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The ecology of the False Bay estuarine environments, Cape, South Africa. 1. The coastal vegetation

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ABSTRACT

The vegetation in and around eleven estuaries flowing into False Bay was surveyed during 1980 and 1981. Use was made of colour aerial photographs and a combination of dominance and phytosociological techniques. Of the communities established, three are aquatic and four are described as emergent or wetlands. Of the terrestrial communities, five are described as fynbos and four occur on coastal sands. One community consists solely of alien plants. The communities thus classified generally compare well with those discussed by other workers in the area. However, differences due to the destruction and disturbance of the vegetation are commented upon.

UITTREKSEL

'n Opname van die plantegroei in en rondom elf riviermondings wat in Valsbaai invloei, is gedurende 1980 en 1981 gemaak. Kleurfotos en 'n kombinasie van dominansie- en fitososiologiese tegnieke is gebruik. Van die gemeenskappe waarvan die teenwoordigheid vasgestel is, is drie akwaties en vier word as vleilande beskryf. Van die landgemeenskappe, word vyf as fynbos beskryf en vier kom op kussand voor. Een gemeenskap bestaan slegs uit uitheemse plante. Die gemeenskappe aldus geklassifiseer, vergelyk goed met dié wat deur ander werkers in die gebied bespreek word. Verskille wat egter aan die vernietiging en versteuring van die plantegroei toegeskryf kan word, word bespreek.

INTRODUCTION

An urban landscape (village, town, city) can be seen as a functional system requiring major inputs and outputs (energy, commodities, waste) to remain viable (Bartowski 1982). Rivers which traverse this system often provide convenient intra- and inter-system transport routes for these inputs and outputs. Rivers and other wetland areas are therefore in great demand and often over-utilized in urban environments. The loss of natural functioning of wetlands is an indication of the conservation mindedness of, or quality of planning by, the developers. Degradation of urban wetlands is usually due to: 1, alteration of hydrological régime; 2, reduction of the quality of water; 3, physical destruction of the system or parts thereof (Day 1987).

A river typically flows through a number of different environmental zones. Within each zone, local factors (for example flow rate, water depth, substrate) can vary considerably, resulting in a variety of wetland types along the river (seeps, bogs, emergent wetlands, submerged wetlands, swamps, vleis)(O'Keefe 1986).

It is generally accepted (see for example Goodman 1987) that wetlands function to improve the quality of the riverine environment (sediment trapping, flood attenuation, nutrient sink, production of food). The variety of wetland ecosystems found along a river should ensure that the riverine and related environments at the end of its course have a high quality. This can be seen by the high productivity estimates for estuaries in numerous texts (e.g. Whittaker 1970). However, even though wetlands are resilient in response to natural disturbance, they are susceptible to human influence. Furthermore, the man-induced effects on the functioning of a riverine ecosystem are cumulative as one proceeds down the river course. Any deterioration of the riverine ecosystem will be reflected in the quality of the estuarine environment. This is shown in the present study by analysing the vegetation in and around the estuaries of False Bay.

STUDY AREA

False Bay (Cape, South Africa) is a large square-shaped bay with open access to the sea (Figure 1). The eastern and western sides of the Bay are bound by the Hottentots Holland and Cape Peninsula mountain ranges respectively

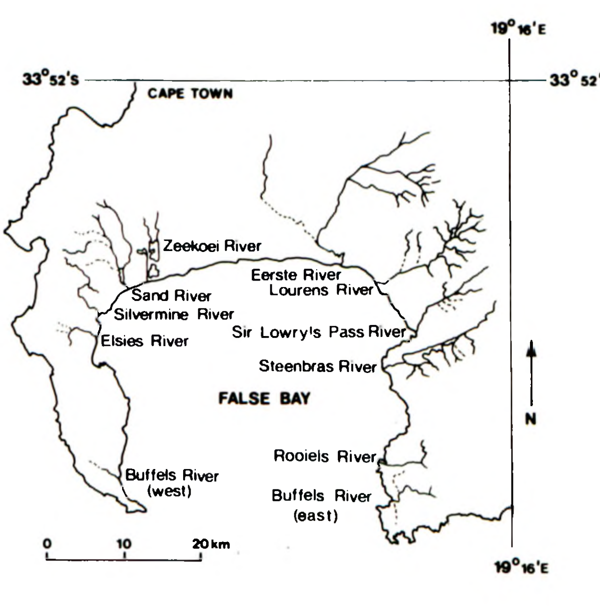

FIGURE 1.—The location of the rivers entering False Bay.

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and the northern shore is formed by the low sandy Cape Flats. The coastline, from Cape Point to Cape Hangklip, is approximately 121,5 km long.

