

A List of Alien Plants in the Kruger National Park

I.A.W. MACDONALD and W.P.D. GERTENBACH

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The alien vascular plant flora of the Kruger National Park is listed. Annotations cover the invasive status, modes of introduction and dispersal, dates of first recording, ecological impacts and control status of each species. The list comprises 156 species of which 113 are considered invasive within the park. Most of the species have been accidentally introduced to the park. The ecological impacts of 27 species (of which 11 are trees and shrubs) were rated as moderate or high. By 1985 only 10 species are thought to have been eradicated from the park. Most of the invasive species are herbaceous weeds of man-disturbed sites and the eradication of these is generally considered impossible.

Most of the important species are dispersed by water and animals. The significance of limiting reinvasion of the park down the rivers flowing into the park, is stressed.

Key words: Plants, alien, exotic, check list, ecological impacts, control.

I.A.W. Macdonald, Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch, 7700 Republic of South Africa; W.P.D. Gertenbach, National Parks Board, Kruger National Park, Private Bag X402, Skukuza, 1350 Republic of South Africa.

Introduction

*This list has been compiled, in main, from a computerised listing of the Skukuza herbarium collection of the park's flora (Gertenbach 1985). This list was compared with a comprehensive listing of the invasive alien flora of southern Africa (Powrie & Macdonald 1985) and the alien taxa were extracted. Additional information on alien plants was extracted from the questionnaire survey of alien plants in the reserve (Gertenbach 1984), from a rapid survey carried out in June 1984 (Macdonald & Macdonald 1984) and from a review of the annual reports of the park and of the files relating to alien plants (Macdonald *in press*). In several cases the alien status of a species occurring in the park is uncertain. In such cases we have had to be guided by the available literature and, in a few cases, by reference to the staff of the Botanical Research Institute, Pretoria.

A total of 156 plant species alien to Kruger National Park are listed. Of these 113 are considered to be "invasive" in so far as they have established self-sustaining populations within the park in the absence of active human assistance.

Presentation of the list

Each genus of alien plant mentioned is given the De Dalla Torre and Harms number as reflected in Gibbs Russell & the Staff of the National Herbarium (1984). The species are numbered using the same system where these species are included in the list of Southern African plants (Gibbs Russell *et al.*, *op. cit.*).

After the species name the first column INTRO gives the known method of introduction to the park of each invasive species (C = intentionally brought in for the purposes of cultivation, N = brought in accidentally or invaded "naturally"). The second column CULT marked with an asterisk (*) indicates those species which are thought to be present only in cultivation within the park, i.e. the non-invasive introduced species.

In the First Records column are given the earliest year in which the plant was recorded from the park according to a particular data source. There are often several "first records". Where the date is unqualified this is the earliest collection represented in the Skukuza herbarium. Where the date has an F-prefix this is the date given for the earliest collection in Obermeijer (1937). An A-prefix signifies the first date of recording in either an Annual Report of the Park Warden or in a National Parks Board file. A Q-prefix indicates the year of first recording given in the questionnaire returned from the park (Gertenbach 1984). A P-prefix indicates the earliest collection date in the PRECIS databank of the National Herbarium, Pretoria.

A "+" sign in the F1 column indicates that the species was included in the first published list of the park's flora (Obermeijer 1937), while an X in the F2 column indicates inclusion in the second published checklist (Van der Schijff 1969).

The remaining columns classify the species firstly, into, Trees and Shrubs and Other Growth Forms and, secondly, into species having slight (S), moderate (M) or high (H) ecological impacts. In these columns, those species rated as having a slight impact are all shown as "1", while those with moderate or high impacts are listed with a letter denoting their main means of dispersal within the park (excluding human distribution). The means of dispersal listed are: water (W), mechanical (M), animals (A) and wind (Z). The lower case letter adjacent to the symbol in these columns indicates those species which have been eliminated (e), those for which control is considered possible given available technologies (p) and those where control is impossible at present (i).

