S. Afr. J. mar. Sci. 18: 369–383
1997

CRITERIA, OBJECTIVES AND METHODOLOGY FOR EVALUATING MARINE PROTECTED AREAS IN SOUTH AFRICA

P. A. R. HOCKEY and G. M. BRANCH†*

In the face of ever-increasing requests for the proclamation of Marine Protected Areas (MPAs) in South Africa, there is a need to develop an objective protocol for their evaluation. To achieve this, a methodology is described for which the acronym "COMPARE" (Criteria and Objectives for Marine Protected ARea Evaluation) is coined. COMPARE also allows existing MPAs to be evaluated in terms of their efficacy, and can assess the effects of changes to either legislation or management of existing MPAs. As a first step, 14 objectives are defined that may be met by MPAs. These fall into three categories: biodiversity protection, fisheries management and human utilization. A series of criteria were then proposed which can be used selectively to quantify the degree to which MPAs meet these objectives. Each of the objectives is scored against the appropriate criteria in a semi-quantitative manner that allows areas to be compared, either overall or in terms of specific objectives. Simply by comparing the degree to which different types of MPAs might meet these objectives, it is clear that fishery reserves, proclaimed for the protection of individual commercial species, meet an extremely limited suite of objectives compared with marine sanctuaries that protect all species, or marine reserves, which protect all but a few species. Prominent among the advantages of COMPARE are that it compels an examination of all possible objectives, pinpoints the reasons for decisions, identifies issues that need resolution and requires development of management plans. Its primary strategic advantage is that its implementation should lead to a rationally planned and defensible network of MPAs that will contribute to the conservation of marine biodiversity in South Africa.

"*Coastal zones are some of the most complex "multiple-use" areas in the world, and may hold the dubious distinction of being the most challenging and problematic areas for which to find solutions that sustain healthy ecosystems and healthy economies"* (Griffis and Kimball 1996, p. 709).

Marine Protected Areas (MPAs) are widely recognized as one method of ensuring the maintenance of functional coastal ecosystems, and the IUCN (World Conservation Union) has proposed a goal of conserving 20% of the world's coastline within MPAs by the year 2000 (IUCN 1992). South Africa has ratified the Convention on Biological Diversity (Rio de Janeiro, 1992) and is thus bound by the Articles and associated Obligations of the Convention. Of particular relevance to the marine environment is Article 8 (a, b and e), which requires the establishment of MPAs for the conservation and sustainable use of threatened species, habitats, living marine resources and ecological processes. A consequent obligation is that Parties must develop guidelines for MPA selection, establishment and management (de Fontaubert *et al.* 1996).

Importantly, MPAs should not be seen only as a means of preserving natural systems, but also of meeting a wide range of human needs, including education, recreation, research and generation of wealth (e.g. Kelleher and Kenchington 1990). They also contribute significantly to the management of commercial and angling fish stocks (Bennett and Attwood 1991), and Clark (1996) and Agardy (1994a) have emphasized that they will become increasingly important as greater proportions of the world's fish stocks are exploited. Griffis and Kimball (1996) note that most fisheries are now exploited to the limit and that 11 of the 15 major fisheries in the world are in decline. Boehlert (1996) has documented the substantial impacts that marine fisheries are having on biodiversity and points out that protected areas allow management of both biodiversity and fisheries simultaneously.

Increases in human population density have placed ever-growing demands on marine resources in South Africa (e.g. Hockey *et al.* 1988), and political changes have led to heightened expectations of greater access to these resources (Branch *et al.* 1996, Van der Elst *et al.* in press). There is, therefore, a vital need to protect marine biodiversity and maintain the food-producing and recreational potential of the marine environment: creating MPAs as a means of achieving this should not be viewed as a

* Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch 7701, South Africa. E-mail: phockey@botzoo.uct.ac.za
† Marine Biology Research Institute, Department of Zoology, University of Cape Town, Rondebosch 7701, South Africa. E-mail gmbranch@pop.uct.ac.za

Manuscript received: April 1997

denial of rights, but as a means of meeting the needs of all South Africans in perpetuity.

