A botanical importance rating of selected Cape estuaries

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Abstract

A formula has been developed which allows a single numerical botanical importance score to be calculated for estuaries. The formula includes the area cover of each estuarine plant community type, its association with the estuary, its condition and the plant community richness. This study focused on temporarily and permanently open estuaries along the Cape coast, which for convenience was divided into four regions: Western Cape; South-Western Cape; Southern Cape and South-Eastern Cape. Thirty three temporarily and permanently open estuaries were studied and rated according to importance within the whole Cape coast, regional importance (i.e. Southern Cape or South-Eastern Cape), as well as against other estuaries of their type (i.e. temporarily or permanently open). The Olifants Estuary on the west coast received the highest importance score for the whole Cape coast. It has extensive marshes in its lower reaches that are in good condition. Reed and submerged macrophyte beds are also a feature of this estuary. Two False Bay estuaries, the Lourens and the Sir Lowry's Pass, had the lowest scores. These estuaries are severely impacted as a result of residential and industrial proximity, and rehabilitatory steps would be necessary to restore any botanical significance to them. Not all the regions' estuaries were used to obtain these scores and more need to be included to make the importance rating relevant to all estuaries along the whole South African coast. This rating can be used to identify estuaries which are worthy of receiving a high conservation status.

Introduction

There are an increasing number of people utilising the South African coastline. This is creating a need to evaluate estuarine and coastal resources and to determine sensitive areas where careful planning and management must take place (Begg, 1984; Allanson, 1992). Important estuaries should be identified and development in their surrounds (including impoundments) and in the catchment should be declared unacceptable if the estuarine environment is not to be degraded.

Any individual estuary can be identified as important for a number of different reasons. It may have especially large salt marsh areas; it may have a rare bird species present; another might have unique hydrological features or it might be an important recreational estuary. These botanical, zoological, physical and socio-economic factors all contribute towards the importance of an estuary and the Consortium for Estuarine Research and Management (CERM) is working towards incorporating all these attributes into an overall importance rating for South African estuaries (CERM, 1994). We believe that in most cases the condition and extent of the plant communities can determine the overall ecological condition of an estuary.

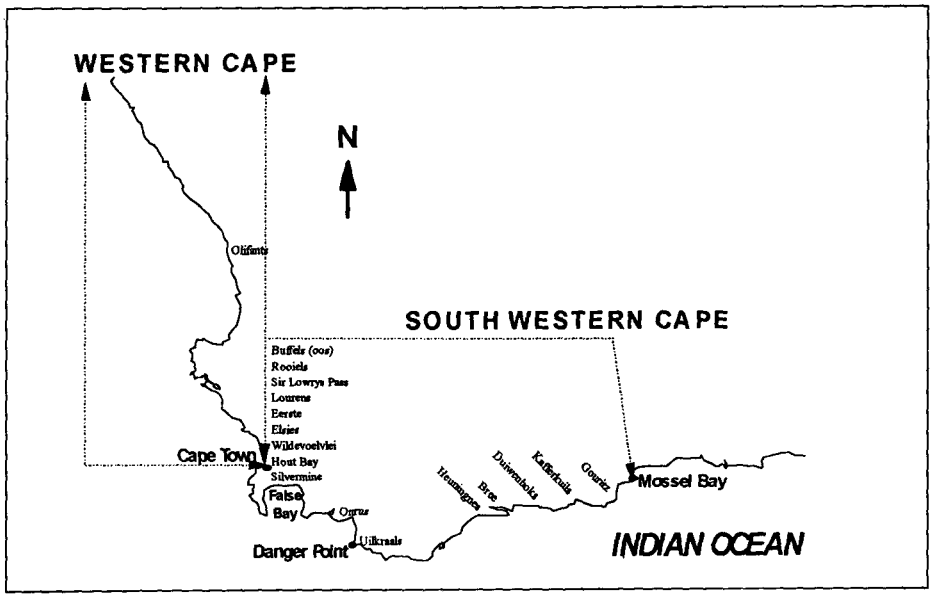

Figure 1
A diagrammatic representation of the West and South-Western Cape. The approximate location of the estuaries used in the scoring system is shown.

This study focused on the botanical importance of Cape estuaries from the Quko (double mouth) Estuary on the south-east coast, to the Olifants Estuary on the west coast (Figs. 1 to 3). The estuaries were rated according to their importance within the

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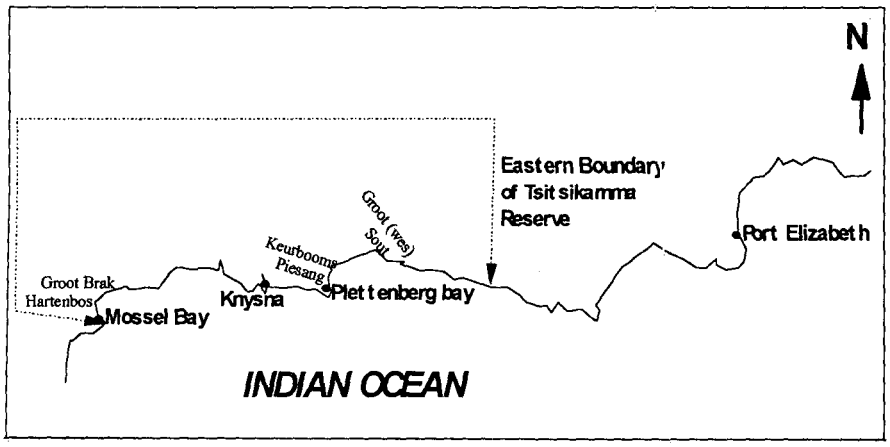

Figure 2
A diagrammatic representation of the Southern Cape region. The approximate location of the estuaries used in the scoring system is shown.

