C.A.P.E. Regional Estuarine Management Programme

CLASSIFICATION AND PRIORITIZATION OF CFR ESTUARIES IN TERMS OF HEALTH, CONSERVATION AND ECONOMIC IMPORTANCE AND THE DEVELOPMENT OF A REGIONAL CONSERVATION PLAN

DISCUSSION DOCUMENT ON PROPOSED TARGETS FOR ESTUARY CONSERVATION

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1 INTRODUCTION

This study forms part of the Cape Action Plan for the Environment (C.A.P.E.) Regional Estuarine Management Programme. The main aim of the overall programme is to develop a strategic conservation plan for the estuaries of the Cape Floristic Region (CFR), and to prepare detailed management plans for each estuary. The estuary programme will be divided into three phases. The first phase, of which this project forms a part, is to establish the conservation plan and prepare detailed management plans for a few selected systems.

The aim of this discussion document is to present the proposed estuary conservation targets to the scientists, managers and other relevant stakeholders for comment and approval. This is an essential first step before the process of planning can be completed.

The document begins with a brief outline of where conservation planning has come from and the current state of the art. Then we discuss the proposed planning domain (geographic extent of the conservation plan) based on current understanding of the biogeography of coastal and estuarine biota. Conservation planning targets are set in terms of absolute or proportional representation within protected areas of different types of measures or units. These units range from populations and species to habitats and ecosystem types. We discuss each of these, paying particular attention to the definition of estuary types and its relevance, based on analysis of fish and bird data. Following this, there is a discussion on how issues such as ecosystem and landscape-level processes should be dealt with. We then define the types of estuarine protection envisaged, and the socio-economic and other practical considerations that will need to be considered in the selection of estuarine protected areas. Finally we lay out the proposed goals and quantitative targets for protection, and briefly outline the next steps of the project.

2 CONSERVATION PLANNING

Conservation planning is a rapidly evolving area of research in which numerous approaches have been explored around the world in recent years. Systematic conservation planning replaces the relatively *ad hoc* way of selecting conservation areas 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. However, a major challenge for conservation planning is to identify priority areas that incorporate biological and environmental patterns and processes (Knight & Cowling 2003). In South Africa and Australia, systematic conservation 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 conservation planning involves several principles, and has numerous distinctive characteristics (Margules & Pressey 2000).

Conservation planning typically involves the following steps (based on Pressey & Cowling 2001):

1. **Set targets**: Identify conservation goals for the region and set quantitative conservation targets for species, vegetation communities and ecosystem types, and quantitative targets for minimum size, connectivity or other design criteria.
2. **Gap analysis**: Review existing conservation areas, assessing the extent to which quantitative targets have already been achieved
3. **Select new sites**: Select additional areas using algorithms to identify preliminary sets of new conservation areas for consideration by managers as additions to established areas.

Having first concentrated on the representation of species, conservation 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 ensures the persistence of targeted populations and maintenance of biodiversity (Reyers *et al.* 2002). In many respects, the C.A.P.E. programme has set the standard for systematic conservation planning (Balmford 2003). Much of its success has been attributed to its two-pronged approach of involving stakeholders early on in the process, coupled with scientific rigour, resulting in wide ownership of the terrestrial conservation plan. The C.A.P.E. planning processes also yielded some important lessons, such as the fact that species-level planning cannot be entirely substituted by a habitat-based approach (Balmford 2003).

In addition, it is becoming increasingly recognised that conservation planning cannot take place in isolation of an understanding of socio-economic pressures and values. There have been some attempts to incorporate species geography and human development patterns in order to assess vulnerability in conservation planning (Abbitt *et al.* 2000). Nevertheless, while there has been some consideration of the direct costs involved (e.g. Balmford *et al.* 2000, Frazee *et al.* 2003, Moore *et al.* 2004, Osano *et al.* 2005), there has been little integration of ecological and economic considerations in regional-level planning initiatives (see Faith & Walker 2002). Socio-economic factors are also potentially very important in identifying the most appropriate types of conservation intervention. Thus resource economics is playing an increasing role in conservation planning.