Robinson and de Graaff (1994) provide a detailed catalogue of the MPAs in South Africa. Relative to other African countries, South Africa appears to be well-endowed with marine reserves (Hockey and Branch 1994). Of the 2 600 km of coastline, 248 km (9.5%) fall within MPAs where the intertidal biota is fully protected, although, in many cases, angling is still permitted (Hockey and Buxton 1989). This falls far short of the IUCN goal of 20%. Moreover, only 0.09% of the area falling within South Africa's Exclusive Economic Zone is protected within MPAs (Hockey and Branch 1994).

In the past, selection of MPAs in South Africa has not been based on predetermined criteria, nor has the overall distribution of MPAs been planned as a rational network. Many MPAs were created on an opportunistic basis or in response to public pressure rather than through an integrated and objective evaluation of the need for these MPAs. This situation is not unique to South Africa: worldwide, there is an increasing awareness that MPA networks need to be rationalized and defensible (Pressey *et al.* 1993), i.e. representative and complementary as well as effective and efficient. This requires a rigorous and objective procedure that will allow an evaluation of the relative merits of different areas that have already been proclaimed or are being considered for MPA status. In particular, there is a need to plan a system of MPAs that will protect the structural and functional components of biodiversity, contribute towards fisheries management, and promote human use of the coast that is compatible with these objectives.

The choice of criteria for the selection of MPAs has changed over the past 20 years. Early attempts at developing criteria arose almost entirely from a desire to preserve areas, and focused on biological attributes such as diversity, rarity and naturalness, as reviewed by Margules and Usher (1981) and discussed in more detail by Usher (1986). More recently, there has been a shift towards incorporating political and socio-economic criteria such as the value of MPAs for recreation, education and tourism (Kelleher and Kenchington 1990). One of the reasons for this change is the increasing recognition that MPAs should fulfil multiple objectives, including catering for a diversity of human needs (Jones 1994). Early approaches to marine conservation were driven by first world sentiment, largely because they developed in the Northern Hemisphere. As these ideas came to be applied to less-developed countries, the awareness grew that the luxuries of protectionism alone are not politically tenable (Dixon *et al.* 1993, Agardy 1994b, Morton 1996). Nevertheless, the maintenance of biodiversity and functional ecosystems remains a cornerstone of the Convention on Biological Diversity (de Fontaubert *et al.* 1996) and MPAs are widely recognized as playing a vital role in meeting these objectives (Norse 1993, Eichbaum *et al.* 1996).

Several authors have listed biological and socio-economic criteria germane to MPA site selection, and this study has drawn particularly from those provided by Margules and Usher (1981), Ivanovici (1984), Kelleher and Kenchington (1991), NOAA (1995) and Salm and Price (1995). Those publications provide valuable guidance, although there is general recognition that the selection of criteria will, to some extent, be politically driven. The difficulty in applying these criteria is that there have been few attempts to develop a practical methodology which will allow them to be matched against defined objectives and derive a quantitative method that will allow direct comparisons between sites. Examples where this has been accomplished include Rabe and Savage (1979), who developed a scoring system for comparing the physical and biological characteristics of proposed protected areas, and Odendaal *et al.* (1995), who used 10 criteria to rank six potential MPAs in eastern Madagascar.

The first aim of this study is to define the objectives that MPAs should fulfil in South Africa. Secondly, relevant criteria that can be used in assessing the degree to which different objectives are being, or could be, met are identified. The overall goal is to develop a practical methodology that will allow:

(i) a quantitative comparison between existing MPAs to assess their relative success in meeting identified objectives;
(ii) rigorous, repeatable and defensible evaluation of the relative merits of proposed MPAs; and
(iii) an assessment of how legislative or managerial changes might improve or reduce the efficacy of an MPA.

