

Figure 2: Shokwe Pan is classified as a Riverine system

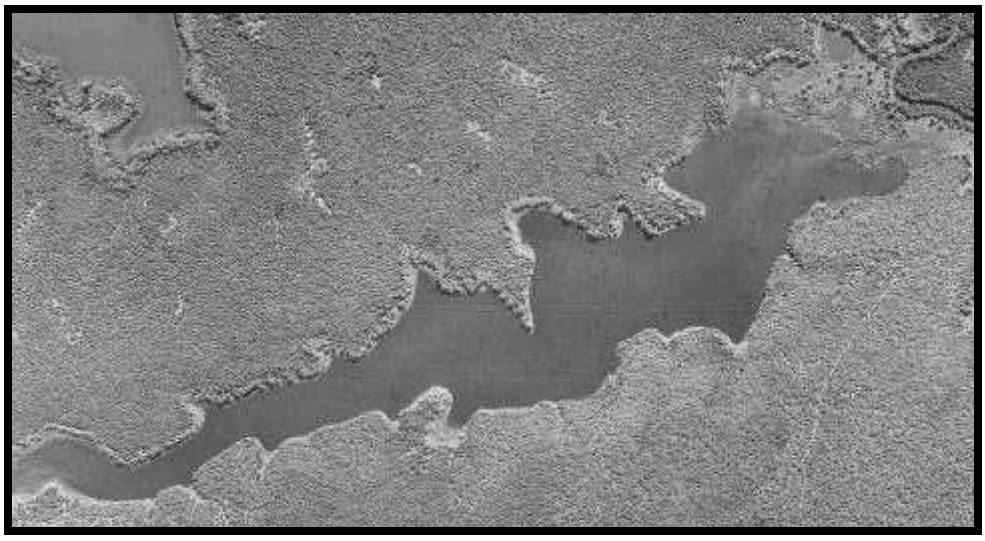

Figure 3: Nyamithi Pan is classified as a Lacustrine system

Table 1. The floristic associations with habitat types at Banzi Pan

Habitat type	1	2	3
	2233	2233	23
Sampling unit	5803	6914	72
Species group a – *Phragmites mauritianus* – *Ficus capreifolia* MBR Habitat Type 1			
Cyperus fastigiatus	3424		
Phragmites mauritianus	NNNN		
Flaveria bidentis	62	+	
Gomphocarpus fruticosus	2 2		
Ficus capreifolia	8F		
Schoenoplectus littoralis	84		
Species group b – *Ficus sycomorus* – *Cynodon dactylon* Riparian Forest Habitat Type 2			
Evolvulus nummularius	1	212A	6
Ficus sycomorus	1	M+42	
Cynodon dactylon	1 2+		
Euclea divinorum		1+	F
Gardenia cornuta		33	
Azima tetracantha		++	C
Manilkara mochisia		++	
Pappea capensis		1+	
Sporobolus africanus		52	
Oxalis sp.	2	2 2	
Species group c – Species common to Habitat Type 1 and 2			
Helitrophium sp.	ADJC	366	
Solanum seaforthianum	E34	1621	3
Euphorbia prostrata	2 4	+34	
Species group d – Species common to Habitat Types 2 and 3			
Dovyalis caffra	5	B1	
Cissus rotundifolia var. rotundifolia	3	+A	
Gymnosporia buxifolia	+3+	C7	
Gymnosporia mossambicensis	131	45	
Dactyloctenium australe	C2	72	
Euclea schimperi var schimperi	++	2D	
Species group e - Species non-diagnostic that is common and rare			
Vachellia xanthophloea	31+	FNKC	LF
Senna italica subsp. arachnoides	+ +		
Ageratum houstonianum	2	3	
Eragrostis heteromera	1	4	
Vachellia ataxacantha	2	K	
Rhus gueinzii		+	
Eteropogon monostachys	1		
Croton menyharthii	1		
Solanum incanum	7		
Phragmites australis	F		
Grewia flavescens	3		
Rauvolfia caffra	C		