The approach adopted in the classification of species by their ecological impacts warrants elaboration. A species was regarded as having a *slight impact* when, at current infestation levels, which are not being maintained by active control measures, the species is thought not to be significantly reducing the populations of any of the park's native species and not to be influencing ecosystem functioning. A *high impact* was attributed to species where it was considered that uncontrolled infestations have reduced or could reduce significantly the populations of native species or markedly alter some aspect of ecosystem functioning. In the absence of detailed ecological studies of alien plants in the park these ratings have had to be made subjectively based on the authors' experience with the species in the park and elsewhere in southern Africa. In addition the relevant published literature (Moran & Moran 1982) has been extensively reviewed. A *moderate impact* was allocated to species which were possible candidates for a high impact rating but where there was considerable uncertainty as to the severity of these impacts under local park conditions. These impact ratings should thus be regarded as providing a preliminary and highly tentative estimate of this extremely important but difficult to quantify component of the invasion process.

Discussion

Obermeijer (1937) listed six alien species for the Kruger National Park. The list of alien plants increased rapidly, partly as a result of increased plant collecting, but also because of new invasions and Codd (1951) listed 32 alien plant

Species list

	I N T R O	C U L T	First Records		Trees and Shrubs			Other Growth Forms		
			F I	F 2	S	M	H	S	M	H
Pteridophyta										
Salviniaceae										
0000210		<i>Salvinia</i>								
00100		<i>S. molesta</i>	N	Q1975 A1975						Wp
Angiospermae										
Monocotyledonae										
Poaceae										
9901070		<i>Paspalum</i>								
00600		<i>P. urvillei</i>	N							li
9901120		<i>Echinochloa</i>								
00200		<i>E. crus-galli</i>	N	1949	X					li
9901390		<i>Pennisetum</i>								
01100		<i>P. purpureum</i>		* 1958						
01200		<i>P. setaceum</i>	N	1953 P1953	X					li
9901400		<i>Cenchrus</i>								
00200		<i>C. brownii</i>	N		X					li
9902130		<i>Arundo</i>								
00100		<i>A. donax</i>	N	P1950	X					Wi
9902860		<i>Eragrostis</i>								
00900		<i>E. barrelieri</i>	N	1971 P1971						li
9904710		<i>Bambusa</i>								
00100		<i>B. balcooa</i>		*						
Cyperaceae										
0459000		<i>Cyperus</i>								
00800		<i>C. compressus</i>	N	1953 P1950	X					li
*Araceae										
0791000		<i>Pistia</i>								
00100		<i>P. stratiotes</i>	N	Q1950 P1953						Wp
Commelinaceae										
0896000		<i>Commelina</i>								
00300		<i>C. benghalensis</i>	N	P1953	X					li
Pontederiaceae										
0921000		<i>Eichhornia</i>								
00100		<i>E. crassipes</i>	N	1975 Q1975 A1977						Wi
Liliaceae										
1026000		<i>Aloe</i>								
00100		<i>A. longibracteata</i>		*						
1050000		<i>Nothoscordum</i>								
00100		<i>N. inodorum</i>	N	1959 P1959						li

Species list (Continued)

