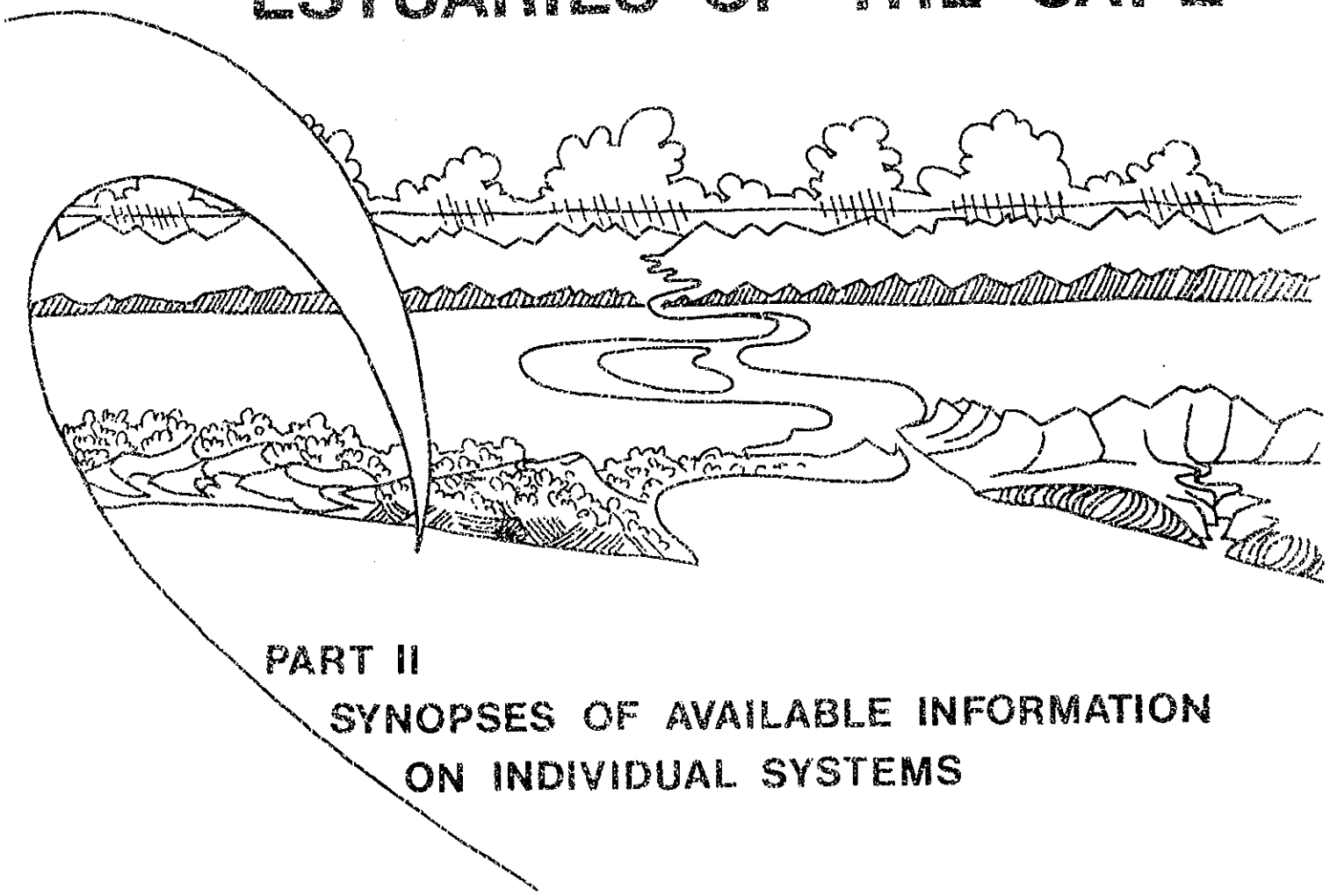
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY
ESTUARINE AND COASTAL RESEARCH UNIT - ECRU

ESTUARIES OF THE CAPE



PART II
SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

REPORT NO. 19

GROOT (WES) (CMS 23) and SOUT (CMS 22)

CSIR RESEARCH REPORT 418

Stellenbosch, South Africa
June 1983

ESTUARIES OF THE CAPE

PART II: SYNOPSES OF AVAILABLE INFORMATION ON INDIVIDUAL SYSTEMS

EDITORS:
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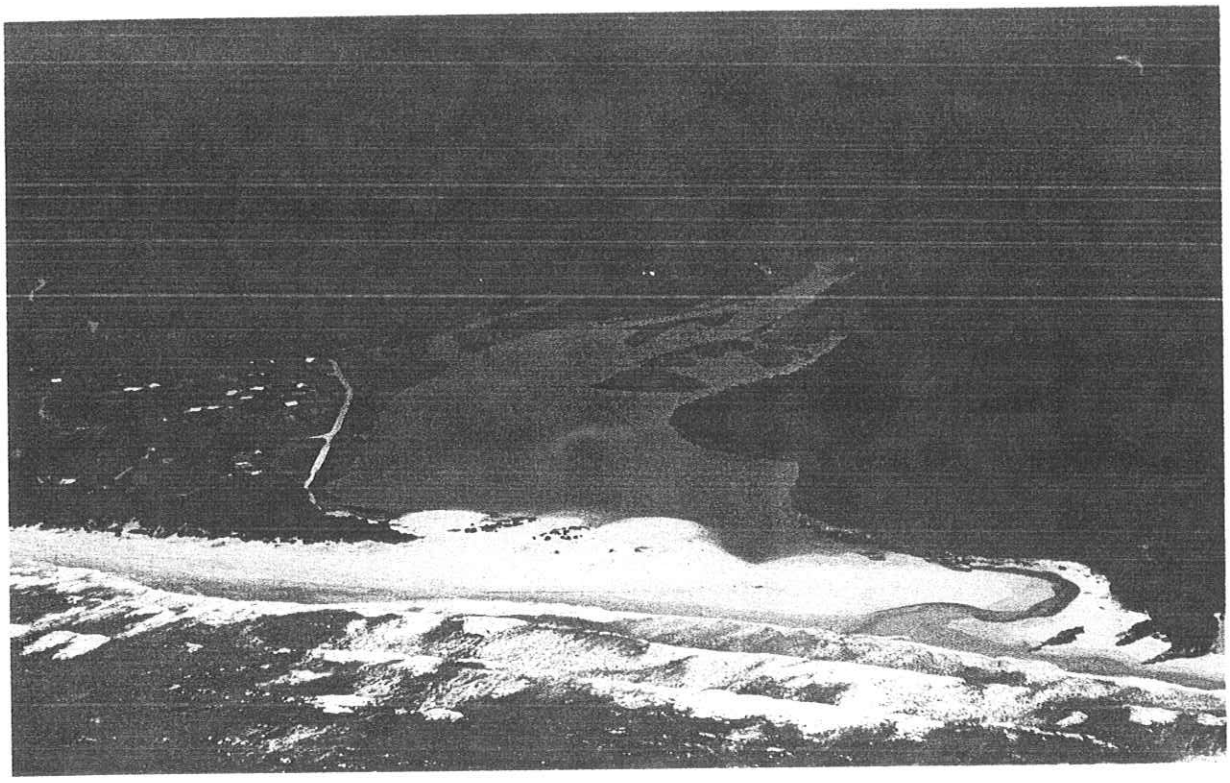

FRONTISPIECE: THE GROOT (WES) ESTUARY — ALT. 150 m, ECRU 79-10-19

REPORT NO. 19: GROOT (WES) (CMS 23) and SOUT (CMS 22)

(CMS 22, 23 — CSIR Estuary Index Number)

BY: P D MORANT and I B BICKERTON

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Stellenbosch, South Africa
June 1983

ECRU SURVEYS: 7 - 11 April 1981; 1 - 3 November 1982

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ISBN 0 7988 1812 3 (Set)
ISBN 0 7988 1813 1 (Part 2)
ISBN 0 7988 2585 5 (Rep. No. 19)

Published in 1983 by:

National Research Institute for Oceanology
Council for Scientific and Industrial Research
P O Box 320, Stellenbosch, 7600.

Printed by:

Associated Printing & Publishing Co (Pty) Ltd, Cape Town

PREFACE

The Estuarine and Coastal Research Unit (ECRU) was established by the National Research Institute for Oceanology (NRIO) of the CSIR in 1979 with the following aims:

- to contribute information relevant to the development of a cohesive management policy for the South African coastline;
- to compile syntheses of all available knowledge on the 167 estuaries of the Cape between the Kei and the Orange rivers;
- to identify gaps in information, to conduct research to fill these and to stimulate Universities, Museums and other institutions to become involved in this kind of work;
- to contribute to *ad hoc* investigations carried out by NRIO on the impacts of proposed developments in the coastal environment, and especially in estuaries.

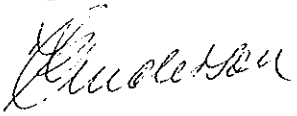
The Unit was established at the request of the Government, and the Department of Environment Affairs contributes substantially to the running costs.

In 1980 the Unit published its first report under the title "The Estuaries of the Cape, Part I - Synopsis of the Cape Coast. Natural Features, Dynamics and Utilization" (by Heydorn and Tinley)[+]. As the name of the report implies, it is an overview of the Cape Coast dealing with aspects such as climate, geology, soils, catchments, run-off, vegetation, oceanography, and of course, estuaries. At the specific request of the Government, the report includes preliminary management recommendations.

The present report is one of a series on Cape Estuaries being published under the general title "The Estuaries of the Cape, Part II". In these reports all available information on individual estuaries is summarized and presented in a format similar to that used in a report on Natal estuaries which was published by the Natal Town and Regional Planning Commission in 1978. It was found however, that much information is dated or inadequate and that the compilation of Part II reports is therefore not possible without brief prior surveys by the ECRU. These surveys are usually carried out in collaboration with the Botanical Research Institute and frequently with individual scientists who have special interest in the systems concerned. One of these is Prof JR Grindley of the University of Cape Town who is co-editor of the Part II series.

These surveys are, however, not adequate to provide complete understanding of the functioning of estuarine systems under the variable conditions prevalent along the South African coastline. The ECRU therefore liaises closely with Universities and other research institutes and encourages them to carry out longer-term research on selected estuarine systems. In this way a far greater range of expertise is involved in the programme and it is hoped that the needs of those responsible for coastal zone management at Local-, Provincial and Central Government levels can be met within a reasonable period of time.

Finally, the attempt has been made to write the Part II reports in language understandable to the layman. However it has been impossible to avoid technical terms altogether and a glossary explaining these is therefore included in each report.



FP Anderson
DIRECTOR

National Research Institute for Oceanology
CSIR

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1.1 Synonyms and Derivations

GROOTRIVIER	(1:10 000 Orthomap sheet 3323 DC 22) (1:50 000 Sheet 3323 DC, Nature's Valley)
NATURE'S VALLEY GROOTRIVIER	(1:250 000 Topographical sheet 3322 Oudtshoorn) (1:150 000 S.A. Navy chart SAN 123)
SOUTRIVIERMOND	(1:10 000 Orthomap sheet 3323DC 21/3423 BA 1) (1:50 000 Sheet 3323 DC, Nature's Valley) (1:250 000 Topographical sheet 3322 Oudtshoorn)
SALT RIVER	(Storrar, 1982)

1.2 Historical Aspects

Little is known of the early history of the area surrounding the Groot and Sout estuaries. The densely forested terrain dissected by deep gorges caused the area to be avoided by early travellers who used the inland route via the Langkloof to Algoa Bay. Lord Charles Somerset, among others, hunted elephant in the vicinity of the Grootrivier during the early 1800s (Storrar, 1982). In the 1830s and 1840s the region to the east of Knysna was penetrated by pioneers in search of timber and potential farmland. The Great Fire of 10 February 1869, which raged from Swellendam to Humansdorp, must have had an impact on the catchments of the Groot and Sout rivers. Some areas of forest were destroyed and replaced by fynbos but the extent of this replacement is unknown and is a subject of debate. The Great Fire is claimed to have made Thomas Bain's task of building the coastal road considerably easier (Palmer & Jenkins, 1978). Bain started construction of the Grootrivier Pass in 1880, completing the work in 1883. With the exception of the tarring of the road surface in 1949 and the replacement of the Grootrivier causeway with a bridge in 1950, the present road differs little from Bain's original. (D. Ackermann, C.P.A. Provincial Roads Engineer, *in litt.*).

Hendrik Barnardo, the first owner of Nature's Valley, was employed at the convict station at Bloukrans established by Thomas Bain when building the road through the Tsitsikamma region in the 1880s (Storrar, 1982). Barnardo claimed that the Grootrivier farm had been granted to his grandfather by Lord Charles Somerset for whom he had acted as beater when his Lordship came to hunt elephants in these parts (Storrar, 1982). However, according to the Deeds Office records, a Barnardo had acquired it as an "immigrant allotment". Barnardo held only the grazing rights to Nature's Valley until 1914 when the farm roughly the extent of the present township, was granted to him. In 1918 Dr Wilhelm von Bonde pursuaded Barnardo to allow him to build a shack on the lagoon near the mouth. This marked the beginning of the development of Nature's Valley as a resort. Barnardo jealously guarded the valley, conducted campers to their sites and lectured them on the depths to which latrines and

rubbish pits were to be dug. He also insisted that the indigenous trees were not to be damaged in any way (Storrar, 1982).

The nine pioneer families - "The Syndicate" bought 2,9 morgen of land facing the lagoon on its western shore in 1936. This sale was somewhat irregular since Joseph van Reenen held an option on Grootrivier farm. In 1943 the option lapsed with the death of Van Reenen and the entire valley was sold to Baron Behr for a total of £8 400. Behr laid out the township to his own design. Finally, title to the valley passed to the Nature's Valley Development Corporation in 1953 (Storrar, 1982). The Nature's Valley Development Corporation remain responsible for the development of the valley although civic affairs are in the hands of the Nature's Valley Ratepayers Assocation and the Outeniqua Divisional Council.

In 1882 the area between the Groot and Bloukrans rivers, the sea and the farm Boven Palmietsrivier was proclaimed State forest. This was followed in 1902 by the Bloukrans Forest Reserve which consists of the farms Blaauwkrantz and Honingbosch originally surveyed in 1889 by HC Fourcade, the State Surveyor. In 1974 the De Vasselot Nature Reserve was proclaimed (Government Gazette, 21 June 1974, Notice No 1053).

Storrar (1982) reports that (before the proclamation of the De Vasselot Nature Reserve) in the early 1970s a small independent Griqua community settled near the mouth of the Salt (Sout) River, hoping to make a living from the sea. The community has since dispersed.

1.3 Archaeology

The only documented archaeological site in the vicinity of the Groot and Sout rivers is the cave known as the Grootrivier shelter at Die Punt just east of the mouth of the Grootrivier (WJ van Ryssen, South African Museum Archaeological Data Recording Centre, Cape Town, *in litt.*). The midden in the cave was excavated in the early 1920s (FitzSimons, 1923, 1926).

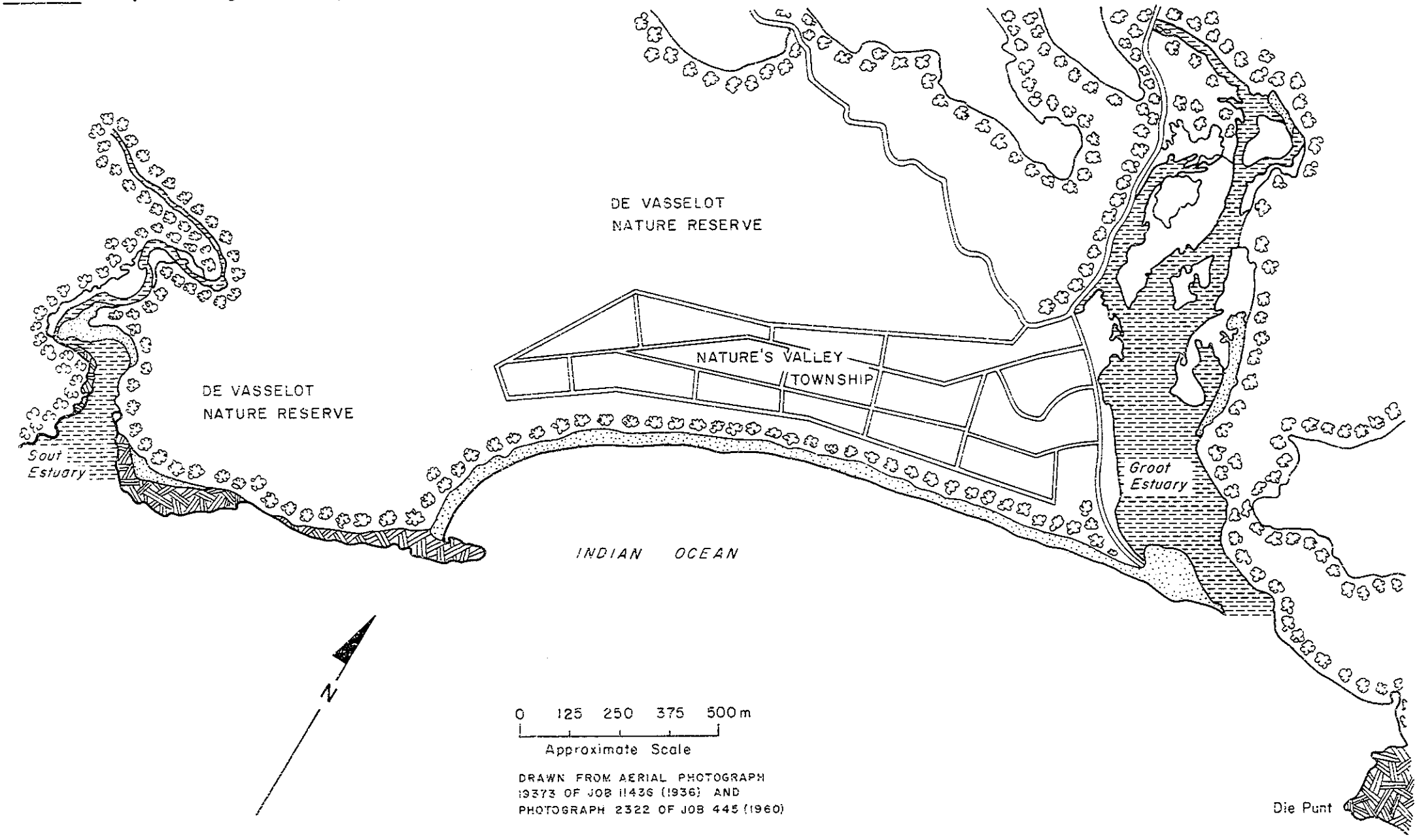
2. LOCATION

The mouth of the Groot is situated at 33°59'S; 23°34'E and that of the Sout at 33°59'S; 23°32'E.