The natural vegetation consists of mountain fynbos communities on sandstone-derived soils, particularly on the western and eastern sides of the Bay. The Cape Flats consist predominantly of calcareous sand supporting strandveld vegetation (Taylor 1980).

Many factors affect the Bay, some of which were discussed at a seminar entitled 'The future management of False Bay' (Gasson 1980). Pressures are being placed on the False Bay environment in the form of utilization by an ever-increasing local population for recreation, residence and industry; and by encroaching alien plants, especially Australian acacias. As such, there is need for well-planned management policies. However, available data are not sufficient for a complete understanding of the diversity and functioning of the False Bay environment. The formulation of well-planned management policies for this Bay is limited by the absence of adequate environmental data (Gasson 1980).

According to the 1:50 000 Topographical Sheets (3418AB & AD; 3418BA; 3418BB; 3418BD), eleven named rivers flow into False Bay. They are, from west to east (Figure 1): Buffels (West) (34°19'S; 18°28'E); Elsies (34°10'S; 18°26'E); Silvermine (34°07'S; 18°27'E); Sand (34°05'S; 18°28'E); Zeekoe (34°06'S; 18°30'E); Eerste (34°05'S; 18°46'E); Lourens (34°06'S; 18°49'E); Sir Lowry's Pass (34°09'S; 18°52'E); Steenbras (34°12'S; 18°49'E); Rooiels (34°18'S; 18°49'E); Buffels (East) (34°20'S; 18°50'E).

Much information concerning the biotic and abiotic features of these rivers has been published by Bickerton (1982), Cliff & Grindley (1982), Grindley (1982), Heinecken (1982a,b), Heinecken *et al.* (1982), Morant & Grindley (1982). The catchment area of these rivers exceeds 1100 km^2 and the mean annual run off is estimated as 200×10^6 m^3/y. Residential and industrial effluent from at least six sewage works and an unknown number of storm water systems discharge into False Bay via these rivers. The rivers contain a number of dams, especially in the Hottentots Holland Mountain area, and water is extracted directly from some of the rivers for irrigation. They also receive runoff from farms, containing fertilizers, pesticides and other farm wastes. The Kuils River summer flow consists almost entirely of treated sewage effluent. Although the vegetation of False Bay has been discussed (Taylor 1980), no mention has been made of the vegetation in and around the estuaries.

METHODS

Physiographic/physiognomic units were demarcated on colour aerial photographs of 1979 (University of Natal Job 326/79) for each of the 11 river mouths. In total, approximately 83,6 ha was studied. The area studied at each river mouth varied from 3,1 ha (Elsies) to 25,8 ha (Sand). Each study site was selected to include aquatic, littoral and terrestrial vegetation.

The vegetation was sampled during 1980 and 1981. Relevés were not used. Each physiographic/physiognomic unit was regarded as a sampling unit. The sampling units were therefore not artificially bound, but each consisted of an entire physiographic/physiognomic unit. Where necessary, physiographic/physiognomic units were combined or further divided to obtain some degree of uniformity in the vegetation of each sampling unit.

The dominant and prominent species were recorded for each unit, together with a Braun-Blanquet cover-abundance value (see Braun-Blanquet 1965) for each recorded species. These floristic data were sorted by tabulation into communities using the TABSORT suite of computer programs (Boucher 1977).

RESULTS

Sampling units and vegetation types

A total of 301 species was recorded from 81 sampling units. Of these, 60% had a single occurrence in the data set. Undersampled vegetation types were not resampled. Of those species that occurred more than once, one could not be identified to the species level. In total, 44 specimens could not be identified to the species level.

Fourteen of the sampling units contained only one species. These monospecific communities were confined to submerged aquatics, emergent reeds and alien shrubs.

Table 1 is a summary of the vegetation types found. The name of each vegetation type was selected for the sake of convenience only, usually according to the two dominant species. A complete list of species and sorted phytosociological tables are available on request.

The average numbers of species recorded for each vegetation type were: Submerged Aquatic Communities, 1,0; Emergent and Wetland Communities, 5,2; *Cassine barbara* Communities, 20,2; Non-littoral Dune Communities, 14,8; Littoral Dune Communities, 6,5.

Vegetation maps of each river mouth were prepared, but have been published elsewhere (Bickerton 1982; Cliff & Grindley 1982; Grindley 1982; Heinecken 1982a,b; Heinecken *et al.* 1982; Morant & Grindley 1982).