		I N T R O	C U L T	First Records	Trees and Shrubs			Other Growth Forms				
					F 1	F 2	S	M	H	S	M	H
Amaryllidaceae												
1219000	<i>Agave</i>											
	<i>A. sisalana</i>		C					Mp				
Dicotyledonae												
Salicaceae												
1873000	<i>Salix</i>											
00100	<i>S. babylonica</i>		N				X	1e				
Cannabaceae												
1973000	<i>Cannabis</i>											
00100	<i>C. sativa</i>			*								
Proteaceae												
2045000	<i>Grevillea</i>											
	<i>G. robusta</i>			*			X					
Aristolochiaceae												
2174000	<i>Aristolochia</i>											
00100	<i>A. elegans</i>			*			X					
Polygonaceae												
2201000	<i>Polygonum</i>											
00300	<i>P. aviculare</i>		N									li
01400	<i>P. limbatum</i>		N		1960		X					li
					P1957							
02150	<i>P. senegalensis</i>		N		1949		X					li
					P1946							
2205000	<i>Antigonon</i>			*								
	<i>A. leptopus</i>											
Chenopodiaceae												
2223000	<i>Chenopodium</i>											
00100	<i>C. album</i>		N		1954		X					li
					P1954							
00300	<i>C. ambrosioides</i>		N		*F1930	+	X					li
					P1932							
					1949							
01900	<i>C. polyspermum</i>		N		1949		X					li
					P1949							
Amaranthaceae												
2299000	<i>Amaranthus</i>											
01200	<i>A. spinosus</i>		N		1952		X					li
					P1952							
2314000	<i>Pupalia</i>											
00200	<i>P. lappaceae</i>		N		P1952		X					li
2328000	<i>Achyranthes</i>											
00100	<i>A. aspera</i>		N		P1953		X					li
00200	<i>A. sicula</i>		N		P1949		X					li
2330000	<i>Brayulinea</i>											
00100	<i>B. densa</i>		N		1952							li
					P1952							

Species list (Continued)

	I N T R O	C U L T	First Records	Trees and Shrubs			Other Growth Forms		
				F 1	F 2	S M H	S M H		
2335000 <i>Alternanthera</i>									
00300 <i>A. pungens</i>	N		1950 P1952	X					li
00400 <i>A. sessilis</i>	N		1949	X					li
2338000 <i>Gomphrena</i>									
00100 <i>G. celosioides</i>	N		F1932 P1949	+ X					li
Nyctaginaceae									
2347000 <i>Mirabilis</i>									
00100 <i>M. jalapa</i>		*							
2349000 <i>Boerhavia</i>									
<i>B. diffusa</i>	N		F1932 P1949	+ X					li
2350000 <i>Bougainvillea</i>									
<i>B. glabra</i>		*							
<i>B. spectabilis</i>		*							
Phytolaccaceae									
2380000 <i>Phytolacca</i>									
00200 <i>P. dioica</i>		*							
Aizoaceae									
2387000 <i>Mollugo</i>									
00300 <i>M. nudicaulis</i>	N		1949 P1953						li
2395010 <i>Zaleya</i>									
00100 <i>Z. pentandra</i>	N		1950 P1950	X					li
Portulacaceae									
2421000 <i>Portulaca</i>									
00700 <i>P. oleracea</i>	N		1954 P1950	X					li
01000 <i>P. quadrifida</i>	N		P1952	X					li
Basellaceae									
2424000 <i>Basella</i>									
00100 <i>B. paniculata</i>	N		1959 P1959						li
2428000 <i>Anredera</i>									
00100 <i>A. baselloides</i>	N		1954						li
Caryophyllaceae									
2455000 <i>Polycarpaea</i>									
00100 <i>P. corymbosa</i>	N		1949 P1949	X					li
Menispermaceae									
2570000 <i>Cocculus</i>									
00100 <i>C. hirsutus</i>	N		F1930 P1930	+					li

Species list (Continued)