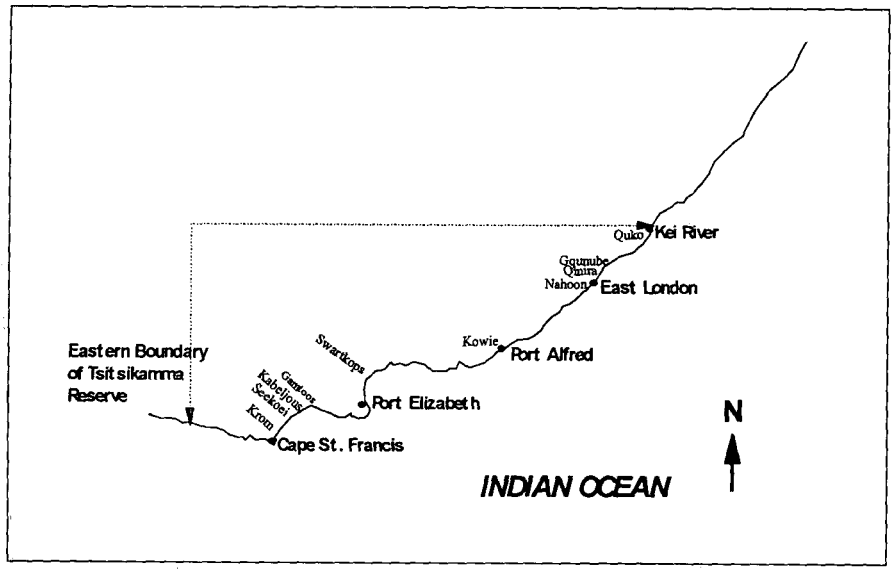

Figure 3
A diagrammatic representation of the South-Eastern Cape region. The approximate location of the estuaries used in the scoring system is shown.

Cape region, their regional importance as well as against other estuaries of their type (i.e. temporarily or permanently open). Only temporarily and permanently open estuaries were considered. Estuarine lakes and estuarine bays (e.g. Knysna and Wilderness, Whitfield, 1992) were excluded from the study. Estuarine lakes and bays are unique with respect to their physical, morphological and biological features. Because these types only occur in very few places they should in any event enjoy an especially high conservation status and shouldn't require to be included in a scoring system designed to categorise similar estuaries. Temporarily and permanently open estuaries on the other hand, have a large diversity of form and structure. The extent and type of plant communities present differ and therefore, the botanical importance and conservation status of these estuaries will also differ.

The morphology of an estuary can restrict the establishment of estuarine plant communities resulting in an estuary receiving a low botanical importance score. Whitfield (1995) classified the condition of the Quko and Sout Estuaries as excellent i.e. the estuaries are in a near pristine condition with negligible human impact on either the estuary or catchment. These estuaries should therefore receive a high conservation status. However these estuaries received low botanical importance scores as they are surrounded by steep banks and the estuarine vegetation is sparse. For this reason it is important that not only the final score be considered but also the components from which it is derived.

Methods

The botanical importance rating of estuaries was determined using the scoring system described in Coetzee et al., (1995 in press). This system indicates which estuaries are botanically important and the reasons for their importance. Factors used in the botanical scoring of estuaries were; plant community area cover, condition (degree of impact), association with the estuary and plant community richness.

The importance score for each estuary is the arithmetic sum of these four factors. The principle behind the scoring was, the greater the area cover of a plant community, the fewer impacts associated with a community and the greater the

TABLE 1
THE PLANT COMMUNITY TYPES

Plant communities	Dominant species
Supratidal salt marshes	*Suaeda fruticosa, Sarcocornia pillansii, Atriplex vestita, Disphyma crassifolium*
Intertidal salt marshes	*Sarcocornia perennis, S. decumbens, Triglochlin bulbosa, T. striata, Spartina maritima, Chenolea diffusa, Cotula coronopifolia*
Submerged macrophyte beds	*Zostera capensis, Ruppia cirrhosa*
Reed and sedge communities	*Phragmites australis, Juncus kraussii, Scirpus littoralis*

number of communities (i.e. community richness), the higher the final score. The four plant communities considered are listed in Table 1.

The information required for the importance scores, i.e. area cover of plant communities and the impacts affecting plant communities, was obtained from the Estuarine and Coastal Research Unit's (ECRU) "*Estuaries of the Cape, Part II*" reports and from field visits. ECRU have since been incorporated into EMATEK (Division of Earth, Marine and Atmospheric Science and Technology) (Wiseman et al., 1993). Although these reports are generally descriptive and aim to be understood by non-scientists (Wiseman et al., 1993), they provide the most coherent form of information available on individual Cape estuaries. The estuaries for which scores were calculated are listed in Table 2.