DESRIPTION OF COMMUNITIES

(Note that alien plants are not mentioned in the description of the communities. They are discussed separately under 3.3)

1 *Submerged Aquatic Communities*

Three aquatic species were recorded in the study area: *Potamogeton pectinatus*, *Ruppia cirrhosa* and *R. maritima*. Each of these species forms monospecific stands and these should be regarded as distinct communities. *Potamogeton pectinatus* forms tall dense subsurface stands in fresh to slightly brackish waters. *Ruppia* spp. are found in shallower water: *R. maritima* forms sparse communities

TABLE 1.—Names of communities and the rivers at which they occur

Community	Rivers
1 Submerged Aquatic Communities	4 10 11
1.1 *Potamogeton pectinatus* Submerged Community	4
1.2 *Ruppia cirrhosa* Submerged Community	10
1.3 *Ruppia maritima* Submerged Community	4 11
2 Emergent and Wetland Communities	1 2 3 4 5 6 7 8 10 11
2.1 *Phragmites australis* Emergent Community	3 4 6 7 10 11
2.2 *Paspalum vaginatum* Wetland Community	2 3 6 7
2.3 *Scirpus maritimus* Mixed Community	4 6 8
2.4 *Typha capensis* Emergent Community	1 2 5 7
3 Terrestrial Communities	1 2 3 4 5 6 7 8 9 10 11
3.1 *Cassine barbara* Fynbos Communities	9 10
3.1.1 *C. barbara–Leucodendron salignum* Dry Mountain Community	9 10
3.1.1.1 *L. salignum–Thamnochortus gracilis* Mountain Community	9
3.1.2 *C. barbara–Polygala myrtiflora* Coastal Community	10
3.1.3 *C. barbara–Rhus lucida* Riparian Community	9 10
3.1.3.1 *R. lucida–Pelargonium angulosum* Riparian Community	9 10
3.2 *Tetragonia decumbens* Coastal Sand Communities	1 2 3 4 5 6 7 8 10 11
3.2.1 *T. decumbens–Sideroxylon inerme* Mature Hind-dune Community	3 6 11
3.2.2 *T. decumbens–Senecio halimifolius* Moist Dune Community	4 5 6 11
3.2.3 *T. decumbens–Metalasia muricata* Mid-dune Community	1 2 3 4 5 6 7 10 11
3.2.4 *T. decumbens–Agropyron distichum* Fore-dune Community	3 5 6 7 8 10 11
3.3 *Acacia cyclops* Monospecific Community	1 2

Rivers: 1 = Buffels (west); 2 = Elsies; 3 = Silvermine; 4 = Sand; 5 = Zeekoe; 6 = Eerste; 7 = Lourens; 8 = Sir Lowry's Pass; 9 = Steenbras; 10 = Rooiels; 11 = Buffels (east).

in areas of weak salinity; *R. cirrhosa* requires higher salinities and can form relatively dense stands. Within this study area, aquatic plants were found only at Sand, Rooiels and Buffels (East). These systems are either very large (Sand) or relatively undisturbed. If the study areas were increased to extend along the rivers, it is likely that submerged aquatics would also be found in some of the other systems.

It should be noted that the aquatic environments are dynamic and imposed management procedures which affect these communities are ongoing in these estuaries (Bickerton 1982; Cliff & Grindley 1982; Grindley 1982; Heinecken 1982a,b; Heinecken *et al.* 1982; Morant & Grindley 1982).

1.1 *Potamogeton pectinatus* Submerged Community: this community was found only at Sand where it is confined mainly to the middle reaches of the vlei. It thrives in this brackish to fresh, nutrient-rich water to form dense meadows that are 'managed' by weed cutting (Morant & Grindley 1982).

1.2 *Ruppia cirrhosa* Submerged Community: this species is restricted to the shallow areas above the road bridge at the Rooiels River.

1.3 *Ruppia maritima* Submerged Community: these communities are found at the Sand and the Buffels (East) Rivers, to a depth of 800 mm in clear water.

2 *Emergent and Wetland Communities*

The only truly tidal estuary along the False Bay coast is found at the Steenbras River. The other estuaries have strong fluvial input during winter and the mouths usually close during summer. However, the banks of the Steenbras River are covered by boulders, and wetland vegetation does not occur. All the other estuaries have wetland communities which, to some extent, reflect the prevailing water régimes. All the wetlands are poorly developed and most show signs of disturbance. They generally contain only one or a few species and do not display zonation patterns. Two of the communities have a tall emergent growth form and two may be flooded seasonally or tidally.

2.1 *Phragmites australis* Emergent Community: *Phragmites australis* usually forms monospecific stands, up to 2,5 m tall, on substrates where silt deposition occurs. This species grows optimally in water with a salinity of less than 15 °/oo, although it can withstand higher salinities (Benfield 1984).