	I N T R O	C U L T O	First Records	F 1	F 2	Trees and Shrubs S M H	Other Growth Forms S M H
Lauraceae							
2783000	<i>Persea</i>						
	<i>P. americana</i>	*					
2825000	<i>Cassytha</i>						
00100	<i>C. filiformis</i>	N	1953				Ai
Papaveraceae							
2852000	<i>Argemone</i>						
00300	<i>A. ochroleuca</i>	N	1932	+			Wi
Brassicaceae							
2883000	<i>Lepidium</i>						
00400	<i>L. bonariense</i>	N	1954				li
			P1954				
2946000	<i>Diplotaxis</i>						
00100	<i>D. muralis</i>	N	1953				li
Capparaceae							
3082000	<i>Cleome</i>						
00900	<i>C. gynandra</i>	N	1953		X		li
Moringaceae							
3128000	<i>Moringa</i>						
	<i>M. oleifera</i>	C	1977			lp	
Crassulaceae							
3166000	<i>Kalanchoe</i>						
	<i>K. tubiflora</i>	*					
Rosaceae							
3340000	<i>Eriobotrya</i>						
	<i>E. japonica</i>	*					
Fabaceae							
3446000	<i>Acacia</i>						
	<i>A. dealbata</i>	N			X	We	
3520000	<i>Bauhinia</i>						
00800	<i>B. variegata</i>	*			X		
3536000	<i>Cassia</i>						
01500	<i>C. corymbosa</i>	*					
01600	<i>C. didymobotrya</i>	C	P1961			1e	
03200	<i>C. obtusifolia</i>	N	P1953			1p	
03300	<i>C. occidentalis</i>	N	P1949		X	1p	
04700	<i>C. tomentosa</i>	N				1p	
3556000	<i>Delonix</i>						
00100	<i>D. regia</i>	*					
3559000	<i>Caesalpinia</i>						
00100	<i>C. decapetala</i>	N	1961			Wp	
			A1948				
			P1953				
00500	<i>C. pulcherrima</i>	C	1949		X	1e	
			P1950				

Species list (Continued)

		I N T R O	C U L T	First Records	Trees and Shrubs			Other Growth Forms		
					F 1	F 2	S M H	S M H		
3669000	<i>Crotalaria</i>									
06800	<i>C. sphaerocarpa</i>	N		1966 P1949						li
3734000	<i>Gliricidia</i>		*			X				
	<i>G. sepium</i>									
3747000	<i>Sesbania</i>									
00100	<i>S. bispinosa</i>	N		1949 P1953		X	1p			
	<i>S. punicea</i>	N		1980				Wp		
3793000	<i>Aeschynomene</i>									
00300	<i>A. indica</i>	N		1949 P1953		X				li
3804000	<i>Zornia</i>									
00100	<i>Z. diphylla</i>	N		1949						li
3825000	<i>Tipuana</i>		*							
	<i>T. tipu</i>									
3857000	<i>Clitoria</i>									
00100	<i>C. ternatea</i>	N				X				li
3905000	<i>Vigna</i>									
01200	<i>V. oblongifolia</i>	N		1949 P1949						li
Oxalidaceae										
3936000	<i>Oxalis</i>									
04500	<i>O. corniculata</i>	N		1952 P1952		X				li
11500	<i>O. latifolia</i>	N		1978 P1962						li
Rutaceae										
4100000	<i>Citrus</i>									
*	<i>C. aurantium</i>		*							
	<i>C. limonia</i>		*							
Meliaceae										
4156000	<i>Toona</i>									
	<i>T. ciliata</i>		*							
4175000	<i>Melia</i>									
00100	<i>M. azedarach</i>	C		Q1940 A1948 1954 P1954		X				Wi
Euphorbiaceae										
4407000	<i>Acalypha</i>									
00100	<i>A. wilkesiana</i>		*							
4424000	<i>Ricinus</i>									
00100	<i>R. communis</i>	N		1949		X	li			
4498000	<i>Euphorbia</i>									
03800	<i>E. chamaesyce</i>		*			X				

Species list (Continued)