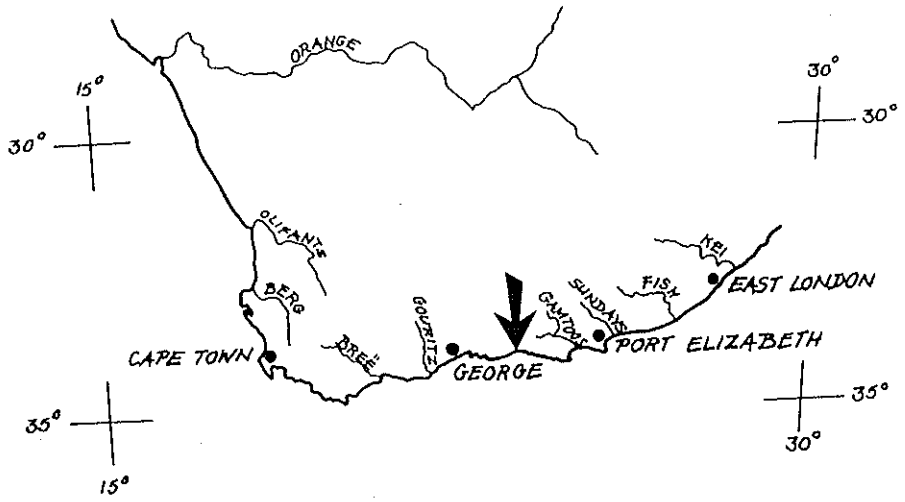
2.1 Accessibility

The Groot Estuary and Nature's Valley are situated on the National Road (N2) 34 km east of Plettenberg Bay. The Soutrivier Estuary lies 3 km west of the Groot (Figure 1). The National Road (N2) is presently being re-aligned so that it crosses the upper reaches of the Bobbejaans and Groot rivers via single-span concrete arch bridges approximately 5 km inland. This re-alignment will result in the virtual elimination of heavy traffic from the tortuous Grootrivier Pass. A branch road gives access to the Groot River estuary and Nature's Valley township on the west bank.

FIG. 1 : Map showing relative positions of Groot and Sout Estuaries.



The shores of the Sout are inaccessible by vehicle. A path runs along the shore from Nature's Valley and a track across the plateau from the National Road reaches to within 300 m of the east bank of the estuary and some 60 m above it. The Sout Estuary falls within the De Vasselot Nature Reserve. Permits are required for entry by vehicle and for fishing. No permit is necessary for entry on foot. No overnight camping is allowed on the estuary itself nor in the De Vasselot Nature Reserve.



2.2 Local Authorities

Both estuaries and their catchments fall within the boundaries of the Outeniqua Divisional Council. The bulk of the Grootrivier catchment lies in the Bloukrans Forest Reserve which consists of fynbos, natural forest, plantations and alien vegetation. The eastern shores of the Groot Estuary forms the western boundary of the Tsitsikamma Forest and Coastal National Park and the western shore south of the National Road comprises the Nature's Valley township. Most of the Soutrivier catchment and the entire estuary lie within the boundaries of the De Vasselot Nature Reserve.

3. ABIOTIC CHARACTERISTICS

3.1 River Catchment

3.1.1 Catchment Characteristics

GROOT RIVER

The area of the catchment is 87,8 km^2 (28 780 ha) (GA Robinson National Parks Board, pers. comm.); 8 680 ha (ECRU).

The rivers, Bobbejaans and Groot, feeding the Grootrivier Estuary, rise on the southern slopes of the Tsitsikamma Mountains. As the land has risen so the rivers have cut deeply into the sandstones of the elevated coastline forming the deep kloofs characteristic of the region. The river beds are rocky and contain little fine sediment.

River lengths (km)

Groot	14	
Bobbejaans	16	(to junction with Groot)
Bobbejaans tributaries	5	(major tributary entering from the west)
Total river length	35	

SOUT RIVER

The area of the catchment is 3 360 ha (ECRU).

The Soutrivier catchment lies entirely on the coastal platform. The river is short; the source is approximately 10 km in a direct line from the sea while the actual river length is 15 km (1:50 000 Sheet 3323 DC).

Geology

General geology (from Toerien, 1976)

The coastline of the Tsitsikamma region consists of a scarp about 180 m high behind which a small coastal plain, 5 km wide in the west and 8 km in the east, rises gradually to approximately 275 m at the foot of the Tsitsikamma Mountains. The mountains themselves rise to 1 675 m at the highest point, Formosa Peak. The many rivers draining from the mountains across the coastal plain to the sea have formed deeply incised narrow kloofs. The younger rivers flow directly into the sea via waterfalls dropping from the scarp.

Characteristic of the Tsitsikamma area is the well-defined wave-cut platform, with an elevation of about 150 m formed during a period of high sea level in the Tertiary (70 - 20 million years ago) when the seashore lay along the Tsitsikamma Mountains. Rising of the land exposed the wave terrace and the rivers which were rejuvenated, steadily cut deeply into the landscape behind the retreating sea. The many kloofs are evidence of a fairly rapid regression.

The straight Tsitsikamma coastline is parallel to the east-southeast strike of the Cape folded mountains. A possible strike fault in the sea along the coast could have influenced this.

The geological sequence in the Tsitsikama area:

Alluvial and aeolian sand, gravel and silicrete			Tertiary to Quaternary
Rock type	Formation	Group	Supergroup
Shale	Gydo	Bokkeveld	Cape
Sandstone, arkose	Baviaanskloof		
Sandstone, quartzite	Kouga		
Sandstone, quartzite	Tchando	Table Mountain	
Shale	Cedarberg		
Sandstone, quartzite	Peninsula		
Sandstone, quartzite phyllite	Kleinrivier	Gamtoos	

The Gamtoos Group correlates with the Malmesbury Group (ca. 550 million years old) of the western Cape. The Cape Supergroup is between 350 and 500 million years old. The Tsitsikamma forms part of a larger geological complex. The formations of the Cape Supergroup make up the Cape Fold Belt which encompasses the southern Cape from south of Namaqualand in the west to east of Grahamstown in the east. Apart from the Quaternary deposits the regional strike is east-southeast. The formations in this area are folded in a deep syncline which runs in a narrow belt through the length of the Tsitskamma.

A detailed discussion of the lithology and stratigraphy of the Tsitsikamma area is given by Toerien (1976).

Geology: *GROOT RIVER*

The following description is based on interpretation of the 1:250 000 Geological Sheet 3322 Oudtshoorn.

The Groot Estuary is underlain by Bokkeveld shales in the upper reaches while the bottom of the main body of the estuary is composed of alluvial and aeolian sands. A fault running approximately northwest-southeast along the long axis of the estuary has given rise to the higher relief on the east side of the estuary than on the west. The low western shore of the estuary consists mainly of Tertiary and Quaternary alluvial and aeolian deposits except at the head where the Gydo Formation of the Bokkeveld Group (BVG) is exposed.

The Grootrivier catchment is composed almost entirely of sandstones of the Peninsula Formation of the Table Mountain Group (TMG). The catchment contains two main streams, namely, the Grootrivier and the Bobbejaansrivier. The rivers cut through short stretches of Cedarberg Formation shales (TMG), Tchando Formation sandstones (TMG) and Baviaanskloof Formation sandstones (TMG) before reaching the Gydo Formation shales (BVG) at the head of the estuary.

On the east the estuary is bounded at the mouth by a headland, Die Punt, composed of Peninsula Formation sandstones (TMG). Moving inland on the east side the high relief continues composed successively of brownish-weathering sandstones of the Tchando Formation (TMG), quartzitic sandstones of the Kouga Formation (TMG) and feldspathic sandstones of the Baviaanskloof Formation (TMG). At the head of the estuary, where it is crossed by the National Road (N2), the rock is shale of the Gydo Formation (BVG).

Geology: *SOUT RIVER*

The following description is based on interpretation of the 1:250 000 Geological Sheet 3322 Oudtshoorn.

The estuary lies entirely in Gydo Formation shales (BVG). The upper reaches of the relatively short Soutrivier drain off Peninsula Formation sandstones (TMG) then successively off Tchando, Kouga and Baviaanskloof sandstones (all TMG) before reaching the Gydo shales of the estuary itself.

Climate and run-off

Climate

The Groot and Sout river catchments and estuaries fall into climatic region A (Schulze, 1965) which receives rain about equally in all seasons although there are peaks in autumn and spring. Rainfall in the mountains (Outeniqua and Tsitsikamma) may exceed 1 100 mm per annum. On average 8 - 12 rain days per month may be expected. The rain is mainly cyclonic and orographic. The climate is mild, frost is a very rare occurrence and hot "berg" winds are infrequent.

Average daily temperatures (Schulze, 1965)

	Max (^{o}C)	Min (^{o}C)
January	26	15
July	19	7

By South African standards this is a cloudy region but even so the yearly duration of sunshine is about 50 percent of that possible (Schulze, 1965).

Run-off

The rivers flow throughout the year, the rate of flow fluctuating with the rainfall. The driest months are May and June whereas the heaviest rainfall occurs in September. There are no gauging stations on the Groot and Sout rivers and their tributaries.

GROOT RIVER

An outgoing current of about 2 m^3/sec was recorded at the mouth on 2 November 1982 (ECRU). Usually the mouth has closed by December as a consequence of low water flow in the river and wind-and wave-transported sand building a bar at the mouth.

The estuary behind the bar fills up, ultimately breaching the mouth when sufficient pressure has developed.

However, before natural breaching occurs, the dammed-up water causes local flooding, covering the road to the beachfront and the "Syndicate" lawns, and also prevents the S.A. Transport Services bus from reaching the Nature's Valley store. At these times parts of "The Island" are inundated at its periphery and the water table is high in the middle.

SOUT RIVER

The river mouth remains open throughout the year but this is more as a result of tidal scour than of run-off.

3.1.2 Land Ownership/Uses

GROOT

Almost the entire catchments of both the Groot and Bobbejaans rivers lie within the Bloukrans State Forest which mainly consists of natural vegetation: fynbos and coastal forest. There are plantations of alien trees at the eastern and western extremities of the lower catchment. Alien acacias, mainly black wattle *Acacia mearnsii*, are present along the river and streams. The northern boundary of the De Vasselot Nature Reserve runs for part of the way along the course of the Bobbejaansrivier.

With the exception of the above-mentioned plantations there has been little human activity in the catchment. Currently the new national road (N2) is being constructed approximately 5 km inland. This involves the construction of two clear-span concrete arch bridges over the gorges of the Bobbejaans and Groot rivers. Rubble from the construction has fallen into the beds of the two rivers. Obstruction to water flow has been minimal since the rubble was swept downstream by the flood of April 1981 (G Pretorius, Regional Director of Forestry, Humansdorp, pers. comm.).

SOUT

Most of the catchment lies within the De Vasselot Nature Reserve. The reserve is open to day hikers and sport fishermen (permit required). No overnight camping is permitted. Previously, coloured fishermen operated their boats from the Sout Estuary. The northern part of the catchment lies in the Keurbooms Forest Reserve. Also within the catchment is Kurland Estate which includes a sawmill.

3.1.3 Obstructions

GROOT

A small weir or "dammetjie", supplying water to Nature's Valley township, is situated about 200 m upstream from the present National Road bridge. This road bridge and the remains of an old causeway on its seaward side effectively form the upper limit of tidal exchange in the Groot Estuary.

Temporary obstruction has been caused by dead alien acacia trees *(Acacia mearnsii* and *A. melanoxylon)* being swept down by floods and jamming against the road bridge. These alien trees are ringbarked as part of an eradication programme conducted by the Directorate of Forestry. The log jam, formed during the April 1981 flood caused the floodwaters to sweep through the Forestry camping site to a depth of approximately one metre. The floodwater continued along the length of "The Island" and thence into the estuary.

SOUT

No known obstructions exist on the Sout.

3.1.4 Siltation

Since the rivers mainly drain off hard sandstones there is little sediment transport. The water is characteristically a clear dark brown (peat-stained) colour.

3.1.5 Abnormal flow patterns

Since the Groot and Sout river systems lie in a region which receives rainfall throughout the year, the river flow can be expected to fluctuate moderately. High levels will occur in autumn and spring and low levels in June/July and December. The well-vegetated catchment also assists in moderating run-off and hence flow.

Flooding of the Grootrivier does occur, as was illustrated by the flood of April 1981, but besides inundating the low-lying areas of Nature's Valley e.g. Lagoon Drive, "The Island" and the "Syndicate" lawns, flooding has proved to have been little more than an inconvenience. The mouth, if closed, is usually breached by floodwaters thereby draining the estuary. The flood of April 1981 was aggravated by the damming-back of the floodwaters behind the log jam against the National Road bridge. Currently "The Island" is undeveloped and thus flooding is no problem. However, should houses be built there (as proposed) the floods would pose a not inconsiderable threat to the properties.

There is no information on the flood regime of the Soutrivier.

3.2 Estuary

3.2.1 Estuary Characteristics

GROOT

The estuary is approximately 2 km in length from the National Road to the mouth and 300 - 400 m wide at the widest point. The estuary is narrow at the head, broadest in the middle and narrows again at the mouth. The western shore (Nature's Valley) is low-lying and prone to flooding, whereas the eastern shore is bounded by hills dropping steeply to the water's edge (Figure 2).

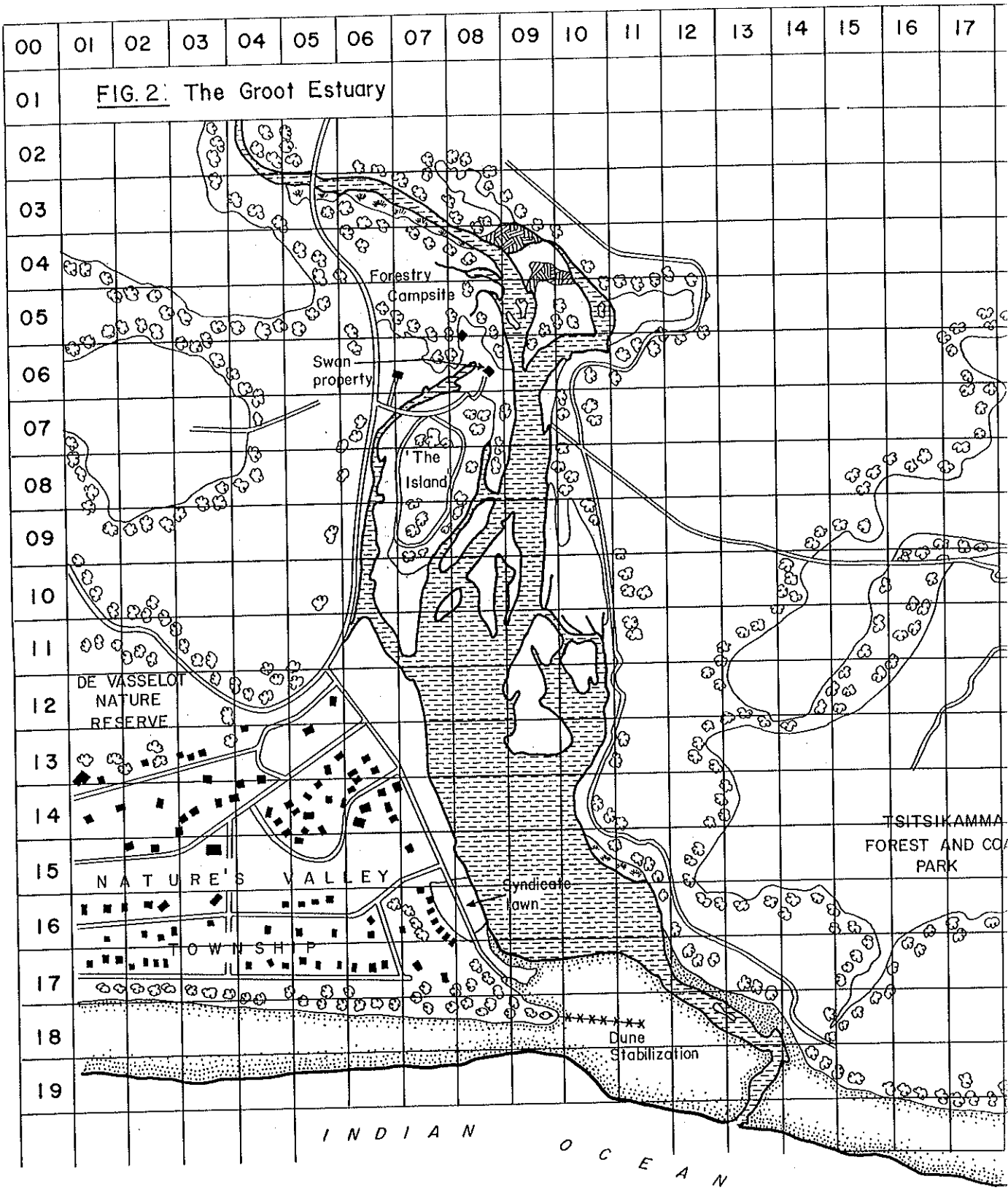


FIG. 2: The Groot Estuary
Forestry Campsite
Swan property
The Island
DE VASSELOT NATURE RESERVE
NATURE'S VALLEY
TOWNSHIP
Syndicate lawn
Dune Stabilization
INDIAN OCEAN
TSITSIKAMMA FOREST AND CO PARK
LEGEND
Open water
Open sand
Grass floodplain
Indigenous forest
Rocks
Roads
N
0 100 200 300 400 500m
Approximate Scale
DRAWN FROM AERIAL PHOTOGRAPH 169 OF JOB 374 (1980)
Die Punt

SOUT

The Soutrivier Estuary is gorge-like with steep slopes dropping from the coastal plateau to the shores of the estuary. The river valley emerges from a narrow gorge about 700 m from the sea and widens to about 100 m in width before entering the sea via a cove bounded by rocky headlands (Figure 3).