3 BIOGEOGRAPHY AND THE PLANNING DOMAIN

The C.A.P.E. planning domain is based primarily on the extent of the Cape Floristic Kingdom (Figure 1).

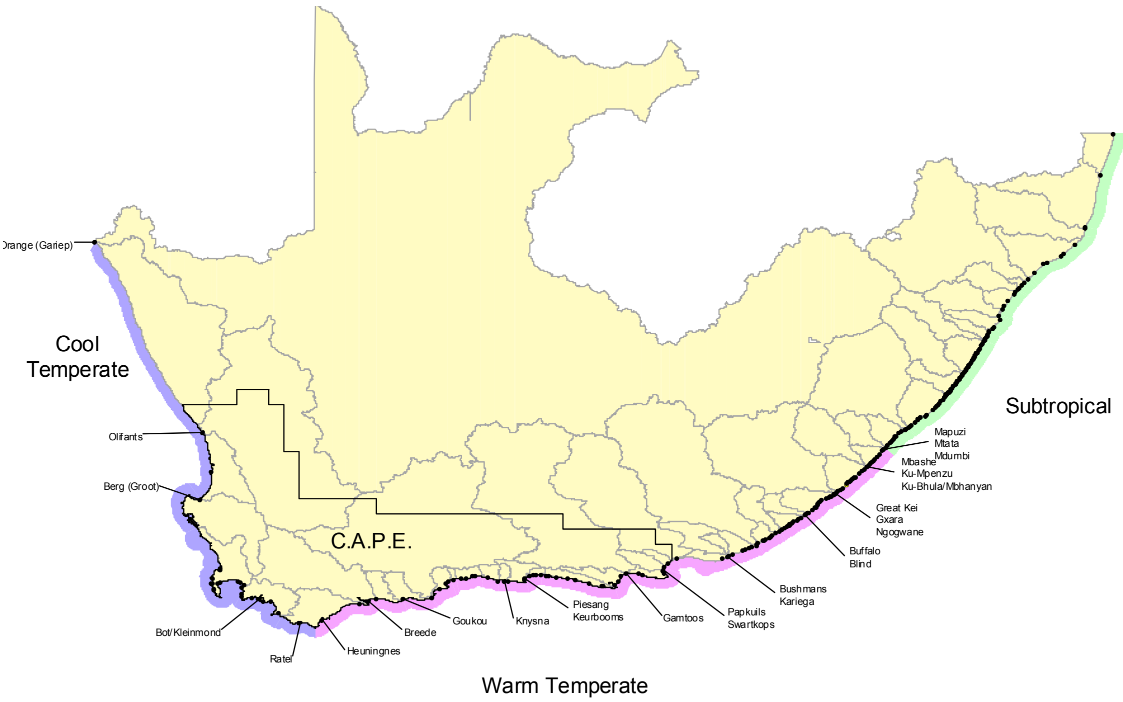

Figure 1. Distribution of estuaries in relation to three biogeographic zones, secondary catchment areas and the C.A.P.E region (Olifants to Swartkops).

From a terrestrial perspective, this makes good biogeographical sense. The coastal limits of this area include the approximately 65 estuaries from the Olifants to the Swartkops. However, this stretch of coast does not correspond to the biogeographic zonation of the South African coast.

The general biogeographic pattern that has been identified for the South African coast is one of a Cool Temperate West Coast Province extending from the Orange River south to somewhere between Cape Point and Cape Agulhas, a Warm Temperate South Coast Province extending east to the area of Mbashe to Port St. Johns, and a Subtropical East Coast Province which extends north from there into Mozambique (Brown & Jarmon 1978, Emanuel et al. 1992, Turpie et al. 2003). 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. 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 zones 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, notably harders *Liza richardsoni*. East of Cape Point, all groups are largely characterised by a gradual eastward change in species and increase in species richness.

The C.A.P.E. coast falls within two of the three coastal biogeographical provinces. Since conservation planning should ideally seek targets within each biogeographic province, it stands to reason that the planning domain for this part of the project should be extended to include the two temperate provinces in their entirety. This means that the number of estuaries under consideration is increased to 152, from the Orange to the Mdumbi (Figure 1).