The formula developed (Coetzee et al., 1995) for the calculation of the final botanical score for each estuary was as follows:

$$1(A_{supra} \times MF) + 1.75(A_{inter} \times MF) + 2(A_{subm} \times MF) + 1.5\,(A_{reed} \times MF)$$

where:

A_{supra} = area cover of supratidal salt marsh
A_{inter} = area cover of intertidal salt marsh.
A_{subm} = area cover of submerged macrophytes
A_{reed} = area cover of reeds and sedges
MF = multiplication factor (plant community condition)
2, 1.75, 1.5, 1 = community importance values based on association with the estuary.

A cover score of either 20, 40, 60, 80 or 100 was assigned to each plant community. The higher the area cover the higher the score. If a site visit to the estuary confirmed the presence of a plant community for which an area was not provided in the ECRU reports then the community was allocated a cover score of 20.

The multiplication factor (MF) is determined from the number of impacts affecting each community, the greater the number of impacts the lower the multiplication factor. The cover score is multiplied by the multiplication factor to obtain a single score for each plant community. This number is then multiplied by the community importance value.

Plant communities were assigned an importance value according to its association with the estuary. Because of their close association with the water, submerged macrophytes (*Zostera* and *Ruppia*) were regarded as the most important plant community (importance value = 2). In addition they support more diverse and abundant invertebrate and juvenile fish communities than soft-bottomed habitats and marshes (Whitfield, 1984; 1989; Fredette et al., 1990; Connolly, 1994). Primary productivity of submerged macrophyte beds is also very high and on par with the most productive plant habitats in marine and terrestrial ecosystems (Day, 1981; Fredette et al., 1990). Intertidal salt marshes were regarded as the second most important plant community (importance value = 1.75). Although they also perform most of the functions associated with submerged macrophytes, they do not support as wide a variety of faunal species (Fredette et al., 1990). Both the submerged macrophyte and intertidal salt marsh communities are important with respect to water-column processes and produce considerable amounts of plant detrital matter (Allanson, 1982; Whitfield, 1988).

Salt marshes are important inorganic and organic nutrient sources for estuaries but the degree of tidal flushing is important in determining how much of the nutrient is released into the water column (Childers and Day, 1990). A supratidal marsh with little tidal flooding would be less important with respect to nutrient exchange than an intertidal marsh or submerged macrophyte bed. For this reason supratidal salt marshes were given the lowest importance value (importance value = 1) as they are rarely flooded and seldom in contact with the water column. Reedswamps and sedge communities were assigned an importance value of 1.5. These wetlands act as natural biological filters, they are important for bank stabilisation and contribute to the diversity of aquatic life (particularly avifauna).

The botanical importance scores for the different estuaries were calculated using the formula described. Because a wide range of scores was obtained, the scores were normalised to make the differences easier to conceptualise. The estuary with the highest score was regarded as having a score of 100 and the rest were ranked as a percentage of the highest score. Mangroves would be an additional estuarine plant community but were excluded as they only occur naturally in subtropical estuaries north of the Quko and Kei Rivers. When the study is extended to include subtropical estuaries and mangrove communities, the method of score normalisation will require manipulation.

The botanical importance rating is presented according to the three categories: "all Cape", "regional" and "estuary type" (i.e. temporarily and permanently open estuaries). The regional importance rated the estuaries within four climatic and rainfall regions (Table 3 and Figs. 1 to 3).

TABLE 2
THE ESTUARIES USED FOR THE BOTANICAL IMPORTANCE RATING TOGETHER WITH THEIR ESTUARIES OF THE CAPE REPORT NUMBERS, CSIR REPORT NUMBERS, INDEX NUMBERS AND THE AUTHOR AND YEAR OF PUBLICATION

Estuary report #	CSIR report #	Estuary #	CSIR index	Author(s) & year
7*	406	Gamtoos	CMS 48	Heinecken (1981)
8*	407	Rooiels	CSW 10	Heinecken (1982a)
9*	408	Uilkraals	CSW 17	Heydorn & Bickerton (1982)
10*	409	Kowie	CSE 10	Heinecken & Grindley (1982)
11*	410	Hartenbos	CMS 1	Bickerton (1982)
12*	411	Buffels (wes), Elsies, Sir Lowrys Pass, Steenbras, Buffels (oos)	CSW 1, 2, 8, 9 & 11	Heinecken et al. (1982)
13*	412	Silvermine	CSW 3	Heinecken (1982b)
16*	415	Eerste	CSW 6	Grindley (1982)
17*	416	Lourens	CSW 7	Cliff & Grindley (1982)
19*	418	Groot (wes) & Sout	CMS 23 & 22	Morant & Bickerton (1983)
20*	419	Groot Brak	CMS 3	Morant (1983)
21*	420	Breë	CSW 22	Carter (1983)
23*	422	Swartkops	CSE 3	Baird et al. (1986)
24*	423	Onrus	CSW 14	Heinecken & Damstra (1983)
25*	424	Heuningnes	CSW 19	Bickerton (1984)
26*	425	Olifants	CW 10	Morant (1984)
27*	426	Wildevoëlvlei/Noordhoek	CW 28	Heinecken (1985)
29*	428	Hout Bay	CW 27	Grindley (1988)
31*	430	Keurbooms/Bitou & Piesang	CMS 19 & 18	Duvenage & Morant (1984)
33*	432	Krom, Seekoei & Kabeljous	CMS 45, 46 & 47	Bickerton & Pierce (1988)
34*	433	Kafferkuils & Duiwenhoks	CSW 24 & 23	Carter & Brownlie (1990)
38*	437	Gouritz	CSW 25	Heydorn (1989)
39*	438	Quko	CSE 56	Burns et al. (1988)
42*	441	Nahoon, Qinira, Gqunube	CSE 44, 45 & 46	Wiseman et al. (1993)