In the estuaries studied, *Phragmites* forms a fairly dense stand at the Rooiels River with other wetland species such as *Chenolea diffusa, Juncus acutis, Sarcocornia* spp., *Scirpus nodosus, Sporobolus virginicus* and *Stenotaphrum secundatum*. At the Silvermine, Sand, Eerste and Buffels (East) estuaries, *Phragmites* forms very dense monospecific stands. These emergent communities generally grow in areas away from the river mouth where there is little or no salt water penetration. They are emergent in varying water depths, especially during the rainy season, or may be exposed to some tidal fluctuation if the mouth is open.

2.2 *Paspalum vaginatum* Wetland Community: this community is found on coarse saline sands and withstands lengthy periods of inundation. It forms monospecific stands at the Elsies Estuary. At the Eerste River estuary, *Cotula coronopifolia* and *Scirpus nodosus* are found in this vegetation type, whereas at the Lourens Estuary, two communities are present, one being monospecific and the other containing various *Cliffortia* and *Cyperus* species. *Paspalum vaginatum* is regarded by some as an alien grass

(Bond & Goldblatt 1984). In some areas, this community also contains numerous alien herbs and shrubs.

2.3 *Scirpus maritimus* Mixed Community: these plants are generally found on non-saline sandy soils that contain some organic matter. Many of them survive inundation in an emergent form. At the Sand River, this community includes other Cyperaceae, *Sarcocornia natalensis, Paspalum vaginatum, Typha capensis* and *Triglochin bulbosa*. At the Sir Lowry's Pass River, *Cliffortia lanceolata, Triglochin bulbosa* and *Juncus rigidus* are included. At the Lourens River estuary, *Scirpus maritimus* forms a monospecific stand.

2.4 *Typha capensis* Emergent Community: this community is emergent in slow-running, fresh water. The species forms monospecific stands at the Elsies and Lourens estuaries, the latter being a wetland not in direct contact with riverine flow. At the Buffels (West) and Zeekoe Rivers, numerous other species such as *Samolus valerandii, Berula thunbergii, Triglochin striata, Senecio halimifolius, Scirpus nodosus, Zantedeschia aethiopica* and *Polygonum salicifolium* also occur.

3 *Terrestrial Communities*

The terrestrial vegetation comprises two basic types. The first is distinguished by the presence of *Cassine barbara* and is found on soils derived from Table Mountain Sandstone. It occurs in the mountainous areas along the eastern and western shores of the Bay. The second type of terrestrial vegetation contains *Tetragonia decumbens*. This vegetation grows on recent calcareous sands along the northern shore of the Bay and in the river valleys where this soil type has accumulated.

3.1 *Cassine barbara* Fynbos Communities: within this study area, fynbos occurs only at the Steenbras River mouth and Rooiels River mouth, predominantly on shallow sandstone soils. Boucher (1978) records *C. barbara* on littoral dunes, on limestone and in riverine scrub in the Cape Hangklip area. It would seem that this species is tolerant of a wide range of habitat factors and its value as a diagnostic species is, therefore, suspect. Nevertheless, Taylor (1969) found this species in a subassociation of upland fynbos. Other species common to this community (*Leucospermum conocarpodendron, Widdringtonia nodiflora*) help to distinguish this fynbos community.

3.1.1 *C. barbara–Leucadendron salignum* Dry Mountain Community: this community is indicative of Dry Mountain Fynbos in this area (see Boucher's (1978) community 3.2.2.1). The *L. salignum–Thamnochortus gracilis* variation (3.1.1.1) was found at the Steenbras River and seems to be a form characteristic of slightly moister conditions.

3.1.2 *C. barbara–Polygala myrtiflora* Coastal Community: this vegetation was found at the Rooiels River and does not compare well with any of Boucher's (1978) communities. It contains *Protea compacta, Phylica ericoides, Chondropetalum microcarpum* and *Myrica quercifolia*. A better sampling technique might indicate a combination of Boucher's (1978) Acid Sand Fynbos and South Coast Strandveld. However, C. Boucher (pers. comm.) suggests that, in this region, *P. compacta* does not occur naturally west of the Palmiet River Mouth and this community might be a dune/limestone community (see 3.1).

3.1.3 *C. barbara–Rhus lucida* Riparian Community: this is found in the narrow valleys of the Steenbras and Rooiels Rivers with *Psoralea pinnata, Podalyria calyptrata* and others. The *R. lucida–Pelargonium angulosum* variation (3.1.3.1) is usually found at the coastal or riverine edge of the community.

3.2 *Tetragonia decumbens* Coastal Sand Communities: these communities were found at all the rivers in this study area.