Table 2. Species cover relations in Habitat Type 1 (only species that has a mean cover of 1 % or more) for Banzi, Shokwe and Nyamithi pans

Species names	Growth form	Comp Status	Canopy cover (%)	Crown Diameter (m)	Individual Per ha	Canopy to canopy gap (m)
Banzi Pan						
Phragmites mauritianus	Grass	Strong	53.31	0.457	32 500	0.169
Cyperus fastigiatus	Grass	Weak	1.13	0.457	690	3.837
Helitrophium sp.	Forb	Strong	19.5	0.272	33 497	0.344
Evolvulus nummularius	Forb	Normal	0.03	0.067	709	4.17
Solanum seaforthianum	Forb	Normal	5.34	1.335	381	4.442
Shokwe Pan						
Euphorbia prostrata	Forb	Weak	1.41	0.042	101 772	0.312
Nyamithi Pan						
Sporobolus africanus	Grass	Weak	2	0.1	26581	0.6
Phragmites australis	Grass	Strong	4.88	0.17	21511	0.6
Evolvulus nummularius	Forb	Strong	1.17	0.08	26380	0.6

Table 3. Growth form relations in Habitat Type 1 for Banzi, Shokwe and Nyamithi pans

Growth form	% Canopy cover		Species Richness - Number of species
	Plant number scale	Proportional	
Banzi Pan			
Trees	0.28	0.29	3
Shrubs	7.38	7.53	2
Grasses	62.18	63.4	6
Forbs	28.24	28.79	9
TOTAL	98.08	100.01	20
Shokwe Pan			
Trees	0.5	0.85	3
Grasses	42.08	70.43	2
Forbs	17.16	28.72	4
TOTAL	59.74	100	9
Nyamithi Pan			
Trees	10.84	28.66	2
Shrubs	0.09	0.24	1
Dwarf Shrubs	0	0	2
Grass	24.4	64.53	7
Forbs	2.48	6.56	8
TOTAL	37.81	100	20

Table 4. Species cover relations in Habitat Type 2 (only species that has a mean cover of 1 % or more) for Banzi Pan

Species names	Growth form	Comp status	Canopy cover (%)	Crown diameter (m)	Individual per ha	Canopy to canopy gap (m)
Vachellia xanthophloea	Tree	Strong	32.7	7.418	75	5.553
Dactyloctenium australe	Grass	Strong	3.73	0.042	269 046	0.176
Helitrophium sp.	Forb	Strong	2.04	0.064	63 491	0.384
Evolvulus nummularius	Forb	Strong	2.75	0.058	102 127	0.295
Solanum seaforthianum	Forb	Weak	0.13	0.226	311	6.166

Table 5: Growth form relations in Habitat Type 2 for Banzi Pan

Growth form	% Canopy cover		Species Richness - Number of species
	Plant number scale	Proportional	
Trees	49.31	78.46	6
Shrubs	0.72	1.15	6
Dwarf Shrubs	0.69	1.09	8
Grasses	4.99	7.94	5
Forbs	7.13	11.35	8
TOTAL	62.84	99.99	33

Table 6: The floristic associations with habitat types at Shokwe Pan

Habitat type	1	4	3
	1122	1122	2
Sampling units	6813	7924	0
Species group a – *Phragmites mauritianus – Ficus capreifolia* MBR Habitat Type 1			
Helitrophium sp.	BB1J		
Phragmites mauritianus	NNGG		
Euphorbia prostrata	26 4		
Ageratum houstonianum	42	2	
Ficus capreifolia	3 1		
Species group b – *Ficus sycomorus – Trichilia emetica* Riparian Forest Habitat Type 2			
Ficus sycomorus	3	KNNK	
Trichilia emetica		FI5K	
Gardenia cornuta		+F	
Gymnosporia mossambicensis		+ 1	
Convolvulus sp.		14	
Species group c - Species non-diagnostic that is common and rare			
Vachellia xanthophloea	1 21	1	
Cyperus fastigiatus	A	B	
Cynodon dactylon		8	
Eriochloa meyeriana		F	
Gomphocarpus fruticosus		2	
Grewia monticola	2		
Dichrostachys cinerea subsp. africana	+		
Capparis tomentosa	2		
Panicum coloratum		1	
Vachellia robusta subsp. robusta	1		
Solanum seaforthianum	1		
Tabernaemontana elegans	C		
Trichilia dregeana	A		
Dovyalis caffra	2		
Ziziphus mucronata	2		