TABLE 3
REGIONAL DIVISIONS ALONG THE CAPE COAST

Region	Boundaries	Climate
Western Cape	Orange River to Cape Town	dry
South-Western Cape	Cape Town to Mossel Bay	winter rainfall
Southern Cape	Mossel Bay to Tsitsikamma	all year rainfall
South-Eastern Cape	Tsitsikamma to Kei mouth	bimodal rainfall

Results

Tables 4 to 7 show the final formula scores and the breakdown of the scoring components for each estuary. The presentation of tables showing the allocation of points is essential as an estuary can achieve a score for different reasons. The final score should therefore be considered in relation to its component scores.

TABLE 4

THE SCORING COMPONENTS USED TO OBTAIN THE FINAL SCORE FOR EACH ESTUARY FOR THE FALSE BAY AND SURROUNDING ESTUARIES. THE COVER SCORE IS GIVEN FOR EACH COMMUNITY. THE MULTIPLICATION FACTOR (MF) INDICATES THE CONDITION OF THE COMMUNITY. EACH COMMUNITY IS ALLOCATED AN IMPORTANCE VALUE. THE FINAL SCORE IS OBTAINED FROM THE ADDITION OF EACH PLANT COMMUNITIES' SCORE AFTER MULTIPLICATION WITH THE IMPORTANCE VALUE. SUPRATIDAL SALT MARSHES WERE ABSENT IN THE ESTUARIES LISTED BELOW.

	Hout Bay	Rooi-els	Wilde-voël	Silver-mine	Elsies	Sir Lowrys Pass	Lourens	Eerste	Buffels Oos
Supratidal									
< 5 %									
5 - 25 %									
25 - 50 %									
50 - 75 %									
>75 %									
MF									
Intertidal									
< 5 %									
5 - 25 %			40.0					40.0	
25 - 50 %									
50 - 75 %									
>75 %								1.0	
MF			1.0						
Reedswamps									
< 5 %						20.0			
5 - 25 %							40.0		
25 - 50 %	60.0	60.0	60.0					60.0	
50 - 75 %					80.0				80.0
>75 %				100.0					
MF	0.5	2.0	2.0	0.5	1.0	1.0	0.5	0.5	2.0
Submerged macrophytes									
< 5 %		20.0							
5 - 25 %									
25 - 50 %									
50 - 75 %									
>75 %									
MF		2.0							
Cover score X importance value									
Supratidal salt marsh									
Importance value									
								40.0	
Intertidal salt marsh			40.0					1.75	
Importance value			1.75					**70.0**	
			70.0						
Reedswamps	30.0	120.0	120.0	50.0	80.0	20.0	20.0	30.0	160.0
Importance value	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	45.0	**180.0**	**180.0**	**75.0**	**120.0**	**30.0**	**30.0**	**45.0**	**240.0**
Submerged macrophytes		40.0							
Importance value		2.0							
		80.0							
Final score	**45.0**	**260.0**	**250.0**	**75.0**	**120.0**	**30.0**	**30.0**	**115.0**	**240.0**

TABLE 5

THE SCORING COMPONENTS USED TO OBTAIN THE FINAL SCORE FOR EACH ESTUARY FOR THE SOUTH-WESTERN CAPE REGION. THE COVER SCORE IS GIVEN FOR EACH COMMUNITY. THE MULTIPLICATION FACTOR (MF) INDICATES THE CONDITION OF THE COMMUNITY. EACH COMMUNITY IS ALLOCATED AN IMPORTANCE VALUE. THE FINAL SCORE IS OBTAINED FROM THE ADDITION OF EACH PLANT COMMUNITIES' SCORE AFTER MULTIPLICATION WITH THE IMPORTANCE VALUE. "20*" INDICATES THOSE COMMUNITIES FOR WHICH AREAS WERE NOT AVAILABLE AND WERE THEREFORE ALLOCATED TO THE LOWEST CLASS.