3.2.1 *T. decumbens–Sideroxylon inerme* Mature Hind-dune Community: this community was found at the Silvermine, Eerste and Buffels (East) Rivers (although it was also noted outside the boundary of the study area at the Buffels (West) River) and compares well with Boucher (1978), Taylor (1969) and Taylor (1980). The structure of this community is highly variable. In protected areas, it forms a low forest (up to 5m) with a closed canopy of *S. inerme*, generally with an open understorey of grasses, herbs and shrubs such as *Cussonia thyrsiflora* and *Chasmanthe aethiopica*. In more exposed areas, this community is usually wind-cropped to form a dense shrubland from 0,5 m to 2 m.

T. decumbens is seldom found in this community and *Ehrharta villosa* might have been a better diagnostic species for these (3.2) communities.

3.2.2 *T. decumbens–Senecio halimifolius* Moist Dune Community: this community compares well with Taylor (1980) and was found at the Sand, Zeekoe, Eerste and Buffels (East) Rivers, mainly in dune slacks and poorly drained dune areas. It varies in height from 0,8 m to 1,5 m and can contain other species such as *Scirpus nodosus, Zantedeschia aethiopica, Typha capensis, Nidorella foetida, Juncus kraussii*, as well as shrubs and herbs more typical of dune vegetation in this area.

3.2.3 *T. decumbens–Metalasia muricata* Dune Community: this community is typical of deep coastal sands where the above conditions do not prevail. Its structure varies from a relatively sparse low-growing shrubland up to 2 m. It was found on the non-littoral dunes near all the rivers except at the Steenbras where dunes do not occur. It can be subdivided into various classes and associations (see below).

3.2.4 *T. decumbens–Agropyron distichum* Fore-dune Community: this community consists of psammophilous pioneer vegetation which is commonly found on the fore-dunes. It is dominated by a sparse or open cover of grasses and herbs. It compares well with Boucher's (1978) '*Ehrharta–Ficinia* Strand Pioneers' and Taylor's (1969) 'Pioneer Mixed Dune Fynbos' to which Taylor gives the status of subassociation.

3.3 *Acacia cyclops* Monospecific Community: alien shrubs and grasses were found throughout most of the emergent, wetland and terrestrial vegetation units. *Acacia cyclops* is particularly common in the vegetation on coastal sands whereas *Pennisetum clandestinum* is found in these as well as wetland communities. Alien plants recorded (according to Bond & Goldblatt 1984) include *Acacia cyclops, A. longifolia, A. mearnsii, A. saligna, Paraserianthes lophantha* subsp. *lophantha, Ammophila arenaria, Aster subulatus, Atriplex vestita, Avena sativa, Briza maxima, Bromus diandrus, Chenopodium ambrosioides, C. murale, Datura stramonium, Eucalyptus globulus, E. lehmannii, Lagurus ovatus, Malva parviflora, Myoporum serratum, Paspalum vaginatum, P urvillei, Pennisetum clandestinum, Populus canescens, Pinus pinaster, P. pinea, Pinus* sp., *Solanum nigrum, Sonchus asper, S. oleraceus, Trapaeolum majus*, and *Urtica urens*.

Where present, these species dominate the vegetation to varying degrees; usually causing a loss in species richness and cover of the natural vegetation. At the Buffels (West) and Elsies Rivers, *A. cyclops* has, in places, ousted the natural vegetation to form monospecific stands.

TABLE 2.—List of communities within 1 km of the False Bay Coast (after Boucher 1987)

Rank	Name	Text reference
Class	*Arctothecetea populifoliae*	5.1
Order	*Arctotheco-Cladoraphietalia cyperoidis*	5.1.1
Alliance	*Cladoraphio-Hebenstretion cordatae*	5.1.1.2
Association	*Hebenstretio-Chenoleetum diffusae*	A
Class	*Ehrhartetea calycinae*	5.2
Order	*Ehrharto-Eucleetalia racemosae*	5.2.1
Alliance	*Eucleo-Ischyrolepion eleocharidis*	5.2.1.4
Association	*Ischyrolepo-Oleetum exasperatae*	A
	Ischyrolepo-Kedrostietum nanae	B
	Ischyrolepo-Iflogetum ambiguae	E
Subassociation	*typicum*	a
	koelerietosum	b
	thamnochortetosum	c
	romuleetosum	d
Association	*Ischyrolepo-Myricetum cordifoliae*	F
Subassociation	*typicum*	a
	senecietosum	b
Association	*Ischyrolepo-Cullumietum squarrosae*	G
	Ischyrolepo-Crassuletum subulatae	H
Subassociation	*typicum*	a
	pharnacetosum	b
Association	*Eucleo-Iscyrolepetum*	J
Order	*Ehrharto-Ericetalia coarctatae*	5.2.4
Alliance	*Erico-Aspalathion*	5.2.4.1
Association	*Aspalatho-Phylicetum ericoides*	A
	Aspalatho-Struthioletum salteri	B
Class	*Sarcocornietea pillansiae*	5.4
Order	*Sarcocornio-Juncetalia kraussii*	5.4.2
Association	*Junco-Chondropetaletum tectorum*	B
	Junco-Phragmitetum australis	C
Order	*Sarcocornio-Galenietalia africanae*	5.4.3
Association	*Sarcocornio-Galenietum*	A
Class	*Scirpetea nodosi*	5.6
Association	*Scirpo-Linetum africani*	A
	Scirpo-Nidorelletum foetidi	B
Class	*Polygonetea salicifoliae*	5.7
Association	*Polygono-Juncetum capensis*	A
	Polygono-Stoebetum vulgaris	B
	Polygono-Pycreetum polystachyi	C
	Polygono-Cliffortietum odoratae	D