Table 7. Species cover relations of Habitat Type 4 (only species that has a mean cover of 1 % or more) at Shokwe Pan

Species names	Growth form	Comp status	Canopy cover (%)	Crown diameter(m)	Individual per ha	Canopy to canopy gap (m)
Ficus sycomorus	Tree	Strong	46.81	7.418	108	3.424
Trichilia emetica	Tree	Weak	24.54	7.418	56	7.556

Table 8. Growth form relations in Habitat Type 4 around Shokwe Pan

Growth form	% Canopy cover		Species richness - Number of species
	Plant number scale	Proportional	
Trees	83.42	99.1	9
Shrubs	0.23	0.27	3
Dwarf Shrubs	0.1	0.12	1
Forbs	0.43	0.51	1
TOTAL	84.18	100	14

Table 9. The floristic associations with habitat types at Nyamithi Pan

Habitat type	1	3
	1 111	11
Sampling units	95123467023	5814

Species group a – *Phragmites australis* – *Cynodon dactylon* MBR Habitat Type 1

Cynodon dactylon	8J51BC7FA E	3
Sporobolus africanus	8 28 92 1	
Hemarthria altissima	2D1 1 C	
Phragmites australis	N2	
Euphorbia prostrata	1 2	
Portulaca quadrifida	+ +	+

Species group b – *Dactyloctenium australe* – *Vachellia ataxacantha* Fringe Terrestrial Habitat Type 3

Dactyloctenium australe	3852
Gardenia cornuta	4481
Gymnosporia mossambicensis	617C
Vachellia ataxacantha	1185
Sporobolus nitens	1442
Euclea divinorum	EA6
Cissus rotundifolia var. rotundifolia	512
Pappea capensis	2 1
Chloris virgata	1+
Schotia brachypetala	11
Solanum seaforthianum	63
Albizia petersiana subsp. evansii	48
Spirostachys africana	E 3
Euclea schimperi var schimperi	5 5
Crassula expansa	41
Gymnosporia buxifolia	6 2

Croton menyharthii	3 4
Justicia sp.	15

Species group c - Species non-diagnostic that is common and rare

Evolvulus nummularius	69 1 3 2125
Vachellia xanthophloea	3E EF L 1 1
Azima tetracantha	1 3 32HA
Gomphrena celosioides	1 1+ + 31
Vachellia robusta subsp. robusta	4 A 11 1
Hibiscus sp.	+ +
Eragrostis curvula	2
Eragrostis superba	1
Grewia flavescens	3
Grewia hornbyi	1
Grewia monticola	4
Grewia occidentalis	+
Grewia villosa	1
Canthium inerme	2
Senegalia nigrescens	9
Euphorbia grandicornis subsp. grandicornis	8
Eragrostis rigidior	1
Hibiscus trionum	+
Hyphaene coriacea	+
Hypoestes forskaolii	2
Vachellia nilotica	+
Manilkara mochisia	1
Panicum maximum	+
Eragrostis heteromera	3
Vachelliasenegal var. rostrata	+
Dichrostachys cinerea subsp. africana	1
Salicornia meyeriana	A
Sarcocornia natalensis var. natalensis	6
Schoenoplectus littoralis	H
Cordia ovalis	2
Sideroxylon inerme	2
Solanum mauritianum	1
Aristida congesta subsp. barbicolis	2
Aristida stipitata	5
Phoenix reclinata	1
Sporobolus pyramidalis	3
Cyperus fastigiatus	3
Thespesia acutiloba	2

Table 10. Species cover relations of Habitat Type 3 (only species that has a mean cover of 1 % or more) for Nyamithi Pan