		I N T R O	C U L T	First Records	Trees and Shrubs			Other Growth Forms		
					F 1	F 2	S M H	S M H		
12500	<i>E. heterophylla</i>	N		1950 P1950	X					li
	<i>E. pulcherrima</i>		*		X					
24050	<i>E. splendens</i>	N		1952	X					li
Anacardiaceae										
4545000	<i>Mangifera</i>									
00100	<i>M. indica</i>		*							
4562000	<i>Harpephyllum</i>									
00100	<i>H. caffrum</i>		*							
4594000	<i>Rhus</i>									
	<i>R. lancea</i>		*							
Sapindaceae										
4831000	<i>Dodonaea</i>									
	<i>D. viscosa</i>	C		1950			lp			
Tiliaceae										
4953000	<i>Corchorus</i>									
01200	<i>C. tridens</i>	N		1949 P1949	X					li
01300	<i>C. trilocularis</i>	N		1949 P1933	X					li
4975000	<i>Triumfetta</i>									
00600	<i>T. pentandra</i>	N		1949 P1953						li
01000	<i>T. rhomboidea</i>	N		1953 P1933						li
Malvaceae										
4995000	<i>Malvastrum</i>									
00100	<i>M. coromandelianum</i>	N		1954 P1954						li
4998000	<i>Sida</i>									
00250	<i>S. alba</i>	N		1973 P1953						li
00400	<i>S. cordifolia</i>	N		P1933	X					li
5013000	<i>Hibiscus</i>									
01300	<i>H. cannabinus</i>	N		1953 P1950	X					li
Bombacaceae										
5024000	<i>Bombax</i>									
	<i>B. spp.</i>		*							
5024010	<i>Pochota</i>									
	<i>P. glabra</i>		*							
Sterculiaceae										
5059000	<i>Waltheria</i>									
00100	<i>W. indica</i>	N		P1949	X					li
Passifloraceae										
5372000	<i>Passiflora</i>									
00200	<i>P. edulis</i>		*							

Species list (Continued)

	I N T R O	C U L T	First Records	Trees and Shrubs			Other Growth Forms		
				F 1	F 2	S M H	S M H		
Caricaceae									
5377000									
		*							
Cactaceae									
5417000									
00100	N		1952						Ae
01000	C			X		Ap			
Myrtaceae									
5559000									
00200	C		1949	X		Ai			
5598000									
		*							
5603000									
		*							
Apiaceae									
5894000									
00350	N		P1954						li
Oleaceae									
6420000									
		*							
6436000									
		*							
Loganiaceae									
6473000									
		*		X					
Apocynaceae									
6560000									
		*							
6582000									
		*							
6597000									
00100	N		1952 P1951						Wi
6687000									
		*							
0000000									
		*							
Convolvulaceae									
6968000									
	N								Ai
7003000									
04200	C								Me
Boraginaceae									
7052000									
01100	N		P1959						li

Species list (Continued)

	I N T R O	C U L T	First Records		Trees and Shrubs			Other Growth Forms		
			F 1	F 2	S	M	H	S	M	H
7056000 <i>Trichodesma</i> 00400 <i>T. zeylanicum</i>	N		1952 P1932		X					li
Verbenaceae										
7138000 <i>Verbena</i> 00100 <i>V. bonariensis</i>	N		1952 P1952		X					li
7144000 <i>Lantana</i> 00200 <i>L. camara</i>	C		Q1940 P1950		X			Ai		
7162000 <i>Duranta</i> 00100 <i>D. repens</i>	N		1953 P1953		X		li			
Labiatae										
7366000 <i>Ocimum</i> 00100 <i>O. canum</i>	N		P1950							li
Solanaceae										
7400000 <i>Withania</i> <i>W. somnifera</i>	N		1949 P1949		X					li
7401000 <i>Physalis</i> 00100 <i>P. angulata</i>	N		1952 P1952		X					li
00500 <i>P. peruviana</i>	N		1949		X		li			
7407000 <i>Solanum</i> 04000 <i>S. mauritianum</i>	C		A1985 P1952		X			Ap		
7415000 <i>Datura</i> 00600 <i>D. stramonium</i>	N		P1953		X					Ai
7434000 <i>Nicotiana</i> 00200 <i>N. glauca</i>	N		A1958 P1948		X			We		
Scrophulariaceae										
7625000 <i>Striga</i> 00100 <i>S. asiatica</i>	N		P1953		X					li
Bignoniaceae										
7705000 <i>Arrabidaea</i> <i>A. mollis</i>		*								
7725000 <i>Jacaranda</i> <i>J. mimosifolia</i>	C		Q1953		X			Zp		
7733000 <i>Tecoma</i> <i>T. stans</i>	C							le		
7742000 <i>Spathodea</i> <i>S. campanulata</i>		*								
Rubiaceae										
8464000 <i>Richardia</i> 00100 <i>R. brasiliensis</i>	N				X					li