COMPARISON OF COMMUNITIES WITH THOSE OF BOUCHER (1987)

Boucher (1987) carried out a survey of the western Cape coastal forelands. Included in his study area was a part of the False Bay coast, approximately from the Zeekoe to Eerste Rivers. The communities he found within 1 km of this coast are listed in Table 2.

From the above table, classes 5.1 and 5.2 are equivalent to coastal sand communities. Class 5.4 indicates halophytic marshes; class 5.6 indicates non-riverine (inter-dune) wetlands; class 5.7 is found along water courses.

When comparing the present study with that of Boucher's (1987) study, the following points are evident: according to Boucher (1987), the association 5.1.1.2 C is found on the dunes along this coast. This should therefore be equivalent to the above *T. decumbens–Agropyron distichum* Community. However, sampling procedures used for the present study do not allow for classification to the level of association. Also, other species in this community seem to indicate a combination of Boucher's *Cladoraphio-Hebenstretion cordatae* (5.1.1.2) alliance and an association designated *Senecioni-Ammophiletum arenariae* (5.1.1.1.A), belonging to the alliance *Cladoraphio-Senecion elegantis* (5.1.1.1). Boucher regards this last association as artificial owing to the dominance of the alien grass *Ammophila arenaria*.

The strong presence of *Metalasia muricata* in the *T. decumbens–Metalasia muricata* Community would, according to Boucher (1987), place this community in the association *Senecioni-Metalasietum muricatae* (5.1.1.1.B). This association again falls into the alliance *Cladoraphio-Senecion elegantis* (5.1.1.1) which he did not record within 100 m of the False Bay coast.

The remainder of the terrestrial dune communities along this coast were classified by Boucher (1987) as belonging to the class *Ehrhartetea calycinae* (5.2). In the present study, *Ehrharta villosa* was recorded as being co-dominant with *Tetragonia decumbens* in the dune communities. It is possible that *E. villosa* was confused with *E. calycina* in some areas. Neither *Sideroxylon inerme* nor *Cussonia thyrsiflora* were recorded by Boucher (1987). The above community described as *T. decumbens–Sideroxylon inerme* Community therefore has no counterpart in his system. Boucher *et al.* (1986) suggest that the class *Arctothecetea populifoliae* be divided into two orders: *Arctotheco-Cladoraphietalia cyperoidis* and *Arctotheco-Passerinetalia rigidae*. According to these latter authors, the geographical separation occurs at Cape Point, with the former order to the west. However, Boucher (1987) includes vegetation sampled along the False Bay coast in the former order. The differential species for these orders were not common in the present study. Considering the preponderance of *Sideroxylon inerme* and *Cussonia thyrsiflora* on the dunes of the southern and eastern Cape (pers. obs.), if this community belongs to the class 5.1, it is likely to be found in the order *Arctotheco-Passerinetalia rigidae* (Boucher *et al.* 1986), even though it was found on the western shores of the Bay. However, if *Ehrharta calycina* was misidentified (as *E. villosa*), this community might fall into the class *Ehrhartetea calycinae* (5.2).

The community found on moist dune slacks (*T. decumbens–Senecio halimifolius* Community) would belong to Boucher's (1987) class 5.6 *Scirpetea nodosi*. This class consists of two associations: *Scirpo-Linetum africanum* and *Scirpo-Nidorelletum foetidi*. The major part of the community described in this study falls within the latter association; according to Boucher, it is found near Swartklip (in the vicinity of the Eerste River). The former association seems to be poorly represented in the present study and, contrary to Boucher's (1987) findings, was found at the Buffels (East) River and not at the rivers near Mitchell's Plain.