	Olifants	Heuning-nes	Uilkraal	Onrus	Breë	Duiwen-hoks	Kafferkuils	Gourits
Supratidal								
< 5 %						**20***	**20***	
5 - 25 %								40.0
25 - 50 %	60.0	60.0						
50 - 75 %			80.0					
>75 %								
MF	1.0	1.0	1.0			2.0	1.0	1.0
Intertidal								
< 5 %								
5 - 25 %					40.0			
25 - 50 %	60.0					60.0	60.0	
50 - 75 %								
>75 %								
MF	2.0				2.0	2.0	1.0	
Reedswamps								
< 5 %		20.0	**20***		**20***		**20***	**20***
5 - 25 %	**20***							
25 - 50 %								
50 - 75 %								
>75 %				100.0				
MF	2.0	2.0	2.0	1.0	2.0		2.0	2.0
Submerged macrophytes								
< 5 %	**20***	**20***				**20***	**20***	**20***
5 - 25 %								
25 - 50 %								
50 - 75 %								
>75 %								
MF	2.0	2.0				2.0	2.0	2.0
Cover score X importance value								
Supratidal salt marsh	60.0	60.0	80.0			40.0	20.0	40.0
Importance value	1.0	1.0	1.0			1.0	1.0	1.0
	60.0	**60.0**	**80.0**			**40.0**	**20.0**	**40.0**
Intertidal salt marsh	120.0				80.0	120.0	60.0	
Importance value	1.75				1.75	1.75	1.75	
		210.0				**140.0**	**210.0**	**105.0**
Reedswamps	40.0	40.0	40.0	100.0	40.0		40.0	40.0
Importance value	1.5	1.5	1.5	1.5	1.5		1.5	1.5
	60.0	**60.0**	**60.0**	**150.0**	**60.0**		**60.0**	**60.0**
Submerged macrophytes	40.0	40.0				40.0	40.0	40.0
Importance value	2.0	2.0				2.0	2.0	2.0
	80.0	**80.0**				**80.0**	**80.0**	**80.0**
Final score	**410.0**	**200.0**	**140.0**	**150.0**	**200.0**	**330.0**	**265.0**	**180.0**

TABLE 6

THE SCORING COMPONENTS USED TO OBTAIN THE FINAL SCORE FOR EACH ESTUARY FOR THE SOUTHERN CAPE REGION. THE COVER SCORE IS GIVEN FOR EACH COMMUNITY. THE MULTIPLICATION FACTOR (MF) INDICATES THE CONDITION OF THE COMMUNITY. EACH COMMUNITY IS ALLOCATED AN IMPORTANCE VALUE. THE FINAL SCORE IS OBTAINED FROM THE ADDITION OF EACH PLANT COMMUNITY SCORE AFTER MULTIPLICATION WITH THE IMPORTANCE VALUE.

	Groot Brak	Harten-bos	Sout	Groot Wes	Piesang	Keur-booms	Krom	Gamtoos
Supratidal								
< 5 %			20.0	20.0		**20***		
5 - 25 %							40.0	
25 - 50 %	60.0	60.0						60.0
50 - 75 %								
>75 %								
MF	1.0	1.0	2.0	2.0		2.0	1.0	2.0
Intertidal								
< 5 %								**20***
5 - 25 %	40.0	40.0				40.0	40.0	
25 - 50 %								
50 - 75 %								
>75 %								
MF	1.0	1.0				1.0	0.5	2.0
Reedswamps								
< 5 %						**20***	**20.0**	20.0
5 - 25 %	40.0			40.0				
25 - 50 %					60.0			
50 - 75 %								
>75 %								
MF	2.0			2.0	1.0	2.0	2.0	2.0
Submerged macrophytes								
< 5 %	**20***	**20***				**20***	**20.0**	
5 - 25 %								
25 - 50 %								
50 - 75 %								
>75 %								
MF	1.0	1.0				2.0	1.0	
Cover score X importance value								
Supratidal salt marsh	60.0	60.0	40.0	40.0		40.0	40.0	120.0
Importance value	1.0	1.0	1.0	1.0		1.0	1.0	1.0
	60.0	**60.0**	**40.0**	**40.0**		**40.0**	**40.0**	**120.0**
Intertidal salt marsh	40.0	40.0				40.0	20.0	40.0
Importance value	1.75	1.75				1.75	1.75	1.75
	70.0	**70.0**				**70.0**	**35.0**	**70.0**
Reedswamps	80.0			80.0	60.0	40.0	40.0	40.0
Importance value	1.5			1.5	1.5	1.5	1.5	1.5
	120.0			**120.0**	**90.0**	**60.0**	**60.0**	**60.0**
Submerged macrophytes	20.0	20.0				40.0	20.0	
Importance value	2.0	2.0				2.0	2.0	
	40.0	**40.0**				**80.0**	**40.0**	
Final score	**290.0**	**170.0**	**40.0**	**160.0**	**90.0**	**250.0**	**175.0**	**250.0**

TABLE 7

THE SCORING COMPONENTS USED TO OBTAIN THE FINAL SCORE FOR EACH ESTUARY FOR THE SOUTH-EASTERN CAPE REGION. THE COVER SCORE IS GIVEN FOR EACH COMMUNITY. THE MULTIPLICATION FACTOR (MF) INDICATES THE CONDITION OF THE COMMUNITY. EACH COMMUNITY IS ALLOCATED AN IMPORTANCE VALUE. THE FINAL SCORE IS OBTAINED FROM THE ADDITION OF EACH PLANT COMMUNITY SCORE AFTER MULTIPLICATION WITH THE IMPORTANCE VALUE.