Species list (Continued)

	I N T R O	C U L T	First Records		Trees and Shrubs			Other Growth Forms		
			F 1	F 2	S	M	H	S	M	H
Asteraceae										
8795000		<i>Ageratum</i>								
00100		<i>A. conyzoides</i>	N	P1949	X				li	
8926000		<i>Conyza</i>								
		<i>C. floribunda</i>	N						li	
9130000		<i>Acanthospermum</i>								
00100		<i>A. australe</i>	N	P1950	X				li	
00300		<i>A. hispidum</i>	N	P1949	X				li	
9148000		<i>Xanthium</i>								
00200		<i>X. strumarium</i>	N	A1948 P1953	X					Wi
9155000		<i>Zinnia</i>								
00200		<i>Z. peruviana</i>	N	P1954	X				li	
9166000		<i>Eclipta</i>								
00100		<i>E. prostrata</i>	N	P1952	X				li	
9196000		<i>Tithonia</i>								
00100		<i>T. diversifolia</i>	N	P1953	X	1p				
9237000		<i>Bidens</i>								
00200		<i>B. biternata</i>	N	P1975						Ai
00300		<i>B. formosa</i>	N	A1973					1e	
00500		<i>B. pilosa</i>	N	P1952	X					Ai
9245000		<i>Tridax</i>								
00100		<i>T. procumbens</i>	N	P1976					li	
9282000		<i>Flaveria</i>								
00200		<i>F. bidentis</i>	N	P1953	X				li	
9291000		<i>Schkuhria</i>								
00100		<i>S. pinnata</i>	N	P1949	X				li	
9311000		<i>Tagetes</i>								
00200		<i>T. minuta</i>	N	F1930 A1948 P1950	+	X				Wi
•										
9595000		<i>Sonchus</i>								
00100		<i>S. asper</i>	N			X			li	
01000		<i>S. oleraceus</i>	N	A1981 P1954		X				Wi

species. Van der Schijff (1957) conducted a detailed survey of the park's flora and classified 43 species as aliens. The number of species had increased to 76 by 1969 (Van der Schijff 1969). This study shows there to be at least 156 plant species alien to the park of which 113 are considered "invasive". The increase in alien plant species over time is presented graphically in Figure 1.

The earliest record for each alien plant species within the park often varies between the different sources. Of the 52 species for which two or more records

exist only 22 had first been recorded in the same year from each source. Fifteen species had all their first records from different sources within five years of one another, 13 species within ten to twenty years, one species had 27 years between records and another had 33 years. In the latter case, which was *Solanum mauritianum*, it appears that an initial invasion along the Crocodile River at Crocodile Bridge (Van der Schijff 1969) either failed or was eliminated and that the plants first reported in 1985 from Skukuza by park authorities were from a totally new introduction. The long interval between the first records of 15 of the species as recorded from different data sources, indicates how little reliance can be placed on these first records when there is no systematic monitoring system in operation.

Of the 113 invasive alien plant species recorded, only 13 are known to have been intentionally cultivated within the park. Of these 13 species (almost all