The wetland vegetation Boucher (1987) recorded along this coast belongs to the classes *Sarcocornietea pillansiae* (5.4) and *Polygonetea salicifoliae* (5.7). The former describes halophytic salt marshes and the latter describes the vegetation fringing water courses.

The estuaries along the False Bay coast are relatively small and do not have a regular tidal fluctuation nor saline input. Halophytic wetlands are therefore poorly developed. Nevertheless, these vegetation types did occur historically (O'Callaghan 1990) and some of the species of these communities are present. Boucher's (1987) differential species *Sarcocornia pillansii* was found only at Sandvlei whereas one of his dominants, *Sporobolus virginicus*, has a wider distribution.

The emergent community described above as the *Phragmites australis* Community is recognized by Boucher (1987) as the association *Junco-Phragmitetum australis* (5.4.2.C) in the order *Sarcocornio-Juncetalia kraussii*. The *Paspalum vaginatum* Wetland Community indicates Boucher's association 5.4.2.B: *Junco-Chondropetaletum tectorum*.

The *Scirpus maritimus* Mixed Community does not have a counterpart in Boucher's system. He recorded this species only once and another species in this community (*Triglochin bulbosa*) is noted as being differential and widespread for his class 5.4.

The *Typha capensis* Emergent Community indicates the association *Junco-Nidorelletum foetidi* (5.4.2.A) in the order *Sarcocornio-Juncetalia kraussii*. However, the presence of *Polygonum salicifolium* indicates the class *Polygonetea salicifoliae*, in particular, the association *Polygono-Juncetum capensis* (5.7.A). *Typha capensis* was recorded in the present study from the inter-dune wetlands, adjacent to permanent water and alongside streams. It is therefore likely that this community represents a mixture of associations found in the classes *Sarcocornietea pillansiae* (5.4), *Scirpetea nodosi* (5.6) as well as *Polygonetum salicifoliae* (5.7), but mainly 5.6 and 5.7.

CONCLUSIONS

The studies by Boucher (1978, 1987) and Taylor (1969, 1980) were carried out in relatively pristine vegetation and over far larger areas than the present study. The communities they established are, therefore, a better indication of the natural vegetation of the area. Although the vegetation units established by the current study are generally similar to their communities, there are problems in matching, particularly with the dune and wetland vegetation types. These difficulties may be due to differences in sampling techniques, but they could also be due to disturbance and destruction of the natural vegetation in the present study area.

O'Callaghan (1990) has shown that much vegetation around these estuaries has been destroyed by residential, recreational and industrial developments. In addition, alien plants and trampling have brought about a loss of species richness and natural plant cover.

The wetland vegetation types are particularly difficult to match with those discussed by Boucher (1987). Although the above influences affect these vegetation types, additional influences such as the quality of water in the rivers and the disturbance of natural flow régimes also play a role. It seems that, where they exist, the wetlands around the rivers entering False Bay are in a poor condition.

Gasson & MacKinnon (1983) have estimated the volume of outfall entering the False Bay catchment. The domestic outfall is expected to increase from 146,525 Ml/d to 261,5 Ml/d, i.e. by 78,5% between 1982 and 1990. The volume of outfall for industrial waste was 7,34 Ml/d in 1982 and it is not unreasonable to assume that these volumes will also increase dramatically. By 1990, more than 500 Ml/d of polluted water might be flowing into False Bay, approximately 60% via the rivers.

Gasson & MacKinnon (1983) state that the standard of effluent disposal is generally above the acceptable norms set by the authorities. However, some treatment works may, at times, release effluent which is below standard (e.g. Kuils River). Furthermore, the record and control of effluent entering the rivers via routes other than through municipal treatment works is scarce.

Whether this effluent enters directly or indirectly by surface run off, it affects the vegetation around the rivers: species richness is reduced and dominance by a single species increased, which results in an increase of structural homogeneity of the wetlands around these estuaries. This, together with the physical destruction of the wetland environments for development will cumulatively affect the ecology of the estuaries and the quality of water entering the Bay. It seems that a well-planned interdepartmental management scheme (see Malan 1982) for False Bay, including catchment areas, is indicated.

REFERENCES

BARTOWSKI, T. 1982. Towns eco-geosystem versus rural geocomplex; case study of the Poznan agglomeration. In S.P. Tjallingii & A.A. de Veers, *Perspectives in landscape ecology*: 74–77. Centre for Agricultural Publication and Documentation, Wageningen.

BENFIELD, M.C. 1984. *Some factors influencing the growth of* Phragmites australis *(Cav.) Trin. ex Steudel*. M.Sc. thesis, University of Natal.