	Seekoei	Kabeljous	Swartkops	Kowie	Nahoon	Qinira	Gqunube	Quko
Supratidal								
< 5 %	20.0		**20***	**20***				
5 - 25 %		40.0						
25 - 50 %								
50 - 75 %								
>75 %								
MF	1.0	2.0	1.0	2.0				
Intertidal								
< 5 %					40.0		40.0	40.0
5 - 25 %				60.0				
25 - 50 %			80.0					
50 - 75 %								
>75 %								
MF			0.5	1.0	1.0		2.0	2.0
Reedswamps								
< 5 %	20.0	20.0	**20***		**20***		**20***	
5 - 25 %						60.0		
25 - 50 %								
50 - 75 %								
>75 %								
MF	2.0	2.0	2.0		2.0	1.0	2.0	
Submerged macrophytes								
< 5 %			20.0	**20***	**20***		**20***	
5 - 25 %		40.0						
25 - 50 %	60.0							
50 - 75 %								
>75 %								
MF	1.0	2.0	0.5	1.0	1.0		2.0	
Cover score X importance value								
Supratidal salt marsh	20.0	80.0	20.0	40.0				
Importance value	1.0	1.0	1.0	1.0				
	20.0	**80.0**	**20.0**	**40.0**				
Intertidal salt marsh			40.0	60.0	40.0		80.0	80.0
Importance value			1.75	1.75	1.75		1.75	1.75
			70.0	**105.0**	**70.0**		**140.0**	**140.0**
Reedswamps	40.0	40.0	40.0		40.0	60.0	40.0	
Importance value	1.5	1.5	1.5		1.5	1.5	1.5	
	60.0	**60.0**	**60.0**		**60.0**	**90.0**	**60.0**	
Submerged macrophytes	60.0	80.0	10.0	20.0	20.0		40.0	
Importance value	2.0	2.0	2.0	2.0	2.0		2.0	
	120.0	**160.0**	**20.0**	**40.0**	**40.0**		**80.0**	
Final score	**200.0**	**300.0**	**170.0**	**185.0**	**170.0**	**90.0**	**280.0**	**140.0**

TABLE 8
BOTANICAL IMPORTANCE RATING FOR ALL CAPE ESTUARIES. THE FORMULA SCORES ARE FOLLOWED BY THE NORMALISED SCORES. THE ECOLOGICAL CONDITION OF EACH ESTUARY (WHITFIELD, 1994) IS GIVEN IN THE LAST COLUMN. * INDICATES ESTUARIES THAT RECEIVED LOW BOTANICAL IMPORTANCE SCORES BECAUSE OF THE LACK OF ESTUARINE VEGETATION.

	Formula score	Normalised score	Whitfield rating
Olifants	**410**	100	Good
Duiwenhoks	**330**	80	Excellent
Kabeljous	**300**	73	Good
Groot Brak	**290**	71	Fair
Gqunube	**280**	68	Good
Kafferkuils	**265**	65	Good
Rooiels	**260**	63	Good
Keurbooms	**250**	61	Good
Gamtoos	**250**	61	Fair
Wildevoelvlei	**250**	61	Good
Buffels Oos	**240**	59	Good
Seekoei	**200**	49	Poor
Breë	**200**	49	Good
Heuningnes	**200**	49	Good
Kowie	**185**	45	Fair
Gouritz	**180**	44	Good
Krom	**175**	43	Fair
Swartkops	**170**	41	Fair
Nahoon	**170**	41	Fair
Hartenbos	**170**	41	Poor
Groot Wes	**160**	39	Good
Onrus	**150**	37	Poor
Quko*	**140**	34	Excellent
Uilkraal	**140**	34	Fair
Elsies	**120**	29	Poor
Eerste	**115**	28	Poor
Piesang	**90**	22	Fair
Qinira*	**90**	22	Good
Silvermine	**75**	18	Poor
Hout Bay	**45**	11	Poor
Sout*	**40**	10	Excellent
Sir Lowrys Pass	**30**	7	Poor
Lourens	**30**	7	Poor

Importance rating for all Cape estuaries

In the following text the estuary score is presented in brackets after the name of the estuary. The actual formula score is given first, followed by the normalised score.

Table 8 shows the importance rating for all the estuaries considered and the condition of each estuary as described by Whitfield (1995). The estuary with the highest score was the Olifants (410, 100), a permanently open estuary on the west coast. The estuaries with the lowest scores were two temporarily open False Bay estuaries, Lourens and Sir Lowry's Pass (30, 7; Plate 1). The Olifants obtained a high score as it has extensive marshes in the lower reaches that have not been impacted. Community diversity was also high as all four estuarine plant communities were present. The Duiwenhoks (330, 80) a permanently open estuary, had the second highest score. Three estuarine plant communities were represented which had few impacts associated with them.

Eleven estuaries had normalised scores above 50. Within these eleven estuaries there was good representation of both temporarily and permanently open estuaries. The Kabeljous (300, 73) a small temporarily open estuary, had the third highest score. It is a dynamic system which frequently opens depending on the rainfall of the region. It has extensive submerged macrophyte beds when water levels are high, as well as intertidal salt marshes and reedbeds (Adams et al., 1992).