Species names	*Growth form*	*Comp status*	*Canopy cover (%)*	*Crown diameter(m)*	*Individual per ha*	*Canopy to canopy gap (m)*
Senegalia nigrescens	Tree	Strong	2.05	5.1	10	30.4
Spirostachys africana	Tree	Strong	5.16	8.2	9	27.9
Senegalia ataxacantha	Shrub	Weak	0.65	4.1	4	46.6
Euclea divinorum	Shrub	Strong	7.5	4.1	56	10.9
Azima tetracantha	Shrub	Strong	10.13	2.2	258	4.78
Euphorbia grandicornis subsp. *grandicornis*	Dwarf Shrub	Strong	1.61	1.2	144	8.2
Dactyloctenium australe	Grass	Strong	2.57	<0.1	185500	0.2
Solanum seaforthianum	Forb	Strong	1.13	0.6	403	5

Table 11. Growth form table for Habitat Type 3 at Nyamithi Pan.

Growth form	% Canopy cover		Species Richness - Number of species
	Plant number scale	Proportional	
Trees	12.3	23.07	18
Shrubs	29.27	54.93	13
Dwarf Shrubs	2.67	5.01	7
Grass	4.86	9.13	11
Forb	4.18	7.85	10
TOTAL	53.28	100	59

DISCUSSION

In a previous study of the vegetation of NGR (De Moor *et al.*, 1997), the riparian vegetation or riparian zones that occur around the three pans were not sampled due to their variability and complexity. Dominant trees like *Ficus sycomorus, Vachellia xanthophloea* and *Trichilia emetica* (Palgrave, 1997) were present at Banzi and Shokwe pans, but Nyamithi Pan was mostly dominated by *Vachellia xanthophloea*. The latter is mostly associated with the outer edge of the pan *i.e.* distal from the water's edge and therefore one could assume, slightly drier conditions, while the other two species can handle wetter conditions (M. Whittington *pers. obs.*). *Vachellia xanthophloea* is also prone to fall over when standing in wet conditions for too long since it often occurs in alluvial sand.

The MBR Habitat Type is a merged habitat type that includes mudflats, beach and reedbeds. Differentiation of this Habitat Type on the aerial photographs was not possible and hence the reason why they were lumped together. This Habitat Type (Habitat Type 1) occurred proximal to the water's edge. This specific area is slightly wetter than Habitat Types 2, 3 and 4. At all three pans the reed *Phragmites australis* and the grass *Hemarthria altissima* dominated this habitat type (Habitat Type 1). In the *Vachellia xanthophloea* and *Cynodon dactylon* RF (Habitat Type 2), no diagnostic species were found although it was floristically distinct from Habitat Types 1, 3 and 4. Habitat Type 4 was dominated by *Ficus sycomorus* and *Trichilia emetica*. This habitat type is best represented at Shokwe Pan and is a distinct RF Habitat Type. Habitat Type 3 was not always clearly delineated. It is the transitional zone from riparian to terrestrial habitat. This FT habitat was dominated by *Dactyloctenium australe*and *Senegalia ataxachantha*.

Banzi Pan was classified as a Riverine system due to its position within the Usuthu River. It has an inflow on its western side that channels out on the eastern side. The reedbeds occupy most of the shoreline and consist of two different reed species; *Phragmites mauritianus* and *P. australis*. These two species are common reeds that grow in or near water sources, *i.e.* rivers or vleis. They are also very closely related (Van Oudtshoorn, 1999). Other species that occur in the MBR Habitat Type 1 with regularity include *Ficus capreifolia, Solanum seaforthianum, S. incanum, Schoenoplectus littoralis* and *Cyperus fastigiatus*, all of which favour fringing rivers, estuarine communities and riverine forests (Pooley, 2003; Pooley, 2005). Other species occurring in this habitat were *Helitrophium* sp., *Flaveria bidentis* and *Euphorbia prostrata* that prefer trampled or disturbed soils (Pooley, 2005).