BICKERTON, I.B. 1982. Report No. 15: Zeekoe (CSW 5). In A.E.F. Heydorn & J.R. Grindley, *Estuaries of the Cape, part II: synopses of available information on individual systems*. CSIR Research Report No. 414.

BOND, P. & GOLDBLATT, P. 1984. Plants of the Cape flora—a descriptive catalogue. *Journal of South African Botany* Supplement 13.

BOUCHER, C. 1977. Cape Hangklip area. I. The application of association-analysis, homogeneity functions and Braun-Blanquet techniques in the description of south-western Cape vegetation. *Bothalia* 12: 293–300.

BOUCHER, C. 1978. Cape Hangklip area. II. The vegetation. *Bothalia* 12: 455–497.

BOUCHER, C. 1987. *A phytosociological study of transects through the western Cape coastal foreland, South Africa*. Ph.D. dissertation, University of Stellenbosch.

BOUCHER, C., LE ROUX, A. & TAYLOR, H.C. 1986 (abstract). *Strand vegetation of the Cape between the Orange and Sundays River Mouth*. Symposium on the structure and functioning of sand dune ecosystems, Port Elizabeth.

BRAUN-BLANQUET, J. 1965. *Plant sociology: the study of plant communities*. (Translated, revised & edited by C. D. Fuller & H. S. Conrad). Hafner, London.

CLIFF, S. & GRINDLEY, J.R. 1982. Report No. 17: Lourens (CSW 7). In A.E.F. Heydorn & J.R. Grindley, *Estuaries of the Cape, part II: synopses of available information on individual systems*. CSIR Research Report No. 416.

DAY, J.A. 1987. Conservation and management of wetlands in the greater Cape Town area. In R.D. Walmsley & M.L. Botten, *Ecology and conservation of wetlands in South Africa*: 185–194. CSIR Occasional Report No. 28.

GASSON, B. ed. 1980. *Proceedings of symposium on the future management of False Bay*. Cape Town.

GASSON, B. & MACKINNON, R. 1983. *False Bay catchment: sewage forecast*. CSIR Research Report C/SEA 8245.

GOODMAN, P.S. 1987. Natal Parks Board. In R.D. Walmsley, & M.L. Botten, *Ecology and conservation of wetlands in South Africa*: 30–37. CSIR Occasional Report No. 28.

GRINDLEY, J.R. 1982. Report No. 16: Eerste (CSW 6). In A.E.F. Heydorn & J.R. Grindley, *Estuaries of the Cape, part II: synopses of available information on individual systems*. CSIR Research Report No. 415.

HEINECKEN, T.J.E. 1982a. Report No. 13: Silvermine (CSW 3). In A.E. F. Heydorn & J.R. Grindley, *Estuaries of the Cape, part II: synopses of available information on individual systems*. CSIR Research Report No. 412.

HEINECKEN, T.J.E. 1982b. Report No. 8: Rooiels (CSW 10). In A.E.F. Heydorn & J.R. Grindley, *Estuaries of the Cape, part II: synopses of available information on individual systems*. CSIR Research Report No. 407.

HEINECKEN, T.J.E., BICKERTON, I.B. & MORANT, P.D. 1982. Report No. 12: Buffels (wes) (CSW 1), Elsies (CSW 2), Sir Lowry's Pass (CSW 8), Steenbras (CSW 9) and Buffels (oos) (CSW 11). In A.E.F. Heydorn & J.R. Grindley, *Estuaries of the Cape, part II: synopses of available information on individual systems*. CSIR Research Report No. 411.

MALAN, J. 1982. *The formulation of an administrative structure for the management of False Bay*. School of Environmental Studies Report No. 35, University of Cape Town.

MORANT, P.D. & GRINDLEY, J.R. 1982. Report No. 14: Sand (CSW 4). In A. E.F. Heydorn & J.R. Grindley, *Estuaries of the Cape, part II: synopses of available information on individual systems*. CSIR Research Report No. 413.

O'CALLAGHAN, M. 1990. The ecology of the False Bay estuarine environments, Cape, South Africa. 2. Changes during the last fifty years. *Bothalia* 20: 113–122.

O'KEEFE, J.H. 1986. *Ecological research on South African Rivers—a preliminary synthesis*. South African Scientific Programmes Report No. 121.

TAYLOR, H.C. 1969. *A vegetation survey of the Cape of Good Hope Nature Reserve*. M.Sc. thesis, University of Cape Town.

TAYLOR, H.C. 1980. Plant communities along the False Bay coast. In B. Gasson, *Proceedings of symposium on the future management of False Bay*: 59–67.

WHITTAKER, R.H. 1970. *Communities and ecosystems*. MacMillan, New York.