The Groot Brak (290, 71) Estuary is perceived to have a number of impacts associated with it, mostly related to effluent seepage into the estuary (Morant, 1983; Slinger et al., 1994). Despite this it received a high botanical importance score. The

Plate 1
Sir Lowry's Pass Estuary which flows into False Bay received the lowest botanical importance score

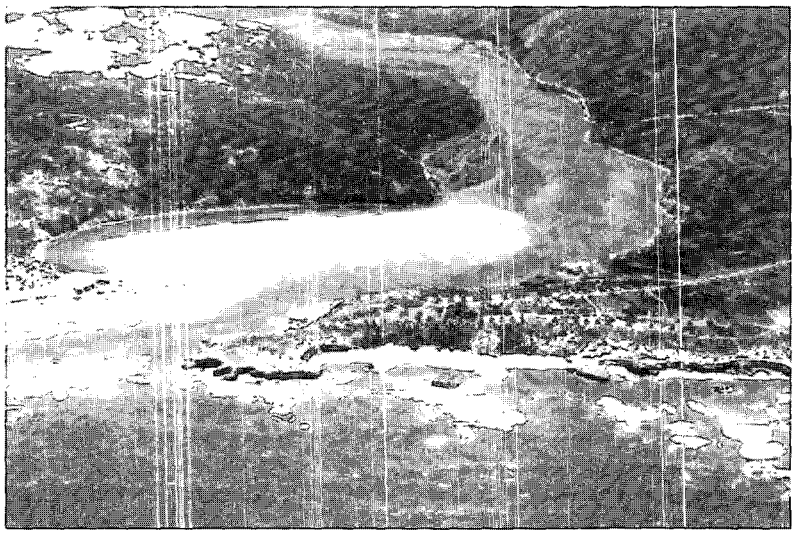

Plate 2
The Duiwenhoks Estuary had the highest botanical importance score in the South-Western Cape region

TABLE 9
REGIONAL BOTANICAL IMPORTANCE RATING. THE FORMULA SCORE IS FOLLOWED BY THE NORMALISED SCORE

Region 1			Region 2			Region 3			Region 4		
Olifants	**410**	100	Duiwenhoks	**330**	100	Groot Brak	**290**	100	Kabeljous	**300**	100
			Kafferkuils	**265**	80	Keurbooms	**250**	86	Gqunube	**280**	93
			Rooiels	**260**	79	Hartenbos	**170**	59	Gamtoos	**250**	83
			Wildevoël	**250**	76	Groot W	**160**	55	Seekoei	**200**	67
			Buffels Oos	**240**	73	Piesang	**90**	31	Kowie	**185**	62
			Breë	**200**	61	Sout	**40**	14	Gouritz	**180**	60
			Heuningnes	**200**	61				Krom	**175**	58
			Onrus	**150**	45				Swartkops	**170**	57
			Uilkraal	**140**	42				Nahoon	**170**	57
			Elsies	**120**	36				Quko	**140**	47
			Eerste	**115**	35				Qinira	**90**	30
			Silvermine	**75**	23						
			Hout Bay	**45**	14						
			S.L.Pass	**30**	9						
			Lourens	**30**	9						

TABLE 10
THE ESTUARY TYPE BOTANICAL IMPORTANCE RATING.
THE FORMULA SCORE IS FOLLOWED BY THE NORMALISED SCORE

Permanently open			Temporarily open		
Olifants	**410**	100	Kabeljous	**300**	100
Duiwenhoks	**330**	80	Groot Brak	**290**	97
Gqunube	**280**	68	Rooiels	**260**	87
Kafferkuils	**265**	65	Wildevoël	**250**	83
Keurbooms	**250**	61	Buffels Oos	**240**	80
Gamtoos	**250**	61	Seekoei	**200**	67
Breë	**200**	49	Hartenbos	**170**	57
Heuningnes	**200**	49	Groot W	**160**	53
Kowie	**185**	45	Onrus	**150**	50
Gouritz	**180**	44	Quko	**140**	47
Krom	**175**	43	Uilkraal	**140**	47
Swartkops	**170**	41	Elsies	**120**	40
Nahoon	**170**	41	Eerste	**115**	38
Sout	**40**	10	Piesang	**90**	30
			Qinira	**90**	30
			Silvermine	**75**	25
			Hout Bay	**45**	15
			S.L.Pass	**30**	10
			Lourens	**30**	10

high score can be attributed to the large marsh areas in the lower reaches which have few visible impacts associated with them. All four estuarine plant communities were also present. Blooms of filamentous green macroalgae have long been associated with eutrophic conditions (Josselyn and West, 1985). Such blooms occur in the Groot Brak estuary and have been shown to adversely impact the social acceptability of water (Huizinga, 1994).

The condition of the Quko (140, 34) and Sout (40, 10) estuaries was rated as excellent by Whitfield (1995). Although these estuaries are in a botanically pristine undisturbed state they did not receive a high botanical score as the estuarine vegetation is sparse and only one estuarine plant community is represented. These systems are surrounded by steep banks with thick terrestrial coastal thicket vegetation up to the water's edge. The morphology of the estuary can therefore limit botanical diversity of an estuary. The two estuaries with the lowest score, the Lourens and Sir Lowry's Pass (30,7) flow into False Bay. These estuaries are in poor condition and rehabilitatory steps would be necessary to restore any botanical significance to them.

Regional importance rating

Table 9 lists the botanical importance scores for the different regions. The Olifants Estuary (410, 100) received the highest score in the Western Cape as it was the only estuary considered in this region. The estuary with the highest score in the South Western Cape was the Duiwenhoks (330, 100). In the Southern Cape, the Groot Brak Estuary (290, 100) had the highest score. The estuary with the second highest score, the Keurbooms (250, 86), is an important recreational estuary near Plettenberg Bay. In the South-Eastern Cape, the Kabeljous Estuary had the highest score. Two of the larger estuaries in this region, the Krom (175, 58) and Swartkops (170, 57) had lower scores than other smaller systems along the coast. Although these estuaries are characterised by extensive intertidal salt marshes and *Zostera capensis* beds, their botanical importance is decreased by numerous residential and industrial impacts which are associated with them. The significance of their large estuarine plant areas is therefore decreased by a low condition score.