Bathymetry and Bottom materials

GROOT

The average depth of the estuary is about one metre but depths of 2 metres were recorded (ECRU 2 November 1982) in the channel in the middle reaches (grid ref. 1307, Figure 2) and a maximum depth of 3,3 m in the upper reaches (grid ref. 0609, Figure 2). Where the river enters the estuary the bottom is rocky (Bokkeveld shales); the bottom of the middle reaches is sandy (fine to medium) with an admixture of organic material. Near the mouth the bottom consists of fine-to-medium-grained sand of marine origin mainly blown (but also wave-transported) into the estuary from the sea. The seaward end of the estuary is formed by a sand bar which is partially covered with natural vegetation and partly stabilised artificially to encourage natural vegetation cover. The mouth lies at the eastern end of the bar where it has formed a sand delta (Figure 4).

SOUT

The river is generally very shallow (0,2 - 0,3 m) with occasional pools up to 2 m deep scattered along the tidal reach. The pools contain fine sand and/or silt and decomposing wood chips from the saw mill adjacent to the National Road bridge spanning the Soutrivier.

Flow and floods

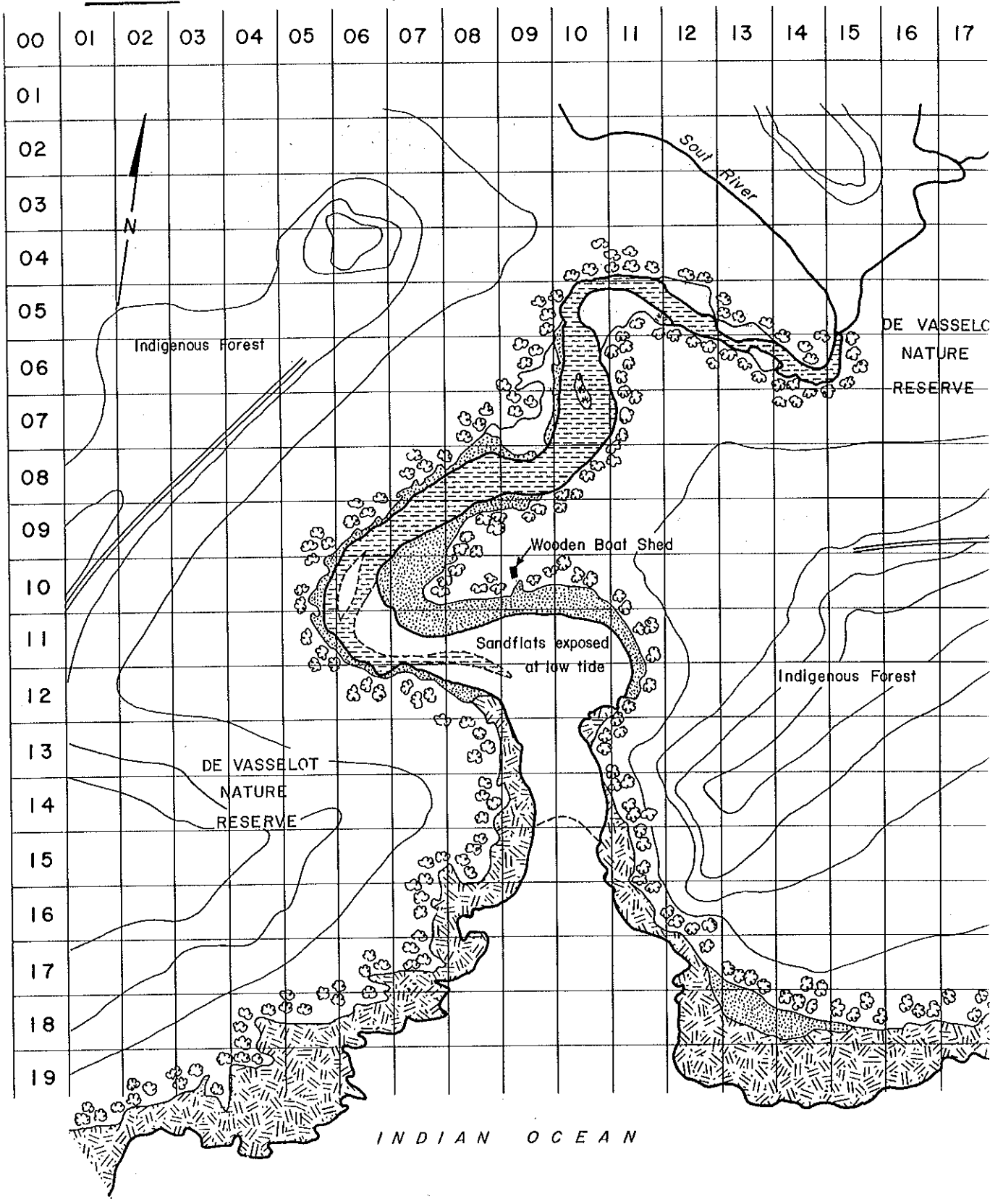
GROOT

The Grootrivier has an outflow-dominated estuary, i.e. river discharge combined with tidal outflow is stronger than the wave-supported tidal inflow, a condition which may only change during very dry summer seasons when there is a tendency for the mouth to close.

The following measurements were made during the ECRU survey of 2 November 1982.

Outgoing current during LWOST	2 m^3/s
Incoming current during HWOST	1,5 m^3/s.

FIG. 3 : The Sout Estuary



0 50 100 150 200 250m

Approximate Scale

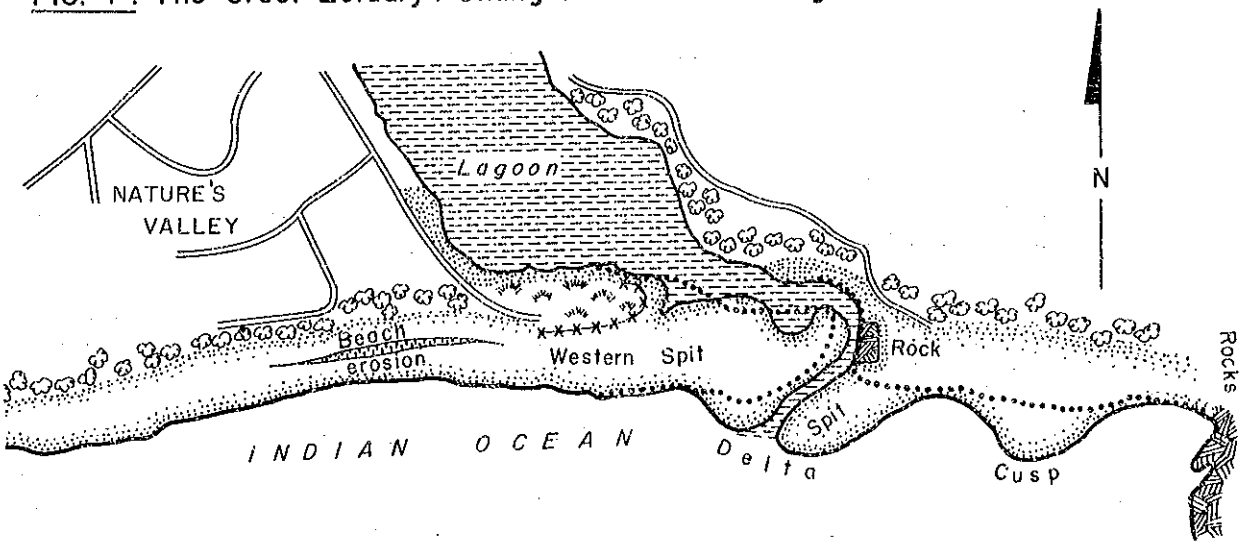
DRAWN FROM AERIAL PHOTOGRAPH
322 OF JOB 326 (1979)

LEGEND

- Open water
- Sandy beaches
- Grassy floodplain
- Indigenous forest
- Rocks
- Roads

Small-scale flooding of the low-lying area immediately to the west of the estuary, i.e. Lagoon Drive and the Syndicate lawn, occurs two or three times a year (GC Martin, a resident of Nature's Valley, pers. comm.). These floods are caused by river back-up behind the bar after closure. The mouth is opened artificially on an *ad hoc* basis by the Forester at Bloukrans Forest Reserve, usually when the water level threatens the Forestry camping site (D Gous, Regional Director, Tsitsikamma Forest Region, *in litt.*).

FIG. 4 : The Groot Estuary : Changes in mouth configuration



LEGEND

Open water

Open sand

Artificially stabilized dune

Indigenous vegetation

Roads

0 100 200 300 400 500m

Approximate Scale

Map shows the shoreline configuration as it appeared on 2 November 1982 (ECRU field survey). Dotted line indicates shoreline on 21 April 1979 (Colour aerial photograph Job No. 326 photo no. 320).

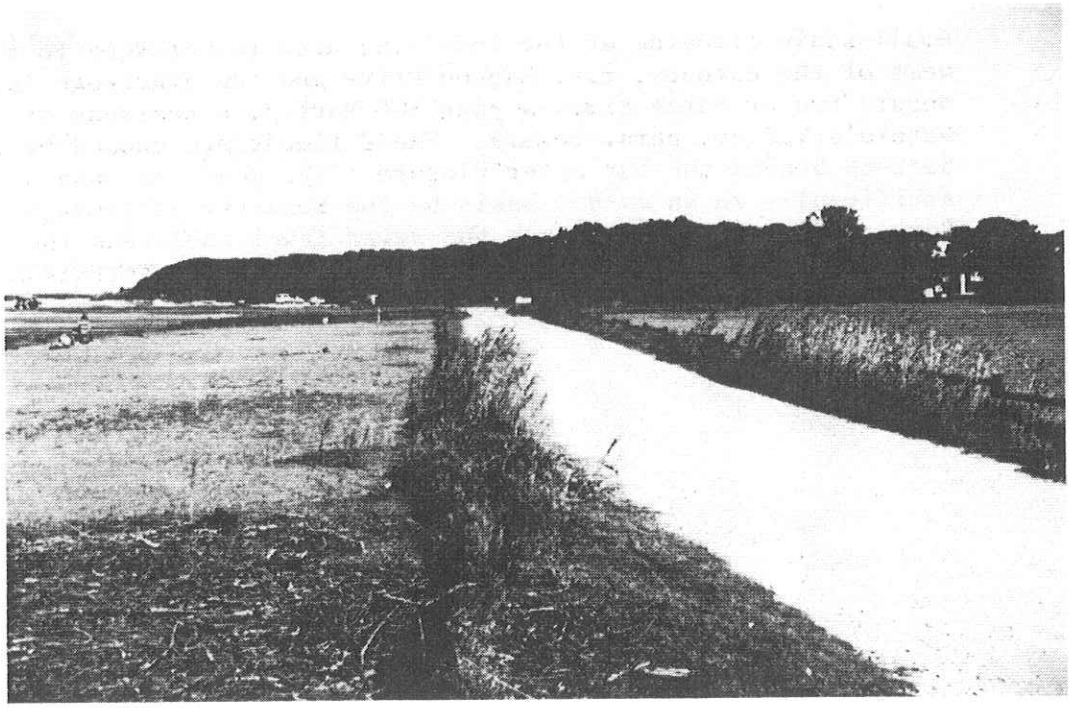


FIG. 5: The Syndicate lawn: a low lying area on the western shore of the lagoon subject to flooding (ECRU 81-04-09).

A more severe flood occurred in April 1981 when dead trees dammed flood waters behind the National Road bridge. The waters finally burst through flooding the Forestry Department camp site, "The Island" and the western shore of the estuary up to the houses. The Outeniqua Divisional Council pump houses were flooded as was the Swan property adjacent to the Forestry camping site.

SOUT

Outflow dominates inflow but at times (June/July and December) the freshwater input to the estuary is minimal. Under such conditions tidal flushing provides the only water movement in the system. The eroded river terraces (about 1 m high) show a succession of four fluviatile mud or silt layers interspersed with 50 - 100 mm thick gravel horizons indicating alternate still water and flood periods.

3.2.2 Mouth Dynamics

(This section is contributed by Dr GAW Fromme of the Sediment Dynamics Division, NRIO).

GROOT

Waves and surfzone currents

The currents in the vicinity of the Grootrivier mouth appear to be mainly wave-driven. A weak, pulsating easterly-moving current

(< 0,3 m/s) was recorded during the ECRU survey of 2 November 1982. A large tidal beach cusp was observed at the east beach but no rip-current could be observed off the cusp (Figure 4). A large flat tidal shoal or delta approximately 300 m wide (E-W) and extending 100 m seawards (N-S) is divided by the mouth channel into a large eastern and a smaller western section. There appears to be a cyclic migration of the mouth over the sand shield of the delta. When the mouth is breached after a period of closure the channel will form on the eastern side of the delta. With time, under the influence of the south-easterly waves the channel will be deflected westward until the mouth closes as a result of low outflow and infilling of the channel by wave-transported sand. The bar forming the seaward end of the estuary consists of a sandspit about 350 m long and 150 m wide at its widest (the western end). This spit deflects the channel towards the rocky embankment at the eastern shore of the estuary. Two embayments on the inner (landward) side of the sandspit indicate the possible sites of previous breachings of the spit. The spit has a "spine" of vegetation-stabilized sand and, on its south-eastern side, artificial drift sand barriers (rows of dead branches) have been erected. The material for the barriers is obtained from plots in Nature's Valley Township which have been cleared for building. These barriers have been successful in consolidating the sandspit and preventing wind- and wave-transported sand from entering the estuary (Mr L le Roux, NVT/ODC, pers. comm.). According to Mr J Squier (ODC) the stabilization works have been instrumental in reducing the need to breach the mouth artificially.

SOUT

The estuary mouth is situated in a narrow cove with steep rocky embankments on both sides. The mouth is always open to the sea. About 150 m from the mouth there is a large sand bank formed as a result of a combination of sediment transport downstream and sediment influx from the sea. During high tides wave action penetrates to the sandbank.

3.2.3 Land Ownership/Uses

GROOT

Working anti-clockwise from the mouth the land ownership at the Groot Estuary is as follows: The eastern shore from the beach almost to the head of the estuary is composed of the western extremity of the Tsitsikamma Forest and Coastal National Park. The Otter (hiking) Trail running from the Storm's River mouth 30 km to the east, ends at Nature's Valley. The head of the estuary is controlled by the Directorate of Forestry as part of the De Vasselot Nature Reserve and includes a caravan and camping site. "The Island" and Nature's Valley township on the western shore are under the ultimate control of the Outeniqua Divisional Council (ODC) but local affairs are handled by the Nature's Valley Ratepayers Association. The Nature's Valley Development Corporation's rôle has been reduced to the approval of building plans and the general control of the nature of development (GL Ashmead, Nature's Development Corporation, *in litt.*). The ODC controls the dune area at the mouth and between the township

and the sea while the Cape Department of Nature and Environmental Conservation controls the use of the estuary itself.

In order to preserve the tranquility of the area, no power boats are permitted on the estuary and no vehicular access to the beach is allowed. Sea bathing can be hazardous but the lagoon provides sheltered swimming ideal for children.

Fishing is permitted in the estuary and west of the mouth; east of the mouth, i.e. at Die Punt, no fishing is permitted since the area is part of the Tsitsikamma Forest and Coastal National Park.

SOUT

The entire estuary lies within the De Vasselot Nature Reserve. Access is by hiking from Nature's Valley, Keurboomstrand or the National Road. No overnight camping is permitted. Formerly, Coloured (Griqua) fishermen operated rowing boats from the estuary (Storrar, 1982). More recently some residents of Nature's Valley kept power ski boats at the Sout Estuary. Some of these boat owners approached the Directorate of Forestry for permission for vehicular access to the Sout Estuary, mainly for the purposes of transporting fuel. However, following protests by other residents of Nature's Valley and an investigation by ECRU, the request was rejected on the grounds that vehicular access was incompatible with the concept of the De Vasselot Nature Reserve. Furthermore, it was felt that to permit some persons vehicular access would be the "thin edge of the wedge", ultimately resulting in general vehicular access with all its associated problems. Consequently, no boats are permitted to be beached at the Sout.

3.2.4 Obstructions

There are no man-made obstructions in either the Groot or the Sout estuaries.

3.2.5 Physico-chemical Characteristics

GROOT (Tables I, II and III)

pH

The water entering the Groot Estuary is typical of that draining from well-vegetated terrain. The water is acid and peat-stained dark brown. The water at the head of the estuary tends to be acid to circumneutral; pH values vary depending on the state of the tide and the volume of influent fresh water. At Station 4 (grid ref. 0609, Figure 2) values of 5,0 - 7,0 have been obtained (Tables I and III). The lower value, recorded in November 1982, reflects the net outflow of freshwater observed at that time. Seawater normally has a pH which varies from 7,8 to 8,3 (Day, 1981).