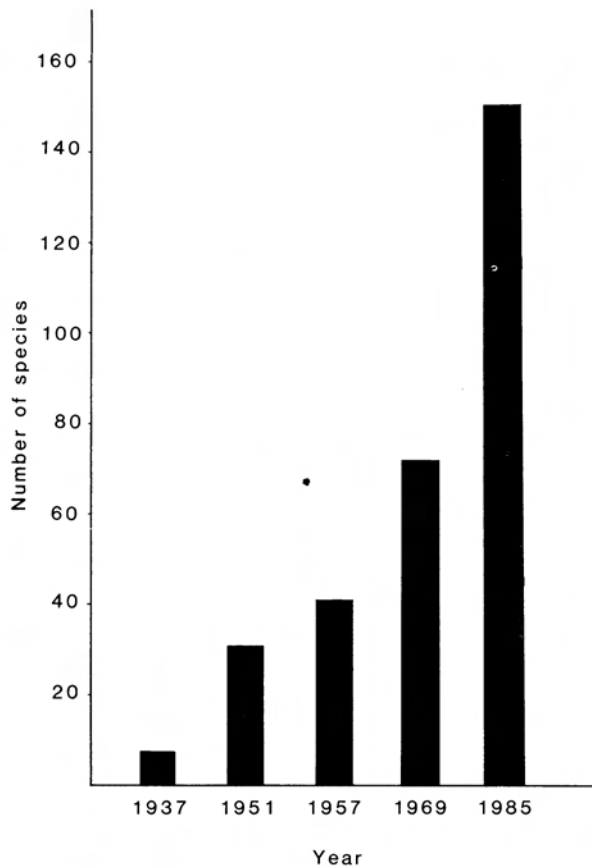


Fig. 1. The number of alien plant species recorded from the Kruger National Park as recorded in successive published floras.

perennial trees, shrubs or creepers) six are considered to have moderate ecological impacts while two, *Lantana camara* and *Melia azedarach*, have high impacts and are currently the two major problem species in the park.

The ecological impacts of 11 of the 25 invasive tree and shrub species were rated as moderate or high, whereas only 16 of the 88 species of other growth forms were so rated. All three of the floating aquatic macrophytes (*Salvinia molesta*, *Pistia stratiotes* and *Eichhornia crassipes*) were rated as having high ecological impacts. The high proportion of trees and shrubs and of floating aquatic macrophytes that were considered to have potentially significant ecological impacts can be attributed to the observation that alien species in both these growth forms can form dense, virtually monospecific stands. These stands have been observed to reduce the densities of native plant species and, in the case of the aquatic macrophytes, to shade out native submerged macrophytes entirely.

By July 1985, when this list was compiled, 10 species are thought to have been successfully eradicated from the park. In addition it was likely that *S. molesta* had also been eliminated. Of the 10 species eliminated, seven were trees and shrubs and six were species rated as having only slight ecological impacts. Excluding *S. molesta*, only one species rated as having a high impact, *Opuntia aurantiaca*, was thought to have been entirely eradicated. Certainly, none of the park staff in 1985 knew of the occurrence of any plants of this species within the park, although it had apparently been collected there in 1952. Most of the invasive alien plant species are herbaceous species which are often associated with man-disturbed areas. In general it is considered impossible to eradicate these herbaceous alien weeds given current control technology. Most of the species are persistent annual weeds of cultivated areas where they survive notwithstanding cultivation and chemical control methods which are far more drastic than would be possible within a national park. A total of 89 species belong to this category. The eradication of 14 species is considered possible. In almost all cases these are large perennial plants which require several years to grow to reproductive size. In most cases they are confined to localised areas around the sites of introduction. In the case of the aquatic macrophytes practical experience within the park indicates that chemical control

- is possible in localised infestations.

Of the 27 species having moderate or high ecological impacts, 14 are dispersed primarily by water, 10 by animals, two (*Agave sisalana* and *Ipomoea purpurea*) mechanically over short distances and only *Jacaranda mimosifolia* by wind. Several of the animal-dispersed species are known or are considered to be dispersed also by water (e.g. *Opuntia aurantiaca*, *O. vulgaris* and *Lantana camara*). It is of cardinal importance to limit the infestations of all these water-dispersed species outside the park's boundaries on rivers flowing into the park. This will only become possible when the authorities responsible for these upstream areas recognise their responsibility to control these problem species and then launch carefully planned and adequately funded control programmes. Once the initial clearance operations have been conducted it is essential that there be continual vigilance to ensure that new infestations do not build up again in these headwater regions. Similarly, routine monitoring of these rivercourses within the park should be undertaken to enable the early detection and removal of new invasions.

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