Estuary-type score

The permanently open estuary with the highest score was the Olifants (410, 100) and the Sout near Natures Valley had the lowest score (40, 10) (Table 10). Examples of heavily impacted permanently open estuaries include the Kowie (185, 45) and Nahoon (170, 41) estuaries. Impacts in the Kowie Estuary include hard engineering structures such as the marina on a wetland area near the mouth and the canalisation of the estuary course in the lower reaches. Trampling, as a result of bait digging and livestock grazing, has severely impacted the largest marsh in this estuary.

The Nahoon Estuary in East London on the South-Eastern Cape coast, is impacted as a result of close residential proximity, decreased freshwater inflow and effluent discharge. The estuarine plant communities cover small areas and consequently receive low cover scores which were further decreased by the low condition score.

The two temporarily open estuaries with the highest scores were the Kabeljous (300, 100) and Groot Brak (290, 97). As already mentioned two False Bay estuaries, Lourens and Sir Lowry's Pass (30, 10) received the lowest score (Table 9). The estuaries in the False Bay area generally obtained low scores, with the exception of the Rooiels (260, 87), Wildevoëlvlei (250, 83) and Buffels (Oos) (240, 80). These three estuaries are located away from the dense residential areas which surround the other estuaries. Although these estuaries are small with low community richness and low community area cover, the absence of

impacts affecting the communities increased the cover score and improved the final score. Of the 10 temporarily open estuaries with scores below 50, seven occur in the area of False Bay and surroundings. These estuaries are severely impacted as a result of residential and industrial proximity. Rehabilitatory steps would be necessary to restore any botanical significance to them.

Discussion

The botanical importance scores highlighted estuaries with important botanical features e.g. the Kabeljous. The importance of the Kabeljous Estuary could be overlooked because it is not very large nor important from a recreational point of view. However, it is a good example of a dynamic temporarily open estuary and the condition of its plant communities is reflected in its high score. The Rooiels and Wildevoëlvlei were two other small estuaries that obtained high botanical importance values. In a separate study by O'Callaghan (1990), the Rooiels received the highest conservability rating, because there has been little human impact on this system.

The Olifants achieved the highest botanical importance score in this study. Two other studies have also indicated its importance (Turpie, 1995; Harrison et al., 1994a; b). Turpie (1995) ranked the Olifants amongst the top 10 estuaries important for waterbird conservation in South Africa. In Harrison et al. (1994a; b) it achieved the highest score in their estuarine health index (EHI) survey of the west coast. The estuarine health index is based on biological health (assessment of fish community), water quality and aesthetic condition of an estuary (Harrison et al., 1994a). The Olifants is an example where three indices, looking at different parameters, can be combined to decide the importance of the estuary.

Management of estuaries inevitably requires trade-offs and it is recognised that not all estuaries are equally important. Certain estuaries have little ecological value and enjoy low priority when water is scarce, whilst others would be regarded as being so important that they would be allocated water in almost any circumstances. The botanical importance rating indicates which estuaries are worthy of receiving a high conservation status and would need existing freshwater flows in order to maintain their importance. A management plan for these estuaries should then be developed. The scoring method helps in this management plan by indicating which botanical communities are present. Different plant communities will have different freshwater requirements. A permanently open estuary which has large brackish communities needs freshwater to maintain the brackish environment. In other estuaries freshwater is needed to keep the mouth of the estuary open and intertidal marsh areas tidally flushed (Adams and Bate, 1995).

The present botanical importance rating has a few limitations. For example estuarine microalgal communities were not considered. Estuaries which have a strong freshwater inflow and a pronounced salinity gradient up the length of the estuary, e.g. the Gamtoos, are capable of supporting a rich phytoplankton community (Adams and Bate, 1994). Lack of knowledge on the phytoplankton communities, however, is a major limiting factor to their inclusion into a botanical importance rating at this stage. Mangroves were also excluded from the botanical importance rating as subtropical estuaries where mangroves occur were not considered. It is recommended that the botanical importance rating is revised to include estuaries north of the Kei River and a fifth estuarine plant community i.e. mangroves. The botanical importance rating does not extract the socio-economic importance of an estuary. For example in the Groot Brak Estuary, effluent discharge creates adverse socio-economic impacts as unsightly macroalgal blooms form when the mouth is closed. The Groot Brak Estuary still received a high botanical importance score as all four estuarine plant communities considered were present and in fair condition.

Only a small number of estuaries were used in this botanical importance rating. There are 127 permanently and temporarily open Cape estuaries. Thirty-three estuaries were used in this study as these were the only systems that had consistent botanical data available. There is an urgent need to extend this botanical importance rating by including further estuaries as this method can be successfully used by water planning managers, scientists and conservationists to determine the overall importance of individual estuaries. In addition, a clear statement regarding the condition of any estuary may result in local residents pushing for improvements.

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