Temperature

The water temperature in the estuary displays a slight gradient from head to mouth, the influent river water being colder than

the seawater (Tables I, II and III). The bottom water tends to be slightly warmer than the surface (Tables I and II). This effect is due to the warmer, denser seawater penetrating the estuary beneath the colder freshwater.

Transparency

Turbidity is low, however, light penetration is reduced by the dark brown peat-stained water entering the estuary from the Grootrivier. Maximum Secchi disc readings of 1,6 m and 1,8 m were obtained, respectively, during the ECRU surveys in April 1981 and November 1982 (Tables I and III).

Salinity

Marked salinity stratification was recorded during both the ECRU surveys of April 1981 and November 1982 (Tables I and III). During April 1981 the estuarine salinity was fairly homogeneous (Table I) probably as a result of the lower water level following breaching of the mouth. Breaching allows inflow of relatively large volumes of sea water. In November 1982 the sandbar at the mouth was fairly high and there was a small net outflow of almost fresh water. At the mouth (grid ref. 1913, Figure 2) the mixing of the less dense fresh water with the denser seawater could be observed visually. Salinity differentials between the surface and bottom waters, of 21 parts per thousand and 24 parts per thousand were recorded at the mouth (grid ref. 1913, Figure 2) and the head (grid ref. 0609, Figure 2) of the estuary respectively (Table III). This seawater penetration of the system probably accounts for the predominantly marine nature of the benthic fauna in the system.

Dissolved Oxygen (DO) and Nutrients

DO readings ranged from 5,48 to 9,2 mg/ℓ (Tables I, II and III). As would be expected lower DO values (1,59 mg/ℓ and 2,42 mg/ℓ) were obtained from the interstitial water samples (Table III).

Nutrient input from the catchment is minimal since it is either entirely natural or under timber plantation. In the vicinity of the estuary itself some seepage input from the septic tanks of properties close to the water's edge may be expected. Thus an increase in the quantity of filamentous algae (*Enteromorpha* or *Cladophora*) along the western shore could possibly be attributed to septic tank seepage (J Squier, pers. comm.). Mr Squier also stated that should the proposed development of "The Island" take place sewage will be collected in conservancy tanks for removal by road tanker for processing and disposal elsewhere. In this eventuality it is proposed to connect all the houses near the water's edge to the conservancy tank system in order to eliminate sewage seepage into the estuary.

Analysis of nutrients in the estuary (Tables I and II) indicates that the system is unpolluted.

TABLE I: Physico-chemical characteristics of the Groot Estuary: high tide (April 1981)

Station number	ECRU Grid Ref. (Fig 2)	Salinity parts per thousand	Phosphate (µmmol/ℓ)	Silicate (µmol/ℓ)	Ammonia (µmol/ℓ)	Nitrate (µmol/ℓ)	OA (oxygen absorbed) (mg/g)	Dissol-solved oxygen (mg/ℓ)	Temp (°C)	pH	Inorganic carbon (mgC/ℓ)	DOC (mgC/ℓ)	Secchi trans-parency (m)
1(S)	1913	34	1,14	7,65	17,03	8,04	0,006	7,62	20,2	8,18	24,14	25,29	<2
2(S)	1608	34	0,75	3,94	7,67	6,29	-	6,46	20,2	8,10	24,35	14,59	>0,4 (> depth)
3(S)	1307	34	0,75	11,83	8,40	6,05	0,007	7,03	20,2	7,02	24,40	16,73	-
4(S)	0609	12	0,58	27,26	8,20	4,54	0,020	7,46	20,2	7,0	9,75	12,39	-
5(S)	0306	0	0,69	1,39	7,36	2,72	0,013	6,82	17,1	6,09	0,93	11,65	-
6(S)	1509	32	0,48	9,90	9,74	4,70	0,002	7,12	17,9	7,98	19,89	13,92	>1,4
6(B)	1509	34	1,30	2,91	1,89	6,99	0,006	7,22	19,8	8,20	23,18	24,98	-
7(S)	1208	30	0,61	10,10	8,53	5,59	0,005	6,92	17,3	8,08	21,18	16,26	>1,3
7(B)	1208	34	0,68	5,51	7,30	5,05	0,006	7,17	19,2	8,23	24,15	16,70	-
8(S)	0609	10	0,61	27,30	7,71	6,47	0,011	6,70	17,0	7,25	6,66	10,11	>1,6
8(B)	0609	33	0,60	11,17	12,98	5,87	0,013	6,89	17,8	8,17	21,01	14,40	-

S = Surface sample; B = Bottom sample

TABLE II: Physico-chemical characteristics of the Groot Estuary: low tide (April 1981)

Station number	ECRU Grid Ref. (Fig 2)	Salinity parts per thousand	Phosphate (µmol/ℓ)	Silicate (µmol/ℓ)	Ammonia (µmol/ℓ)	Nitrate (µmol/ℓ)	OA (oxygen absorbed) (mg/g)	Dissol-solved oxygen (mg/ℓ)	Temp (°C)	pH	Inorganic carbon (mgC/ℓ)	DOC (mgC/ℓ)
1(S)	1913	33	0,68	10,87	8,50	4,90	0,003	5,48	20,7	7,67	22,36	15,41
1(I)	1913	34	1,09	16,38	13,90	5,20	0,014	-	-	7,60	22,84	29,72
6(S)	1509	30	0,54	20,20	8,31	5,72	0,010	7,18	21,1	7,19	20,33	19,87
6(I)	1509	35	1,06	16,40	8,21	12,97	0,032	2,42	-	7,15	22,57	25,28
7(S)	1208	24	0,50	21,33	7,14	4,29	0,009	7,00	21,6	6,97	11,14	28,06
7(I)	1208	34	0,72	20,30	8,90	6,65	0,022	1,59	-	7,00	18,88	17,50
8(S)	0609	3	0,71	6,90	6,25	5,75	0,017	7,40	18,7	7,08	2,21	10,88

S = Surface sample; I = Interstitial sample

TABLE III: Physical characteristics of the Groot Estuary: high tide (November 1982)

Station number	ECRU Grid Ref. (Fig 2)	Depth (m)	Width (m)	Dissolved oxygen (mg/ℓ)	Salinity parts per thousand (mg/ℓ)	Temp (°C)	pH	Secchi transparency (m)	Water colour	Substrate
1(S)	1913	0,3	50	7,1	14	22,8	6,0	>0,3	light brown	Fine-medium sand
1(B)	1913	-	-	7,8	35	22,6	-	-	-	-
2(S)	1608	1,0	200	8,8	8	22,5	5,5	>1,0	light brown	Fine-medium brown sand
2(B)	1608	-	-	8,5	22	22,5	-	-	-	-
3(S)	1307	2,0	300	9,2	8	21,0	5,5	1,8	light brown	-
3(B)	1307	-	-	8,7	25	22,3	-	-	-	-
4(S)	0609	3,3	60	8,5	0	20,4	5,0	1,8	light brown	Rocky
4(B)	0609	-	-	6,5	24	21,4	-	-	-	-

S = Surface sample; B = Bottom sample

TABLE IV: Physico-chemical characteristics of the Sout Estuary: high tide (April 1981)

Station number	ECRU Grid Ref. (Fig 3)	Salinity parts per thousand	Phosphate (µmol/ℓ)	Silicate (µmol/ℓ)	Ammonia (µmol/ℓ)	Nitrate (µmol/ℓ)	OA (oxygen absorbed) (mg/g)	Dissol-solved oxygen (mg/ℓ)	Temp (°C)	pH	Inorganic carbon (mgC/ℓ)	DOC (mgC/P)	Secchi trans-parency (m)
1(S)	1109	25	0,55	27,77	8,07	4,81	0,009	6,47	18,16	7,32	16,32	19,32	>0,7 (>depth)
2(S)	0809	16	0,70	24,05	8,89	6,92	0,018	5,81	18,0	7,47	10,78	12,55	2 m
2(B)	0809	32	0,50	18,20	11,33	9,13	0,005	6,29	17,7	7,92	18,37	15,34	-
3(S)	0510	5	0,99	7,66	9,43	3,67	0,043	6,39	17,7	7,04	3,57	15,32	>0,09 (>depth)
3(B)	0510	20	0,66	29,22	8,69	5,09	0,011	3,38	17,3	7,23	19,46	23,93	-
4(S)	0614	2	0,76	4,80	9,42	3,80	0,014	6,45	-	6,60	1,92	14,30	>0,6 (>depth)
4(B)	0614	6	0,77	13,33	9,43	8,23	0,016	6,08	-	6,60	3,81	14,01	-

S = Surface sample; B = Bottom sample

Trace metals

Watling and Watling (1979) surveyed the metal concentrations in the brown mussel *(Perna perna)* along the southern Cape coast. No abnormal levels of zinc, cadmium, copper, lead, iron, manganese, nickel, cobalt and chromium were recorded in samples taken off the mouth of the Groot indicating that the system is unpolluted by these metals. Watling and Watling (1980) also undertook a metal survey of the estuary itself. Cadmium levels in surface water samples were higher than might be expected and could possibly be attributed to a geochemical source of the element in that area. Two core samples were also analysed: one from the head and the other from the mouth of the estuary. The sample from the head was collected in a series of very reducing sands rich in clay minerals. Levels of lead, zinc, cobalt, nickel, cadmium and chromium were high in the core and probably represent contamination from some source or some geochemical concentration process. Levels of mercury in this core were also high but "not yet hazardous". Metal levels in the core sample from the mouth of the estuary were average for Eastern Cape rivers. It would appear that the sediments at the head of the estuary act as a trace metal trap and are not characteristic of the system as a whole.

SOUT (Table IV)

pH

The pH ranged from 7,37 at the mouth (Station 1, grid ref. 1109, Figure 3) to 6,60 at Station 4 (grid ref. 0614, Figure 3) some 700 m upstream. This pattern reflects the input of acid freshwater from the Soutrivier.

Temperature

The water temperature at Stations 1 - 3 was fairly homogeneous both with respect to depth and along the length of the estuary. At Station 4 (grid ref. 0614, Figure 3) the effect of freshwater inflow was evident: the surface (fresh) water was cooler than the bottom (slightly saline) water. During floods temperature differentials between top and bottom and between the head and mouth of the estuary can be expected.

Transparency

The water has the clear dark red-brown colour characteristic of peat-stained acid waters draining from a vegetated sandstone catchment. A maximum Secchi disc value of 2 m was obtained in a pool at Station 2, (grid ref 0809, Figure 3). Turbidity was extremely low indicating the virtual absence of suspended particulate matter.

Salinity

Stratification was evident. Tidal seawater penetrates the estuary under the outflowing fresh river water. Salinity differentials of 16 and 15 parts per thousand were recorded

at Stations 2 and 3 (grid ref. 0809 and 0510, Figure 3), respectively where saline water is trapped in the deeper pools.

3.2.6 Pollution and Public Health Aspects

GROOT

Currently all sewage disposal in the Nature's Valley township and at the Forestry camp site is by means of septic tanks. There is no evidence of pollution of the estuary but the greater reed growth along Lagoon Drive opposite the "Syndicate" houses might possibly be the result of sewage seepage from the septic tanks via a stormwater pipe (J Squier, pers. comm.).

SOUT

The bottoms of the deeper pools are covered with a layer of decomposing wood chips washed downstream from the mill close to the National Road bridge. A photograph taken in 1962 shows a considerable area of the cove covered with wood chips (Plate II).

There were a few empty beverage cans in the vicinity of the boathouse.

4. BIOTIC CHARACTERISTICS

4.1 Flora

(This section is contributed by Miss R Parsons and Mr M O'Callaghan of the Botanical Research Unit, Stellenbosch.)

GROOT

4.1.1 Phytoplankton/Diatoms

Although no data are available concerning phytoplankton and/or diatoms in this estuary, there were green deposits on the river bank, indicating that microscopic algae are present in the river.

4.1.2 Algae

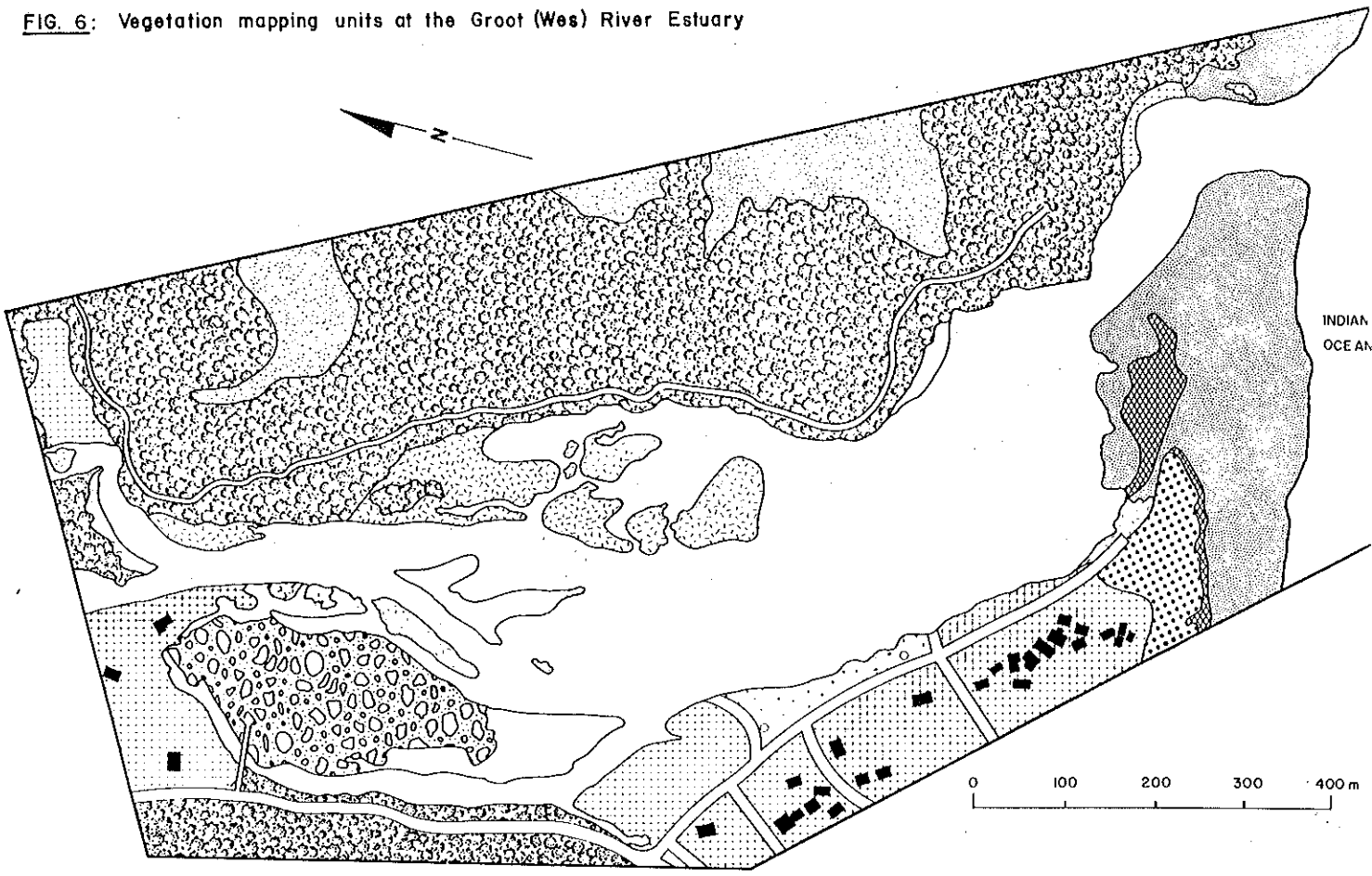
Numerous macroscopic marine algae occur on rocky substrates along this shore. A number of these are illustrated by Seagrief (1967). Marine algae were not sampled during the ECRU survey of 1 - 3 November 1982.

In the estuary, there were numerous filamentous algal species. In the main stream, approximately 1 km from the mouth, *Stilophera* sp. was found on the stony substrate. Further downstream, *Chaetomorpha* occurred on the sandy bottom. In the creek to the west of "The Island", 2 species of *Enteromorpha* were found amongst the aquatic angiosperms.

4.1.3 Aquatic Angiosperms

There was profuse growth of *Ruppia maritima* with some *R. spiralis* in the creek (grid ref. 0806 - 1006, Figure 2) to the west of "The Island". This area is an important habitat for birds,

FIG. 6: Vegetation mapping units at the Groot (Wes) River Estuary



LEGEND

- Arctotheca populifia / Scaevola thunbergii Dune Shrubland
- Cassine aethiopica / Rhus crenata Tall Shrubland
- Mariscus thunbergii / Stenotaphrum secundatum / Juncus kraussii Herbland
- Scirpus nodosus / Juncus kraussii Sedgeland
- Samolus porosus / Cotula coronopifolia Herbland
- Disturbed alien Woodland
- Littoral Bush Forest
- Fynbos
- Water
- Sand
- Intensive Human Use

juvenile fish and invertebrates (Figure 7). During periods of low water, this area can become stagnant with rotting vegetation causing unpleasant odours.

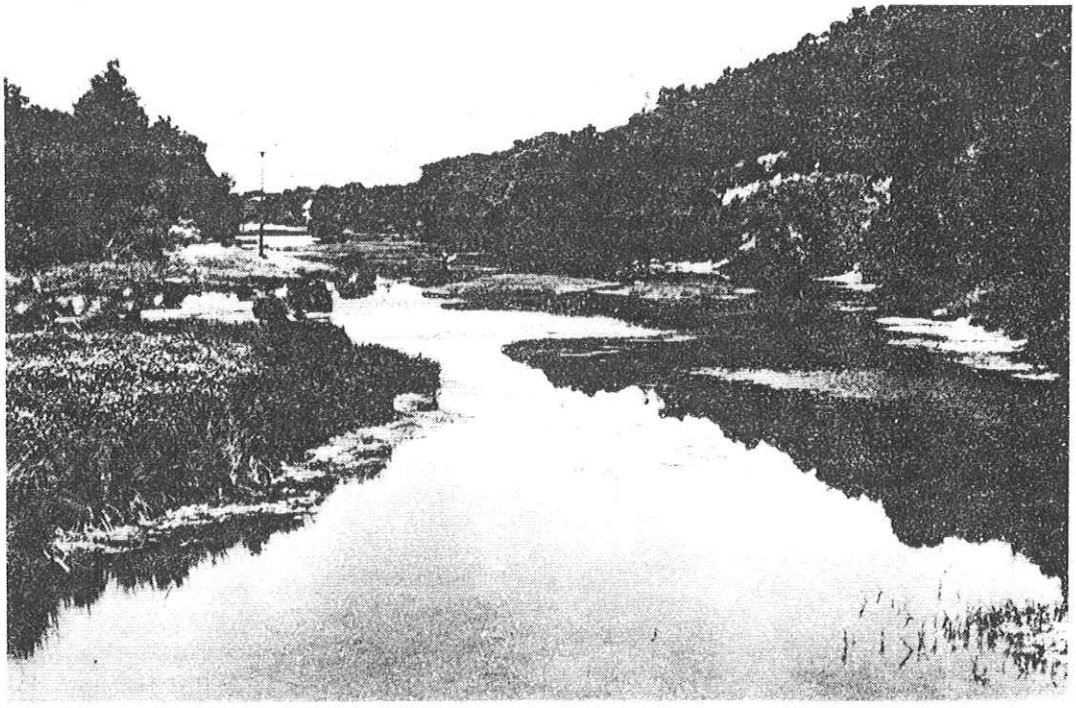


FIG. 7: Shallow creek between the western side of "The Island" and the National Road. View downstream (ECRU 82-11-02).

4.1.4 Terrestrial Vegetation

Eight mapping units were identified at the Groot River estuary. The spatial distribution of these is shown in Figure 6 while Appendix IA shows some species and physical features of each unit. These units can be arranged into five basic types, namely:

(a) Dune Vegetation

(b) Wetland Vegetation

(c) Disturbed Alien Woodland

(d) Riverine Bush Forest

(e) Fynbos

(a) Dune Vegetation: The foredune areas have a sparse covering of pioneer plants such as *Arctotheca populifolia* (sea pumpkin), *Scaevola thunbergii* (seeplakkie) and *Agropyron distichum* (sea wheat). Attempts are being made to stabilize these areas by placing dead brush on the sand.

On the larger stabilized dunes is a dense dune scrub containing *Cassine aethiopica* (Cape cherry), *Carissa bispinosa*

(lemoenbessie), *Rhus glauca* (korentebessie) and others. This vegetation type is generally undisturbed as access by means of footpaths is restricted.

(b) Wetland Vegetation: These vegetation types grow in areas with a high water table and/or are flooded periodically. On the western bank of the river, the wetland vegetation consists mainly of reeds, sedges and herbs such as *Mariscus thunbergii*, *Phragmites australis* (common reed), *Juncus kraussi* (common rush) and others. The small islands in the river and part of the eastern bank are dominated by *Samolus porosus* and numerous herbs and grasses.

As can be seen from Figure 5, wetland vegetation also covers the southern part of "The Island", and development of this area is ill-advised.

(c) Disturbed Alien Woodland: The major part of "The Island" was covered with *Acacia mearnsii* (black wattle) with numerous herbs and shrubs. Some of these trees have been removed to make way for development.

Although alien plant infestation around this river is not great, aliens are present, mainly in the form of *A. mearnsii* and *A. cyclops* (rooikrans). It is recommended that further steps be taken to remove these before they dominate large areas.

Due mainly to a lack of time, neither of the following vegetation types were sampled in any detail. Both the forest vegetation and the fynbos are discussed by Phillips (1931) and Acocks (1975) while Von Breitenbach (1974) and Rycroft (1980) illustrate a number of the forest tree species. In this area, both these vegetation types are under the jurisdiction of the Directorate of Forestry.

(d) Riverine Bush Forest: This vegetation is relatively dense and reaches a height of up to 10 m. True dominance is lacking and species include *Sideroxylon*, *Pterocelastrus*, *Rhus*, *Scutia*, *Tarconathus* with some *Podocarpus*, *Kiggelaria* and other forest species.

(e) Fynbos: The fynbos is typical of this area and varies from sparse short scrub with mesembryanthemums, occasional ericas and other shrubs to a taller dense scelerophyllous scrub with proteas and restionacceae.

SOUT

4.1 Flora

4.1.1 Phytoplankton/Diatoms

Although no phytoplankton nor diatom data are available, discolorations on the sand show where some of these are deposited, especially at the high-water mark.

4.1.2 Algae

The rocky shore adjacent to the rocky mouth support numerous macrophytic algae, many of which are illustrated by Seagrief (1967). A number of these are washed into the river (e.g. *Codium lucasii*) where they might serve as an important food source for benthic organisms.

In the estuary *per se*, a short filamentous green alga, *Enteromorpha fucicola* covers many of the pebbles in the shallow areas. On the shallow sandy river bottom, a tufted red alga, *Polysiphonia* sp. forms dense mats in which numerous juvenile fish and invertebrates were noted.

4.1.4 Terrestrial Vegetation

Three basic vegetation mapping units were recognised at this estuary, namely,

(a) *Metalasia muricata* Shrubland

(b) *Chenolea diffusa/Juncus kraussi* Herbland

(c) Forest

The spatial distribution of these is shown in Figure 8 while Appendix IB shows some of the species and physical features of each mapping unit.

(a) *Metalasia muricata* Shrubland: This low shrubland occurs along the banks near the mouth of the river and consists mainly of dune plants such as *Arctotheca populifolia* (sea pumpkin), *Tetragonia decumbens* (klappiesbrak) and others. All the vegetation fringing the river banks plays an important role in stabilizing the river banks and preventing erosion (see below).

(b) *Chenolea diffusa/Juncus kraussi* Shrubland: This vegetation type contains numerous plants with marsh affinities such as *Cotula coronopifolia* (gansgras), *Chenolea diffusa* (soutbossie), *Juncus kraussi* (common rush) etc. as well as plants from more terrestrial (coastal) habitats, including *Carpobrotus edulis* (Hottentots Fig) *Scirpus nodosus* (steekbiesie) *Chironia baccifera* (aambeibossie) and others. Most of these, however, grow above a salt marsh cliff and are thus flooded only during very high waters. Erosion of the river banks seems to be natural and due to the dynamic nature of the river.

(c) Forest: The forests of this area are described by Phillips (1931) while Von Breitenbach (1974) and Rycroft (1980) illustrate some of the species which occur here.

The forest around this river varies from riverine bush to a true Knysna forest. On the drier north-facing slopes, is a less dense scrub and especially nearer the sea, wind-cropping of the vegetation does take place. This vegetation type was not sampled.

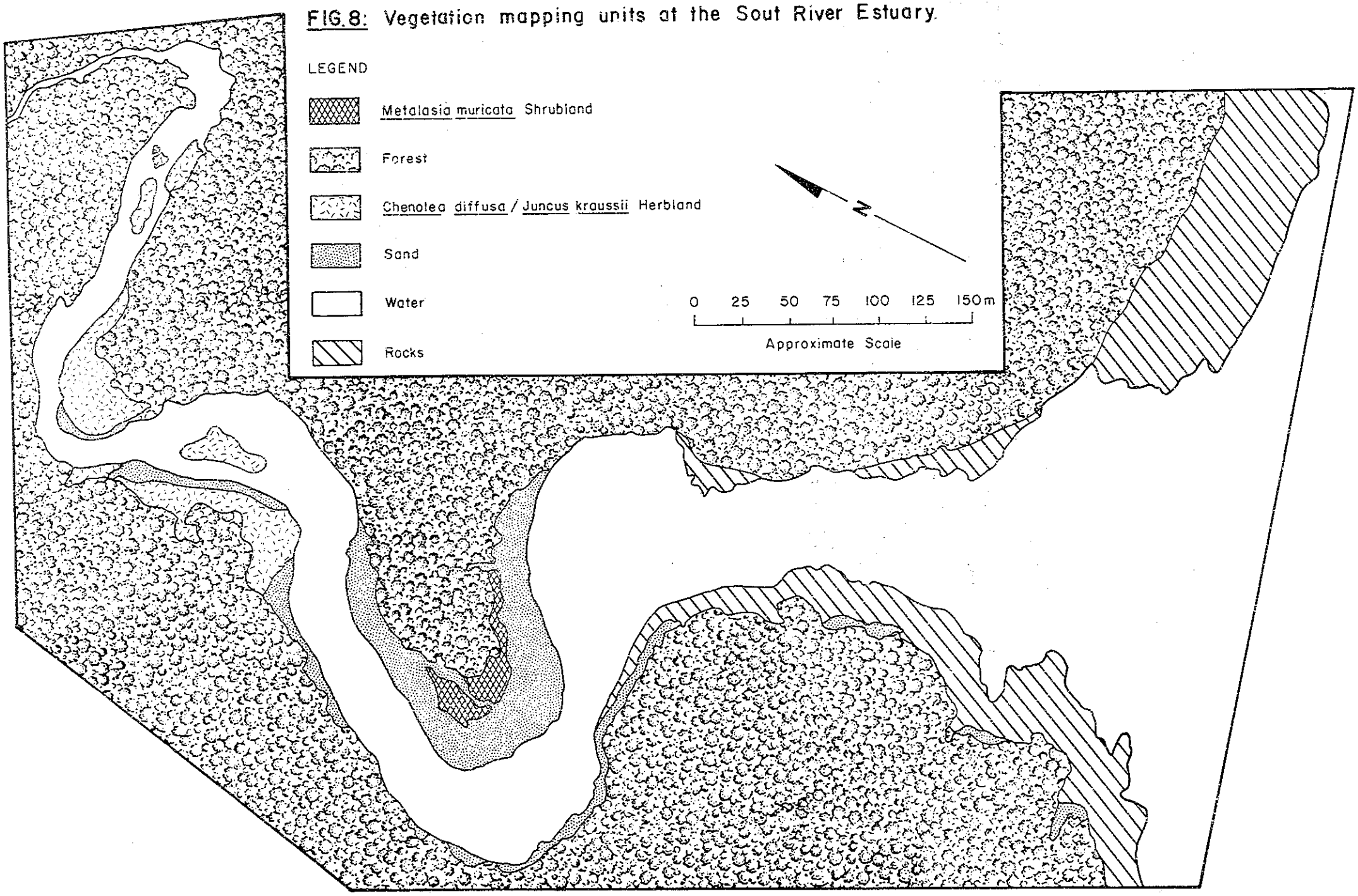


FIG.8: Vegetation mapping units at the Sout River Estuary.
LEGEND
Metalasia muricata Shrubland
Forest
Chenolea diffusa / Juncus kraussii Herbland
Sand
Water
Rocks
N
0 25 50 75 100 125 150m
Approximate Scale

4.2 Fauna

4.2.1 Zooplankton

GROOT

Le Roi le Riche and Hey (1947) sampled the plankton of the Groot in April 1947 and reported that it was "very low" relative to the other estuaries to the west, which were also sampled at the time. Grindley *(in litt.)* recorded 42 zooplankton species and a mean zooplankton biomass of 31,01 mg/m^3. A list of the zooplankton found there is presented in Appendix II.

SOUT

No available information.

4.2.2 Aquatic Invertebrates

GROOT

Harrison and Agnew (1962) give a checklist of the freshwater invertebrates found in the acid peat-stained waters of the Groot just above the estuarine influence. This was made up mostly of insects and insect larvae.

The aquatic invertebrate species recorded during the ECRU surveys in April 1981 and November 1982 are listed in Appendix III. The species in the estuary were collected mainly by means of a small beam trawl.

Gaigher (CPA Department of Nature and Environmental Conservation, *in litt.*) surveyed the distribution and densities of burrowing sand prawns *(Callianassa kraussi)* and mud prawns *(Upogebia africana)* on the western side of the Groot on 20 February 1981. *C. kraussi* was sparse near the mouth but dense in the tidal sand banks in front of "The Syndicate" lawn (grid ref. 1608, Figure 2), the silt-rich gritty sand closer to the mouth (grid ref. 1609, Figure 2) and in the sublittoral shallow (1 m deep) regions (grid refs. 1509 and 1408, Figure 2). Densities declined on the western banks upstream of these areas but *C. kraussi* was common in the very soft silty, gritty sand at the mouth of the creek (grid ref. 1107, Figure 2) situated next to the National Road.

The mudprawn *U. africana* was common on the eastern side of the main channel (grid ref. 1008, Figure 2), adjacent to "The Island" and sparse on the western banks of the creek (grid ref. 1106, Figure 2) but absent elsewhere on the western side of the estuary. Gaigher *(in litt.)* has suggested that *Upogebia* is not very successful in the Groot due to extended periods of high water level and low salinity which extend it to the limits of its tolerance of such conditions.

Generally the Groot is not particularly rich in aquatic invertebrates. This is probably because there are no extensive intertidal saltmarshes and also that the mouth closes periodically thereby eliminating tidal flushing. The fauna is also subjected to periods of low salinity during mouth closure.

SOUT

The aquatic invertebrate species recorded during the ECRU survey in April 1981 are listed in Appendix III. The hermit crab *Diogenes brevirostris* was common on the tidal sand flats at the mouth and the false limpet *Siphonaria capensis* was found on the rocks.

Large numbers of sand shrimps *Palaemon pacificus* were present throughout the middle reaches of the estuary in April 1981.

During both ECRU surveys a large population of marsh crabs *Sesarma catenata* was living in the banks of a river terrace in the upper reaches of the estuary (grid ref. 0511, Figure 3).

Gaigher *(in litt.)* surveyed the distribution and abundance of *C. kraussi* and *U. africana* in the Sout during November 1979. His results are shown in Table V.

Table V: Densities of *Callianassa kraussi* and *Upogebia africana* in the Sout Estuary in November 1979. The data are from Gaigher *(in litt.)*. See Figure 3 for grid references.

ECRU Grid ref. (Figure 2)	Sediment description	Mean no of burrow openings/m^3	
		C. kraussi	*U. africana*
1209	gravelly sand	100	0
0807	gravel and sand	160	0
0610	gritty sand/silt	152	230

In addition to the above data, Gaigher *(in litt.)* described the densities of *C. kraussi* as sparse at grid ref. 1110 (Figure 3) and fairly dense at grid ref. 0907 (Figure 3).

As can be seen from the data *U. africana* was confined to the middle and upper reaches of the Sout while *C. kraussi* was distributed throughout the estuary. These distributions were confirmed during the ECRU survey in April 1981. Gaigher *(in litt.)* indicated that previously there had been a very dense colony of *U. africana* in the middle reaches (grid ref. 0610, Figure 3). He concluded that *U. africana* was being displaced by unstable sediments in the form of invasive marine sands and by *C. kraussi* penetrating further upstream both as a result of low river flow.

Generally the aquatic invertebrate fauna of the Sout does not appear to have been seriously disturbed although it is not clear what the effect of the deposition of wood chips on the benthos in particular, has been.

4.2.3 Fish

GROOT

The fish fauna of the Groot is dominated by marine species. This can be seen from the species list in Appendix IV which was

compiled largely from gill net and beam trawl sampling during the ECRU surveys in April 1981 and November 1982. The list is composed of 16 marine species and two freshwater species. As the mouth does not close for lengthy periods, the predominance of marine species is to be expected.

The blind ending creek (grid refs. 0806 - 1006, Figure 2) situated between the National Road and "The Island" is an important shallow water area for juvenile marine species as was borne out by observations during the ECRU surveys.

SOUT

A list of the fish species sampled during the ECRU survey in April 1981 is given in Appendix IV. Six marine species but no freshwater species were recorded. As the mouth remains open under the influence of tidal action, marine species are always able to utilize the estuary, particularly during high spring tides.

4.2.4 Amphibians

Only two species, the Raucous Toad *(Bufo rangeri)* and the Cape River Frog *(Rana fuscigula)*, were recorded from Nature's Valley during the Cape Department of Nature and Environmental Conservation survey (RC Boycott and AL de Villiers, *in litt.*). Carruthers and Robinson (1977) recorded six species from the Tsitsikamma Coastal National Park. The potential list for the Groot (Nature's Valley) is presented in Appendix V.

Tortoises

Greig and Burdett (1976) record the Angulate tortoise *(Chersina angulata)* and the Padlopertjie or Parrots beak tortoise *(Homopus aerolatus)* at Knysna. It is thus possible that these species also occur at the Groot Estuary or its environs.

Snakes

FitzSimons (1962) records only the Common or Southern Slug-eater *(Duberria lutrix)* from this specific area. However, Boycott and De Villiers *(in litt.)* have compiled a potential list based on records from adjacent areas (Appendix V).

4.2.5 Birds

Twenty species of water-associated birds (i.e. marine and freshwater) were recorded from the Groot and Sout estuaries (Appendix VI). The actual numbers of each species were low indicating that these estuaries are not prime habitats for these birds. The fact that the Groot is infrequently tidal results in very little bare shoreline (sand and/or mud) being exposed regularly so that it provides relatively little suitable foraging habitat for waders. The Groot Estuary supports a limited number of piscivorous birds such as Fish Eagles, cormorants and kingfishers. With the exception of the kingfishers these probably extend their foraging range along the coast and primarily use the estuary as a refuge and breeding site. The Sout Estuary is regularly tidal and

the sandy bottom is exposed with each low tide providing forage areas for White-fronted Sand-plovers and other waders. However, the amount of available prey is restricted by the very limited area of intertidal habitat.

The forests surrounding the Groot and Sout estuaries contain a rich avifauna. Sixty-nine species have been recorded in this area (Appendix VIII) but the list is by no means exhaustive.

4.2.6 Mammals

Twenty-two species of mammals have been recorded in the De Vasselot Nature Reserve and the environs of the Groot and Sout estuaries (Appendix VIII). The construction of the new alignment of the N2 will affect the movement of these mammal species between the coast and the mountainous hinterland. The fragmentation of the forest by highways into smaller units inevitably leads to the reduction in the amount of suitable habitat available. Link roads between the existing N2 and the new alignment should, therefore, be kept to an absolute minimum.

5. SYNTHESIS

GROOT

The Groot Estuary is in an almost pristine condition. The catchment consists of virtually undisturbed natural vegetation and areas under forestry plantation (Section 3.1.2). Currently a small part of the catchment is subject to considerable disturbance as a consequence of the re-alignment of the National Road (N2) involving the construction of two major concrete arch bridges over the Bobbejaans and Groot rivers. However, the impact of this construction work on the rivers should be only temporary.

The normal regime in the estuary is a cycle of mouth closure by a sandbar; back-up of river water until the hydraulic pressure is sufficient to breach the bar; rapid outflow with scouring of sediments; ingress of seawater; and, finally, closure of the mouth again. The frequency with which this cycle occurs depends mainly upon rainfall, although there has been fairly frequent artificial breaching of the sandbar to prevent flooding of low-lying areas on the western shore. This practice is done on an *ad hoc* basis and should either be prevented altogether or at least be undertaken only as an emergency measure.

The estuary itself is used only for recreation e.g. swimming, sailing, canoeing and fishing mostly during the summer vacation period (December - January). The existing houses do not intrude upon the overall peacefulness of the area. This quietness will be further enhanced by the re-alignment of the N2 highway which will result in the removal of the noise of heavy traffic from the environs. Visually the effects of present human activity have little impact: the views from the national road, especially when east-bound, are of almost unspoiled wilderness. The only developments in the estuarine area itself are the Directorate of Forestry's camping site at the head of the estuary (see Figure 2,) and the Swan property (grid ref 0608, Figure 2). The

houses on the western shore, including the "Syndicate", are set well back from the water's edge and do not intrude upon the scene. The National Parks Board considered the possibility of establishing a campsite at the western end of the Tsitsikamma Forest and Coastal National Park i.e. on the eastern shore of the Groot Estuary. To this end the Board commissioned a firm of landscape and ecological planners to assess the impact of various campsite and holiday resort developments on the eastern shore. The consultants concluded that any development would have some irreversible effect on the environment with camping having the least impact progressing through caravanning to permanent chalets with the greatest and most permanent impact (Ben Farrell, Van Riet and Botha, 1975). To date no such development has taken place and any attempt to revive the scheme cannot be supported because of the importance of preservation of the natural environment in an area where so much of the original forest has already been destroyed by timber extraction and other developments.

As discussed previously by Dr AEF Heydorn (ECRU) in an *ad hoc* report of 16 April 1981, the main threat to the estuary lies in the proposed development of 21 erven on the peninsula, known as "The Island", in the northwestern portion of the estuary (Figure 2); "The Island", low-lying and prone to partial flooding (Section 3.1.1), has been subdivided into 21 plots, 19 of which lie within a perimeter service road and two which lie outside the road at the southern end. The houses will have to be built on stilts at least one metre high as required by the Outeniqua Divisional Council (J Squier, pers. comm.). Sewage is to be collected in conservancy tanks for removal by road tanker to a treatment plant. Despite this requirement for conservancy tanks there is still the risk that they may leak and pollute the estuary either due to distortions caused by buoyancy forces when the area is flooded or as the result of corrosion of pipes etc. by the saline water. Aesthetically such a development could be highly detrimental to the views and tranquility of Nature's Valley and the Groot Estuary which are so much of a feature at present. Waterside housing brings with it secondary development such as telephone cables, jetties, launching ramps and the desire to have lawns sloping down to the water's edge, thus destroying the natural marginal vegetation. In particular, such developments will deleteriously affect the creek on the western side of "The Island" (grid refs. 0806 - 1006, Figure 3). The creek is one of the biologically richest areas of the Groot Estuary, providing food and shelter for juvenile fish and a host of other organisms.

The objections to the development of "The Island" must also be reviewed in the broader context of development in areas liable to frequent flooding. The erection of fixed structures (houses) below the 50-year flood line should not be permitted in the light of basic policies being developed for coastal zone management in South Africa at present and in many other countries. The inevitable consequence of construction below this level is that owners of such properties liable to flood damage will demand that the relevant local or governmental authorities open the estuary prematurely or provide flood control structures. In other words, failure to take note of the intrinsic flood regime of an estuary/river system is not only liable to disturb the natural equilibrium of the system, but is also likely to result in costly

long-term maintenance requirements. Consideration should therefore be given to modifying the relevant ordinances to include:

(a) the restriction or total banning of the construction of fixed structures below the 50-year flood line, and

(b) a clause allowing adverse environmental effects to be sufficient cause for the rejection of a proposed development.

The development of "The Island" bears serious implications for the natural environment of the estuary as a whole. As has been pointed out it can be foreseen that the residents of "The Island" will find the periodic flooding of their properties unacceptable despite the fact that the Deed of Sale contains a clause requiring the purchaser of a plot to acknowledge that the plots are liable to periodic flooding and that no claim against either the Outeniqua Divisional Council or the Nature's Valley Development Corporation in this regard will be entertained (Appendix IX). Consequently the residents will demand that the estuary mouth be maintained in an open state which will completely destroy the present cyclic regime of opening and closure of the mouth. The scouring action of the rapid outflow following breaching removes sand which has been deposited in the estuary by waves overtopping the bar or blown in by the prevailing southerly winds. One consequence of maintaining the mouth in a (semi-) permanently open state (quite apart from the cost) is an increase in the salinity of the system with far-reaching consequences for the entire ecology of the estuary. Another possible effect is that, in the absence of periodic scouring, sand penetration from seaward will occur thus reducing the depth of the lower reaches of the estuary.

It must therefore be stated unequivocally that if development of properties on "The Island" goes ahead, this will be in blatant defiance of the most basic criteria of sound estuarine management and most certainly of plain common sense. It is simply not acceptable that the sale of 21 plots in a totally unsuitable area, should be allowed to jeopardize the ecological health of one of the very few estuarine systems which is still in pristine condition on the South African coast. The degradation of the Groot Estuary would not only be an indictment of coastal zone managers in South Africa, but it would also lead to a reduction in the value of the existing properties at Nature's Valley.

Currently there is no overall management policy for the Groot Estuary. As mentioned above the mouth is periodically opened on an *ad hoc* basis without regard to any environmental considerations. It is important that artificial opening of the estuary mouth should be kept to the absolute minimum and that a single authority be responsible for the management of the mouth. The Outeniqua Divisional Council (ODC) owns the vegetated dune between the sea and Nature's Valley township (Figure 9). The dune has been fenced on the landward side and a small number of surfaced paths allow access to the beach. This enlightened approach ensures that the dune vegetation remains intact thus avoiding any problems of sand encroachment on the houses to leeward. The ODC is also stabilizing the sandspit at the estuary

mouth (grid ref. 1810, Figure 2) with natural vegetation in order to prevent wind-blown sand from entering the estuary. The vegetated dune which is forming as a result of this operation will shelter the southern end of the lagoon from the wind and thus improve the recreational value of the area, particularly for small children.

In conclusion, the Groot Estuary, bordering on South Africa's only coastal National Park, is in an almost completely natural condition. Every effort should be made to maintain this desirable state of affairs particularly as each year the coastal zone comes under greater pressure for the development of recreational facilities and retirement homes.

SOUT

The Sout Estuary is a predominantly tidally driven system consisting of narrow upper reaches opening into a relatively broad sandy cove which in turn opens to the sea through rocky promontories. Tidal scour is strong in the lower reaches and keeps the mouth permanently open, while floods remove sediments from the upper reaches. During periods of low flow, saline water is trapped in the deeper pools in the middle and upper reaches of the estuary, thereby creating suitable conditions for several species of typical estuarine fauna.

The surrounding terrain consists of indigenous forest with fynbos on the plateau. The entire estuary lies within the De Vasselot Nature Reserve and the only obvious sign of human intrusion is the old wooden boat shed set back from the beach at the base of the cove. There is no vehicular access and only day visits by hikers and anglers are permitted.

The deposition of wood chips into the Sout River by the sawmill on Kurland Estates was a serious problem in the past. Photographs taken in March 1962 (Van Wyk, unpublished) and October 1962 (Plate II) show large amounts of wood chips deposited in the cove at the mouth of the estuary. Wood chips are still present in the deeper pools in the middle and upper reaches, which suggests that smaller amounts still enter the river but not on the same scale as in the past.

Some of the residents of Nature's Valley have used the Sout Estuary as a harbour for their ski-boats. These anglers made unofficial use of the track to the top of the cliffs on the east side of the estuary to bring in fuel and other supplies. Dr AEF Heydorn (ECRU), in an *ad hoc* report of 16 April 1981 advised against such utilization of the Sout on the grounds of the reserve status of the area. This practice has now been stopped and should not be allowed to recur.

The Sout Estuary should be managed to maintain the natural features of the system. An area of such unspoilt beauty is of immense importance to day-trippers and residents of Nature's Valley and hence should be guarded rigidly. This would seem to be particularly appropriate since the land and coastline to the east of the Groot Estuary form part of the Tsitsikamma Forest and Coastal National Park. As access to the park from Nature's

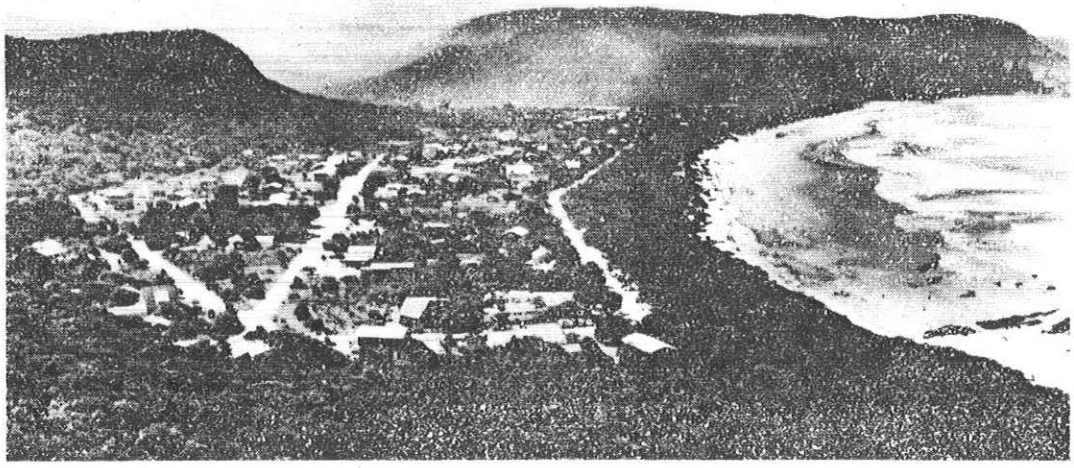


FIG. 9: View eastwards over Nature's Valley township showing the well-managed vegetated primary dune between the houses and the sea. The primary dune protects the township from the prevailing southerly winds and from sand encroachment. The Groot Estuary lies between the township and the hills in the background.

Valley is prohibited, the Sout Estuary is the only undisturbed part of the scenic section of coast which is readily accessible to the public from Nature's Valley.

6. ACKNOWLEDGEMENTS

Thanks are due to the following persons, institutions and organizations for the information and assistance received during the compilation of this report: Outeniqua Divisional Council: Mr J Squier, Secretary; Mr L le Roux. Nature's Valley Ratepayers Association: Mr GCP Martin; Mr L Barnardo. National Parks Board: Dr GA Robinson. South African Museum: Mr WJ van Ryssen. University of Cape Town: Prof JR Grindley, School of Environmental Studies; Dr BL Furness, Percy FitzPatrick Institute of African Ornithology. Cape Department of Nature and Environmental Conservation: Messrs RC Boycott, AL de Villiers and C Gaigher. Cape Provincial Administration Roads Department: Mr D Ackermann. Sea Fisheries Research Institute: Mr R Simons. National Research Institute for Oceanology: Dr GA Eagle. Nature's Valley Development Corporation: Mr GL Ashmead. Rhodes University: Dr PC Heemstra, JLB Smith Institute of Ichthyology. Port Elizabeth Museum: Dr JH Wallace, Director. Directorate of Forestry: Mr G Pretorius, Regional Director, Humansdorp; Mr D Gous, Regional Director, Tsitsikamma and Mr P Reyneke, Tstisikamma.

The advice and assistance of all members of ECRU is acknowledged.

The survey was carried out at the request of the Department of Environment Affairs. The encouragment of this Department, the Steering Committee for Estuarine and Coastal Research and the SA National Committee for Oceanographic Research is gratefully acknowledged.

7. GLOSSARY OF TERMS USED IN PART II REPORTS

abiotic: non-living (characteristics).
aeolian (deposits): materials transported and laid down on the earth's surface by wind.
alien: plants or animals introduced from one environment to another, where they had not occurred previously.
alluvium: unconsolidated fragmental material laid down by a river or stream as a cone or fan, in its bed, on its floodplain and in lakes or estuaries, usually comprised of silt, sand or gravel.
anaerobic: lacking or devoid of oxygen.
anoxic: the condition of not having enough oxygen.
aquatic: growing or living in or upon water.
arcuate: curved symmetrically like a bow.
barchanoid (dune): crescent-shaped and moving forward continually, the horns of the crescent pointing downwind.
bathymetry: measurement of depth of a water body.
benthic: bottom-living.
berm: a natural or artificially constructed narrow terrace, shelf or ledge of sediment.
bimodal: having two peaks.
biogenic: originating from living organisms.
biomass: a quantitative estimation of the total weight of living material found in a particular area or volume.
biome: major ecological regions (life zones) identified by the type of vegetation in a landscape.
biotic: living (characteristics).
breaching: making a gap or breaking through (a sandbar).
calcareous: containing an appreciable proportion of calcium carbonate.
calcrete: a sedimentary deposit derived from coarse fragments of other rocks cemented by calcium carbonate.
Chart Datum: This is the datum of soundings on the latest edition of the largest scale navigational chart of the area. It is -0,900 m relative to land levelling datum which is commonly called Mean Sea Level by most land surveyors.
coliforms: members of a particularly large, widespread group of bacteria normally present in the gastro-intestinal tract.
community: a well defined assemblage of plants and/or animals clearly distinguishable from other such assemblages.
conglomerate: a rock composed of rounded, waterworn pebbles 'cemented' in a matrix of calcium carbonate, silica or iron oxide.
cusp: a sand spit or beach ridge usually at right angles to the beach formed by sets of constructive waves.
"D" net: a small net attached to a "D" shaped frame riding on skids and pulled along the bottom of the estuary, used for sampling animals on or near the bottom.
detritus: organic debris from decomposing plants and animals.
diatoms: a class of algae with distinct pigments and siliceous cell walls. They are important components of phytoplankton.
dynamic: relating to ongoing and natural change.
ecology: the study of the structure and functions of ecosystems, particularly the dynamic co-evolutionary relationships of organisms, communities and habitats.
ecosystem: an interacting and interdependent natural system of organisms, biotic communities and their habitats.
eddies: a movement of a fluid substance, particularly air or water, within a larger body of that substance.
endemic: confined to and evolved under the unique conditions of a particular region or site and found nowhere else in the world.
enon: most striking formation in the Cape. Crammed with pebbles and boulders, phenomenally embedded and massive, yellow or brilliantly red in colour, producing remarkable hills. Curiously carved into crags and hollows.

epifauna: animal life found on the surface of any substrate such as plants, rocks or even other animals.

epiphyte: a plant living on the surface of another plant without deriving water or nourishment from it.

episodic: sporadic and tending to be extreme.

estuary: a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land drainage (Day 1981).

eutrophication: the process by which a body of water is greatly enriched by the natural or artificial addition of nutrients. This may result in both beneficial (increased productivity) and adverse effects (smothering by dominant plant types).

flocculation (as used in these reports): the settlement or coagulation of river borne silt particles when they come in contact with sea water.

fluvial (deposits): originating from rivers.

food web: a chain of organisms through which energy is transferred. Each "link" in a chain feeds on and obtains energy from the preceding one.

fynbos: literally fine-leaved heath-shrub. Heathlands of the south and south-western Cape of Africa.

geomorphology: the study of land form or topography.

gill net: a vertically placed net left in the water into which fish swim and become enmeshed, usually behind the gills.

habitat: area or natural environment in which the requirements of a specific animal or plant are met.

halophytes: plants which can tolerate salty conditions.

HAT (Highest Astronomical Tide) and LAT (Lowest Astronomical Tide): HAT and LAT are the highest and lowest levels respectively, which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions; these levels will not be reached every year. HAT and LAT are not the extreme levels which can be reached, as storm surges may cause considerably higher and lower levels to occur (South African Tide Tables 1980).

hummock (dune): a low rounded hillock or mound of sand.

hydrography: the description, surveying and charting of oceans, seas and coastlines together with the study of water masses (flow, floods, tides etc.).

hydrology: the study of water, including its physical characteristics, distribution and movement.

indigenous: belonging to the locality; not imported.

intertidal: generally the area which is inundated during high tides and exposed during low tides.

isohyets: lines on maps connecting points having equal amounts of rainfall.

isotherms: lines on maps joining places having the same temperature at a particular instant, or having the same average, extremes or ranges of temperature over a certain period.

lagoon: an expanse of sheltered, tranquil water. (Thus Langebaan lagoon is a sheltered arm of the sea with a normal marine salinity; Knysna lagoon is an expanded part of a normal estuary and Hermanus lagoon is a temporarily closed estuary (Day 1981)).

limpid: clear or transparent.

littoral: applied generally to the seashore. Used more specifically it is the zone between high- and low-water marks.

longshore drift: a drift of material along a beach as a result of waves breaking at an angle.

macrophyte: any large plant as opposed to small ones. Aquatic macrophytes may float at the surface or be submerged and/or rooted on the bottom.

marls: crumbly mixture of clay, sand and limestone, usually with shell fragments.

matrix: medium in which a structure is embedded.

meiofauna: microscopic or semi-microscopic animals that inhabit sediments but live quite independently of the macrofauna, or benthos.

metamorphic: changes brought about in rocks within the earth's crust by the agencies of heat, pressure and chemically active substances.

MHWS (Mean High Water Springs) and MLWS (Mean Low Water Springs): the height of MHWS is the average, throughout a year when the average maximum declination of the moon is 23°, of the height of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is greatest. The height of MLWS is the average height obtained by the two successive low waters during the same periods (South African Tide Tables 1980).

morphometry: physical dimensions such as shape, depth, width, length etc.

osmoregulation: the regulation in animals of the osmotic pressure in the body by controlling the amount of water and/or salts in the body.

pathogenic: disease producing.

photosynthesis: the synthesis of carbohydrates in green plants from carbon dioxide and water, using sunlight energy.

phytoplankton: plant components of plankton.

piscivorous: fish eating.

plankton: microscopic animals and plants which float or drift passively in the water.

quartzite: rock composed almost entirely of quartz recemented by silicon. Quartzite is hard, resistant and impermeable.

riparian: adjacent to or living on the banks of rivers, streams or lakes.

rip current: the return flow of water which has been piled up on the shore by waves, especially when they break obliquely across a longshore current.

salinity: the proportion of salts in pure water, in parts per thousand by mass. The mean figure for the sea is 34,5 parts per thousand, written 34,5°/$_{oo}$.

secchi disc: a simple instrument used to measure the transparency of water.

sheet flow: water flowing in thin continuous sheets rather than concentrated into individual channels.

slipface: the sheltered leeward side of a sand-dune, steeper than the windward side.

teleost: modern day bony fishes (as distinct from cartilaginous fishes).

trophic level: a division of a food chain defined by the method of obtaining food either as primary producers, or as primary, secondary or tertiary consumers.

trough: a crescent shaped section of beach between two cusps.

wetlands: areas that are inundated or saturated by surface or ground water frequently enough to support vegetation adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

zooplankton: animal components of plankton.

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Aerial Photographs

GROOT

{GROOT ESTUARY} Bl. & Wh. Job No. 114 36, Photo Nos. 19374 and 19375, Trig. Survey, Mowbray. 1:20 000, 1936.

{GROOT ESTUARY} Bl. & Wh. Job No. 6/42, Photo Nos. 11406 - 11409, Trig. Survey, Mowbray. 1:28 000, 1942.

{GROOT ESTUARY} Bl. & Wh. Job No. 686, Photo No. 6240, Trig. Survey, Mowbray. 1:40 000, 1971.

{GROOT ESTUARY} Bl. & Wh. Job No. 736, Photo No. 1045, Trig. Survey, Mowbray. 1:60 000, 1974.

{GROOT ESTUARY} Bl. & Wh. Job No. 349, Photo No. 46, Trig. Survey, Mowbray. 1:20 000, April 1980.

{GROOT ESTUARY} Bl. & Wh. Job No. 374, Photo Nos. 168 and 169, Trig. Survey, Mowbray. 1:20 000, December 1980.

{GROOT ESTUARY} Colour. Job No. 326, Photo Nos. 319 and 320, Dept. Land Surveying, University of Natal. 1:10 000, 1979.

SOUT

{SOUT ESTUARY} Bl. & Wh. Job No. 114 36, Photo Nos. 19326, 19327 and 19373, Trig. Survey, Mowbray. 1:20 000, 1936.

{SOUT ESTUARY} Bl. & Wh. Job No. 445, Photo No. 2323, Trig. Survey, Mowbray. 1:36 000, 1960.

{SOUT ESTUARY} Colour. Job No. 326, Photo Nos. 321 and 322, Dept. Land Surveying, University of Natal. 1:10 000, 1979.

APPENDIX IA: Plant species and physical features of the area mapped at the Groot Estuary.

Mapping Unit	+Area (ha)	% of area studied	Cover (%)	Average height (m)
Dune Vegetation: *Arctotheca populifolia/ Scaevola thunbergii* Dune Shrubland	0,98	1,00	5	0,50
Cassine aethiopica/ Rhus crenata Tall Shrubland	1,33	1,36	60	2,00
Wetland Vegetation: *Mariscus thunbergii/ Juncus kraussi* Herbland	0,76	0,78	85	0,75
Scirpus nodosus/Juncus kraussi Sedgeland	2,54	2,56	80	0,40
Samolus porosus/ Cotula coronopifolia Herbland	5,62	5,74	80	0,40
Disturbed Alien Woodland	4,03	4,12	60	2,00
Littoral Bush Forest	32,14	32,84	100	3,00
Fynbos	4,80	4,92	80	1,50
Water	27,86	28,46		
Sand	8,12	8,26		
Intensive Human Use	9,72	9,94		
Total	97,88			

(+estimated values)

Arctotheca populifolia/Scaevola thunbergii Dune Shrubland

Agropyron distichum (+); *Chrysanthemoides monolifera* (+); *Colpoon compressum* (+); *Grewia occidentalis* (+); *Passerina falcifolia* (+); *Scaevola thunbergii* (+); *Senecio arenarius* (+); *Tetragonia decumbens* (+).

Cassine aethiopica/Rhus crenata Tall Shrubland

Asparagus cf *racemosus* (+); *Carissa bispinosa* (1); *Carpobrotus edulis* (+); *Cassine aethiopica* (1); *Euclea* cf *racemosa* (+); *Ficinia lateralis* (+); *Gasteria* sp. (+); *Knowltonia capensis* (+); *Rhus crenata* (+); *Salvia africa-lutea* (1); *Silene bellidioides* (+);

APPENDIX IA: (Cont.)

Solanum quadrangulare (+); *Tarchonanthus camphoratus* (+); *Viscum rotundifolium* (r).

Mariscus thunbergii/Stenotaphrum secundatum/Juncus kraussi Herbland

Cenia sericea (+); *Chenopodium album* (r); *Chrysanthemoides monolifera* (+); *Juncus kraussi* (1); *Mariscus thunbergii* (1); *Myrica quercifolia* (+); *Paspalum vaginatum* (+); *Phragmites australis* (+); *Psoralea fruticans* (+); *Samolus porosus* (1); *Scirpus nodosus* (+); *Stenotaphrum secundatum* (1).

Scirpus nodosus/Juncus kraussi Sedgeland

Juncus kraussi (1); *Mariscus thunbergii* (r); *Phragmites australis* (+); *Samolus porosus* (1); *Scirpus nodosus* (1); *Stenotaphrum secundatum* (1);

Samolus porosus/Cotula coronopifolia Herbland

Cotula coronopifolia (1); *Juncus kraussi* (1); *Samolus porosus* (2); *Sporobolus virginicus* (+); *Stenotaphrum secondatum* (1); *Triglochin bulbosa* (+).

Disturbed Alien Woodland

Acacia cyclops (+); *A. mearnsii* (1); *Chrysanthemoides monolifera* (+); *Erica sparsa* (+); *Helichrysum cymosum* (1); *Passerina falcifolia* (+); *P. rubra* (+); *Podalyria sericea* (+); *Psoralea fruticans* (+); *Rhus glauca* (+); *R. lucida* (+); *Selago corymbosa* (+); *Stoebe plumosa* (+).

APPENDIX IB: Plant species and physical features of the area mapped at the Sout Estuary

Mapping Unit	+Area (ha)	% of area studied	Cover (%)	Average height (m)
Metalasia muricata Shrubland	0,10	0,14	25	0,50
Chenolea diffusa/ Juncus kraussi Herbland	0,49	0,70	90	0,20
Forest	15,96	22,71	90	3,00
Sand	9,30	13,24		
Rocks	1,98	2,82		
Water	42,43	60,39		
Total	70,26			

(+estimated values)

APPENDIX IB: (Cont.)

Metalasia muricata Shrubland

Arctotheca populifolia (+); *Chenolea diffusa* (+); *Gazania rigens* var *uniflora* (+); *Metalasia muricata* (1); *Passerina vulgaris* (+); *Senecio arenarius* (+); *Stenotaphrum secundatum* (+); *Tetragonia decumbens* (+).

Chenolea diffusa/Juncus kraussi Herbland

Carpobrotus edulis (1); *Cenia sericea* (+); *Chenolea diffusa* (1); *Chenopodium album* (+); *Chironia baccifera* (r); *Cotula coronopifolia* (+); *Exomis microphylla* var *axyrioides* (r); *Ficinia lateralis* (+); *Gazania rigens* var *uniflora* (+); *Juncus kraussi* (1); *Maricus thunbergii* (+); *Oxalis* sp. (r); *Passerina vulgaris* (+); *Rhus lucida* (+); *Sarcocornia natalensis* (+); *Scirpus nodosus* (+); *Silene bellidioides* (+); *Sporobolus virginicus* (+); *Stenotaphrum secundatum* (+).

Note: The symbols in brackets following each species name represent adapted Braun-Blanquet Cover-Abundance Classes as follows:

r - 1/few individuals, cover less than 0,1% of area
\+ - occasional plants, cover less than 1% of area
1 - abundant, cover 1 - 5% of area
2 - any number, cover 6 - 25% of area
3 - any number, cover 26 - 50% of area
4 - any number, cover 51 - 75% of area
5 - any number, cover 76 - 100% of area.

APPENDIX II: Zooplankton recorded from the Groot Estuary (JR Grindley *in litt.*).

OSTRACODA
Ostracod spp.

COPEPODA
Copepod nauplii
Acartia natalensis
Acartia longipatella
Harpacticoid spp.
Harpacticus sp.
Hemicyclops sp.
Oithora brevicorris
Pseudodiaptomus hessei
Tegastes sp.

CIRRIPEDIA
Cypris larvae
Cirripede nauplii

MYSIDACEA
Gastrosaccus brevifissura

CUMACEA
Iphinoe truncata

APPENDIX II: (Cont.)

ISOPODA
Cirolana sp.
Leptanthura laevigata

AMPHIPODA
Austrochiltonia subtenuis
Corophium sp.
Grandidierella bonneroides
Paramoera capensis

DECAPODA
Hymenosoma orbiculare larvae
Mysis larvae
Zoaea larvae

MOLLUSCA
Gastropod larvae
Lamellibranch larvae

OSTEICHTHYES
Fish eggs and larvae

APPENDIX III: Invertebrate species recorded from A. the Groot Estuary and B. The Sout Estuary

A Groot

(Records from ECRU surveys of April 1981 and November 1982.)

Common name	Scientific name
Crab	*Cleistostoma edwardsii*
Crown crab	*Hymensoma orbiculare*
Marsh crab	*Sesarma catenata*
Amphipod (Gammarid)	*Melita zeylanica*
Isopod (Flabelliferid)	*Cirolana* sp. (probably *fluviatilis*)
Sand-shrimp	*Palaemon pacificus*
Winkle	*Assiminea* cf. *ponsonbyi*
Burrowing sand prawn	*Callianassa kraussi*
Mud prawn	*Upogebia africana*
Plough shell	*Bullia rhodostoma*

B Sout

(Records from ECRU survey April 1981.)

Common name	Scientific name
Marsh crab	*Sesarma catenata*
Common hermit-crab	*Diogenes brevirostris*
Sand-shrimp	*Palaemon pacificus*
Limpet	*Siphonaria capensis*
Burrowing sand prawn	*Callianassa kraussi*
Mud prawn	*Upogebia africana*

APPENDIX IV: Fish species recorded from: A. Groot Estuary and B. Sout Estuary.

A Groot - (Common names according to Smith, 1975)

I Fresh Water

Records from: Le Roi le Riche and Hey (1947).

Common name	Scientific name
Cape Kurper	*Sandelia capensis*
-	*Barbus* sp.

II Marine

Records from: Le Roi le Riche and Hey (1947)
GA Robinson pers. comm.
ECRU surveys April 1981 and November 1982

Common name	Scientific name
Leervis	*Lichia amia*
White steenbras	*Lithognathus lithognathus*
Sand steenbras	*Lithognathus mormyrus*
Cape moony	*Monodactylus falciformis*
Stumpnose	*Rhabdosargus holubi*
Spotted grunter	*Pomadasys commersonni*
Cape sole	*Heteromycteris capensis*
Blackhand sole	*Solea bleekeri*
Southern mullet	*Liza richardsoni*
Flathead mullet	*Mugil cephalus*
Striped mullet	*Liza tricuspidens*
Freshwater mullet	*Myxus capensis*
Elf	*Pomatomus saltatrix*
Needlefish	*Hemiramphus far*
Knysna sandgoby	*Psammogobius knysnaensis*
Prison goby	*Caffrogobius multifasciatus*

B. Sout

I Fresh Water

No information is available on freshwater fish species from the Sout Estuary.

II Marine fish

All records from the ECRU survey of 10 April 1981

Common name	Scientific name
White steenbras	*Lithognathus lithognathus*
Cape moony	*Monodactylus falciformis*
Stumpnose	*Rhabdosargus holubi*
Southern mullet	*Liza richardsoni*
Flathead mullet	*Mugil cephalus*
Knysna sandgoby	*Psammogobius knysnaensis*

APPENDIX V: Amphibians and Reptiles occurring in the area covered by the 1:50 000 topographic Sheet 33223 DC Nature's Valley (RC Boycott and AL de Villiers, *in litt.*).

CLASS AMPHIBIA (Frogs and Toads)

Common Name	Scientific Name
Common Platanna	*Xenopus laevis*
Raucous Toad	*Bufo rangeri*
Cape Sand Frog	*Tomopterna delalandii*
Cape River Frog	*Rana fuscigula*
Spotted Rana	*Rana grayii*
Striped Grass Frog	*Rana fasciata*
Bronze Caco	*Cacosternum nanum*
Long-toed Running Frog	*Kassina wealliii*
Spotted Tree Frog	*Hyperolius marmoratus verrucosus*

CLASS REPTILIA

ORDER CHELONIA (Tortoises)

Common Name	Scientific Name
Angulate Tortoise	*Chersina angulata*
Padlopertjie or Parrot's-beak Tortoise	*Homopus aerolatus*

SUBORDER SERPENTES (Snakes)

Common Name	Scientific Name
Black Worm Snake	*Leptotyphlops nigricans*
Common or Brown Water Snake	*Lycodonomorphus rufulus*
Common Green Water Snake	*Philothamnus loplogaster*
Natal Green Water Snake	*Philothamnus natalensis*
Common Mole Snake	*Pseudaspis cana*
Common or Southern Slug-eater	*Suberria lutrix*
Herald or Red-lipped Snake	*Crotaphopeltis lotamboeia*
Boomslang	*Dispholidus typus*
Spotted Grass Snake or Skaapsteker	*Psammophylax rhombeatus*
Cross-marked Grass Snake	*Psamnophis crucifer*
Spotted Dwarf Garter Snake	*Elaps lacteus*
Cape Cobra	*Naja nivea*
Common or Rhombic Night Adder	*Causus rhombeatus*
Common or African Puff-adder	*Bitis arietans*

Pelamis platurus the Yellow and black Sea-snake has been recorded from Storms River Mouth and specimens may occasionally be washed ashore in the area.

APPENDIX VI: Counts of waders (Charadrii) and other birds at the Groot and Sout Estuaries

		COUNTS							
		GROOT					SOUT		
Roberts No.	Common Name	1	2	3	4	5	1	2	3
47	White-breasted Cormorant	4	10	5	12	11	2	–	–
50	Reed Cormorant	18	–	–	–	6	–	–	–
89	Egyptian Goose	–	–	–	–	1	–	–	–
96	Yellow-billed Duck	4	–	–	–	2	–	–	–
149	Fish Eagle	2	–	2	–	–	–	2	2
231	Black Oystercatcher	–	–	–	–	–	4	–	–
235	White-fronted Sandplover	6	–	–	–	–	–	6	1
258	Common Sandpiper	4	–	–	–	–	–	–	–
263	Greenshank	1	–	–	1	1	–	–	–
268	Whimbrel	–	–	–	–	–	1	–	–
274	Water Dikkop	–	–	–	–	2	–	–	–
287	Kelp Gull	12	2	71	–	2	11	2	–
291	Common Tern) "Comic" Tern	–	12	4	–	–	–	–	–
294	Arctic Tern)								
296	Sandwich Tern	–	–	–	13	–	–	–	–
298	Swift Tern	–	–	–	55	–	–	–	–
394	Pied Kingfisher	2	1	2	2	3	–	–	–
395	Giant Kingfisher	1	–	1	–	1	–	1	–
396	Half-collared Kingfisher	–	–	1	2	–	–	1	–
686	Cape Wagtail	–	6	–	–	–	2	–	–

GROOT

1. Underhill *et al.* (1980)
2. ECRU 8 April 1981
3. ECRU 9 April 1981
4. ECRU 10 April 1981
5. ECRU 2 November 1982

SOUT

1. Underhill *et al.* (1980)
2. ECRU 9 April 1981
3. ECRU 2 November 1982

APPENDIX VII: Bird list for the De Vasselot Nature Reserve

Sources: G Pretorius, Regional Director, Directorate of Forestry, Humansdorp, *(in litt.)*. Underhill *et al.* 1980; ECRU Surveys 8 - 10 April 1981 and 1 - 3 November 1982; BL Furness, *in litt.*

Roberts No.	Common Name	Scientific Name
44	Cape Gannet	*Morus capensis*
47	White-breasted Cormorant	*Phalacrocorax carbo*
48	Cape Cormorant	*Phalacrocorax capensis*
49	+Bank Cormorant	*Phalacrocorax neglectus*

APPENDIX VII: (Cont.)

Roberts No.	Common Name	Scientific Name
50	Reed Cormorant	*Phalacrocorax africanus*
54	Grey Heron	*Arclea cinerea*
55	Black-headed Heron	*Arclea melanocephala*
72	Hamerkop	*Scopus umbretta*
84	Hadeda	*Hagedashia hagedash*
89	Egyptian Goose	*Alopochen aegyptiacus*
96	Yellow-billed Duck	*Anas undulata*
130	Black-shouldered Kite	*Elanus caeruleus*
149	+Fish Eagle	*Haliaeetus vocifer*
155	+Mountain Buzzard	*Buteo oreophilus*
181	Cape Francolin	*Francolinus capensis*
188	Red-necked Francolin	*Pternistis afer*
231	Black Oystercatcher	*Haematopus moquini*
235	White-fronted Sandplover	*Charadrius marginatus*
242	Crowned Plover	*Stephanybix coronatus*
258	Common Sandpiper	*Actitis hypoleucos*
263	Greenshank	*Tringa nebularia*
268	Whimbrel	*Numenius phaeopus*
274	Water Dikkop	*Burhinus vermiculatus*
275	Dikkop	*Burhinus capensis*
287	Kelp Gull	*Larus dominicanus*
291	Common Tern	*Sterna hirundo*
294	Arctic Tern	*Sterna paradisaea*
296	Sandwich Tern	*Sterna sandvicensis*
298	Swift Tern	*Sterna bergii*
311	Rock Pigeon	*Columba guinea*
312	Rameron Pigeon	*Columba arquatrix*
316	Cape Turtle Dove	*Streptopelia capicola*
336	Knysna Loerie	*Turacus corythaix*
394	Pied Kingfisher	*Ceryle rudis*
395	Giant Kingfisher	*Megaceryle maxima*
396	Half-collared Kingfisher	*Alcedo semitorquata*
397	Malachite Kingfisher	*Corythornis cristata*
402	Brown-hooded Kingfisher	*Halcyon albiventris*
419	Red-billed Hoopoe	*Phoeniculus purpureus*
452	Olive Woodpecker	*Mesopicos griseocephalus*
517	Fork-tailed Drongo	*Dicrurus adsimilis*
521	Black-headed Oriole	*Oriolus larvatus*
524	White-necked Raven	*Corvultur albicollis*
546	Terrestrial Bulbul	*Phyllastrephus terrestris*
551	Sombre Bulbul	*Andropadus importunus*
553	Olive Thrush	*Turdus olivaceous*
578	Chorister Robin	*Cossypha dischroa*
581	Cape Robin	*Cossypha caffra*
612	+Victorin's Scrub Warbler	*Bradypterus victorini*
622	Bar-throated Apalis	*Apalis thoracica*
627	Bleating Bush Warbler	*Comaroptera brachyura*
637	Neddicky	*Cisticola fulvicapilla*
655	Dusky Flycatcher	*Muscicapa adusta*
671	Yellow-throated Flycatcher	*Seicerus ruficapilla*
672	Cape Batis	*Batis capensis*
682	Paradise Flycatcher	*Terpsiphone viridis*
686	Cape Wagtail	*Motacilla capensis*
707	Fiscal	*Lanius collaris*
709	Boubou	*Laniarius ferrugineus*

APPENDIX VII: (Cont.)

Roberts No.	Common Name	Scientific Name
712	Puffback Shrike	*Dryoscopus cubla*
749	Cape Sugarbird	*Promerops cafer*
753	Orange-breasted Sunbird	*Anthobaphes violacea*
760	Lesser Double-collared Sunbird	*Cinnyris chalybeus*
775	Cape White-eye	*Zosterops pallidus*
825	Swee Waxbill	*Coccopygia melanotis*
855	Cape Siskin	*Serinus totta*
858	Forest Canary	*Serinus scotops*
863	Bully Seed-eater	*Crithagra sulphurata*

+Classified as rare: Red Data Book - Aves (Siegfried *et al.*, 1976).

APPENDIX VIII: Mammals occurring in the De Vasselot Nature Reserve

SOURCES: Stuart *et al.* 1980, G Pretorius *in litt.* GA Robinson and GC Martin pers. comm.

Common Name	Scientific Name
Forest shrew	*Mysorex varius*
Red musk shrew	*Crocidura flaverscens*
Reddish-grey musk shrew	*Crocidura cyanea*
Chacma baboon	*Papio ursinus*
Vervet monkey	*Cercopithecus pyperythrus*
Large spotted genet	*Genetta tigrina*
Cape grey mongoose	*Herpestes pulverulentus*
Clawless otter	*Aonyx capensis*
Bushpig	*Potamochoerus porcus*
Bushbuck	*Tragelaphus scriptus*
Blue duiker	*Cephalophus monticola*
Grysbok	*Raphicerus campestris*
Striped mouse	*Rhabdomys pumilio*
Cape spring mouse	*Acomys subspinosus*
Namaqua rock rat	*Hethomys namaquensis*
Verreaux's rat	*Praomys verreauxi*
Forest dormouse	*Graphiusus marinus*
Caracal	*Felis caracal*
Leopard	*Panthera pardus*
Honey badger	*Mellivora capensis*
Water mongoose	*Atilax paludinosus*

APPENDIX IX: The Island: a synopsis of legal developments to date

Development of the erven (Numbers 353 - 373) on the Island has been in contention since 1968. During spring tides early in 1968 part of the Island was flooded to a depth of 18 inches (approximately 0,5 m). Consequently the then Knysna Divisional Council (KDC) wrote to the Nature's Valley Development Corporation (Pty) Ltd suggesting that they consider the withdrawal of these plots from their sales list "in view of their obvious unsuitability as building erven". The KDC further advised that they would be very reluctant to pass plans for the erection of buildings on the plots in view of the flood threat. The Nature's Valley Development Corporation

APPENDIX IX: (Cont.)

replied stating that they could not accede to the KDC's request. The KDC responded by drawing the Nature's Valley Development Corporation's attention to the regulation requiring that all buildings in the township be provided with flush lavatories and septic tanks and to warn the company that the KDC would not be able to approve of septic tanks and french drains in any area with a water table as high as that on the Island.

The Nature's Valley Development Corporation obtained a report from a member of Messrs Ninham Shand & Partners in regard to the possible detrimental effect on the environment of the use of household septic tank systems on the Island plots. The consultant concluded that provided that the tanks were designed as specified in his report they would not constitute a danger to public health.

The KDC remained unconvinced and requested Dr Smith of the State Health Department to inspect the site. Dr Smith noted that some plots were very low lying and recommended that septic tanks should not be permitted on plots where more than 25% of the ground area lay below the level of the road on the Island. Dr Smith added that "An irreversible health hazard must not be created in an area of outstanding scenic beauty, a heritage which needs to be closely guarded". Dr Smith also criticised the proposed erection of buildings purely on aesthetic grounds.

The matter effectively rested until May 1972 when the owner of Erf No 368 (Home Service Security (Pty) Ltd) submitted building plans to the KDC for approval. Aware that the KDC had disapproved of previously proposed sewage disposal schemes the owner requested that he should have the opportunity to address the KDC personally with consultants and advisers. The KDC failed to respond to this request and rejected the plans on the basis that the proposed means of sewage disposal was unacceptable. The KDC was supported by the CPA Director of Local Government who stated "... the Administration is in agreement with your Council that building plans for the erven in question must be refused unless of course the owners can provide a more acceptable means of sewage disposal".

The owner of Erf No 368 then applied for a court order to enforce the KDC to reconsider its rejection of the plans for the development of the erf. The owner's application was successful and the court (Cape of Good Hope Provincial Division, Supreme Court of South Africa, 27 February 1975) ruled *inter alia* that the KDC should:

(i) consider new plans submitted to it by the owner; and

(ii) supply reasons within 14 days if the plans were rejected.

The matter then appears to have lain dormant until 1982 when the Nature's Valley Development Corporation met representatives of the Outeniqua Divisional Council (successor to the Knysna Divisional Council) to discuss the problem of sewage disposal from the Island erven. It was agreed that a system of conservancy tanks would be acceptable to the Outeniqua Divisional Council (ODC) although they (the ODC) made it clear that they were fundamentally opposed to building on the Island. The Nature's Valley Development Corporation agreed to pay R30 000 towards a tanker to service the conservancy tanks. The ODC arranged to negotiate with the Directorate of Forestry for a suitable site for the construction of an oxidation pond.

APPENDIX IX: (Cont.)

The Nature's Valley Development Corporation proposed to incorporate the following conditions in its Deeds of Sale (not verbatim):

(1) Purchaser to assist in the eradication of exotic acacia.

(2) Purchaser to comply with requirements for sewage disposal i.e. conservancy tank.

(3) Purchaser to acknowledge that he has been advised of the possibility of the erf being subject to periodic flooding and accepting that he will have no claim against either the ODC or the Nature's Valley Development Corporation in this regard.

(4) Purchaser to be limited to certain standardised criteria with regard to the exterior finish of any structure.

At the time of the ECRU survey (1 - 3 November 1982) no building had been commenced although some clearing of vegetation (Black Wattle) had taken place.

APPENDIX X: Summary of available information

ESTUARY / RIVERMOUTH / LAGOON: GROOT (WES)/SOUT ESTUARIES

Summary of available information

		Sources of Information	Acocks	Ben Farrell *et al.*	Cape of Good Hope Provincial Division	Carruthers and Robinson	Day	FitzSimons, F.W.	FitzSimons, F.W.	FitzSimons, V.F.M.	Greig and Burdett	Harrison and Agnew	Heydorn and Tinley	Le Roi le Riche and Hey	Palmer and Jenkins	Phillips	Roberts	Rycroft	Schulze	Seagrief
		YEAR (DATE OF INFORMATION)	1975	1975	1975	1977	1981	1923	1926	1962	1976	1962	1980	1947	1978	1931	1978	1980	1965	1967
BIOTIC		Food Webs															*			
BIOTIC	Fauna	Mammals																		
BIOTIC	Fauna	Birds																		*
BIOTIC	Fauna	Reptiles & Amphibians				*				*	*									
BIOTIC	Fauna	Fish																		
BIOTIC	Fauna	Fauna on soft substrates										*								
BIOTIC	Fauna	Fauna on hard substrates										*								
BIOTIC	Fauna	Insects																		
BIOTIC	Fauna	Other invertebrates										*								
BIOTIC	Fauna	Zooplankton												*						
BIOTIC	Flora	Terrestrial	*													*		*		
BIOTIC	Flora	Phytoplankton																		*
BIOTIC	Flora	Halophytes																		*
	Other	Historical			*										*					
	Other	Utilization		*	*															
	Other	Conservation																		
	Other	Modelling																		
	Other	Aquaculture																		
	Other	Management		*	*															
ABIOTIC		Bacteriology																		
ABIOTIC	Chemistry	Pesticide residues																		
ABIOTIC	Chemistry	Metal residues																		
ABIOTIC	Chemistry	Eutrophication																		
ABIOTIC	Chemistry	General chemistry					*													
ABIOTIC	Geomorphology	Sediment transport & deposition																		
ABIOTIC	Geomorphology	Paleoenviroment						*	*											
ABIOTIC	Geomorphology	Geology																		
ABIOTIC	Physics	Circulation & mixing																		
ABIOTIC	Physics	Density variations																		
ABIOTIC	Physics	Hydrology																	*	
ABIOTIC	Physiography	Morphology																		
ABIOTIC	Physiography	Catchment characteristics																		

ESTUARY / RIVERMOUTH / LAGOON	YEAR (DATE OF INFORMATION)	ABIOTIC																						BIOTIC											
		Physiography		Physics			Geomorphology			Chemistry					Bacteriology	Other							Flora		Fauna									Food Webs
GROOT (WES)/SOUT ESTUARIES		Catchment characteristics	Morphology	Hydrology	Density variations	Circulation & mixing	Geology	Paleoenvironment	Sediment transport & deposition	General chemistry	Eutrophication	Metal residues	Pesticide residues			Management	Aquaculture	Modelling	Conservation	Utilization	Historical		Halophytes	Phytoplankton	Terrestrial	Zooplankton	Other invertebrates	Insects	Fauna on hard substrates	Fauna on soft substrates	Fish	Reptiles & Amphibians	Birds	Mammals	
Sources of Information		Summary of available information																																	
Siegfried *et al.*	1976																															*		
Smith	1975																													*				
Storrar	1982																				*													
Stuart *et al.*	1980																																*	
Toerien	1976						*																											
Vanderhill *et al.*	1980																															*		
Von Breitenbach	1974																							*										
Watling and Watling	1979									*		*																						
Watling and Watling	1980									*		*																						
Maps																																		
SA 1:10 000 33223 DC 22	1975		*																															
SA 1:10 000 3323 DC 21/3423 BA 1	1975		*																															
SA 1:50 000 3323 DC	1967	*																																
SA 1:250 000 3322	1972	*																																
SA 1:250 000 3322 Geological series	1979							*																										
SA Navy 1:150 000 Chart SAN 123	1976	*																																

PLATE I:

A view of "The Island" at the Groot Estuary, taken from the National Road (N2) during high water level conditions on 11 June 1983. The mouth was closed at the time. The plots for the proposed development are situated in the background. It is notable that water levels up to half a metre higher than that shown here have been recorded.
(ECRU 83-06-11).

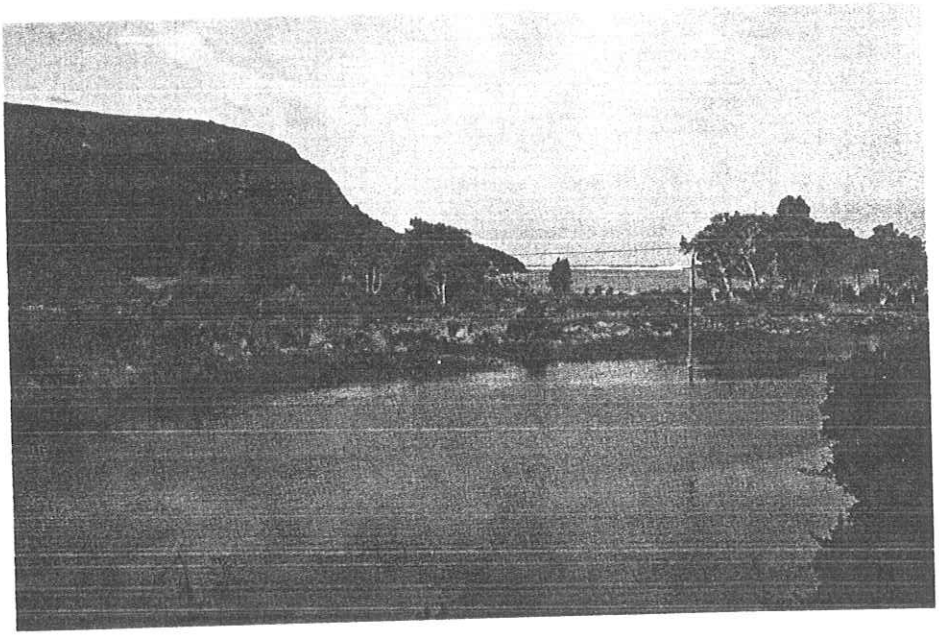

PLATE II:

The mouth of the Sout Estuary - altitude approximate 150 m.
(ECRU 79-10-17).

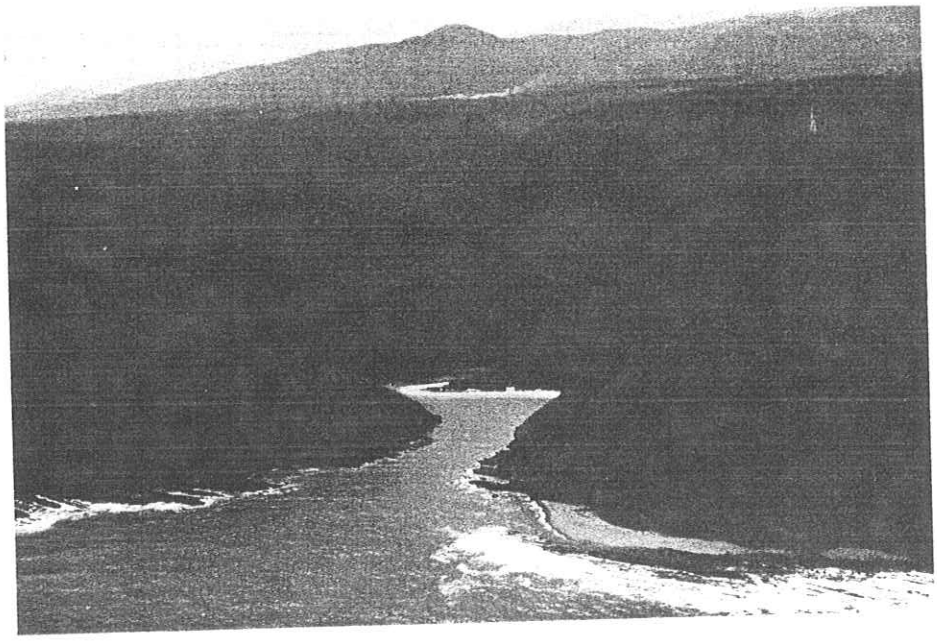

PLATE III:

Mouth of the Sout Estuary in October 1962 showing deposition of wood chips on the edges of the cove.
(Photo: AEF Heydorn).