The dominant species (according to cover and frequency) that occur in Banzi Pan's RF Habitat Type are *Ficus sycomorus* and *Cynodon dactylon*. Other species that also occur in this habitat type includes *Vachellia xanthophloea, Rauvolfia caffra, Dactyloctenium australe,*

Evolvulus nummularius, Helitrophium sp., *Cissus rotundifolia* var. *rotundifolia, Dovyalis caffra* and *Chamaesyce prostrata.*

Shokwe Pan was also classified as a Riverine system. This pan gets its water from heavy rainfall and when the Usuthu River is in flood. The water therefore seeps into the pan via a small channel. Three Habitat Types were identified at this pan. The MBR Habitat type is dominated by *Phragmites mauritianus, Ficus capreifolia, Cyperus fastigiatus, Ageratum houstonianum, Euphorbia prostrata* and *Helitrophium* sp. The reed *Phragmites* is arranged into clumps around the pans edges, where *Ficus capreifolia* can be found in-between the reed clumps. The other species present can be found in the openings where the soil is trampled by the animals that come to drink water. Floating vegetation species (i.e. *Nymphaea* sp. and *Trapa bispinosa*; Heeg, Breen and Rogers, 1980) also forms part of the MBR Habitat Type.

The Forest Habitat Type (Habitat Type 4) at Shokwe Pan is dominated by *Ficus sycomorus, Trichilia emetica, T. dregeana, Tabernaemontana elegans* and *Gardenia cornuta*. Most of these species grow on riverine margins (Pooley, 2003). Big trees and almost no undergrowth are characteristic of this Habitat Type, whereas Banzi Pan was different with a lot of undergrowth below the trees. Reasons for this difference may be the difference in canopy cover.

The third Habitat Type found at Shokwe Pan was an anomalous sampling unit that was classified as FT (Habitat Type 3), *i.e.* a grassy floodplain on the western edge of the pan. If comparisons are made from 1942 to 2002 on the aerial photographs, it seems that this area was still under water in the early 70's.

Two Habitat Types were identified at Nyamithi Pan, namely *Phragmites australis-Cynodon dactylon* MBR Habitat Type 1 and *Dactyloctenium australe-Senegalia ataxachantha* Fringe Terrestrial Habitat Type 3. The MBR Habitat Type is dominated by *Phragmites australis* and *Cynodon dactylon*, and other species at lower frequencies include *Vachellia robusta* subsp. *robusta, V. xanthophloea, Sporobolus africanus, Schoenoplectus littoralis, Hemarthria altissima* and *Evolvulus nummularius*.

The second habitat type, Habitat Type 3 (FT), at Nyamithi Pan is dominated by *Dactyloctenium australe, Senegalia ataxachantha, S. nigrescens, Vachellia xanthophloea, Albizia petersiana* subsp. *evansii, Gardenia cornuta, Spirostachys africana, Euclea schimperi* var. *schimperi, E. divinorum, Gymnosporia mossambicensis, G. buxifolia, Azima tetrachantha, Euphorbia grandicornis* subsp. *grandicornis* and *Solanum seaforthianum.* This Habitat Type had a great diversity but was dominated by trees and shrubs.

Solanum seaforthianum, an alien plant, was recorded at all three pans. It occurred in high densities and needs to be controlled immediately to prevent it from increasing. If not controlled, encroachment by this species can be expected and the loss of desirable species (Bromilow, 2010) can be the result. Management needs to make the removal of this species a priority.

The three major pans in NGR represented two different wetland systems (Dini, *et al.* 1998). Their uniqueness adds value to the Reserve (Naguran, 2002), and needs to be conserved and monitored as a whole. Long-term monitoring of plant communities is an essential pre-requisite for understanding and eventually predicting responses of vegetation change (Goldberg and Turner, 1986). Once every five years should be sufficient to keep track of changes. Since this study has provided a baseline dataset, future changes in specific floristic characteristics such as species composition, structure, cover and density can now be monitored. The habitat type that is the most threatened would be the RF. Managing and monitoring of alien plants and overgrazing would be two of the main factors that would play a role in the change of this habitat type. It should be considered a priority to manage these two factors.