4 CONSERVATION UNITS: SPECIES, HABITATS AND ECOSYSTEM TYPES

4.1 Species and populations

Targets may include provision for representation of a proportion of the species that occur in systems. 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 exercise, abundance data are 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. Palearctic 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 metapopulations, even if the exploitation does not occur directly within the protected system.

4.2 Habitat type

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 protected area system. In terrestrial system this might be in terms of vegetation types. In the case of estuaries, habitat types can be broadly delineated as follows:

- subtidal,
- intertidal flats,
- eelgrass beds,
- rocks,
- emergent reeds and sedges,
- saltmarsh,
- supratidal saltmarsh,
- mangrove and
- swamp forest.

Proportional representation may vary depending on the relative uniqueness or vulnerability of the different habitats. In the case of estuaries, the selection of habitats is inextricably linked to the selection of estuaries (part or whole). While it is recommended that this approach is used, it should be noted that the area data on habitat type are missing for some of the very small systems.

4.3 Estuary type

The National Biodiversity Strategy and Action Plan (NBSAP) suggests the approach of identifying targets within ecosystem types, with an overall target of 30% representation in protected areas. For estuaries, the analysis of current levels of protection, health and threats were done in terms of the five types of estuaries defined by Whitfield (1992). If targets are set as a percentage of each estuary type, then the majority of conserved systems will be temporarily open (Table 1). If the 30% is taken as area, then the spread would be more even across different estuary types, with permanently open being the most represented.

Table 1. Typical characteristics of the 5 types of estuaries defined by Whitfield (1992)

Type	Typical size	Typical mouth condition	Number in temperate provinces	%	Total area (ha)	%
Bay	Large	Open	1	1%	3 594	15%
Permanently open	Med to large	Open	30	22%	9 257	40%
River mouth	Small to large	Open	8	6%	998	4%
Lake	Large	Closed	4	3%	5 734	25%
Temporarily open	Small to med	Closed	95	69%	3 749	16%
TOTAL			**138**		**23 332**	

However, the above estuary typology, though widely used, does not necessarily make sense as an ecosystem typology from a biodiversity perspective. Neither fish nor bird communities group according to this classification (details to be described in main report).

Multidimensional scaling (MDS) and cluster analysis of **bird communities** suggests four main groupings for birds (Figure 2). Type A are large open systems that support diverse waterbird communities and are characterised by high numbers of waders. Type B are systems that have restricted or closed mouths, frequently have brackish lake characteristics, and support large waterfowl communities. Some systems (A/B) can have a mixture of these characteristics. Type C are typically medium to large sandy estuaries, often support gull and tern roosts, but have relatively low overall diversity. Type D systems are depauperate and are generally small and nutrient poor.