For ease of reference the methodology has been termed COMPARE (Criteria and Objectives for Marine Protected ARea Evaluation).

TERMINOLOGY

In South Africa, two main legislative acts are used in the promulgation of MPAs, namely the Sea Fisheries Act (No. 58 of 1973) and the National Parks Act (No. 57 of 1976). One of the current problems is that inconsistent terminology is used to describe

MPAs, which vary in their designated function from the equivalent of "nature sanctuaries", where no exploitation is allowed, to areas where protection is accorded to only one, or a small suite, of species. The regulations which pertain to conserved marine areas are complex and the definition of the terms "park", "reserve" and "sanctuary" vary according to these regulations (Hockey and Buxton 1989).

It is proposed that in South Africa the following terms should be employed to describe four categories of MPAs, with different functions:

Marine sanctuary – a site or area in which *no extractive exploitation of any marine resources is allowed.*

Marine reserve – an area in which *some consumptive utilization is allowed, but protection is afforded to most species* (e.g. all except rock-and-surf angling fish).

Fishery reserve – an area set aside for the *protection of individual, exploited species*, which should be qualified with the name of the protected species, e.g. "rock lobster reserve".

Marine park – a protected area that includes any combination of sanctuaries, marine reserves or fishery reserves, i.e. an area zoned for multiple use.

Marine protected areas have three main functions, the first of which deals primarily with ecological issues, the second with managerial considerations for fisheries and the third with human rights and expectations:

Protection – the maintenance of ecosystems undisturbed by human activities, and their component biodiversity.

Fisheries management – the provision of refuges for exploited species with the aim of improving stock status outside protected areas.

Utilization – the promotion of human activities that are compatible with the objectives of conservation.

In the sections that follow, general considerations that must be addressed at the outset of any evaluation are first identified. Second, the objectives of Marine Protected Areas under each of the three categories mentioned above are outlined. The criteria that can be used to assess the extent to which MPAs meet these objectives are then developed. Using these criteria, the efficacy of sanctuaries, marine reserves and fishery reserves are assessed. Finally, by way of an example, the application of COMPARE is illustrated and its benefits discussed.

GENERAL CONSIDERATIONS

Initially, a set of 22 criteria which should be considered in determining whether an MPA will achieve, or is achieving, its objectives were identified. However, when attempts were made to apply these criteria to particular objectives, five of them were applicable only to proposed (not existing) MPAs, and were inappropriate for the evaluation of individual objectives. Rather, they identify issues that have to be addressed before an MPA can be evaluated. Some of them are of such overriding importance that they have the potential to eliminate an area from further consideration. These five general considerations should therefore be addressed as a first step:

A. Are there any external threats that would render the proclamation of the MPA futile?

"Future safety" is an important consideration in MPA selection and is one of the criteria used by the Ramsar Convention. For example, proclamation of an MPA on a site already gazetted for heavy industry is unlikely to be as effective as selecting an equivalent site where such impacts are avoidable.

B. Will the proclamation of the MPA create conflicts with existing activities within the MPA or on adjacent land?

In most cases, the areas of sea required for marine protected areas will be state-owned, but the adjacent terrestrial areas will not. It is therefore important to establish whether management objectives for MPAs will be compatible with the activities of adjacent landowners and with any established or perceived rights, including the historical activities of commercial industries, recreational anglers, divers and subsistence users.

C. If conflicts exist, are they reconcilable?

There are several ways of resolving conflicts, including compromise, arbitration, payment of compensation or purchase of rights. Increasingly, negotiation is seen as the way forward, rather than edict, and has enormous potential for winning supporters to the cause of MPAs. Indeed, several authors argue that local support is imperative if an MPA is to succeed (e.g. Tisdell and Broadus 1989, Ballantine 1991).