Acknowledgements: We thank Ezemvelo KZN Wildlife for supporting the project and giving access to the sites and historical data as well as historical reports. We thank Wayne Matthews, Catherine Hannekom, Pete Ruinard and Ferdi Myburgh for their assistance and help during the whole study. The authors also thank the Tshwane University of Technology and SHIKAR for financial assistance.

REFERENCES

Anon, (1993). Tembe – Ndumo Management and Development Plan 1993 (unpublished). KZN Wildlife, KwaZulu-Natal.

Bromilow, C. (2010). Problem Plants and Weeds of South Africa, 3rdEd. Briza Publishers, Pretoria.

Darby, E. S. (1999). Effect of riparian vegetation on flow resistance and flood potential. J. Hydraul. Div., 125(5): 443-454.

De Moore, P.P., E. Pooley, G. Neville, and J. Baricheivey, (1977). The vegetation of Ndumo Game Reserve, Natal: A quantitative physiognomic survey. Annals of the Natal Museum 23(1): 239-272.

Dini, J., G. Cowan, and P. Goodman (1998). South African National Wetland Inventory: Proposed wetland classification system for South Africa. First draft. Department of Environmental Affairs and Tourism, Pretoria.

ESRI (2008). ArcGIS Desktop: Release 9.3. Redlands, CA: Environmental Systems Research Institute.

Goldberg, D.E. and R. M. Turner (1986). Vegetation change and plant demography in permanent plots in the Sonoran Desert. Ecology 67(3): 695-712.

Heeg, J., C. M. Breen, and K. H. Rogers (1980). The Pongola Floodplain: A unique ecosystem threatened. South African Institute of Civil Engineers. The Civil Engineer in South Africa, Johannesburg. Issue 22(5): 125-158.

Naguran, R. (2002). Property rights and Protected areas: The case study of Ndumo Game Reserve. (unpublished; A paper presented at the research seminar on Property rights and Environmental Degradation, May 2002, Durban, SA).

Nilsson, C. and K. Berggren (2000). Alterations of riparian ecosystems caused by river regulation. Bioscience 50(9): 783-792.

Palgrave, K.C. (1977). Trees of Southern Africa. Struik Publishers, Cape Town.

Pooley, E. (2003). The complete field guide to trees of Natal, Zululand and Transkei. Durban: Natal Flora Publications Trust.

Pooley, E. (2005). A Field Guide to Wild Flowers KwaZulu-Natal and the Eastern Region. Durban: Natal Flora Publications Trust.

Richardson, D.M., P. M. Holmes, K. J. Esler, S. M. Galatowitsch, J. C. Stromberg, S. P. Kirkman, P. Pyšek and R. J. Hobbs (2006). Riparian vegetation: degradation, alien plant invasions, and restoration prospects. Diversity and Distributions 13(1): 126-139.

Rogers, K.H. (1995). Riparian wetlands. In: Cowan, G.I. Wetlands of South Africa. (ed.), pp 41-52. Department of Environmental Affairs and Tourism, Pretoria.

Van Der Nat, D., A. P. Schmidt, K. Tockner, P. J. Edwards, and J. V. Ward (2002). Inundation Dynamics in braided floodplains: Tagliamento River, Northeast Italy. Ecosystems 5: 636-647.

Van Oudtshoorn, E. (1992). Guide to grasses of Southern Africa. Briza Publications. Pretoria.

Westfall, R.H. (1992). Objectivity in stratification, sampling and classification of vegetation. Ph.D. thesis. University of Pretoria, Pretoria.

Westfall, R.H. and M. D. Panagos (1988). The plant number scale - an improved method of cover estimation using variable-sized belt transects. Bothalia 18:289-291.

Westfall, R.H., J. M. Van Staden, M. D. Panagos, P. J. J. Breytenbach, and A. Greeff (1996). Scale-related vegetation sampling. ARC-RFI, Pretoria.

Wissmar, R.C. and R. L. Beschta (1998). Restoration and management of riparian ecosystems: a catchment perspective. Freshwater Biol. 40(3): 571-585.