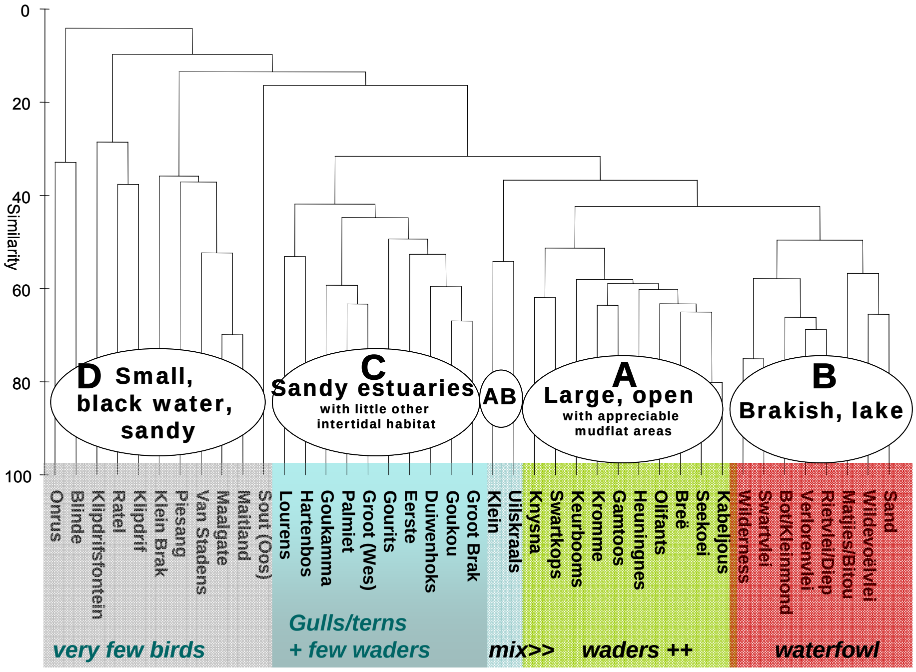

Figure 2. Cluster diagram showing groupings of estuaries on the basis of bird community structure.

However, it is also important to distinguish between subset communities and distinct communities. In effect, types A and B are relatively distinct, whereas types C and D support subsets of the communities found in type A (Figure 3). This suggests that for birds it would be best to concentrate conservation efforts on type A and B systems. Furthermore, since type B communities are likely to bear some resemblance to freshwater wetland systems, the main effort should be on type A systems.

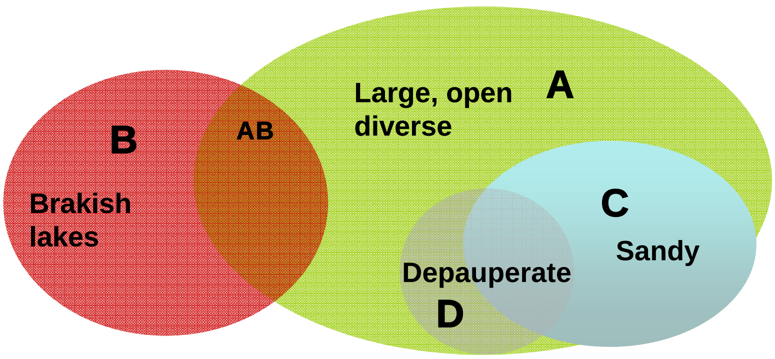

Figure 3. Schematic of the overlap between bird communities of the different estuary types

Within each biogeographical zone, Harrison & Whitfield (2006) found that estuarine **fish communities** were determined by a combination of estuary size and mouth condition. They defined three main types of estuaries: small closed, medium closed and large open systems.

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 the limited access to 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 systems, there are few that are restricted to small or closed systems. Nevertheless, some species are relatively more important in small closed estuaries (Harrison & Whitfield 2006).

We conducted a similar analysis using absolute abundance data of each species in each estuary, generated from the raw data collected by Trevor Harrison, due to the importance of considering total populations in the reserve selection process. This analysis suggested that the principle determinant of fish community characteristics, apart from geographic location, was estuary size (Figure 4), and 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 zone, fish communities of smaller systems are subsets of larger systems, rather than certain types of systems having distinct types of fish communities (Figure 5).

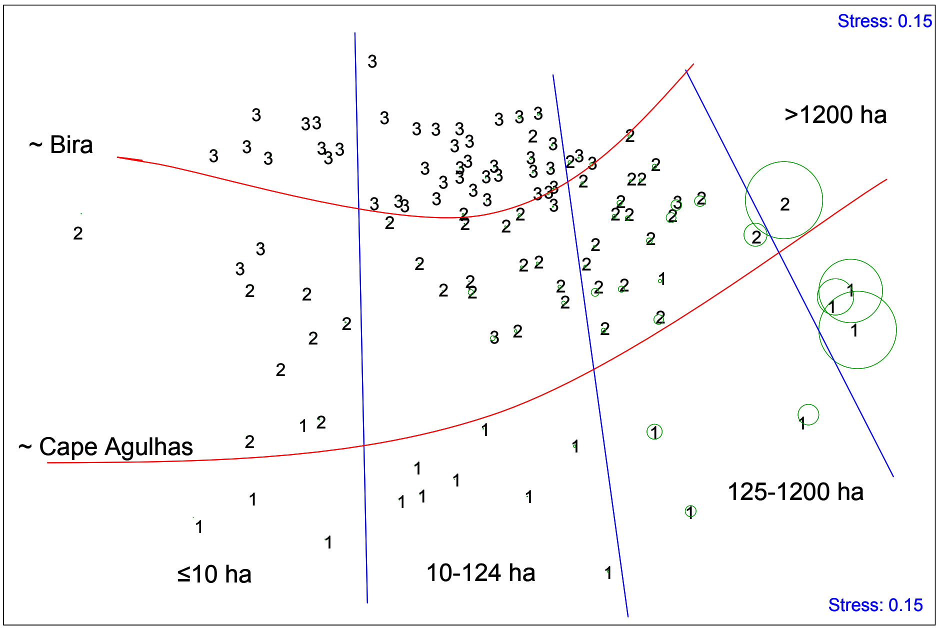

Figure 4. MDS plot showing how estuary fish communities are influenced by size and geographic position.

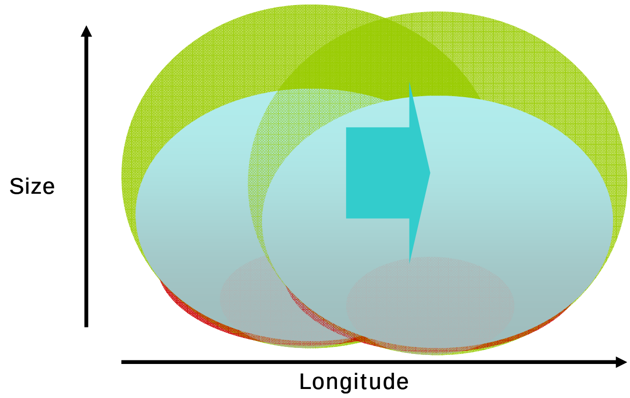

Figure 5. Schematic diagram showing that estuary communities change gradually around the coast, and small communities are mostly subsets of larger communities.

5 ACCOMMODATON OF 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 systems selected makes a difference in terms of conservation efficiency. Larger estuaries contain more fish, but there is no significant difference in fish density between small and large estuaries (Figure 6, Table 2). A similar phenomenon is found in floodplain wetlands (Welcomme 1979). This means that population targets can be met with the same total area, irrespective of whether small or large systems are selected to make up the total area.

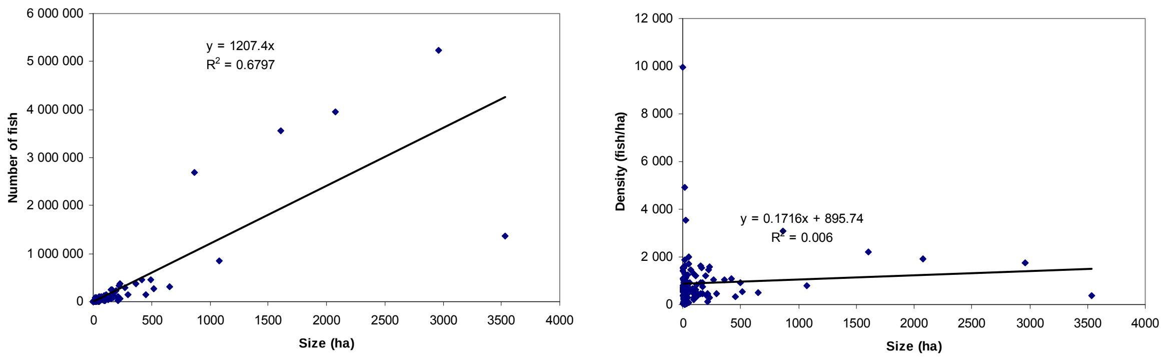

Figure 6. Relationship between fish abundance and density and estuary size.

Table 2. Average numbers and densities of fish in different size systems

Size category (ha)	Sample size (n)	Average no. fish	Fish per ha
0 – 10	56	2 520	821
10.1 – 125	95	27 400	732
125.1 – 1250	33	268 000	770
> 1250	6	4 750 000	1125

However, there are other ecological considerations that will influence whether small or large systems should be protected. Larger protected areas protect larger populations, ensuring greater probability of persistence. These systems 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 systems 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 systems. The large systems are often a considerable distance from one another, but general connectivity is boosted by the small systems when they are open. What is also particularly important is that not all the systems 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 systems are much more vulnerable to reduction in mouth opening (due to reduced water supply) than larger systems. 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 breeding habitat and opportunities available to important migrant fish such as White Steenbras.

6 TYPES OF ESTUARY PROTECTION

Before setting targets it is important to define the meaning of estuarine protected areas. Ideally, and given the above considerations, estuary conservation needs to be approached from the perspective that all estuaries are sufficiently valuable to warrant the maintenance of their health. Fortunately, many of the human activities associated with estuaries are compatible with their conservation, when managed appropriately. Thus estuary conservation on a broad scale does not necessarily carry an opportunity cost. Nevertheless, it is also desirable to protect a core set of estuaries in a highly natural state, to the level where freshwater and other protection requirements may limit human certain economic activity or at least change its nature. This is necessary to safeguard certain endangered species (such as the estuarine pipefish), to maintain viable populations of all estuarine species, and to maintain a representative set of estuaries in their reference state.

In devising guidelines for a strategy for the conservation of estuarine biodiversity, Turpie (2004) envisaged assigning all South African estuaries to one of three categories, as follows (Figure 7): 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 regulation is augmented by estuary-specific regulation; and Estuarine Management Areas (EMAs), to which general regulation applies. EPAs are state run, and should be selected with both biodiversity representation and socio-economic considerations in mind. ECAs may be initiated by local communities through their estuary forums, and are particularly suited to estuaries used primarily for recreation. The zonation and bylaws applied in these systems could be designed by the communities, under advice from relevant authorities and professionals. 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 study is concerned mainly with the selection of EPAs but will also make recommendations regarding the siting of ECAs, since these will contribute to maintenance of populations and processes.

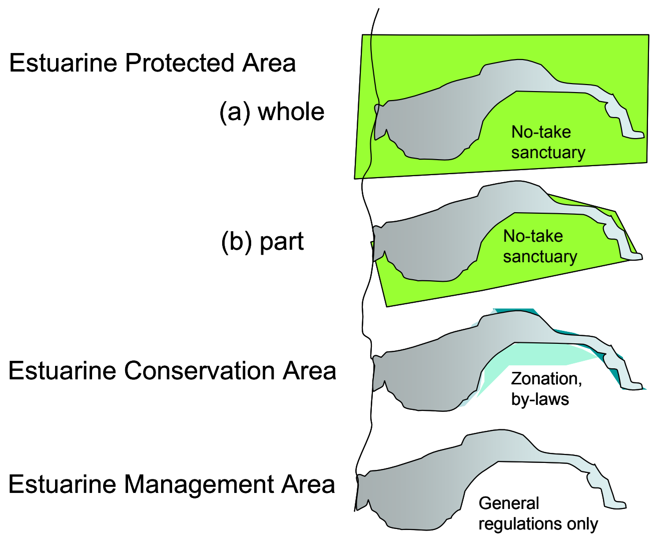

Figure 7. Schematic illustrating the different types of estuarine protection.

7 SOCIO-ECONOMIC AND OTHER PRACTICAL CONSIDERATIONS

The selection of estuarine protected areas has to take both biodiversity targets and economic costs and benefits into consideration. 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. These factors result in opportunity costs associated with the loss of water availability for alternative activities upstream, as well as in opportunity costs of limiting development around an estuary, or effects on property prices if certain forms of recreation are excluded. Protection of a system may also yield economic gains, however, 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 a system.

The biodiversity targets may be met by different combinations of estuaries, but each of these combinations is likely to have a different net economic impact. If conservation is to be successful, the economic losses will have to be minimised.

Another consideration is the sheer practicality of establishing a protected area at an estuary. Factors that should be considered are the degree to which the protected area is enforceable, or to which access can be limited. Both the economic and practical aspects are likely to differ substantially for a partially versus a wholly protected area. Whereas a partially protected system is likely to have lower opportunity costs, it is potentially less practical in some instances in that users will have to understand the boundaries. Practicalities may also influence decisions on whether protection of fewer large systems or several small systems is preferable.

8 PROPOSED TARGETS

8.1 Overall goals

Ideally, the core Estuarine Protected Area network should take into account the following goals:

1. Representativeness: all estuarine species within a bioregion should be represented in viable numbers in the protected areas network.

2. Maintenance of ecological processes: the protected area network should allow for connectivity and interaction with other adjoining ecosystems.

3. Maintenance of fishery stocks: the protected area network should provide enough protection to exploited species that they are able to act as source areas for surrounding exploited areas.

4. Minimisation of economic opportunity costs: biodiversity targets should be met at least possible opportunity cost, through careful selection of the estuaries included in the protected area network. Estuaries where protection offers greatest economic benefits or lowest economic costs should be prioritised in the EPA selection process.

5. Implementabilty: consideration should be given to the practicalities of protection in each estuary.

The World Conservation Union (IUCN) has proposed a goal of conserving 20% of the world's coastline by the turn of the century (IUCN 1992). This value is based on the result of fishery modelling studies which show 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). The NSBA suggested a target of 30% of estuaries, though in the light of the above rationale it is clear that this should be a minimum of 30% of estuarine area rather than estuaries, given the enormous variation in their size.

8.2 Biodiversity targets

In setting the biodiversity targets, it is important to consider the fact that both EPAs and ECAs will offer some degree of protection. While EPAs are here defined as no-take areas, ECAs may take a number of forms, which could include sanctuaries or limited use zones. An ECA can be assumed to have a lower protection capacity of an EPA, possibly as low as 10 -20%, depending on the wishes of the local community. ECAs should be likened to the role of private nature reserves and conservancies in the protection of terrestrial biodiversity, and are generally not considered to contribute to protected area conservation targets because their contribution to conservation is less secure in the long term.

The following biodiversity targets are proposed for the EPA system within each biogeographical zone:

Species targets:

- All non-vagrant species recorded in estuaries should be represented in at least one EPA.

Population targets[1]*:*

- 50% of the population of red data (threatened) species;
- 30% of the population of exploited species; and
- 20% of the population of all other species.

Habitat targets:

- 30% of the total estuarine area, such that the following individual targets are met for each broad habitat type (based on the relative importance of estuaries for these habitats)
    - subtidal: 25%
    - intertidal flats: 25%
    - eelgrass beds: 15%
    - rocks: -
    - emergent reeds and sedges: 5%
    - saltmarsh: 25%
    - supratidal saltmarsh: 15%
    - mangrove: 25%
    - swamp forest: 25%

Targets for maintaining ecosystem and landscape-level processes:

- EPAs should protect a minimum of 33% of each habitat within an estuary as a no take sanctuary;
- There should be a relatively even distribution of protected estuarine area around the coast;
- Protected areas should be no more than 200km apart, if possible;
- Estuaries adjoining terrestrial or marine protected areas will be prioritised in the selection process, and those adjoining undeveloped land will be prioritised over those that are developed;
- Systems with higher conservation importance scores should be given greater priority, *ceteris paribus;*
- Large open systems should be prioritised over smaller systems, *ceteris paribus;* and
- Healthier systems should be given greater priority, *ceteris paribus.*

These biodiversity targets address goals 1 – 3 listed above. The choice of estuaries used to meet these targets will be subject to goals 4 and 5.

9 NEXT STEPS

Comment on this report and on the biodiversity targets in particular is requested by latest 18 January 2006, to be emailed to jturpie@botzoo.uct.ac.za, and cc'd to anchor@botzoo.uct.ac.za. Meanwhile, data on species presence, populations, protected areas, and economic indices are being compiled in such a way as to facilitate an iterative and participative reserve selection process. The reserve selection methodology and preliminary results will be described in a report at the end of January, and will be presented and modified based on inputs at a workshop in Cape Town on 13-14 February 2007. The workshop will be attended by a representative set of scientists, estuary managers and other relevant stakeholders, but will be kept small enough to engage in productive decision-making.

[1] These only apply to fish and birds; there are insufficient data on other taxa, notably invertebrates.

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