D. Are there impending threats that would be mitigated by proclamation of the MPA?

A site which is important for conservation, fisheries management or public utilization, but is threatened by impending developments, must be a prime candidate for protection if this will avoid or reduce the threat. The proclamation of the West Coast National Park, an area once threatened with development of commercial salt pans and dense holiday housing, could be viewed as particularly successful in this regard. If the proclamation of an MPA cannot avoid such threat, the area should be disqualified on the grounds of consideration (A) above.

E. Are the monetary costs of establishment and maintenance affordable?

The cost and ease of proclaiming an MPA will be strongly influenced by who owns or has rights to the area. State land can be transferred or proclaimed at little cost, whereas privately owned land may involve costly purchase. A more critical issue is the need for sufficient funding to ensure subsequent management, the costs of which will be determined largely by the objectives of the MPA. Proclamation may be inexpensive, but ongoing management is what makes the difference between reserves on paper and those that fulfil their objectives.

OBJECTIVES OF MARINE PROTECTED AREAS IN SOUTH AFRICA

Protection

A major goal of MPAs has always been the protection of biota from human activities. The preservation of biodiversity and associated genetic resources is now viewed as one of the major aims of conservation (Jones 1994), and its importance in the marine environment has been highlighted in the Global Marine Biological Diversity Strategy (Norse 1993). This philosophy underpins Objectives 1–4 below.

OBJECTIVE 1. TO ENSURE PROTECTION OF REPRESENTATIVE SECTIONS OF THE MARINE ENVIRONMENT IN ALL MAJOR BIOGEOGRAPHIC REGIONS

On the southern African coast, there are four biogeographic regions: one is restricted to Namibia, two fall entirely within South Africa and a fourth extends from South Africa into Moçambique (Emanuel *et al.* 1992). Representative MPAs must be established in the core of each of the three South African biogeographic regions, otherwise a substantial proportion of the country's marine bioversity will not be conserved. There is also a strong case for establishing MPAs at the boundaries of biogeographic regions, because these tend to be areas of high species diversity and because they provide important sites for monitoring range shifts in response to environmental changes (Hockey and Branch 1994).

OBJECTIVE 2. TO MAXIMIZE HABITAT DIVERSITY (AND THEREBY SPECIES AND COMMUNITY DIVERSITY) WITHIN PROTECTED AREAS

Different types of coastal habitats (e.g. estuaries, dunes, sandy beaches and rocky shores) support different species, and these species assemblages can be further modified by the degree of exposure of the shore to wave action (Emanuel *et al.* 1992, Dye *et al.* 1994) and by the nature of the substratum (Davidson and Chadderton 1994). Choosing an area that includes a wide spectrum of habitats should maximize the number of species and communities conserved while minimizing the area required to achieve this.

OBJECTIVE 3. TO ENSURE PROTECTION OF RARE, LOCALIZED OR ENDEMIC SPECIES THROUGH ENSURING PROTECTION OF THEIR HABITATS

Species which are globally rare or have a very limited range, or are found only in South Africa, need special consideration. High proportions of southern Africa's marine flora and fauna are endemic, in spite of the fact that marine species are characterized by large ranges (Hockey and Branch 1994). For example, 36% of polychaetes, 46% of amphipods and 87% of isopods are endemic to southern Africa (Hockey and Buxton 1989). The level of endemism in shelf-inhabiting fish ranges from 45% on the West Coast to 9% on the East Coast (Turpie *et al.* in prep.). If MPAs are well-sited on the basis of biogeography and habitat diversity, conservation of rare and endemic species will often follow automatically.

OBJECTIVE 4. TO PROTECT AREAS ESSENTIAL FOR THE COMPLETION OF VULNERABLE LIFE-HISTORY STAGES OF COASTAL SPECIES

Some species aggregate when breeding (e.g. turtles and seabirds – Hughes 1974, Cooper *et al.* 1984), when migrating (e.g. waders – Hockey *et al.* 1992) or at "nursery" sites (e.g. juvenile fish in estuaries – Wallace *et al.* 1984). Most of these aggregations are predict-

able in time and space. This predictability makes these species particularly vulnerable at a specific stage of their life, not only to exploitation, but also to human disturbance and the effects of habitat alteration.

Fisheries management

In terms of fisheries management, the primary function of MPAs is to provide refuges for exploited species, with the aim of improving stocks outside MPAs (Bennett and Attwood 1991, Quinn *et al.* 1993). This might function through, *inter alia*, direct reduction of fishing pressure, protection of spawning stocks or improving yields in adjacent areas through active or passive emigration. Objectives 5–8 below relate directly to fisheries management.

OBJECTIVE 5. TO PREVENT OVEREXPLOITATION BY PROVIDING REFUGE AREAS FOR EXPLOITED SEDENTARY SPECIES

Marine protected areas can reduce fishing effort and hence overall mortality, and they can guard against the loss of intraspecific genetic diversity. They are, however, only effective for species that are not highly mobile (Hockey and Bosman 1986, Lasiak and Field 1995).

OBJECTIVE 6. TO PROTECT EXPLOITED SPECIES AT SITES WHERE THEY BECOME VULNERABLE

Some exploited species become predictably concentrated at life-history stages and can then become "easy targets" (e.g. squid on their breeding grounds – Sauer *et al.* 1992). It is important to provide protection in such areas.

OBJECTIVE 7. TO IMPROVE OR SUSTAIN YIELDS IN ADJACENT AREAS

There is extremely good evidence to show that stocks recover in areas in which they are protected (Polunin and Roberts 1993). This is well documented in the case of recreational angling fish (Buxton and Smale 1989). Emigration by active or passive means may then take place from protected areas to enhance catches in adjacent areas (Bennett and Attwood 1991).

OBJECTIVE 8. TO MAINTAIN SPAWNER BIOMASS

It is important that breeding stocks are maintained at sufficiently high levels to supply recruits to fishing grounds. Marine protected areas may serve this purpose. Furthermore, for species that reproduce by external fertilization, adult density is probably the key factor determining the success of fertilization (as in the case of sea urchins and abalone – Quinn *et al.* 1993, Tegner *et al.* 1996). Even when such species are relatively common, they may be unable to reproduce if their densities are low. Dense populations in protected areas have been shown to be vital sources of recruitment (Hockey and Branch 1994).

Utilization

Different forms of resource use may take place inside protected areas, as long as they do not conflict with other objectives set for these areas. Such use may include sustainable harvesting of particular species, provided this does not detrimentally affect either the target species or other components of the ecosystem. However, there are many non-consumptive forms of use, including education, research, nature watching, hiking, photography and diving, that can be fully compatible with conservation objectives. Objectives 9–14 below are all related to human use of MPAs.

OBJECTIVE 9. TO PROVIDE UNDISTURBED LOCALITIES, POPULATIONS AND COMMUNITIES FOR RESEARCH

Vital information required for the management of exploited species, such as natural mortality rates, can often only be obtained from the study of populations in undisturbed situations (Branch and Moreno 1994). Marine protected areas have also proved invaluable in demonstrating the magnitude and effects of human activities by providing controls against which impacts elsewhere can be measured (e.g. Castilla and Durán 1985).

OBJECTIVE 10. TO PROVIDE SITES IN WHICH MONITORING CAN BE CONDUCTED

One of the major problems in assessing the impacts of human actions is the inability to separate them from natural variations in populations and communities. Studies in undisturbed areas allow quantification of natural variations (Dye 1988). This is becoming of increasing importance because of large-scale human effects such as global warming, and because of more short-term natural phenomena, such as *El Niño*, which can cause major population fluctuations of great significance to fisheries management (Arntz *et al.* 1987). Detection of fluctuations in populations is most likely to be effective in marine protected areas that are placed at biogeographic boundaries (Hockey and Branch 1994).

OBJECTIVE 11.TO PROMOTE AND FACILITATE THE DEVELOPMENT OF TOURISM IN SOUTH AFRICA

Tourism is the most rapidly growing sector of South Africa's economy and ecotourism is one of the fastest-growing industries in the world. Marine Protected Areas draw large numbers of tourists, and well managed areas, such as Tsitsikamma Coastal National Park, Sodwana Bay National Park and Cape Vidal more than pay for tourist-related and recreational activities, and generate funds that subsidize conservation actions. Tourism based largely on recreational diving in Bonaire Marine Park in the Caribbean yields considerable returns, and modelling economic returns for this MPA shows that it is possible to gain profits from MPAs while retaining their protective function (Dixon *et al.* 1993). Specific designation of parts of the coastline as MPAs heightens their attractiveness to tourists, as has been documented following the establishment of MPAs in New Zealand and Australia (Ballantine 1991).

OBJECTIVE 12. TO PROVIDE SITES FOR LOW IMPACT, NON-CONSUMPTIVE RECREATION

South Africa's coastline is coming under increasing pressure from recreation, much of which (e.g. the use of off-road vehicles) is not compatible with environmental conservation principles (Schulz and Stock 1993, Ricard *et al.* 1994). At the same time there is increasing demand for facilities to allow people to make use of protected, natural havens for low-impact recreation such as hiking and diving.

OBJECTIVE 13. TO PROVIDE SITES WHERE FIELD-BASED EDUCATION CAN BE UNDERTAKEN

Given South Africa's burgeoning human population, environmental education is becoming increasingly important: this is best achieved by example in the field in undisturbed environments with a high diversity of habitats. The popularity of education centres, such as those in De Hoop Nature Reserve and at Treasure Beach in KwaZulu-Natal, exemplifies this need.

OBJECTIVE 14. TO ALLOW EXPLOITATION OF SELECTED TAXA AT A SUSTAINABLE LEVEL

At least within marine reserves, it is possible to allow people to harvest particular species, provided this is monitored and controlled at a sustainable level and does not have any indirect adverse effects on other species. Such exploitation could be recreational, subsistence or commercial. In the context of research, MPAs can also be used to allow experimental harvesting to determine acceptable exploitation levels (as has been done for the mussel *Perna perna* on the KwaZulu-Natal north coast adjacent to Mapelane Nature Reserve – J. Harris, KwaZulu-Natal Nature Conservation Services, pers. comm.).

CRITERIA USED TO MEASURE PERFORMANCE

Various criteria can be used to evaluate the degree to which different MPAs fulfil particular objectives and, thereby, can be used to develop a ranking system for comparing MPAs. These have been grouped below according to whether they are: (1) scientific and relating to protection or fisheries management of an area or the species therein; (2) practical considerations that address how effective an MPA may be or how easily it may be managed; or (3) criteria that relate to socio-economic or legal considerations. It may be surprising to note that a measure of biological diversity has not been included among the criteria for choosing between two or more candidate MPAs. There are two reasons for this: first, species richness differs greatly between ecosystems and biogeographic regions and cannot *per se* be used to afford a high ranking to a particular system; second, the preservation of biodiversity is better served by ensuring protection of areas that represent biogeographic regions and have a high habitat diversity.

Scientific performance measures

1. IS THE SITE REGIONALLY REPRESENTATIVE?

It is important that all of the biogeographic regions of the South African coast are represented in an MPA network, preferably with at least one MPA sited close to the core of each biogeographic region. The primary purpose of such MPAs is to preserve representative biotas and therefore national marine biodiversity. In addition to core MPAs, those sited at the edges of biogeographic regions can fulfil important roles for monitoring and research.

2. IS THE BIOGEOGRAPHIC REGION CURRENTLY INADEQUATELY CONSERVED?

The purpose of an MPA network is to ensure that MPAs complement, rather than duplicate, one another. Therefore, the question needs to be asked whether a proposed area fills a gap in the existing network of protected areas. Higher priority should be given to establishing MPAs in biogeographic regions that have few or no protected areas rather than increasing the number of MPAs in already well-protected regions.

3. IS HABITAT DIVERSITY HIGH?

Within a given biogeographic region, the diversity of biological communities is related to the range of habitats present. Sandy beaches, rocky shores, estuaries, lagoons and dunes all support completely different biotic communities. Even within these habitat categories, community composition varies with geology and exposure to wave action. Therefore, an area incorporating a range of habitats will support a higher diversity of species than will a physically uniform landscape.

4. DOES THE AREA INCLUDE VULNERABLE/FRAGILE HABITATS?

Some habitats are more vulnerable or fragile than others, because they are easily disturbed or do not recover quickly after disturbance. Habitats that are structured by their biota are particularly at risk, and examples include saltmarshes, mangrove swamps, coral reefs and vegetated dunes. Inclusion of fragile/vulnerable habitats will obviously strengthen the case for an MPA's proclamation.

5. ARE VULNERABLE SPECIES WELL REPRESENTED?

Species are particularly vulnerable if they are rare or range-restricted, and countries have an obligation to conserve species that do not occur elsewhere (endemic species). Whereas the creation of MPAs for the purpose of conserving single species is not advocated, if a proposed MPA houses species that fall into the above categories, this would strengthen the case for its proclamation.

6. WILL THE AREA PROTECT VULNERABLE LIFE-HISTORY STAGES?

Many species become vulnerable to the effects of exploitation or habitat loss if they aggregate to breed or feed. Examples include migrating birds that feed in wetlands, turtles returning to beaches to lay eggs, squid that aggregate to reproduce, whales that calve in sheltered bays and juvenile fish that use estuaries as nursery grounds. In many cases, these points of aggregation are well known and protected areas that include them should be given priority.

7. IS THE AREA NEAR-PRISTINE OR RESTORABLE TO AN ACCEPTABLE NATURAL CONDITION?

It is difficult to advocate the preservation of an area unless it is in a pristine or near-pristine state or can be restored to such a condition. In the past it has been argued that an area should be near-pristine if it is to be considered for conservation. In reality, this is a poor justification, because it is equally easy to argue that disturbed but restorable areas have a higher priority. The crux of this criterion is that, if an area has been damaged to the point where it serves no useful purpose for conservation and there is no hope of restoring the area, it is futile attempting to conserve it.

8. DOES IT HAVE NATURAL FEATURES OF INTERNATIONAL INTEREST OR IMPORTANCE?

The justification for an MPA cannot be based solely on the perception of it having one or more unique features. Too often in the past MPAs have been motivated on the grounds of "uniqueness". The opposing view is taken here, that representativeness is more important than uniqueness, because it is always possible to find some unique feature in any stretch of coastline (Dye *et al.* 1994). Nevertheless, it is recognized that there are some natural features that are of exceptional international interest and deserve special treatment. However, it is believed that there are very few such features in South Africa that alone justify the creation of an MPA.

9. DOES THE AREA SUPPORT EXPLOITED SPECIES?

In terms of fisheries management, it is important that a proposed MPA house exploited species to provide a buffer against overexploitation elsewhere. Some species can never be protected by an MPA because of their mobility, but for species that are relatively sedentary, MPAs often provide the only effective means of controlling their exploitation.

10. WILL THE AREA SUPPLY STOCKS TO ADJACENT AREAS?

One reason for proclaiming an MPA is that population sizes of exploitable species may increase within the MPA to the point where emigration supplies stocks to adjacent areas where they can be harvested.

Practical performance measures

11. IS THE AREA LARGE ENOUGH TO FULFIL ITS DESIGNATED OBJECTIVES?

The smaller an MPA, the more likely it is to be impacted by events in adjacent areas. In general, the larger an MPA, the more objectives it is likely to fulfil. More of the resources required by the biota will be contained within a large MPA and there will be less movement of biota across its boundaries. Ultimately, however, the minimum effective size of an MPA will be determined by its objectives. For example, if stock recruitment and export are primary objectives, an MPA which does not support an adequate spawner biomass will fail.

12. DOES THE AREA LIE ADJACENT TO A TERRESTRIAL CONSERVED AREA?

Current marine legislation does not extend inland of the high-water mark. The benefits of an MPA covered by such legislation might therefore be nullified by activities taking place on adjacent land. In purely practical terms, management of a marine protected area will always be easier if the adjacent land is also protected, particularly if both terrestrial and marine components are administered by the same authority.

13. CAN THE AREA BE EFFECTIVELY MANAGED AND ADEQUATELY POLICED?

If it is impossible to enforce the management measures necessary to fulfil the objectives of an MPA, there is little point in establishing that MPA. The invasion in 1997 of Dwesa Nature Reserve in the Eastern Cape by local people and their illegal removal of large quantities of intertidal shellfish provide an unhappy testimonial to the importance of this criterion.

Socio-economic and legal performance measures

14. IS THE AREA AESTHETICALLY APPEALING?

Aesthetics are an important tourist attraction in addition to an area's biological richness. Indeed, landscape aesthetics are probably the primary magnet and, therefore, whenever possible, should be an important consideration in siting MPAs. This is particularly true if the promotion of tourism is an important objective of an MPA.

15. IS THE AREA ACCESSIBLE TO PEOPLE?

If human use is a primary objective of MPA establishment, accessibility of the MPA to the target market is vitally important. For example, an MPA that can be accessed using existing infrastructure may be preferable to one requiring the development of new infrastructure.

16. WILL THE AREA SATISFY NEEDS FOR EDUCATION, RECREATION, RESEARCH AND/OR TOURISM?

These criteria are largely self-explanatory and require evaluation in terms of the diversity of functions that an MPA is intended to fulfil. It should be borne in mind, however, that "education" does not always mean the public at large or decision-makers. If an MPA serves to educate just one user group, but does so in a convincing way, the MPA has demonstrable value.

17. WILL THE AREA PRESERVE HISTORICAL, ARCHAEOLOGICAL, OR GEOLOGICAL FEATURES OR CULTURAL ACTIVITIES?

The greater the number of geological features or archaeological or historical sites present in an area, the greater will be the value of protecting that area. In addition, protected areas may also preserve cultural and traditional activities, such as the fishing activities in Kosi Bay.

DEVELOPMENT AND APPLICATION OF COMPARE

How effective are different types of MPA?

Drawing up a list of objectives is the first step in defining the roles of a Marine Protected Area. This step has, surprisingly, been taken for very few of the MPAs in South Africa. The three functions of protection, fisheries management and human utilization are fulfilled to varying degrees by different types of MPA. There is no reason why these functions need be mutually exclusive: indeed, the strongest case for an MPA is if it can satisfy the objectives of protection, fisheries management and utilization simultaneously. However, any integration of objectives will result in tradeoffs, and the outcome of any analysis of such

Table I: Assessment of the extent to which marine sanctuaries, marine reserves and fishery reserves are likely to satisfy the objectives identified for marine protected areas. A "++" indicates that a particular type of marine protected area is very effective in satisfying a particular objective. A "+" indicates moderate success, and a "–" indicates little or no success. The "score" is the sum of all plus and minus values in a column

Objective	Marine sanctuaries	Marine reserves	Fisheries reserves
1. Biogeography	++	++	–
2. Habitat diversity	++	++	–
3. Rare/endemic spp.	++	++	–
4. Vulnerable stages (all spp.)	++	+	–
5. Reduced fishing mortality	++	+	+
6. Vulnerable stages (exploited spp.)	++	++	++
7. Adjacent yield	++	++	+
8. Spawner biomass	++	++	–
9. Research - a) pristine communities	++	+	+
b) pristine populations	++	+	+
10 Monitoring	++	+	–
11. Ecotourism	++	+	–
12. Low impact recreation	++	++	+
13. