NATIONAL BIODIVERSITY ASSESSMENT 2011

National Estuary Biodiversity Plan for South Africa

Technical Report

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This report forms part of a set of six reports on South Africa's National Biodiversity Assessment 2011. The full set is as follows:

Synthesis Report

Driver, A., Sink, K.J., Nel, J.L., Holness, S., Van Niekerk, L., Daniels, F., Jonas, Z., Majiedt, P.A., Harris, L. & Maze, K. 2012. *National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis Report.* South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria.

Technical Reports

Volume 1: Terrestrial Component
Jonas, Z., Daniels, F., Driver, A., Malatji, K.N., Dlamini, M., Malebu, T., April, V. & Holness, S. 2012. *National Biodiversity Assessment 2011: Technical Report. Volume 1: Terrestrial Component*. South African National Biodiversity Institute, Pretoria.

Volume 2: Freshwater Component
Nel, J.L. & Driver, A. 2012. *National Biodiversity Assessment 2011: Technical Report. Volume 2: Freshwater Component*. CSIR Report Number CSIR/NRE/ECO/IR/2012/0022/A. Council for Scientific and Industrial Research, Stellenbosch.

Volume 3: Estuary Component
Van Niekerk, L. & Turpie, J.K. (eds). 2012. *National Biodiversity Assessment 2011: Technical Report. Volume 3: Estuary Component*. CSIR Report Number CSIR/NRE/ECOS/ER/2011/0045/B. Council for Scientific and Industrial Research, Stellenbosch.

Turpie, J.K., Wilson, G. & Van Niekerk, L. 2012. *National Biodiversity Assessment 2011: National Estuary Biodiversity Plan for South Africa*. Anchor Environmental Consultants, Report No AEC2012/01, Cape Town. Report produced for the Council for Scientific and Industrial Research and the South African National Biodiversity Institute.

Volume 4: Marine Component
Sink, K.J, Holness, S., Harris, L., Majiedt, P.A., Atkinson, L., Robinson, T., Kirkman, S., Hutchings, L., Leslie, R., Lamberth, S., Kerwath, S., von der Heyden, S., Lombard, A.T., Attwood, C., Branch, G., Fairweather, T., Taljaard, S., Weerts, S., Cowley, P., Awad, A., Halpern, B., Grantham, H. and Wolf, T. 2012. *National Biodiversity Assessment 2011: Technical Report. Volume 4: Marine and Coastal Component*. South African National Biodiversity Institute, Pretoria.

The National Biodiversity Assessment 2011 was led by the South African National Biodiversity Institute in partnership with a range of organisations including the Department of

Environmental Affairs and Tourism, the Council for Scientific and Industrial Research (CSIR) and South African National Parks (SANParks).

PREFACE AND ACKNOWLEDGEMENTS

This National Estuary Biodiversity Plan was funded by the South African National Biodiversity Institute (SANBI) as part of the National Biodiversity Assessment 2011, and builds on the regional conservation plan developed for temperate South African estuaries under the Cape Action for People and the Environment (CAPE) programme's Regional Estuary Management Programme (Turpie & Clark 2007). Core estuary priorities are identified at the national level to inform a broader social process of negotiations around water resources and estuary management in the country.

In addition to the numerous estuary scientists and managers that provided data and ideas to the CAPE project (see Turpie & Clark 2007; names included on cover page), we would like to thank the following people for their input into this assessment:

- Amanda Driver (SANBI), Jeanne Nel (CSIR) and Barry Clark (Anchor Environmental Consultants) for valuable discussions and inputs on the approach for this study and its integration with other national initiatives;
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EXECUTIVE SUMMARY

Introduction

This analysis forms part of South Africa's National Biodiversity Assessment 2011 (NBA 2011). The NBA is central to fulfilling SANBI's mandate in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004) to monitoring and report regularly on the state of biodiversity in South Africa. The NBA provides an assessment of the current state of health and protection of all types of ecosystems in South Africa, including estuaries, and fills gaps in the biodiversity planning efforts that have been made to date. One of these gaps is a national-level biodiversity plan[1] for South Africa's estuaries. The main objective of this analysis was to develop a biodiversity plan for the estuaries of South Africa by prioritising estuaries and establishing which should be assigned Estuarine Protected Area (EPA) status. This analysis represents a significant milestone in that it is the first biodiversity plan to include all the estuaries of South Africa, providing the first national set of priority estuaries.

Overall approach

Biodiversity planning is an evolving field that has allowed a move from *ad hoc* protection to systematic planning that takes pattern, process and biodiversity persistence into account. More recently, attention has been focused on incorporating socio-economic realities into biodiversity planning, particularly in terms of minimising the management and opportunity costs of protection. While we have not explicitly taken social and economic costs and benefits into consideration, we have taken ecosystem health into account, which provides a surrogate for the former to some extent, in that estuaries where the opportunity costs of protection are likely to be high are also likely to be heavily utilised systems that are in a poorer state of health.

Biodiversity planning involves defining the planning domain and planning units, then setting targets, assessing how well the current protected areas meet those targets and selecting new planning units to meet the targets subject to some constraint such as minimising the

[1] Note on terminology: Biodiversity planning is also referred to as conservation planning. In South Africa the term "biodiversity planning" is preferred, as in many people's minds "conservation planning" implies working purely with the establishment or expansion of formal protected areas, rather than with influencing the management and use of biodiversity more broadly.

number of sites or the costs. A variety of sophisticated algorithms have been developed for this purpose. We made use of MARXAN (operated via CLUZ).

This plan builds largely upon the CAPE Estuary Conservation Plan which covered the temperate regions of South Africa only. It will also be aligned with the regional biodiversity plan being developed in KwaZulu-Natal, through ongoing discussions of methods as well as data sharing.

Planning units

A total of 289 estuaries from the cool temperate, warm temperate and sub-tropical regions were included[2]. The main objective was to identify which South African estuaries should be assigned protected area status. Where feasible, estuaries were divided into two (non-spatially-explicit) planning units – each theoretically representing 50% of the biodiversity features of the estuary. This allowed for the possibility of partial protection, as opposed to only having the option of protecting whole estuaries.

Biodiversity targets

Targets are often defined in terms of achieving representation of ecosystem types, habitats and species, as well as meeting population targets that ensure their viability. The overall target was to protect a minimum of 20% of total estuarine area. Targets for ecosystem type are sometimes used as a surrogate for biodiversity for which data are lacking. In this plan, estuary ecosystem type was defined on the basis of mouth state, salinity structure, freshwater type and size, to align with the estuary ecosystem types used for the assessment of threat status and protection level in the NBA (see Van Niekerk & Turpie 2012). A target of 20% was set for the total area of each type. Sensitivity analysis was conducted by excluding type and by varying the number of factors used in defining estuary ecosystem type.

[2] The number of estuaries differs from study to study. In this study we have considered all estuaries whose mouths are naturally joined. This includes the St Lucia-Mfolozi and the Mhlathuze-Richards Bay systems..The list also includes a number of small systems identified by van Niekerk & Turpie (2011) that were not included in Whitfield's (2000) list of South African estuaries or other earlier assessments.

Habitat targets were set as a 20% of the total area of each estuarine habitat type,[3] except for mangroves and swamp forest habitats. Nationally, mangrove and swamp forest utilisation is regulated under the National Forests Act and destruction or harvesting of indigenous trees is prohibited. While the mangrove trees and swamp forest are protected, the area under the forests and the associated estuarine habitat in many cases is not. Because of this, targets were not set for mangroves or swamp forest per se, but instead protection was given to all estuaries that contained >5ha of these habitats by automatically including them into the set of priority estuaries, thereby offering formal protection to estuaries where swamp forest or mangroves occur. Population targets, based on numbers of individuals per species, were set for estuary dependent fish and bird species (84 and 35 species, respectively) as follows: 50% of the population for red data species, 40% for exploited species and 30% for the rest. Ecosystem and landscape level processes were accommodated by ensuring that the set of priority estuaries had a good geographic spread, included large as well as small estuaries, and favoured healthier estuaries. Alignment with existing and/or proposed land-based and marine protected areas was also taken into consideration.

Gap analysis

Fully-protected areas currently account for 56 082 ha or 62% of the estuarine area within the planning domain. However, the St Lucia-Mfolozi estuary system covers a total of 50 800 ha and contributes 91% of this area. The remaining fully-protected estuaries cover a total area of 5280 ha, which is 6% of the total area of estuaries in South Africa.

Site selection procedure

Biodiversity planning algorithms are used to find the most efficient, or lowest cost, solution required to meet defined biodiversity targets. We used the MARXAN site optimisation algorithm, run through a GIS interface programme called CLUZ. MARXAN starts by selecting a random set of planning units, and then makes iterative changes to the set of sites by randomly adding or subtracting planning units. At each iteration within a run the new set is compared with the previous set, and the better one is selected. The MARXAN application was run for up to 50 runs at 1 million iterations per run. The programme then selected the best output out of the 50 runs.

[3] Estuarine habitat types are distinct from estuary ecosystem types. Habitat types include, for example, sand and mud banks, submerged macrophyte beds, rocks, intertidal saltmarsh, mangroves and swamp forest. For a full list of habitat types see Section 2.4.2.

While socio-economic costs and benefits were not directly included in the analysis, estuary health was incorporated as a cost, in that more degraded estuaries were assigned exponentially increasing costs. Highly impacted estuaries probably also have relatively high costs of conservation – both in terms of rehabilitation costs as well as forgone opportunity costs.

To account for data limitations, the expert opinions of the scientific and management community were also taken into account. Estuary scientists and managers participated in a workshop to finalise the definition of the planning units and their feasibility of protection, and to agree on which planning units should be automatically included into the final set of priority estuaries, giving reasons.

Finally, sensitivity analyses were conducted, in which inclusion or definition of targets for estuary ecosystem types was varied.

Results and recommendations

The primary analysis, which included area targets for estuary ecosystem type, suggested that 133 estuaries, including those already protected, would be required to meet the defined biodiversity targets, with some of these requiring partial protection. Of these, 61 should be fully protected, and 72 require partial protection. This amounts to about 46% of estuaries and 79% of estuarine area..

Fully protected estuaries are taken to be full no-take areas. Partial protection might involve zonation which includes a no-take zone, or might address other pressures with other types of action. In both these cases, the management objective would be to protect 50% of the biodiversity features of the partially protected estuary. Fully protected and partially protected estuaries can be considered Estuarine Protected Areas, whereas all other estuaries should be designated Estuarine Management Areas. All estuaries require an Estuary Management Plan in terms of the Integrated Coastal Management Act (Act 24 of 2008), and these plans should be guided by the results of this National Estuary Biodiversity Plan.

Based on the list of priority estuaries generated in this analysis, plus preliminary estimates of their present ecological status (health; this analysis) and their importance rating (Turpie & Clark 2007), Table 1 lists the national and regional priority estuaries, provides

recommendations regarding the extent of protection required for each, the recommended extent of the estuary perimeter that should be free from development to an appropriate setback line of at least 500m, and a provisional estimate of the Recommended Ecological Category, or recommended future health class determining the limitations on future water use, as required under the National Water Act.

Table 1. National and/or sub-national (CAPE) priorities, the extent of protection required (full = full no-take protection, partial includes no-take sanctuary zone where feasible), the recommended proportion of the estuary margin that should remain undeveloped or with a >500m development setback line, and provisional estimate of the Recommended Ecological Category.

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Orange	D	SA/CAPE	Full	50%	C*
Buffels	C				C
Spoeg	B	SA	Full	100%	A or BAS
Groen	B	SA	Full	100%	A or BAS
Sout	D				D
Olifants	C	SA/CAPE	Partial	50%	B*
Jakkalsvlei	D				D
Wadrift	E				D
Verlorenvlei	D	SA	Partial	50%	C
Berg	D	SA/CAPE	Partial	25%	C*
Rietvlei/ Diep	E	SA/CAPE	Partial	50%	C
Sout W	F				D
Hout Bay	E				D
Wildevoëlvlei	D				B
Bokramspruit	C				C
Schuster	A				A
Krom	A	SA/CAPE	Full	100%	A or BAS
Buffels Wes	F				D
Elsies	E				D
Silvermine	D				D
Sand	D	SA/CAPE	Partial	20%	C
Zeekoei	E				D
Eerste	E	SA/CAPE	Full	75%	D
Lourens	C	SA/CAPE	Full	75%	D
Sir Lowry's Pass	E				D
Steenbras	B				B
Rooiels	B				B
Buffels (Oos)	B				B
Palmiet	C	SA/CAPE	Full	50%	B*
Bot / Kleinmond	C	SA/CAPE	Partial	50%	B
Onrus	E				D
Klein	C	SA/CAPE	Partial	50%	B
Uilkraals	D	SA	Partial	75%	C
Ratel	C	SA	Full	75%	C
Heuningnes	D	SA/CAPE	Partial	75%	A or BAS
Klipdrifsfontein	A	SA/CAPE	Full	75%	A
Breede	B	SA	Partial	50%	B*
Duiwenhoks	B				A

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Goukou	C	SA/CAPE	Partial	50%	B
Gourits	C	SA/CAPE	Partial	50%	B
Blinde	B				B
Hartenbos	D				C
Klein Brak	C				C
Groot Brak	E				C*
Maalgate	B				B*
Gwaing	B				C*
Kaaimans	B	SA	Full	50%	B*
Wilderness	B	SA/CAPE	Partial	50%	A or BAS
Swartvlei	B	SA/CAPE	Partial	50%	B*
Goukamma	B	SA/CAPE	Full	75%	A*
Knysna	B	SA/CAPE	Partial	50%	B*
Noetsie	B	CAPE			A*
Piesang	C	SA	Partial	50%	B
Keurbooms	A	SA/CAPE	Partial	50%	A*
Matjies	B				B*
Sout (Oos)	A	SA/CAPE	Full	100%	A*
Groot (Wes)	B	SA/CAPE	Full	75%	A or BAS
Bloukrans	A	SA/CAPE	Full	100%	A or BAS
Lottering	A	SA/CAPE	Full	100%	A or BAS
Elandsbos	A	SA/CAPE	Full	100%	A or BAS
Storms	A	SA/CAPE	Full	100%	A or BAS
Elands	B	SA/CAPE	Full	100%	A or BAS
Groot (Oos)	B	SA/CAPE	Full	100%	A or BAS
Tsitsikamma	B	SA	Full	50%	B*
Klipdrif	D				D
Slang	D				D
Kromme	D	SA/CAPE	Partial	25%	C*
Seekoei	D	SA/CAPE	Partial	25%	B*
Kabeljous	C				B
Gamtoos	C	SA/CAPE	Partial	50%	A or BAS
Van Stadens	B	SA/CAPE	Full	50%	A or BAS
Maitland	C	SA/CAPE	Full	75%	C
Bakens	E				D
Papkuils	F				D
Swartkops	C	SA/CAPE	Partial	25%	B
Coega (Ngcura)	F				D
Sundays	C	SA/CAPE	Partial	50%	A or BAS
Boknes	C				C
Bushman's	B	SA/CAPE	Partial	50%	A*
Kariega	C	SA/CAPE	Partial	50%	B
Kasuka	B				A
Kowie	C				B
Rufane	C				C
Riet	B				A
West Kleinemonde	B				A
East Kleinemonde	B				B*
Klein Palmiet	D				D
Great Fish	C	SA/CAPE	Partial	50%	B
Old woman's	C				C
Mpekweni	B				A
Mtati	B	CAPE			A
Mgwalana	B	SA	Partial	50%	A
Bira	B	SA	Partial	50%	A

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Gqutywa	B	SA/CAPE	Full	75%	A
Ngculura	B				B
Freshwaterpoort	A				A
Mtana	B				B
Keiskamma	C	SA/CAPE	Partial	50%	B
Ngqinisa	B	SA	Full	75%	B
Kiwane	B				B
Tyolomnqa	B				A
Shelbertsstroom	C				C
Lilyvale	B				B
Ross' Creek	B				B
Ncera	B	SA	Full	75%	B
Mlele	B				B
Mcantsi	C				C
Gxulu	B				B
Goda	B	CAPE	Full	75%	B
Hlozi	B				B
Hickman's	B				B
Mvubakazi	B				B
Ngqenga	C				C
Buffalo	D				C
Blind	C				C
Hlaze	C				C
Nahoon	C				B*
Qinira	B				A
Gqunube	B	SA	Partial	50%	A
Kwelera	B	SA	Partial	50%	A
Bulura	B				B
Cunge	A				A
Cintsa	C				C
Cefane	B				A
Kwenxura	B	SA/CAPE	Full	75%	A
Nyara	A				A
Mtwendwe	B				B
Haga-haga	B				B
Mtendwe	B				B
Quko	A	SA/CAPE	Full	50%	A
Morgan	C				C
Cwili	B				B
Great Kei	C	SA/CAPE	Partial	50%	B*
Gxara	B				B
Ngogwane	B				B
Qolora	B				A
Ncizele	B	SA	Full	75%	B
Timba	A				A
Kobonqaba	B				B
Nxaxo/Ngqusi	B	SA/CAPE	Full	75%	A
Cebe	B				B
Gqunqe	A				A
Zalu	A				A
Ngqwara	A	SA	Full	75%	A
Sihlontlweni/Gcini	B				B
Nebelele	A				A
Qora	B	SA/CAPE	Partial	75%	A
Jujura	B				B

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Ngadla	A	SA	Full	75%	A
Shixini	B	CAPE			B
Beechamwood	A				A
Un-named EC	A				A
Kwa-Goqo	A				A
Ku-Nocekedwa	A				A
Nqabara	B	SA	Partial	75%	A
Ngoma/Kobule	A				A
Mendu	A	SA			A
Mendwana	A	SA			A
Mbashe	C	SA/CAPE	Partial	75%	A or BAS
Ku-Mpenzu	B	SA/CAPE	Full	75%	B
Ku-Bhula/Mbhanyana	A	SA/CAPE	Full	75%	A
Kwa-Suka	B	SA			B
Ntlonyane	B	SA/CAPE	Full	75%	B
Nkanya	B	SA/CAPE	Full	75%	B
Sundwana	A	SA	Full	75%	A
Xora	B	SA	Partial	75%	A
Bulungula	B				B
Ku-amanzimuzama	A				A
Ngakanqa	A	SA	Full	75%	A
Un-named KZN	A				A
Mncwasa	B				B
Mpako	B				B
Nenga	C				C
Mapuzi	B				B
Mtata	D	SA	Partial	50%	C*
Tshani	B				B
Mdumbi	B	CAPE			A
Lwandilana	A	SA	Full	75%	A
Lwandile	A				A
Mtakatye	B	SA	Partial	75%	B
Hluleka	A	SA	Full	75%	A or BAS
Mnenu	B				B
Mtonga	B				B
Mpande	B				B
Sinangwana	B				B
Mngazana	B	SA	Partial	50%	B
Mngazi	C				C
Gxwaleni	A				A
Bulolo	B				B
Mtambane	B				B
Mzimvubu	C	SA	Partial	50%	C
Ntlupeni	B				B
Nkodusweni	B	SA	Partial	75%	A or BAS
Mntafufu	B	SA	Full	75%	A or BAS
Mzintlava	B	SA	Full	75%	A or BAS
Umzimpunzi	B	SA	Full	75%	B
Kwa-Nyambala	B	SA	Partial	50%	B
Mbotyi	B	SA	Partial	50%	A or BAS
Mkozi	A	SA	Full	75%	A
Myekane	A	SA	Full	75%	A
Sitatshe	A	SA	Full	75%	A
Lupatana	A	SA	Full	75%	A

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Mkweni	A	SA	Partial	75%	A or BAS
Msikaba	A	SA	Full	75%	A or BAS
Butsha	A	SA	Partial	100%	A
Mgwegwe	A	SA	Partial	100%	A
Mgwetyana	A	SA	Partial	100%	A
Mtentu	A	SA	Full	75%	A or BAS
Sikombe	A	SA	Partial	75%	A
Kwanyana	B	SA	Partial	75%	B
Mtolane	A	SA	Partial	75%	A
Mnyameni	B	SA	Partial	75%	A or BAS
Mpahlanyana	A	SA	Full	75%	A
Mpahlane	A	SA	Partial	75%	A
Mzamba	B	SA	Partial	75%	A
Mtentwana	C	SA	Full	75%	C
Mtamvuna	B	SA	Full	75%	A or BAS
Zolwane	B				B
Sandlundlu	C				C
Ku-Boboyi	B				B
Tongazi	B				B
Kandandhlovu	B				B
Mpenjati	B	SA	Partial	75%	A or BAS
Umhlangankulu	C				C
Kaba	B				B
Mbizana	B				B
Mvutshini	B				B
Bilanhlolo	C				C
Uvuzana	C				C
Kongweni	C				C
Vungu	B				B
Mhlangeni	C				C
Zotsha	C	SA	Partial	50%	C
Boboyi	C				C
Mbango	E				D
Mzimkulu	C	SA	Partial	50%	B
Mtentweni	C				C
Mhlangamkulu	C				C
Damba	C	SA	Partial	50%	C
Koshwana	C	SA	Partial	50%	C
Intshambili	B	SA	Partial	50%	B
Mzumbe	D				D
Mhlabatshane	B	SA	Partial	50%	B
Mhlungwa	C				C
Mfazazana	C	SA	Partial	50%	C
Kwa-Makosi	B	SA	Partial	75%	B
Mnamfu	C				C
Mtwalume	D				D
Mvuzi	C				C
Fafa	D				D
Mdesingane	C				C
Sezela	D				D
Mkumbane	C				C
Mzinto	C				C
Mzimayi	C				C
Nkomba	C				C
Mpambanyoni	C				C

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Mahlongwa	C				C
Mahlongwana	B				B
Mkomazi	C	SA	Partial	25%	B
Ngane	B				B
Umgababa	B	SA	Full	50%	B
Msimbazi	B	SA	Full	75%	B
Lovu	C	SA	Partial	50%	C
Little Manzimtoti	D				D
Manzimtoti	D				D
Mbokodweni	E				D
Sipingo	F				D
Durban Bay	E	SA	Partial	25%	B
Mgeni	D	SA	Partial	25%	A or BAS
Mhlanga	D	SA	Full	75%	B*
Mdloti	D				C*
Tongati	E				D
Mhlali	C	SA	Partial	50%	B
Bobs Stream	C				C
Seteni	C				C
Mvoti	D	SA	Full	75%	D
Mdlotane	B	SA	Full	75%	A
Nonoti	B				B
Zinkwasi	C	SA	Partial	50%	B
Thukela	C				C*
Matigulu/Nyoni	B	SA	Partial	50%	A
Siyaya	F	SA	Full	50%	B*
Mlalazi	B	SA	Full	75%	A or BAS
Mhlathuze/R.Bay	C	SA	Partial	50%	A or BAS
Nhlabane	D				C
St Lucia/Mfolozi	D	SA	Full	75%	A*
Mgobezeleni	B	SA	Full	75%	A or BAS
Kosi	B	SA	Full	75%	A or BAS

*Actual Recommended Ecological Category from Department of Water Affairs RDM study that has been conducted on the estuary

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1 INTRODUCTION

This analysis forms part of South Africa's National Biodiversity Assessment 2011 (NBA 2011). The NBA is central to fulfilling SANBI's mandate in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004) to monitoring and report regularly on the state of biodiversity in South Africa. The NBA provides an assessment of the current state of health and protection of all types of ecosystems in South Africa, including estuaries, and fills gaps in the biodiversity planning efforts that have been made to date. One of these gaps is a national-level biodiversity plan[4] for South Africa's estuaries. The main objective of this analysis was to develop a biodiversity plan for the estuaries of South Africa by prioritising estuaries and establishing which should be assigned Estuarine Protected Area (EPA) status. This analysis represents a significant milestone in that it is the first biodiversity plan to include all the estuaries of South Africa, providing the first national set of priority estuaries.

While many South African estuaries do enjoy some level of protection, there is still a need for a systematic, integrated biodiversity plan which integrates inputs from a range of stakeholders as well the scientific community. This was recognised as one of the priorities for both the CAPE programme and the NBA 2011, and a substantial amount of work has already been carried out on estuaries which can inform this process.

Among numerous studies which collate information on South African estuaries, Turpie (1995) prioritised estuaries in terms of waterbirds in a test of alternative site selection methods for conservation, Maree *et al.* (2003) performed a similar analysis of fish, and Colloty *et al.* (2001) and subsequent work established the botanical importance of a large proportion of South African estuaries. In a collaborative effort of the estuarine research community these analyses were later updated using complementarity analysis to produce a minimum representative set of estuaries, taking plants, invertebrates, fish and birds into account (Turpie *et al.* 2002, Driver *et al.* 2005). As part of the Eastern Cape Estuaries Management Programme and in collaboration with both estuary managers and scientists, Turpie (2004a) also developed guidelines for a strategy for the conservation of estuarine biodiversity in South Africa, which included the proposal for three types of estuary

[4] Note on terminology: Biodiversity planning is also referred to as conservation planning. In South Africa the term "biodiversity planning" is preferred, as in many people's minds "conservation planning" implies working purely with the establishment or expansion of formal protected areas, rather than with influencing the management and use of biodiversity more broadly.

management: estuarine protected areas (EPAs), co-managed estuarine conservation areas (ECAs) and estuarine management areas (EMAs), which together provide for active management of *all* estuaries in the country.

The latter studies all acknowledged a need to improve some of the datasets, and the need to take socio-economic considerations into account before finalising a set of priority estuaries, such as the trade-offs involved in estuary development and in the allocation of freshwater flows to alternative uses. Working towards this goal, Turpie *et al.* (2004a) collated much of the existing data on all South African estuaries, identified ongoing data collection efforts and undertook additional work to fill some key gaps, and these efforts continued as part of the CAPE Estuary Conservation Plan (Turpie & Clark 2007). The CAPE Estuary Conservation Plan, which was carried out under the CAPE Estuaries Management Programme, identified priority estuaries in the temperate biogeographic regions. A similar regional plan is currently being conducted in KwaZulu-Natal through Ezemvelo KZN Wildlife and will produce a biodiversity plan for the estuaries of KwaZulu-Natal.

The National Estuary Biodiversity Plan builds upon the biodiversity aspects of the CAPE Estuary Conservation Plan, which covered the temperate regions only. It presents the biodiversity sector's priorities for protection of estuarine biodiversity, which should inform a broader stakeholder negotiation process that considers socio-economic constraints. This plan will also be aligned with the regional biodiversity plan being developed in KZN, through ongoing discussions of methods as well as data sharing. The main objective of the National Estuary Biodiversity Plan, which was undertaken in collaboration with estuarine managers and scientists and the broader stakeholder community, is to identify which South African estuaries should be assigned protected area status. The plan included all cool temperate, warm temperate and sub-tropical estuaries from the Orange on the West Coast to Kosi Bay on the East Coast.

2 BIODIVERSITY PLANNING APPROACH

2.1 Overall approach

Biodiversity planning is a rapidly evolving area of research and practice for which numerous approaches have been explored around the world in recent years. Systematic biodiversity planning replaces the relatively *ad hoc* way of selecting priority sites in the past, and is becoming increasingly holistic in terms of ecological goals and in terms of integrating conservation and development needs in a region. In South Africa and Australia, systematic biodiversity planning has, over the past years, become a widely accepted methodology in establishing new protected areas to protect biodiversity (von Hase *et al.* 2003). Systematic biodiversity planning involves several principles, and has numerous distinctive characteristics (Margules & Pressey 2000).

Biodiversity planning typically involves the following steps (expanded from Pressey & Cowling 2001):

1. **Define the planning domain**: This involves defining the region within which the priority sites will be chosen, and may have a biogeographical or political basis.
2. **Define the planning units**. These are the sites that may be selected as priorities for conservation. In many cases these are defined as grid squares, hexagons or by cadastral units (properties).
3. **Set targets**: Identify conservation goals for the region and set quantitative biodiversity targets for the biodiversity features (e.g. species, vegetation communities and ecosystem types), and quantitative targets for minimum size, connectivity or other design criteria.
4. **Gap analysis**: Review existing protected areas, assessing the extent to which quantitative targets have already been achieved in these protected areas
5. **Select new sites**: Select additional areas using algorithms to identify preliminary sets of new priority areas for consideration by managers as additions to established areas.

Having first concentrated on the representation of species, biodiversity planning has generally evolved to incorporate ecosystem processes and now gives greater emphasis to biodiversity persistence (e.g. Cabeza & Moilanen 2001). One of the biggest challenges is

setting spatially-explicit targets for the maintenance of ecological and evolutionary processes. This involves identifying the processes and finding spatial surrogates for them and setting targets for these (Pressey *et al.* 2003). Another key challenge is delivering a plan that not only achieves representativeness but which also ensures the persistence of targeted populations and maintenance of biodiversity (Reyers *et al.* 2002).

The overall goals of the national set of priority estuaries were taken to be as follows (Turpie & Clark 2009):

1. **Representation**: all estuary-dependent species should be represented in viable numbers in the set of priority estuaries;
2. **Maintenance of ecological processes**: the set of priority estuaries should allow for connectivity and interaction with other adjoining ecosystems;
3. **Maintenance of fishery stocks**: the set of priority estuaries should provide enough protection to exploited species that they are able to act as source areas for surrounding exploited areas; and
4. **Feasibility of implementation**: consideration should be given to the practicalities of protection in each estuary – in this plan we considered this first through decisions about whether the estuary was able to achieve full or partial protection, and by favouring where possible healthier estuaries that offer a lower rehabilitation and opportunity cost of protection.

It should be noted that biodiversity planning cannot take place in isolation of an understanding of socio-economic pressures and values, and the priorities identified in this study will ultimately inform a broader stakeholder negotiation in which trade-offs between costs and benefits of protection versus utilisation are considered, as required under the National Water Act and Integrated Coastal Management Act. The selection of estuarine protected areas should ultimately take both biodiversity targets and costs and benefits into consideration (e.g. Balmford *et al.* 2000, Faith & Walker 2002, Frazee *et al.* 2003, Moore *et al.* 2004, Osano *et al.* 2005). If an estuary is proclaimed a protected area, then it will gain advantage in the priority it receives for water allocation as well as limiting activity within and around the estuary. This will incur opportunity costs associated with the loss of water availability for alternative activities upstream, as well as opportunity costs of limiting development around an estuary, or effects on property prices if certain forms of recreation are excluded. Protection of an estuary may also yield economic gains, in that it may boost an ecotourism-based economy, the outputs of the estuary to marine fisheries, and the option and non-use (existence) values associated with protection of an estuary. The current health

of a system will also influence the cost of protection, which is likely to be high for more degraded estuaries. Although not taken directly into account for this plan, economic and social considerations have been taken into account indirectly in the form of estuary health, with more heavily impacted estuaries less likely to be selected as priority estuaries.

2.2 Biogeography and the planning domain

The planning domain for the National Estuary Biodiversity Plan includes the entire South African coastline, which is divided into three biogeographical regions (Figure 2.1).

The general biogeographical pattern that has been identified for the South African coast is one of a Cool Temperate West Coast Region extending from the Orange River south to somewhere between Cape Point and Cape Agulhas, a Warm Temperate South Coast Region extending east to the area of Mbashe to Port St. Johns, and a Subtropical East Coast Region which extends north from there into Mozambique (Brown & Jarman 1978, Emanuel *et al.* 1992, Turpie *et al.* 2000). Based on the clear patterns demonstrated for intertidal invertebrates and coastal fishes, the breaks are generally taken to be at Cape Point and the Mbashe. Lombard *et al.* (2004) recently further subdivided the cool temperate region into a northern Namaqua bioregion (extending from the Orange River down to Cape Columbine) and a South-western Cape bioregion (from Columbine to Cape Point) but this was mostly to accommodate differences in algal distribution patterns. While some groups display a clear south coast zone (with several species endemic to this zone), it appears to be more of an overlap zone for coastal and estuarine birds (Siegfried 1981, Hockey *et al.* 1983, Hockey & Turpie 1999). The only other study of estuarine biogeography is for fish, and describes the breaks between the three biogeographic regions being at Cape Agulhas and the Mdumbi estuary, north-east of the Mbashe (Harrison 2002). The westerly break is largely driven by the high abundance of a few species in the cool temperate region. East of Cape Point, all groups are largely characterised by a gradual eastward change in species and an increase in species richness.

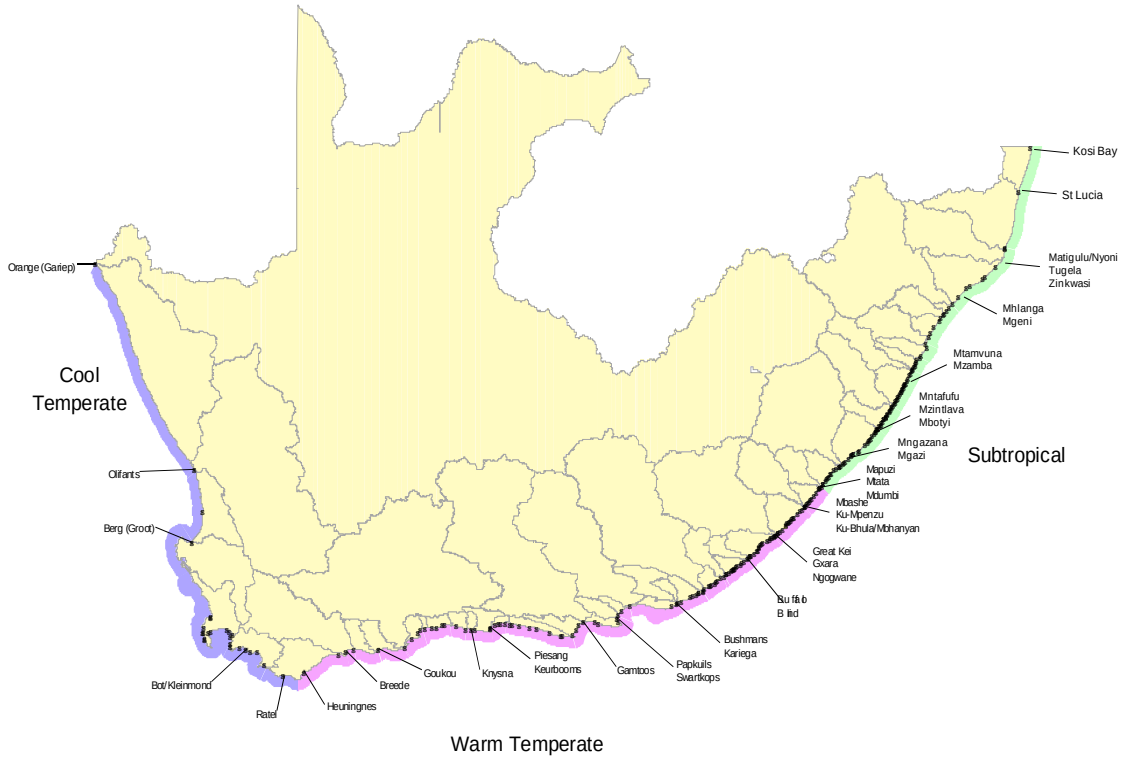

Figure 2.1 Distribution of estuaries in relation to the three biogeographic regions and secondary catchment areas

2.3 Definition of planning units

A total of **289 estuaries** were considered in this assessment. The total number that were considered to be functional estuaries has increased from the 258 given in the National Spatial Biodiversity Assessment 2004 for estuaries (Turpie 2004b), following further discussions by estuary scientists during the NBA 2011 assessment. A total of 32 estuaries were added to the list (Appendix 1). In addition, systems that had shared mouths were considered as single estuaries. Some systems, such as the Nxaxo-Nquisi, were already described as a single estuary. The changes applied to St Lucia–Mfolozi estuary system (which also includes the Msunduzi system, not formerly listed as an estuary), and the Richard's Bay–Mhlatuze estuary system. It should be noted that there are more than 75 systems in South Africa that are not considered to function as estuaries. All functional estuaries were included in this plan, with their present health being factored into the analysis (see later explanation).

Previous planning exercises have selected estuaries as either in or out of a priority set, suggesting that a whole estuary should be considered as a planning unit. However, given the fact that it is often not feasible to protect an entire estuary as a fully-protected no-take zone, due to social and economic pressures, it was decided to consider partial protection as a feasible option for most estuaries, potentially requiring more planning units than if just whole estuaries were considered (Turpie & Clark 2007). Thus, as far as was considered feasible (see section on stakeholder/expert input), most of the estuaries were split into **two planning units**. This resulted in a total of **430 planning units** being used in the analysis.

2.4 Biodiversity features: habitats, species and populations

2.4.1 Estuary ecosystem type

There are two main classification systems for estuaries in South Africa. The geomorphological classification used by Harrison *et al.* (2000) recognises six main types based on mouth condition (open or closed), size and the presence of a bar. The Whitfield (1992) classification is also based on physical characteristics (mainly mouth condition and size of tidal prism), and has become the more widely used classification system. Whitfield's (1992) classification recognises five types, of which temporarily open systems dominate in terms of number and estuarine lakes and permanently open systems dominate in terms of area (Table 2.1).

Table 2.1 Typical characteristics of the five types of estuaries defined by Whitfield (1992) and their relative prevalence in South Africa

Type	Typical size	Typical mouth condition	Number in South Africa	%	Total area (ha)	%
Bay	Large	Open	3	1%	5 118	6%
Permanently open	Med to large	Open	44	15%	17 944	20%
River mouth	Small to large	Open	11	4%	4 947	5%
Lake	Large	Closed	9	3%	56 205	62%
Temporarily open	Small to med	Closed	222	77%	6 631	7%
TOTAL			**289**		**90 844**	

Within each biogeographical region, Harrison & Whitfield (2006) found that estuarine fish communities (based on density and presence-absence data) were influenced by a combination of estuary size and mouth condition. They defined three main types of estuaries: small closed, medium closed and large open estuaries. They found that open

estuaries have relatively high species richness, mainly due to the presence of marine species, and moderate to large closed estuaries have reduced species richness due to reduced access by these marine species. Small closed estuaries have the lowest species richness due to their small area and greater isolation from the sea. Whereas some species are largely restricted to permanently open estuaries, there are few that are restricted to small or closed estuaries. Nevertheless, some species are relatively more important in small closed estuaries (Harrison & Whitfield 2006).

Turpie & Clark (2007) conducted a similar analysis, but used total estimated abundance data of each species in each estuary, generated from the raw data collected by Trevor Harrison. This analysis suggested that the principle determinant of fish community characteristics, apart from geographic location, was estuary size. Mouth condition did not have a consistent influence, except inasmuch as mouth condition is correlated with size. A SIMPER analysis demonstrated that, within each biogeographical region, fish communities of smaller estuaries are subsets of larger estuaries rather than certain types of estuaries having distinct types of fish communities (Turpie & Clark 2007). Their analysis of bird communities in temperate estuaries suggested four main groupings for birds: (A) large open estuaries that support diverse waterbird communities characterised by high numbers of waders; (B) estuaries that have restricted or closed mouths, frequently have brackish lake characteristics, and support large waterfowl communities; those that are a mixture of A and B, and (C) medium to large sandy estuaries, often supporting gull and tern roosts, but with relatively low overall diversity. Type D estuaries were small, oligotrophic, black water systems which were generally depauperate

Thus, Whitfield's (1992) estuary typology, though widely used, does not necessarily make sense as an ecosystem typology from a fish or water bird perspective (Turpie & Clark 2007). Thus it was decided to use a typology that would make greater sense from a biodiversity perspective. Estuary ecosystem type was redefined using a simple categorisation based on four factors, in no particular order (Table 2.2, Table 2.3). Targeting estuaries based on type results in the selection of a specific set of estuaries that fully represent all the different types found in South Africa and may act as a surrogate for biota, such as plant species or invertebrates. Sensitivity analysis was conducted by varying the number of factors used in defining a combination of estuary type features.

Table 2.2 The four variables used to define estuary type for this assessment

Variable	Options
Mouth State	Temporarily open/closed estuary
	Permanently open estuary
Salinity Structure	Marine dominated
	Freshwater dominated
	Mixed
Freshwater Type	Clear (<10NTU)
	Turbid (>10NTU)
	Black water
Size	Large (>100ha)
	Medium (>10ha)
	Small (<10ha)

Table 2.3 Summary of the estuary typology used and the numbers of estuaries associated with each type

	Large	Medium	Small	Total
Temporarily Closed Fresh Black	0	5	10	15
Temporarily Closed Fresh Turbid	2	4	0	6
Temporarily Closed Marine Clear	1	0	0	1
Temporarily Closed Mixed Turbid	1	16	0	17
Temporarily Closed Mixed Black	10	17	25	52
Temporarily Closed Mixed Clear	7	86	50	143
Permanently Open Fresh Black	0	0	6	6
Permanently Open Marine Black	1	0	0	1
Permanently Open Marine Clear	6	1	0	7
Permanently Open Marine Turbid	1	0	0	1
Permanently Open Mixed Clear	4	4	0	8
Permanently Open Mixed Black	5	1	3	9
Permanently Open Mixed Turbid	14	9	0	23
Total	**52**	**143**	**94**	**289**

2.4.2 Habitats

Because data on species and populations are usually limited to the larger taxa, another approach commonly used is to include a representative proportion of all the different habitats within the set of priority areas identified in a biodiversity plan. In terrestrial systems this might

be in terms of vegetation types. In the case of estuaries, habitat types can have been estimated for most South African estuaries under the following categories (Adams 2010):

1. open water area;
2. sand and mud banks;
3. submerged macrophyte beds;
4. rocks;
5. emergent reeds and sedges;
6. intertidal saltmarsh;
7. supratidal saltmarsh;
8. mangroves; and
9. swamp forest.

Unlike the selection of vegetation types in terrestrial biodiversity plans where one planning unit is one patch of habitat X, the selection of estuarine habitats is inextricably linked to the selection of estuaries (part or whole). For example, if a habitat area from estuary X is selectedto meet a biodiversity target, then all the other habitat areas (and other biota) in that planning unit will also be selected. It should be noted that detailed data on habitat areas are missing for some of the very small estuaries.

2.4.3 Species and populations

Biodiversity targets may include provision for representation of a proportion of the species that occur in estuaries. For a species to be considered represented in a protected area system, it has to be present in sufficiently high, or viable, numbers. In the case of this plan, abundance data were available for major plant communities (in terms of area), for fish and birds, but not for invertebrates.

Population targets may be set as a proportion of the total population in the planning domain. However, care needs to be taken to ensure that there is connectivity between protected sub-populations, and that relatively isolated breeding populations are sufficiently large to be viable. In the case of migrants (e.g. Palaearctic shorebirds) this is not an issue.
Viable populations have been traditionally set using the 50-500 rule, which is the assumed viability criterion (in terms of numbers of breeding-age individuals in the population) for short-term or long-term viability. However, populations of fish and birds within estuaries are highly variable, due to mobility between systems, mouth dynamics and influences beyond the estuary. Moreover, this rule may not be particularly suitable for migratory species. It must

also be noted that the 50-500 rule is designed for populations within a fully protected area. Many of the populations in the estuaries under consideration will be part of exploited meta-populations, even if the exploitation does not occur directly within the protected estuary.

2.5 Biodiversity targets

2.5.1 Introduction

Based on stakeholder discussions on an initial proposed set of goals and targets, the following conservation goals and biodiversity targets are proposed for the estuarine protected area system. Note that these pertain to estuary ecosystem type, habitats, fish and birds only, and that other elements, such as invertebrates are not directly targeted. While the latter omission is due to lack of data, it is hoped that the inclusion of habitats, fish and birds will be sufficient to cover the needs of other taxonomic groups. This assumption should be checked in future as further information comes to light.

2.5.2 Overall area target

The World Conservation Union (IUCN) proposed a goal of conserving 20% of the world's coastline by 2000 (IUCN 1992). This value was based on the result of fishery modelling studies which showed that the risk of a fishery collapsing increases dramatically if spawner biomass (the mass of adult fish above the age of sexual maturity) falls below 25% of its unexploited biomass. It has been suggested however, that marine protected area coverage should be extended to 30% where fishery management in exploited areas is poor (Plan Development Team 1990). In line with national policy objectives for conserving inland water ecosystems (Roux *et al.* 2006), a biodiversity target of 20% of estuarine area was used in this plan. Note that for estuaries selected for partial protection, half the area was assumed to be protected, irrespective of whether the partial-protection strategy for that estuary would be area-based. This applied to biodiversity targets for habitat types as well.

2.5.3 Habitat targets

Nationally, mangrove and swamp forest utilisation is regulated under the National Forests Act No. 84 of 1998 and destruction or harvesting of indigenous trees without a license is prohibited. While the mangrove trees and swamp forest are protected, the area under the

forests and the associated estuarine habitat in many cases is not designated as a protected area (Traynor & Hill 2008). Because of this, biodiversity targets were not set for mangroves or swamp forest per se, but instead all estuaries that contained >5ha of these habitats were automatically included into the set of priority estuaries. Targets for all other habitat types apart from rocks were set at 20% (Table 2.4). No target was set for rocks due to the lack of estuarine dependence of the associated fauna and/or flora.

Table 2.4 Targets for estuarine habitat types and for the total estuarine area

Estuarine habitat type	Total area (ha) within the planning domain	Target (% of area)
Supratidal salt marsh	7051	20%
Intertidal salt marsh	4310	20%
Reeds and sedges	11 806	20%
Swamp forest	4843	All occurrences of > 5ha
Mangroves	2111	All occurrences of > 5ha
Sand/mud banks	4017	20%
Submerged macrophytes	1327	20%
Open water area	55 284	20%
Rocks	96	No target
Total estuarine area	**90 844**	**20%**

2.5.4 Species targets

All fish and bird species for which estuaries make a significant contribution to their persistence in the Southern African region should be included in the set of priority estuaries.

Estuary-dependent fish have already been defined by Whitfield (1994). Thus fish assigned to categories I, II and V were included, while those belonging to categories III and IV were not considered in terms of population targets. In addition, species whose distributions were mainly tropical but which did occur within the planning domain in small numbers were also not targeted. In total, biodiversity targets were set for 84 fish species (Table 2.5).

Although estuarine bird species were listed by Hockey & Turpie (1999), estuary dependence was not defined. There are no entirely estuary-dependent bird species. Species were considered dependent on estuaries if more than 15% of their regional population (as per Hockey *et al.* 2005) was found in coastal lagoons and estuaries. This estimate was fairly crude, due to the crude nature of regional population estimates. It thus eliminated species such as Ruff for which a large proportion of the population is found inland, and species such as Cape Cormorant for which the bulk of the population is coastal, outside of estuaries. Vagrants were also excluded. Biodiversity targets were set for a total of 35 bird species (Table 2.6).

Population targets were calculated as a proportion of the total abundance for each species. The following population targets were applied to the estuary-dependent fish and bird species, agreed in workshop discussions:

- 50% of the population of threatened species (based on Red Lists) and overexploited/collapsed species;
- 40% of the population of exploited species; and
- 30% of the population of all other species.

Population targets used for estuary-dependent species are summarised in Table 2.5 and Table 2.6.

Table 2.5 Targets for estuary-dependent fish species (% of population)

Fish Species	Category	Target % of total abundance	Fish Species	Category	Target
Acanthopagrus berda	IIA	30	*Lutjanus argentimaculatus*	IIC	50
Ambassis natalensis	IB	40	*Lutjanus fulviflamma*	IIC	40
Anguilla mossambica	VA	30	*Megalops cyprinoides*	VB	40
Argyrosomus japonicus	IIA	40	*Monodactylus argenteus*	IIB	40
Atherina breviceps	IB	30	*Monodactylus falciformis*	IIA	30
Caffrogobius gilchristi	IB	30	*Mugil cephalus*	IIA	40
Caffrogobius natalensis	IB	30	*Mugillogobius merteni*	IB	30
Caffrogobius nudiceps	IB	30	*Oligolepis acutipennis*	IA	30
Caranx ignobilis	IIB	40	*Oligolepis keiensis*	IA	30
Caranx papuensis	IIC	40	*Omobranchus woodi*	IA	30
Caranx sexfasciatus	IIB	40	*Oxyurichthys opthalmonema*	IB	30
Chanos chanos	IIC	40	*Periopthalmus koelreuteri*	IA	30
Clinus superciliosus	IB	30	*Platycephalus indicus*	IIC	40
Crenimugil crenilabis	IIB	30	*Pomadasys commersonnii*	IIA	40
Diplodus capensis	IIC	40	*Pomadasys kaakan*	IIC	40
Eleotris fusca	IA	30	*Pomatomus saltatrix*	IIC	40
Elops machnata	IIA	40	*Psammogobius biocellatus*	IA	30
Favonigobius melanobranchus	IB	30	*Psammogobius knysnaensis*	IB	30
Favonigobius reichei	IB	30	*Pseudorhombus arsius*	IIC	30
Galeichthys feliceps	IIB	40	*Redigobius dewaali*	IB	30
Gerres longirostris/acinaces	IIB	40	*Rhabdosargus globiceps*	IIC	40
Gerres macracanthus	IIB	30	*Rhabdosargus holubi*	IIA	40
Gerres methueni/rappi	IIB	40	*Rhabdosargus sarba*	IIB	50
Gilchristella aestuaria	IA	30	*Sarpa salpa*	IIC	40
Glossogobius callidus	IB	30	*Scomberoides lysan*	IIB	30
Hemiramphus far	IIC	30	*Silhouettea sibayi*	IB	30
Heteromycteris capensis	IIB	30	*Sillago sihama*	IIC	40
Hilsa kelee	IIC	30	*Solea bleekeri*	IIB	30
Hippichthys heptagonus	IB	30	*Sphyraena jello*	IIC	40
Hippichthys spicifer	IB	30	*Stolephorus holodon*	IIC	30
Hippocampus capensis	IA	50	*Strophidon sathete*	V	30
Johnius dorsalis	IIC	40	*Syngnathus acus*	IB	30
Leiognathus equula	IIB	40	*Syngnathus watermeyeri*	IA	50
Lichia amia	IIA	40	*Terapon jarbua*	IIA	40
Lithognathus lithognathus	IIA	40	*Thryssa vitrirostris*	IIB	40
Liza alata	IIB	40	*Torpedo fuscumaculata*	IIC	30
Liza dumerilii	IIB	40	*Torpedo sinusperci*	IIC	30
Liza macrolepis	IIA	40	*Trypauchen microcephalus*	IB	30
Liza melinoptera	IIB	40	*Valamugil buchanani*	IIC	40
Liza richardsonii	IIC	40	*Valamugil cunnesius*	IIA	40
Liza tricuspidens	IIB	40	*Valamugil robustus*	IIA	40
			Valamugil seheli	IIC	40

Table 2.6 Targets for estuary-dependent bird species (% of population)

Bird species	Target	Bird species	Target
Great White Pelican	50	Sanderling	30
White-breasted Cormorant	30	Bar-tailed Godwit	30
Greater Flamingo	50	Eurasian Curlew	30
Lesser Flamingo	50	Common Whimbrel	30
African Black Oystercatcher	50	Pied Avocet	30
Common Ringed Plover	30	Black-winged Stilt	30
White-fronted Plover	30	Water thick-knee	30
Chestnut-banded Plover	30	Kelp Gull	30
Greater Sand Plover	30	Hartlaub's Gull	30
Grey Plover	30	Caspian Tern	50
Ruddy Turnstone	30	Swift Tern	30
Terek Sandpiper	30	Sandwich Tern	30
Common Sandpiper	30	Common Tern	30
Common Greenshank	30	Damara Tern	50
Red Knot	30	Little Tern	30
Curlew Sandpiper	30	Mangrove Kingfisher	50
Little Stint	30	Pink backed Pelican	50
		Squacco Heron	30

2.5.5 Targets for estuary ecosystem types

Estuary ecosystem type was defined based on a simple categorisation of four factors; mouth state, salinity structure, freshwater type and size. A target of 20% was set for the area (ha) of each estuary ecosystem type. Sensitivity analysis was carried out in the analysis was run with or without this target, and using different numbers of factors to define estuary ecosystem type, as follows, with Target set 3 being used in the primary analysis:

- Target set 1: No estuary ecosystem type targets
- Target set 2: Estuary ecosystem type based on mouth state, salinity structure and freshwater type (13 types)
- Target set 3: Estuary ecosystem type based on mouth state, salinity structure, freshwater type and size (25 types)
- Target set 4: Estuary ecosystem type based on all four factors and biogeographical region (46 types)

2.5.6 Targets for maintaining ecosystem and landscape-level processes

In order to accommodate ecosystem and landscape level process, issues of connectivity and scale need to be addressed. Size and connectivity of the components of a protected area system have a major bearing on the efficiency of a protected area system and the degree to which it facilitates ecosystem and evolutionary processes and the replenishment of exploited stocks.

While it goes without saying that the greater the overall area protected, the greater the ecological benefits (this is constrained by economic and practical considerations), a pertinent question is whether size of individual estuaries selected makes a difference in terms of conservation efficiency. Our analysis of fish data suggested that there is no significant difference in fish density between small and large estuaries. A similar phenomenon is found in floodplain wetlands (Welcomme 1979). This means that fish population targets can be met with the same total area, irrespective of whether small or large estuaries are selected to make up the total area. However, there are other ecological considerations that will influence whether small or large estuaries should be prioritised for protection. Larger protected areas protect larger populations, ensuring greater probability of persistence. These estuaries also generate larger cues to marine species in terms of freshwater outputs, thus potentially increasing the landscape level integrity of the protected area system. The choice of several small versus few large estuaries also affects the overall connectivity of the protected area system.

Maintaining connectivity and landscape-level ecological functioning presents an interesting problem in the case of estuaries. In general, estuaries in the study area are arranged as a set of fairly evenly-dispersed large open systems with very large catchment areas, interspersed with a much larger number of small closed systems which have very small catchment areas, except on the West Coast where there is a lack of small estuaries. The large estuaries are often a considerable distance from one another, but general connectivity is boosted by the small estuaries when they are open. What is also particularly important is that not all the estuaries open at the same time or for the same length of time. Thus the way in which populations interact is relatively unpredictable in some areas. Connectivity is important for populations of resident estuarine species in particular. Smaller estuaries are much more vulnerable to reduction in mouth opening (due to reduced freshwater supply) than larger estuaries. The reduction in usability of closed systems along the coast affects

species have to move between rivers, estuaries and marine environments to breed, also limiting the nursery habitat available to important migrant fish such as White Steenbras.
From an evolutionary point of view, protecting small estuaries may be important owing to their high variability (in terms of their physical characteristics). Incorporating such variability into a biodiversity plan is considered valuable in that it ensures that within-species genetic diversity is maintained at a high level and because it facilitates the persistence of rare species that may be outcompeted and extirpated in the larger, more stable estuaries.

The following measures are aimed to ensure that the populations protected are viable, in that they are sufficiently large and there is connectivity at a sufficiently broad scale to maintain genetic integrity and evolutionary processes. They also aim to maintain landscape-level processes that maintain ecological integrity at a large scale.

- **Viability:** Estuaries designated for full protection should be or should become no-take areas; estuaries designated for partial protection should include a no-take sanctuary zone wherever feasible;
- **Viability:** Estuaries in a poor state of health should not be selected as part of the priority set as far as possible.
- **Connectivity:** There should be a relatively even distribution of priority estuaries around the coast relative to the distribution of estuarine habitat around the coastline;
- **Landscape level processes:** Estuaries adjoining land-based or marine protected areas should be prioritised in the selection process, and those adjoining undeveloped land should be prioritised over those that are developed;
- **Viability, ecosystem processes, evolutionary processes and representativeness:** Large estuaries should be prioritised over smaller estuaries, *ceteris paribus*, but a range of different sized estuaries should nevertheless be represented in the priority set.

Table 2.7 Estuaries within South Africa that have some level of protection, showing the amount in a protected area, the extent of no-take protection, whether ecological water requirements have been secured, whether an estuary management plan is in place, the present health of the estuary, and the level of protection of the estuary.

#	Estuary	Protected area	Agency	Amount of estuary in protected area	No Take Restrictions	Ecological Reserve	Estuary Manage-ment Plan	Health	Level of protect-ion*
1	Orange	Planned	Provincial	Part	Boat restriction	Yes		D	M
2	Spoeg	Namaqualand NP	SANParks	All				B	M
3	Groen	Namaqualand NP	SANParks	All				B	M
4	Diep	Rietvlei NR	Municipal	Part	Part			E	L
5	Krom	Table Mountain NP	SANParks	Entirely				A	H
6	Wildevoëlvlei	Table Mountain NP	SANParks	Part				D	L
	Sand	Sandvlei NR	Municipal	<10% of estuary (Top)				D	L
8	Ratel	Agulhas NP	SANParks	All				C	M
9	Heuningnes	De Mond NR	CapeNature	Part			Yes	D	M
10	Goukou	Stilbaai MPA	CapeNature	Part	Part		Yes	C	M
11	Wilderness	Wilderness Lakes NP	SANParks	Part				B	L
12	Swartvlei	Wilderness Lakes NP	SANParks	Part		Yes		B	L
13	Goukamma	Goukamma NR	CapeNature	Most		Yes		B	M
14	Knysna	Knysna NP	SANParks	Part		Yes	Yes	B	L
15	Keurbooms	Keurbooms River NR	CapeNature	Part (upper reaches)		Yes	Yes	A	L
16	Sout	De Vasselot NP	SANParks	All				A	M
17	Groot (W)	Tsitsikamma NP	SANParks	All	Yes			B	H
18	Bloukrans	Tsitsikamma NP	SANParks	All	Yes			A	H
19	Lottering	Tsitsikamma NP	SANParks	All	Yes			A	H
20	Elandsbos	Tsitsikamma NP	SANParks	All	Yes			A	H
21	Storms	Tsitsikamma NP	SANParks	All	Yes			A	H
22	Elands	Tsitsikamma NP	SANParks	All	Yes			B	H
23	Groot (E)	Tsitsikamma NP	SANParks	All	Yes			B	H
24	Tsitsikamma	Huisklip NR	EC Parks	Lower reaches		Yes		B	L

#	Estuary	Protected area	Agency	Amount of estuary in protected area	No Take Restrictions	Ecological Reserve	Estuary Manage-ment Plan	Health	Level of protect-ion*
25	Seekoei	Seekoei River NR	Municipal	Part (upper)		Yes		D	L
26	Gamtoos	Gamtoos R. Mouth NR	Municipal	Part			Yes	C	L
27	Van Stadens	Van Stadens NR	Municipal	All				B	L
28	Sundays	Addo Elephant NR	Municipal	Part		Yes	Yes	C	M
29	Nahoon	Nahoon Estuary NR	Municipal	Very small part		Yes	Planned	C	L
30	Mendu	Dwesa-Cwebe MPA	DEA/DAFF	Undefined as yet	Yes			A	M
31	Mendwana	Dwesa-Cwebe MPA	DEA/DAFF	Undefined as yet	Yes			A	M
32	Mbashe	Dwesa-Cwebe MPA	DEA/DAFF	All, but half in practice	Yes		Yes	C	H
33	Ku-Mpenzu	Dwesa-Cwebe NR	EC Parks	Undefined as yet	Yes			B	M
34	Ku-Bhula/Mbhanyana	Dwesa-Cwebe NR	EC Parks	Undefined as yet	Yes			A	M
35	Kwa-Suka	Dwesa-Cwebe NR	EC Parks	Undefined as yet	Yes			B	M
36	Ntlonyane	Dwesa-Cwebe NR	EC Parks	Undefined as yet	Yes			B	M
37	Nkanya	Dwesa-Cwebe NR	EC Parks	Undefined as yet	Yes			B	M
38	Hluleka	Hluleka NR	EC Parks	All				A	L
39	Nkodusweni	Pondoland MPA	DEA	Part				B	L
40	Mtafufu	Pondoland MPA	DEA	Part				B	L
41	Mzintlava	Pondoland MPA	DEA	Part				B	L
42	Mzimpunzi	Pondoland MPA	DEA	Part				B	L
43	Kwa-Nyambalala	Pondoland MPA	DEA	Part				B	L
44	Mbotyi	Pondoland MPA	DEA	Part				B	L
45	Mkozi	Pondoland MPA	DEA	Part				A	L
46	Myekane	Pondoland MPA	DEA	Part				A	L
47	Sitatsha	Pondoland MPA	DEA	Part				A	L
48	Lupatana	Pondoland MPA	DEA	Part				A	L
49	Mkweni	Pondoland MPA	DEA	Part				A	L
50	Msikaba	Mkambati NR	EC Parks	All				A	H
51	Butsha	Mkambati NR	EC Parks	All	Yes			A	H
52	Mgwegwe	Mkambati NR	EC Parks	All	Yes			A	H

#	Estuary	Protected area	Agency	Amount of estuary in protected area	No Take Restrictions	Ecological Reserve	Estuary Manage-ment Plan	Health	Level of protect-ion*
53	Mgwetyana	Mkambati NR	EC Parks	All	Yes			A	H
54	Mtentu	Mkambati NR	EC Parks	All	Yes		Yes	A	H
55	Sikombe	Pondoland MPA	DEA	Part				A	L
56	Kwanyana	Pondoland MPA	DEA	Part				B	L
57	Mtolane	Pondoland MPA	DEA	Part				A	L
58	Mnyameni	Pondoland MPA	DEA	Part				B	L
59	Mpahlanyana	Pondoland MPA	DEA	Part				A	L
60	Mpahlane	Pondoland MPA	DEA	Part				A	L
61	Mzamba	Pondoland MPA	DEA	Part				B	L
62	Mtentwana	Pondoland MPA	DEA	Part				C	L
63	Mtamvuna	Pondoland MPA	DEA	Part				B	L
64	Mpenjati	Mpenjati NR	EKZNW	Part				B	M
65	Mgeni	Beechwood NR	EKZNW	Part				D	M
66	Mhlanga	-	EKZNW	All	Yes	Yes		D	H
67	Mlalazi	Mlalazi NR	EKZNW	All	Yes			B	H
68	Mhlathuze	-	EKZNW	Part				C	M
69	St Lucia-Mfolozi	iSimangaliso WP	ISWP Authority	90%		Yes		E/D	H/M
70	Mgobozeleni	iSimangaliso WP	ISWP Authority	All				B	L
71	Kosi	iSimangaliso WP	ISWP Authority	All				B	M

*High = no-take for fish and invertebrates, Medium = contains no-take area for invertebrates, Low = does not contain a no-take area

2.6 Gap analysis: to what extent are targets already being met?

A total of 71 estuaries in the planning domain already have some level of protection (Table 2.7). However, only the Krom in the Western Cape, the seven small estuaries within Tsitsikamma NP/MPA, Mbashe (under dispute and currently only partially protected in practice), Msikaba and Mtentu in the Eastern Cape, and Mhlanga, Mlalazi, St Lucia-Mfolozi and Kosi in KwaZulu-Natal have full no-take protection. These were the only estuaries considered to be fully protected in the gap analysis. It should be noted, however, that while St Lucia-Mfolozi is listed as being fully protected on paper, the estuary's current health category is an E/D due to human interference in floodplain hydrodynamics and mouth functioning, nd limited use of resources is allowed. In addition, several of these systems, while protected on paper, are under significant pressure from legal and illegal fishing, including at St Lucia, and notably at Kosi Bay, where traditional fishing has become increasingly efficient as a result of subtle changes in gear, and is considered unsustainable.

The abovementioned protected areas account for 56 082 ha or 62% of the estuarine area within the planning domain, and contain all eight of the estuarine habitat types for which targets were set (Table 2.8). However, the St Lucia-Mfolozi estuary system, which covers a total of just over 50 800 ha (56% of the total estuarine area), makes up 91% of the existing area under protection.. The other fully protected estuaries cover a total area of 5 282 ha (6% of the total estuarine area) only account for 9% of the existing area under protection (or). For temperate estuaries, Turpie & Clark (2007) found that protected areas met less than 5% of all habitat targets, apart from mangroves.

Table 2.8 Representation of estuarine habitat types within estuaries that are currently fully protected, and percentage of total area for each habitat type in South Africa

Habitat type	Total area in fully protected estuaries (ha)	% of total	Total area in fully protected estuaries (ha) excluding St Lucia-Mfolozi system	% of total
Supratidal salt marsh	1 757	25	51	1
Intertidal salt marsh	529	12	13	0
Reeds and sedges	7 285	62	335	3
Swamp Forest	4 574	94	177	4
Mangroves	886	42	381	18
Sand/mud banks	325	8	99	2
Submerged macrophytes	181	14	0	0
Open water area	40 533	73	4 200	8
Rocks	12	12	12	12
Total area	56 082	56	5 268	6

2.7 Filling the gaps: the selection process

2.7.1 Site-selection algorithm

Ideally, the biodiversity targets should be met at the lowest possible cost. There are various methods of arriving at this efficient solution, and these can be applied manually, using spreadsheets, or using supporting software which is custom-built for the purpose. We chose to use the MARXAN site optimisation algorithm (Ball 2000, Possingham *et al.* 2000), which is fast becoming the more popular application because of its ability to take costs into account. The MARXAN algorithm was run through a GIS interface programme called CLUZ. The MARXAN model seeks to minimise the following objective function:

$$Total\ Cost = \sum_{i} Cost\ site\ i + \sum_{j} Penalty\ cost\ for\ element\ j + w_b \sum boundary\ length$$

The first term generally refers to the costs associated with each site, which can be monetary management costs, opportunity costs, or a relative score that makes some sites more costly to select than others (for example on the basis of poor ecological condition). The second term describes the cost associated with not meeting a biodiversity target, with high penalties helping to ensure that targets are always met. The third term is relates to the inefficiency of several small versus few large conglomerated areas. Although of crucial importance for land-based biodiversity priority areas, boundary length was neutralised in the selection of estuaries.

MARXAN starts by selecting a random set of planning units, and then makes iterative changes to the set of sites by randomly adding or subtracting planning units. At each iteration within a run, the new set is compared with the previous set, and the less costly one is selected. The algorithm uses a method called “simulated annealing” to reject sub-optimal sets, thus greatly increasing the probability of converging on the most efficient portfolio.

The MARXAN application was run for up to 50 runs at 1 million iterations per run. The programme then selected the best output out of the 50 runs.

2.7.2 Socio-economic considerations

Socio-economic considerations were not directly incorporated into this plan, but the incorporation of estuary health probably does influence the results in the same direction, in that highly impacted estuaries are also those for which the opportunity costs of conservation are likely to be high.

2.7.3 Consideration of estuary health

As part of the NBA 2011, each estuary in the country has been provisionally rated in terms of its health, on a scale of A to F, the same scale used by the Department of Water Affairs, for example in the National Water Resource Classification System (Dollar *et al*. 2010). This process and scale is described in detail in Chapter 9 of the technical report for the estuary component of the NBA 2011. In this plan, estuary health was used to influence the outcome of the selection process by influencing the likelihood of an estuary being selected to meet biodiversity targets, favouring the selection of healthier estuaries. Estuaries considered to be pristine were given low cost values, whilst severely degraded estuaries were given high cost values. The cost values increased exponentially with a decrease in health score. This method of incorporating health into costs influences MARXAN to select estuaries in better ecological condition, those with poor health scores having higher costs and therefore not being selected as part of the priority set. Estuaries that are in healthy condition and thus cheaper to conserve are chosen over and above estuaries that have high cost values.

2.7.4 Consideration of other biodiversity priority areas and plans

Although this is not the first estuary biodiversity plan in South Africa, it is the first to include all estuaries along the entire South African coastline. There are earlier and ongoing sub-national studies which overlap with this one. Recently-completed biodiversity plans overlapping in planning domain include the fine-scale CAPE Marine Conservation Plan (2006); the Wild Coast Conservation Plan (2006), the Fish-to-Tsitsikamma Water Management Area Conservation Plan (2006), the CAPE Estuary Conservation Plan (2007), the KZN Estuary Conservation Plan (in prep) and the National Freshwater Ecosystem Priority Areas project (NFEPA 2011). The Wild Coast and Fish-to-Tsitsikamma plans include estuaries, but this is done on the basis of estuary type (meeting target numbers of each type), rather than biodiversity targets, and is not considered further here. Estuaries falling within existing MPAs, within areas identified as priority areas in the CAPE Marine

Conservation Plan, or on rivers highlighted as priorities in the draft NFEPA outputs were highlighted and this information was used to decide whether an estuary should be automatically included in the set of priority estuaries. The same process was used for this national plan – estuaries falling within existing MPAs or areas identified as priority areas along the South African coastline were highlighted and all this information was used by estuarine scientists and managers from all three biogeographic regions to decide whether an estuary should be automatically included in the selected set of priority estuaries (see below). However, it was agreed that the selection of estuaries should not be overly influenced by these, and that the priority estuaries should, in turn, influence biodiversity planning for other ecosystems. Indeed, the outputs of this plan were used in the NFEPA project to influence the selection of the final set of Freshwater Ecosystem Priority Areas. Finally, we have maintained a record of estuaries that were sub-national priorities under CAPE but not national priorities. It is anticipated that once the KZN study has been completed, additional sub-national priorities will be added to the list in the subtropical region.

2.7.5 Incorporation of stakeholder and expert opinion

Iterative algorithms such as those used in this process are not intended to replace expert knowledge of estuarine systems, but to serve as a tool to help fine tune a biodiversity plan. Not all of the factors that make a site worthy or unworthy of selection can be easily incorporated into such algorithms. These include political and social feasibility as well as desirable attributes such as inaccessibility that may make an estuary more or less desirable as a protected area. Thus, workshop participants were first asked to peruse a complete set of close-up colour aerial photographs of each of the estuaries in the planning domain and to consider which estuaries they would like to see vetoed from or voted into the protected area set, and the reasons for this.

Participants agreed in plenary which planning units would be feasible as protected areas. The discussion centred mainly on whether an estuary could be (a) feasible to protect in its entirety, or (b) feasible to have under partial protection. If (a) was valid but not (b), then the estuary was taken to be a single planning unit, available for selection. If both (a) and (b) were valid, then the estuary was divided into two planning units and both were available for selection. If only (b) was valid, then only one of the two planning units was made available for selection. If neither option was feasible, then the estuary was not available for selection. Very small estuaries were not considered viable for partial protection. For estuaries that were large enough to be split into two planning units, the full protection of the second half

was considered infeasible in nearly all cases for political and practical reasons. Participants also agreed on which planning units should be automatically included into the set of priority estuaries, giving reasons (Appendix 2). This was used to finalise the set of planning units and their status (Appendix 2). This final set of planning units incorporated existing full or partial protected areas as appropriate, and excluded infeasible planning units.

2.7.6 Sensitivity analysis

Three other analyses were run in addition to the primary analysis with biodiversity targets as described above. These varied the degree to which estuary ecosystem type was included in the analysis – from exclusion of targets for estuary ecosystem types to including targets for each type in each biogeographic region (Table 2.9).

Table 2.9 The four analyses run in MARXAN

Primary analysis	Population targets, habitat area targets, total area targets and targets for estuary ecosystem types based on mouth state, salinity structure, freshwater type and size.
No targets for estuary ecosystem types	Population targets, habitat area targets and total area targets. Estuary ecosystem type not included.
Targets for estuary ecosystem types excluding size	Population targets, habitat area targets, total area targets and estuary type targets based on mouth state, salinity structure and freshwater type.
Targets for estuary ecosystem types for each biogeographic region	Population targets, habitat area targets, total area targets and targets for estuary types based on mouth state, salinity structure, freshwater type, size and biogeographic region.

3 RESULTS

For the primary analysis, 146 planning units were required to meet the targets (Appendix 2), although not all targets for estuary ecosystem types could be achieved. These 146 planning units include those already protected, those automatically included in the set of priority estuaries and those additionally selected by the MARXAN program to reach biodiversity targets. These planning units represent 133, or 46%, of South African estuaries and about 79% of South Africa's estuarine area (Table 3.1). Of these, 61 should be fully protected, and 72 require partial protection. The list of estuaries selected is given in Table 3.1.

If estuary ecosystem type was excluded from the analysis, then this number was reduced to 140 planning units/126 estuaries, and a similar result was achieved if targets for estuary ecosystem types did not include size (Table 3.1). There was very little difference in the total area selected.

Including biodiversity targets for estuary ecosystem types by biogeographic region meant that the number of planning units selected increased to 154 (138 estuaries), but again there was little difference in the area selected. There was very little difference in the geographic spread of estuaries under the different scenarios (Appendix 2), suggesting that including targets for estuary ecosystem type by biogeographic region would result in high complementarity in terms of priority estuaries selected.

Table 3.1. Differences in the numbers of the planning units selected under each analysis, giving total area and percentage of each habitat selected

	Primary analysis	No targets for estuary ecosystem types	Targets for estuary ecosystem types excluding size	Targets for estuary ecosystem types for each biogeographic region
No. of planning units selected	146	140	140	154
Number of estuaries selected	133	126	125	138
% of spp targets achieved	100	100	100	100
% of habitat targets achieved	100	100	100	100
% of targets for estuary ecosystem types achieved	96	100	100	96
Total Area (ha)	71 996	71 985	71 998	72 029
% of total estuarine area	79%	79%	79%	79%
Percentage of total habitat area				
Supratidal saltmarsh	61	61	60	60
Intertidal saltmarsh	55	55	55	54
Reeds and sedges	78	78	78	78
Swamp forest	97	97	97	97
Mangroves	70	70	70	70
Sand and mud banks	47	47	48	48
Submerged macrophytes	55	56	55	55
Open water area	85	85	86	85

All habitat and species targets were met under each analysis, and the percentage of each habitat area selected was significantly higher than the 20% target that was set (Table 3.1). Although only 96% of swamp forest area and 70% of mangrove area was selected under each scenario, this is an artefact of the split estuary planning units. All estuaries with more than 5 ha of these habitats were automatically included in the set of priority estuaries, in order to ensure protection (partial or full) of these habitats, but by law they will have to be fully protected even in a partially protected estuary.

The only target not met in the primary analysis was the target for estuary ecosystem type because one estuary of a unique type, the Sipingo, was excluded from the analysis due to consensus expert input, therefore making it impossible to reach the target. The same was seen for the analysis that included biogeographic region where the Sipingo and Gwaing estuaries could not be selected as they were excluded from the analysis. The primary analysis was used to define the priority estuaries.

4 DISCUSSION AND RECOMMENDATIONS

4.1 National priority estuaries that require protection

As has been shown in the past (Turpie *et al*. 2002), estuarine biodiversity targets can be met with the protection of relatively few estuaries, when it is assumed that any estuaries can be protected in their entirety. The CAPE Estuary Conservation Plan showed that the number of estuaries required was far higher compared to previous plans because the possibility of achieving targets through partial protection of a larger number of estuaries, rather than having to fully protect a smaller number of estuaries, was opened up and applied. It was considered to be a more feasible solution. Similarly, in this plan, a fairly large proportion of South Africa's estuaries (46%) were included in the overall set of priority estuaries.

One of the biggest factors driving the large number of estuaries selected is the high number of very small estuaries that already fall within the boundaries of coastal nature reserves and MPAs, notably some of the recently proclaimed MPAs such as Pondoland MPA and Dwesa-Cwebe. For many of these systems protection has not been legally gazetted, but they are

being managed as protected areas, and we have included them as such, though there is a fine line for some between “protected” and “voted in”. Several of these smaller systems contribute little, if anything, to meeting quantitative biodiversity targets, but they may contribute to ecosystem processes at a larger scale.

The results of this analysis suggest that approximately 46% of estuaries and almost 80% of estuarine area in South Africa should be afforded formal protection status, either full or partial. The percentage area sounds high because it includes the already-protected St Lucia-Mfolozi system, which accounts for about 56% of estuarine area in South Africa. About 52% of the remaining estuarine area is required to be under some protection, but most of this is partial protection. This fits well with the general consensus among the estuarine research community that all estuaries are sufficiently valuable to warrant the maintenance of a high proportion of estuaries in good ecological condition.

The national set of priority estuariesis listed in Table 4.2, along with additional sub-national priorities identified in the CAPE study. It is anticipated that KZN priorities will also be added to this list.

4.2 Defining the level of protection

In devising guidelines for a strategy for the management and conservation of estuarine biodiversity, Turpie (2004a) envisaged assigning all South African estuaries to one of three categories, as follows: Estuarine Protected Areas (EPAs), in which part or all of an estuary is a sanctuary, providing protection from consumptive use; Estuarine Conservation Areas (ECAs) - co-managed estuaries in which general regulations are augmented by estuary-specific regulations; and Estuarine Management Areas (EMAs), to which general regulations apply. EPAs were defined as formally protected in terms of national legislation, to be selected with both biodiversity representation and socio-economic considerations in mind. ECAs were envisaged as being initiated by local communities through their estuary forums, being particularly suited to estuaries used primarily for recreation. According to Turpie (2004a), all remaining estuaries should be treated as EMAs, in that every estuary should at least have a management plan in order to facilitate compliance with general regulation and maintain estuarine health at an acceptable level. This is also in line with the requirements of the National Estuarine Management Protocol being developed under the Integrated Coastal Management Act. Estuary management plans (EMPs) are currently being rolled out following

the guidelines developed under the CAPE Programme (Van Niekerk and Taljaard 2007, Taljaard and Van Niekerk 2009).

Turpie & Clark (2007) suggested that it may not be necessary to distinguish ECAs, since partial protection was envisaged to be achieved through zonation with the inclusion of a no-take zone. The latter would have to be formalised as an MPA, control over the harvesting of living marine resources could only be effected through the Marine Living Resources Act (1997). Thus to achieve even partial protection means invoking the MLRA and declaring some kind of MPA, which is more akin to an EPA than an ECA. In this assessment, it was suggested that in some cases, particularly in KwaZulu-Natal estuaries, partial protection can be best achieved through other actions than zonation and no-take areas, such as better control of water quality and mouth manipulation. An estuary managed in this way might be more suitably called an ECA than an EPA, and might be achievable through other legislation, for example under the National Water Act, the Biodiversity Act or the Integrated Coastal Management Act.

Estuaries that require full protection are envisaged in this plan to be fully no-take protected areas. For those requiring partial protection, , protection should be sufficient to adequately safeguard at least 50% of the habitats and populations of estuary-dependent species.

4.3 Freshwater flow requirements

In the case of estuaries, protection is not only effected by localised management actions but also through ensuring adequate quantity and quality of freshwater flows into the estuary. The National Water Act stipulates that no estuary should be in lower than a D-class. Future flows into an estuary will be decided on the basis of its Ecological Class (A, B, C or D) determined under the National Water Resources Classification System (Dollar *et al.* 2010). In the meantime, preliminary classification of estuaries is done on the basis of preliminary Reserve Determination Methods, which yield a Recommended Ecological Category (REC). This REC is defined on the basis of health and importance of estuaries and whether it is an existing or planned protected area (Turpie 2000, Taljaard *et al*. 2004, Turpie *et al*. 2010; Table 4.1). Given that the NBA 2011 an estuary health assessment that updated the present ecological status for all estuaries, and that this plan has provided a list of national priority estuaries that require protection, it is now possible to provide a provisional estimate of the REC for each estuary based on the guidelines for assigning the REC outlined in Turpie (2000) and

Taljaard *et al*. (2004), which can help in broad-scale water planning and help to ensure that water requirements can be met for priority estuaries.

Table 4.1 Existing guidelines for assigning the Recommended Ecological Category to estuaries in the reserve determination methods (Turpie 2000, Taljaard *et al*. 2004)

Current/Desired Protection Status and Estuary Importance	Recommended Ecological Category	Policy Basis
Protected Area	A or BAS*	Protected and desired protected areas should be restored to and maintained in the best possible state of health
Highly Important	PES + 1, min B	Highly important estuaries should be in an A or B class
Important	PES + 1, min C	Important estuaries should be in an A, B or C class
Of low to average importance	PES, min D	The remaining estuaries can be allowed to remain in a D class

*BAS = Best Attainable State

4.4 Surrounding development

Both fully and partially-protected estuaries should also include some level of protection of their terrestrial margins, for both ecological and aesthetic purposes. It is difficult to make specific recommendations in this regard, since the degree to which surrounding terrestrial habitats can or should be incorporated is very site specific. However, we have provided a rough guideline as to the proportion of estuary perimeter that should have a substantial setback line or incorporate a nature reserve, based on degree of protection required for the estuary and consideration of existing developments around the estuary (Table 4.1). In general, estuaries requiring full protection were assigned an undeveloped margin of no lower than 50%, whilst most were assigned either 75% or 100%. Estuaries with partial protection were assigned an undeveloped margin extent ranging from 20% to 75%. This recommended extent of undeveloped margin is thought to be sufficient to maintain connectivity and ecological functioning of the estuary margin and also to protect the aesthetic character of the. Delineating setback lines is very site-specific and they have therefore not been defined here, but it is suggested that they are at least 500m.

Table 4.2 National and/or sub-national (CAPE) priorities, the extent of protection required (full = full no-take protection, partial includes no-take sanctuary zone where feasible), the

recommended proportion of the estuary margin that should remain undeveloped or with a >500m development setback line, and provisional estimate of the Recommended Ecological Category.

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Orange	D	SA/CAPE	Full	50%	C*
Buffels	C				C
Spoeg	B	SA	Full	100%	A or BAS
Groen	B	SA	Full	100%	A or BAS
Sout	D				D
Olifants	C	SA/C.A.P.E.	Partial	50%	B*
Jakkalsvlei	D				D
Wadrift	E				D
Verlorenvlei	D	SA	Partial	50%	C
Berg	D	SA/CAPE	Partial	25%	C*
Rietvlei/ Diep	E	SA/CAPE	Partial	50%	C
Sout W	F				D
Hout Bay	E				D
Wildevoëlvlei	D				B
Bokramspruit	C				C
Schuster	A				A
Krom	A	SA/CAPE	Full	100%	A or BAS
Buffels Wes	F				D
Elsies	E				D
Silvermine	D				D
Sand	D	SA/CAPE	Partial	20%	C
Zeekoei	E				D
Eerste	E	SA/CAPE	Full	75%	D
Lourens	C	SA/CAPE	Full	75%	D
Sir Lowry's Pass	E				D
Steenbras	B				B
Rooiels	B				B
Buffels (Oos)	B				B
Palmiet	C	SA/CAPE	Full	50%	B*
Bot / Kleinmond	C	SA/CAPE	Partial	50%	B
Onrus	E				D
Klein	C	SA/CAPE	Partial	50%	B
Uilkraals	D	SA	Partial	75%	C
Ratel	C	SA	Full	75%	C
Heuningnes	D	SA/CAPE	Partial	75%	A or BAS
Klipdrifsfontein	A	SA/CAPE	Full	75%	A
Breede	B	SA	Partial	50%	B*
Duiwenhoks	B				A
Goukou	C	SA/CAPE	Partial	50%	B
Gourits	C	SA/CAPE	Partial	50%	B
Blinde	B				B
Hartenbos	D				C
Klein Brak	C				C
Groot Brak	E				C*
Maalgate	B				B*
Gwaing	B				C*
Kaaimans	B	SA	Full	50%	B*
Wilderness	B	SA/CAPE	Partial	50%	A or BAS
Swartvlei	B	SA/CAPE	Partial	50%	B*
Goukamma	B	SA/CAPE	Full	75%	A*

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Knysna	B	SA/CAPE	Partial	50%	B*
Noetsie	B	CAPE			A*
Piesang	C	SA	Partial	50%	B
Keurbooms	A	SA/CAPE	Partial	50%	A*
Matjies	B				B*
Sout (Oos)	A	SA/CAPE	Full	100%	A*
Groot (Wes)	B	SA/CAPE	Full	75%	A or BAS
Bloukrans	A	SA/CAPE	Full	100%	A or BAS
Lottering	A	SA/CAPE	Full	100%	A or BAS
Elandsbos	A	SA/CAPE	Full	100%	A or BAS
Storms	A	SA/CAPE	Full	100%	A or BAS
Elands	B	SA/CAPE	Full	100%	A or BAS
Groot (Oos)	B	SA/CAPE	Full	100%	A or BAS
Tsitsikamma	B	SA	Full	50%	B*
Klipdrif	D				D
Slang	D				D
Kromme	D	SA/CAPE	Partial	25%	C*
Seekoei	D	SA/CAPE	Partial	25%	B*
Kabeljous	C				B
Gamtoos	C	SA/CAPE	Partial	50%	A or BAS
Van Stadens	B	SA/CAPE	Full	50%	A or BAS
Maitland	C	SA/CAPE	Full	75%	C
Bakens	E				D
Papkuils	F				D
Swartkops	C	SA/CAPE	Partial	25%	B
Coega (Ngcura)	F				D
Sundays	C	SA/CAPE	Partial	50%	A or BAS
Boknes	C				C
Bushman’s	B	SA/CAPE	Partial	50%	A*
Kariega	C	SA/CAPE	Partial	50%	B
Kasuka	B				A
Kowie	C				B
Rufane	C				C
Riet	B				A
West Kleinemonde	B				A
East Kleinemonde	B				B*
Klein Palmiet	D				D
Great Fish	C	SA/CAPE	Partial	50%	B
Old woman's	C				C
Mpekweni	B				A
Mtati	B	CAPE			A
Mgwalana	B	SA	Partial	50%	A
Bira	B	SA	Partial	50%	A
Gqutywa	B	SA/CAPE	Full	75%	A
Ngculura	B				B
Mtana	B				B
Keiskamma	C	SA/CAPE	Partial	50%	B
Ngqinisa	B	SA	Full	75%	B
Kiwane	B				B
Tyolomnqa	B				A
Shelbertsstroom	C				C
Lilyvale	B				B
Ross' Creek	B				B

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Ncera	B	SA	Full	75%	B
Mlele	B				B
Mcantsi	C				C
Gxulu	B				B
Goda	B	CAPE	Full	75%	B
Hlozi	B				B
Hickman's	B				B
Mvubakazi	B				B
Ngqenga	C				C
Buffalo	D				C
Blind	C				C
Hlaze	C				C
Nahoon	C				B*
Qinira	B				A
Gqunube	B	SA	Partial	50%	A
Kwelera	B	SA	Partial	50%	A
Bulura	B				B
Cunge	A				A
Cintsa	C				C
Cefane	B				A
Kwenxura	B	SA/CAPE	Full	75%	A
Nyara	A				A
Mtwendwe	B				B
Haga-haga	B				B
Mtendwe	B				B
Quko	A	SA/CAPE	Full	50%	A
Morgan	C				C
Cwili	B				B
Great Kei	C	SA/CAPE	Partial	50%	B*
Gxara	B				B
Ngogwane	B				B
Qolora	B				A
Ncizele	B	SA	Full	75%	B
Timba	A				A
Kobonqaba	B				B
Nxaxo/Ngqusi	B	SA/CAPE	Full	75%	A
Cebe	B				B
Gqunqe	A				A
Zalu	A				A
Ngqwara	A	SA	Full	75%	A
Sihlontlweni/Gcini	B				B
Nebelele	A				A
Qora	B	SA/CAPE	Partial	75%	A
Jujura	B				B
Ngadla	A	SA	Full	75%	A
Shixini	B	CAPE			B
Beechamwood	A				A
Un-named EC	A				A
Kwa-Goqo	A				A
Ku-Nocekedwa	A				A
Nqabara	B	SA	Partial	75%	A
Ngoma/Kobule	A				A
Mendu	A	SA			A
Mendwana	A	SA			A

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Mbashe	C	SA/CAPE	Partial	75%	A or BAS
Ku-Mpenzu	B	SA/CAPE	Full	75%	B
Ku-Bhula/Mbhanyana	A	SA/CAPE	Full	75%	A
Kwa-Suka	B	SA			B
Ntlonyane	B	SA/CAPE	Full	75%	B
Nkanya	B	SA/CAPE	Full	75%	B
Sundwana	A	SA	Full	75%	A
Xora	B	SA	Partial	75%	A
Bulungula	B				B
Ku-amanzimuzama	A				A
Ngakanqa	A	SA	Full	75%	A
Un-named KZN	A				A
Mncwasa	B				B
Mpako	B				B
Nenga	C				C
Mapuzi	B				B
Mtata	D	SA	Partial	50%	C*
Tshani	B				B
Mdumbi	B	CAPE			A
Lwandilana	A	SA	Full	75%	A
Lwandile	A				A
Mtakatye	B	SA	Partial	75%	B
Hluleka	A	SA	Full	75%	A or BAS
Mnenu	B				B
Mtonga	B				B
Mpande	B				B
Sinangwana	B				B
Mngazana	B	SA	Partial	50%	B
Mngazi	C				C
Gxwaleni	A				A
Bululo	B				B
Mtambane	B				B
Mzimvubu	C	SA	Partial	50%	C
Ntlupeni	B				B
Nkodusweni	B	SA	Partial	75%	A or BAS
Mntafufu	B	SA	Full	75%	A or BAS
Mzintlava	B	SA	Full	75%	A or BAS
Umzimpunzi	B	SA	Full	75%	B
Kwa-Nyambala	B	SA	Partial	50%	B
Mbotyi	B	SA	Partial	50%	A or BAS
Mkozi	A	SA	Full	75%	A
Myekane	A	SA	Full	75%	A
Sitatshe	A	SA	Full	75%	A
Lupatana	A	SA	Full	75%	A
Mkweni	A	SA	Partial	75%	A or BAS
Msikaba	A	SA	Full	75%	A or BAS
Butsha	A	SA	Partial	100%	A
Mgwegwe	A	SA	Partial	100%	A
Mgwetyana	A	SA	Partial	100%	A
Mtentu	A	SA	Full	75%	A or BAS
Sikombe	A	SA	Partial	75%	A
Kwanyana	B	SA	Partial	75%	B
Mtolane	A	SA	Partial	75%	A
Mnyameni	B	SA	Partial	75%	A or BAS

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Mpahlanyana	A	SA	Full	75%	A
Mpahlane	A	SA	Partial	75%	A
Mzamba	B	SA	Partial	75%	A
Mtentwana	C	SA	Full	75%	C
Mtamvuna	B	SA	Full	75%	A or BAS
Zolwane	B				B
Sandlundlu	C				C
Ku-Boboyi	B				B
Tongazi	B				B
Kandandhlovu	B				B
Mpenjati	B	SA	Partial	75%	A or BAS
Umhlangankulu	C				C
Kaba	B				B
Mbizana	B				B
Mvutshini	B				B
Bilanhlolo	C				C
Uvuzana	C				C
Kongweni	C				C
Vungu	B				B
Mhlangeni	C				C
Zotsha	C	SA	Partial	50%	C
Boboyi	C				C
Mbango	E				D
Mzimkulu	C	SA	Partial	50%	B
Mtentweni	C				C
Mhlangamkulu	C				C
Damba	C	SA	Partial	50%	C
Koshwana	C	SA	Partial	50%	C
Intshambili	B	SA	Partial	50%	B
Mzumbe	D				D
Mhlabatshane	B	SA	Partial	50%	B
Mhlungwa	C				C
Mfazazana	C	SA	Partial	50%	C
Kwa-Makosi	B	SA	Partial	75%	B
Mnamfu	C				C
Mtwalume	D				D
Mvuzi	C				C
Fafa	D				D
Mdesingane	C				C
Sezela	D				D
Mkumbane	C				C
Mzinto	C				C
Mzimayi	C				C
Nkomba	C				C
Mpambanyoni	C				C
Mahlongwa	C				C
Mahlongwana	B				B
Mkomazi	C	SA	Partial	25%	B
Ngane	B				B
Umgababa	B	SA	Full	50%	B
Msimbazi	B	SA	Full	75%	B
Lovu	C	SA	Partial	50%	C
Little Manzimtoti	D				D
Manzimtoti	D				D

Estuary (West to East)	Current health category	Priority set for national and/or CAPE	Recommended extent of protection	Recommended extent of undeveloped margin	Provisional estimate of Recommended Ecological Category
Mbokodweni	E				D
Sipingo	F				D
Durban Bay	E	SA	Partial	25%	B
Mgeni	D	SA	Partial	25%	A or BAS
Mhlanga	D	SA	Full	75%	B*
Mdloti	D				C*
Tongati	E				D
Mhlali	C	SA	Partial	50%	B
Bobs Stream	C				C
Seteni	C				C
Mvoti	D	SA	Full	75%	D
Mdlotane	B	SA	Full	75%	A
Nonoti	B				B
Zinkwasi	C	SA	Partial	50%	B
Thukela	C				C*
Matigulu/Nyoni	B	SA	Partial	50%	A
Siyaya	F	SA	Full	50%	B*
Mlalazi	B	SA	Full	75%	A or BAS
Mhlathuze/R.Bay	C	SA	Partial	50%	A or BAS
Nhlabane	D				C
St Lucia/Mfolozi	D	SA	Full	75%	A*
Mgobezeleni	B	SA	Full	75%	A or BAS
Kosi	B	SA	Full	75%	A or BAS

*Actual REC from RDM study that has been conducted on the estuary

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6 APPENDIX 1. NEW ESTUARIES ADDED TO THE NATIONAL LIST SINCE NSBA 2004

The new estuaries added to the national list of estuaries for this plan, increasing the total number of estuaries in South Africa from 258 to 289.

Estuary	Biogeographic region	Size
Buffels	Cool Temperate	Large
Spoeg	Cool Temperate	Small
Groen	Cool Temperate	Medium
Sout	Cool Temperate	Medium
Jakkalsvlei	Cool Temperate	Small
Wadrift	Cool Temperate	Medium
Buffels Wes	Cool Temperate	Small
Elsies	Cool Temperate	Medium
Zeekoei	Cool Temperate	Small
Mvubukazi	Warm Temperate	Small
Ngqenga	Warm Temperate	Small
Mtwendwe	Warm Temperate	Small
Timba	Warm Temperate	Small
Nebelele	Warm Temperate	Small
Beechamwood	Warm Temperate	Small
un-named EC	Warm Temperate	Small
Kwa-Goqo	Warm Temperate	Small
Ku-Nocekedwa	Warm Temperate	Small
Mendwana	Warm Temperate	Small
Kwa-Suka	Warm Temperate	Medium
Sundwana	Warm Temperate	Small
Ngakanqa	Warm Temperate	Small
Un-named KZN	Warm Temperate	Small
Tshani	Warm Temperate	Small
Gxwaleni	Sub-Tropical	Small
Kwa-Nyambalala	Sub-Tropical	Small
Sitatshe	Sub-Tropical	Small
Butsha	Sub-Tropical	Small
Mtolane	Sub-Tropical	Small
Nkomba	Sub-Tropical	Small
Bob's Stream	Sub-Tropical	Small

7 APPENDIX 2. PLANNING UNITS, AVAILABILITY AND SELECTION

Planning units and the priority sets generated under the four different analyses – main result is the Primary analysis. A = available, E = excluded, C = already protected, V = Voted in, X = additional units selected. Estuaries with 'a' after the name are split into two planning units, with no 'a' meaning the estuary is one planning unit. All part b's were excluded apart from those that were explicitly voted in. Reasons for planning units being voted in are given. NR = nature reserve, SF = swamp forest, MF = mangrove forest, WQ = water quality.

E#	PU#	Estuary	Health	Availa-bility (this plan)	Reason*	CAPEP riorit-ies	Prim-ary analysis	No type targets	No size targets	Targets for type by bio-region
1	1	Orange a	D	C	Biodiversity importance & Ramsar status	C	**C**	C	C	C
1	2	Orange b	D	V	As above		**V**	V	V	V
2	3	Buffels a	C	A						
2	4	Buffels b		E						
3	5	Spoeg	B	C	In NP		**C**	C	C	C
4	6	Groen a	B	C	In NP		**C**	C	C	C
4	7	Groen b		C	In NP		**C**	C	C	C
5	8	Sout	D	A						
6	9	Olifants a	C	V	Proposed Ramsar Status	V	**V**	V	V	V
6	10	Olifants b		E						
7	11	Jakkalsvlei	D	A						
8	12	Wadrift	E	A						
9	13	Verlorenvlei a	D	V	Ramsar Status		**V**	V	V	V
9	14	Verlorenvlei b		E						
10	15	Berg a	D	V	Proposed Ramsar Status	V	**V**	V	V	V
10	16	Berg b		E						
11	17	Diep a	E	C	In NR	C	**C**	C	C	C
11	18	Diep b		E						
12	19	Sout (W)	F	A						X
13	20	Hout Bay	E	E	Poor WQ					
14	21	Wildevoël vlei	D	E	Poor WQ					
15	22	Bokramspruit	C	E						
16	23	Schuster	A	A						
17	24	Krom	A	C	In NP	C	**C**	C	C	C
18	25	Buffels (W)	F	A						
19	26	Elsies	E	A						X
20	27	Silvermine	D	A						
21	28	Sand a	D	V	In NR	V	**V**	V	V	V
21	29	Sand b		E						
22	30	Zeekoei	E	A						X
23	31	Eerste	E	V	In MPA	V	**V**	V	V	V
24	32	Lourens	C	V	In MPA	V	**V**	V	V	V
25	33	Sir Lowry's Pass	E	A						
26	34	Steenbras	B	A						X
27	35	Rooiels	B	A						X
28	36	Buffels (E)	B	A						
29	37	Palmiet	C	V	In Biosphere reserve	V	**V**	V	V	V

30	38	Bot/Kleinmond a	C	A		X	**X**	X	X	X
30	39	Bot/Kleinmond b		E						
31	40	Onrus	E	A						
32	41	Klein a	C	A		X	**X**	X	X	X
32	42	Klein b		E						
33	43	Uilkraals a	D	V	High plant diversity		**V**	V	V	V
33	44	Uilkraals b	D	A						
34	45	Ratel	C	V	In NP		**V**	V	V	V
35	46	Heuningnes a	D	C	In NR	X	**C**	C	C	C
35	47	Heuningnes b		E						
36	48	Klipdrifsfontein	A	V	Within De Hoop NR	V	**V**	V	V	V
37	49	Breede a	B	V	Large Kob, Zambezi shark	X	**V**	V	V	V
37	50	Breede b		E						
38	51	Duiwenhoks a	B	A						
38	52	Duiwenhoks b	B	A						
39	53	Goukou a	C	V	Unusual turbid system	V	**V**	V	V	V
39	54	Goukou b		E						
40	55	Gourits a	C	V	Unusual turbid system	V	**V**	V	V	V
40	56	Gourits b		E						
41	57	Blinde	B	A						
42	58	Hartenbos a	D	E	Poor WQ					
42	59	Hartenbos b		E						
43	60	Klein Brak a	C	A						
43	61	Klein Brak b		E						
44	62	Groot Brak a	E	A		X				
44	63	Groot Brak b		E						
45	64	Maalgate	B	A						X
46	65	Gwaing	B	E	Poor WQ					
47	66	Kaaimans	B	A			**X**			X
48	67	Touw a	B	C	In NP	C	**C**	C	C	C
48	68	Touw b		E						
49	69	Swartvlei a	B	C	In NP	C	**C**	C	C	C
49	70	Swartvlei b		E						
50	71	Goukamma a	B	C	In NR	C	**C**	C	C	C
50	72	Goukamma b		C	In NR	C	**C**	C	C	C
51	73	Knysna a	B	C	In NP	C	**C**	C	C	C
51	74	Knysna b		E						
52	75	Noetsie	B	A						
53	76	Piesang a	C	A			**X**	X	X	X
53	77	Piesang b		E						
54	78	Keurbooms a	A	A		X	**X**	X	X	X
54	79	Keurbooms b		E						
55	80	Matjies	B	A						X
56	81	Sout (E)	A	C	In NP	C	**C**	C	C	C
57	82	Groot (W) a	B	C	In NP	C	**C**	C	C	C
57	83	Groot (W) b		C	In NP	C	**C**	C	C	C
58	84	Bloukrans	A	C	In NP/MPA	C	**C**	C	C	C
59	85	Lottering	A	C	In NP/MPA	C	**C**	C	C	C
60	86	Elandsbos	A	C	In NP/MPA	C	**C**	C	C	C
61	87	Storms	A	C	In NP/MPA	C	**C**	C	C	C
62	88	Elands	B	C	In NP/MPA	C	**C**	C	C	C
63	89	Groot (E)	B	C	In NP/MPA	C	**C**	C	C	C
64	90	Tsitsikamma	B	C	In NR		**C**	C	C	C
65	91	Klipdrif	D	A						X

66	92	Slang	D	A						
67	93	Kromme a	D	V	High plant diversity	X	**V**	V	V	V
67	94	Kromme b		E						
68	95	Seekoei a	D	C	In NR	C	**C**	C	C	C
68	96	Seekoei b		E						
69	97	Kabeljous a	C	A		X				
69	98	Kabeljous b		E						
70	99	Gamtoos a	C	C	In NR	C	**C**	C	C	C
70	100	Gamtoos b		E						
71	101	Van Stadens a	B	C	In NR	C	**C**	C	C	C
71	102	Van Stadens b		C	In NR	C	**C**	C	C	C
72	103	Maitland	C	A		X	**X**			
73	104	Baakens	E	E	Modified canals					
74	105	Papkuils	F	E	Modified canals					
75	106	Swartkops a	C	V		V	**V**	V	V	V
75	107	Swartkops b		E						
76	108	Coega (Ngcura)	F	E	Modified salt pan					
77	109	Sundays a	C	C	In NP	C	**C**	C	C	C
77	110	Sundays b		E						
78	111	Boknes	C	A						
79	112	Bushmans a	B	A		X	**X**	X	X	X
79	113	Bushmans b		E						
80	114	Kariega a	C	A		X	**X**	X	X	X
80	115	Kariega b		E						
81	116	Kasuka a	B	A						
81	117	Kasuka b		E						
82	118	Kowie a	C	A						X
82	119	Kowie b		E						
83	120	Rufane	C	A						
84	121	Riet	B	A		X				
85	122	W Kleinemonde a	B	A						
85	123	W Kleinemonde b		E						
86	124	E Kleinemonde a	B	A						
86	125	E Kleinemonde b		E						
87	126	Klein Palmiet	D	A						
88	127	Great Fish a	C	A		X	**X**	X	X	
88	128	Great Fish b		E						
89	129	Old woman's	C	A						
90	130	Mpekweni a	B	A				X	X	X
90	131	Mpekweni b		E						
91	132	Mtati a	B	A		X				
91	133	Mtati b		E						
92	134	Mgwalana a	B	A		X	**X**	X	X	X
92	135	Mgwalana b		E						
93	136	Bira a	B	A			**X**	X	X	X
93	137	Bira b		E						
94	138	Gqutywa	B	V	Isolated	V	**V**	V	V	V
95	139	Ngculura	B	A						
96	140	Freshwater Poort	A	A						
97	141	Mtana	B	A						
98	142	Keiskamma a	C	V	Naturally turbid	V	**V**	V	V	V
98	143	Keiskamma b		E						
99	144	Ngqinisa	B	A			**X**			

100	145	Kiwane	B	A							
101	146	Tyolomnqa a	B	A							
101	147	Tyolomnqa b		E							
102	148	Shelbertsstroom	C	A							
103	149	Lilyvale	B	A							
104	150	Ross' Creek	B	A							
105	151	Ncera	B	A				**X**	X	X	X
106	152	Mlele	B	A							
107	153	Mcantsi	C	A							
108	154	Gxulu a	B	A							
108	155	Gxulu b		E							
109	156	Goda	B	A			X			X	
110	157	Hlozi	B	A							
111	158	Hickman's	B	A							X
112	159	Mvubukazi	B	A							
113	160	Ngqenga	C	A							
114	161	Buffalo	D	E	Harbour						
115	162	Blind	C	E	Over-developed						
116	163	Hlaze	C	A							
117	164	Nahoon a	C	A							
117	165	Nahoon b		E							
118	166	Qinira a	B	A					X		
118	167	Qinira b	B	A							
119	168	Gqunube a	B	A				**X**			X
119	169	Gqunube b		E							
120	170	Kwelera a	B	A				**X**			X
120	171	Kwelera b		E							
121	172	Bulura a	B	A							
121	173	Bulura b		E							
122	174	Cunge	A	A							
123	175	Cintsa a	C	A							
123	176	Cintsa b		E							
124	177	Cefane a	B	A							
124	178	Cefane b		E							
125	179	Kwenxura	B	V	Isolated		V	**V**	V	V	V
126	180	Nyara	A	A							
127	181	Mtwendwe	B	A							
128	182	Haga-haga	B	A							
129	183	Mtendwe	B	A							
130	184	Quko a	A	V	Isolated		V	**V**	V	V	V
130	185	Quko b		E							
131	186	Morgan	C	E	Over-developed						
132	187	Cwili	B	A							
133	188	Great Kei a	C	V	Naturally silty		V	**V**	V	V	V
133	189	Great Kei b		E							
134	190	Gxara	B	A							
135	191	Ngogwane	B	A							X
136	192	Qolora	B	A			X		X	X	X
137	193	Ncizele	B	A				**X**			
138	194	Timba	A	A							
139	195	Kobonqaba	B	A							
140	196	Nxaxo/Ngqusi a	B	V	Biodiversity, ecotourism		V	**V**	V	V	V
140	197	Nxaxo/Ngqusi b		E							
141	198	Cebe	B	A							
142	199	Gqunqe	A	A							
143	200	Zalu	A	A							
144	201	Ngqwara	A	A				**X**			X

145	202	Sihlontlweni/Gcini	B	A							
146	203	Nebelele	A	A							
147	204	Qora a	B	A			X	**X**	X	X	X
147	205	Qora b		E							
148	206	Jujura	B	A							
149	207	Ngadla	A	A			X	**X**	X	X	X
150	208	Shixini	B	A							
151	209	Beechamwood	A	A							
152	210	un-named	A	A							
153	211	Kwa-Goqo	A	A							
154	212	Ku-Nocekedwa	A	A							
155	213	Nqabara a	B	V	>5ha MF			**V**	V	V	V
155	214	Nqabara b		E							
156	215	Ngoma/Kobule	A	A							
157	216	Mendu	A	C	In MPA			**C**	C	C	C
158	217	Mendwana	A	C	In MPA			**C**	C	C	C
159	218	Mbashe a	C	C	In MPA		C	**C**	C	C	C
159	219	Mbashe b	C	A			X				
160	220	Ku-Mpenzu	B	C	In MPA		C	**C**	C	C	C
161	221	Ku-Bhula/Mbhanyana	A	C	In MPA		C	**C**	C	C	C
162	222	Kwa-Suka	B	C	In MPA			**C**	C	C	C
163	223	Ntlonyane	B	C	In MPA		C	**C**	C	C	C
164	224	Nkanya	B	C	In MPA		C	**C**	C	C	C
165	225	Sundwana	A	A				**X**	X	X	X
166	226	Xora a	B	V	>5ha MF			**V**	V	V	V
166	227	Xora b		E							
167	228	Bulungula	B	A							
168	229	Ku-amanzimuzama	A	A							
169	230	Ngakanqa	A	A				**X**			
170	231	Un-named	A	A							
171	232	Mncwasa	B	A							
172	233	Mpako	B	A							
173	234	Nenga	C	A							
174	235	Mapuzi	B	A							
175	236	Mtata a	D	V	>5ha MF		X	**V**	V	V	V
175	237	Mtata b		E							
176	238	Tshani	B	A							
177	239	Mdumbi a	B	A			X				
177	240	Mdumbi b		E							
178	241	Lwandilana	A	A				**X**			X
179	242	Lwandile	A	A							
180	243	Mtakatye a	B	V	>5ha MF			**V**	V	V	V
180	244	Mtakatye b		E							
181	245	Hluleka	A	C	In NR			**C**	C	C	C
182	246	Mnenu a	B	A							
182	247	Mnenu b		E							
183	248	Mtonga	B	A							
184	249	Mpande	B	A							
185	250	Sinangwana a	B	A							
185	251	Sinangwana b		E							
186	252	Mngazana a	B	V	>5ha MF			**V**	V	V	V
186	253	Mngazana b		E							
187	254	Mngazi a	C	A							
187	255	Mngazi b		E							
188	256	Gxwaleni a	A	A							
188	257	Gxwaleni b		E							
189	258	Bululo a	B	A							

189	259	Bululo b		E						
190	260	Mtambane a	B	A						
190	261	Mtambane b		E						
191	262	Mzimvubu a	C	V	NB spawning area & >5ha SF		**V**	V	V	V
191	263	Mzimvubu b		E						
192	264	Ntlupeni	B	A						
193	265	Nkodusweni a	B	C	In MPA		**C**	C	C	C
193	266	Nkodusweni b		E						
194	267	Mntafufu a	B	C	In MPA		**C**	C	C	C
194	268	Mntafufu b	B	V	Natural beauty & productive MF		**V**	V	V	V
195	269	Mzintlava a	B	C	In MPA		**C**	C	C	C
195	270	Mzintlava b	B	V	Natural beauty & productive MF		**V**	V	V	V
196	271	Mzimpunzi	B	C	In MPA		**C**	C	C	C
197	272	Kwa-Nyambalala a	B	C	In MPA		**C**	C	C	C
197	273	Kwa-Nyambalala b		E						
198	274	Mbotyi a	B	C	In MPA		**C**	C	C	C
198	275	Mbotyi b		E						
199	276	Mkozi	A	V	Special		**V**	V	V	V
200	277	Myekane	A	V	Special		**V**	V	V	V
201	278	Sitatshe	A	C	In MPA		**C**	C	C	C
202	279	Lupatana	A	A	In MPA		**C**	C	C	C
203	280	Mkweni a	A	C	In MPA		**C**	C	C	C
203	281	Mkweni b		E						
204	282	Msikaba	A	C	In NR		**C**	C	C	C
205	283	Butsha a	A	C	In NR		**C**	C	C	C
205	284	Butsha b		E						
206	285	Mgwegwe a	A	C	In NR		**C**	C	C	C
206	286	Mgwegwe b		E						
207	287	Mgwetyana a	A	C	In NR		**C**	C	C	C
207	288	Mgwetyana b		E						
208	289	Mtentu a	A	C	In NR		**C**	C	C	C
208	290	Mtentu b		E			**C**	C	C	C
209	291	Sikombe a	A	C	In MPA		**C**	C	C	C
209	292	Sikombe b		E						
210	293	Kwanyana a	B	C	In MPA		**C**	C	C	C
210	294	Kwanyana b		E						
211	295	Mtolane a	A	C	In MPA		**C**	C	C	C
211	296	Mtolane b		E						
212	297	Mnyameni a	B	C	In MPA		**C**	C	C	C
212	298	Mnyameni b		E						
213	299	Mpahlanyana	A	C	In MPA		**C**	C	C	C
214	300	Mpahlane a	A	C	In MPA		**C**	C	C	C
214	301	Mpahlane b	A	A						
215	302	Mzamba a	B	C	In MPA		**C**	C	C	C
215	303	Mzamba b	B	A						
216	304	Mtentwana	C	C			**C**	C	C	C
217	305	Mtamvuna a	B	C	In MPA		**C**	C	C	C
217	306	Mtamvuna b	B	A			**X**	X		X
218	307	Zolwane	B	A						
219	308	Sandlundlu	C	A						
220	309	Ku-boboyi a	B	A						

220	310	Ku-boboyi b		E						
221	311	Tongazi a	B	A						
221	312	Tongazi b		E						
222	313	Kandandhlovu a	B	A						
222	314	Kandandhlovu b	B	A						
223	315	Mpenjati a	B	C	In NR		**C**	C	C	C
223	316	Mpenjati b	B	A						
224	317	Umhlangankulu a	C	A						
224	318	Umhlangankulu b		E						
225	319	Kaba a	B	A						
225	320	Kaba b		E						
226	321	Mbizana a	B	A						
226	322	Mbizana b		E						
227	323	Mvutshini a	B	A						
227	324	Mvutshini b		E						
228	325	Bilanhlolo a	C	A						
228	326	Bilanhlolo b		E						
229	327	Uvuzana a	C	A						
229	328	Uvuzana b		E						
230	329	Kongweni	C	E						
231	330	Vungu a	B	A						
231	331	Vungu b		E						
232	332	Mhlangeni a	C	A						
232	333	Mhlangeni b		E						
233	334	Zotsha a	C	V	>5ha SF		**V**	V	V	V
233	335	Zotsha b	C	A						
234	336	Boboyi	C	A						
235	337	Mbango	E	E						
236	338	Mzimkulu a	C	V	>5ha SF		**V**	V	V	V
236	339	Mzimkulu b	C	A						
237	340	Mtentweni a	C	A						
237	341	Mtentweni b		E						
238	342	Mhlambankulu a	C	A						
238	343	Mhlambankulu b		E						
239	344	Damba a	C	V	>5ha SF		**V**	V	V	V
239	345	Damba b		E						
240	346	Koshwana a	C	V	>5ha SF		**V**	V	V	V
240	347	Koshwana b		E						
241	348	Intshambili a	B	V	Partial SF & good benthos		**V**	V	V	V
241	349	Intshambili b		E						
242	350	Mzumbe a	D	A						
242	351	Mzumbe b		E						
243	352	Mhlabatshane a	B	V	>5ha SF		**V**	V	V	V
243	353	Mhlabatshane b		E						
244	354	Mhlungwa a	C	A						
244	355	Mhlungwa b		E						
245	356	Mfazazana a	C	V	>5ha SF		**V**	V	V	V
245	357	Mfazazana b		E						
246	358	Kwa-Makosi a	B	V	>5ha SF		**V**	V	V	V
246	359	Kwa-Makosi b		E						
247	360	Mnamfu a	C	A						
247	361	Mnamfu b		E						
248	362	Mtwalume a	D	A						
248	363	Mtwalume b	D	A						
249	364	Mvuzi a	C	A						
249	365	Mvuzi b		E						
250	366	Fafa a	D	A						

250	367	Fafa b		E					
251	368	Mdesingwana a	C	A					
251	369	Mdesingwana b		E					
252	370	Sezela	D	E					
253	371	Mkumbane	C	A					
254	372	Mzinto	C	A					
255	373	Mzimayi	C	A					
256	374	Nkomba	C	A					
257	375	Mpambanyoni a	C	A					
257	376	Mpambanyoni b		E					
258	377	Mahlongwa a	C	A					
258	378	Mahlongwa b		E					
259	379	Mahlongwana a	B	A					
259	380	Mahlongwana b	B	A					
260	381	Mkomazi a	C	V	NB for nutrients & sediments offshore	**V**	V	V	V
260	382	Mkomazi b		E					
261	383	Ngane	B	A					
262	384	Umgababa a	B	V	High invertebrate diversity	**V**	V	V	V
262	385	Umgababa b		E					
263	386	Msimbazi a	B	V	High invertebrate diversity	**V**	V	V	V
263	387	Msimbazi b		E					
264	388	Lovu a	C	V	>5a SF	**V**	V	V	V
264	389	Lovu b		E					
265	390	Little Manzimtoti	D	A					
266	391	Manzimtoti	D	A					
267	392	Mbokodweni	E	E					
268	393	Sipingo	F	E					
269	394	Durban Bay a	E	V		**V**	V	V	V
269	395	Durban Bay b		E					
270	396	Mgeni a	D	C	In NR	**C**	C	C	C
270	397	Mgeni b		E					
271	398	Mhlanga a	D	C	Fully protected	**C**	C	C	C
271	399	Mhlanga b		C		**C**	C	C	C
272	400	Mdloti a	D	E					
272	401	Mdloti b		E					
273	402	Tongati a	E	A					
273	403	Tongati b		E					
274	404	Mhlali a	C	V	>5ha SF	**V**	V	V	V
274	405	Mhlali b		E					
275	406	Bob's Stream	C	A					
276	407	Seteni	C	A					
277	408	Mvoti	D	V	NB for nutrients & sediments offshore	**V**	V	V	V
278	409	Mdlotane	B	V	>5ha SF	**V**	V	V	V
279	410	Nonoti a	B	A					
279	411	Nonoti b		E					
280	412	Zinkwasi a	C	V	>5ha SF	**V**	V	V	V
280	413	Zinkwasi b		E					
281	414	Thukela a	C	A					
281	415	Thukela b		E					
282	416	Matigulu/Nyoni a	B	V		**V**	V	V	V
282	417	Matigulu/Nyoni b	B	A				X	

283	418	Siyaya	F	V	NB for type	**V**	V	V	V
284	419	Mlalazi a	B	C	Fully protected	**C**	C	C	C
284	420	Mlalazi b		C		**C**	C	C	C
285	421	Mhlathuze/ Richard's Bay a	C	C	Partial protection	**C**	C	C	C
285	422	Mhlathuze/ Richard's Bay b		E					
286	423	Nhlabane a	D	A					
286	424	Nhlabane b		E					
287	425	St Lucia-Mfolozi	D	C	In NP	**C**	C	C	C
288	427	Mgobezeleni a	B	C	In NP	**C**	C	C	C
288	428	Mgobezeleni b		C		**C**	C	C	C
289	429	Kosi a	B	C	In NP	**C**	C	C	C
289	430	Kosi b		C		**C**	C	C	C
		Total units already protected (C)				**72**	**72**	**72**	**72**
		Total units forced in (V)				**51**	51	51	51
		Total additional units selected (X)				**23**	17	17	31
		Total planning units selected				**146**	140	140	154
		Total estuaries selected				**133**	126	125	138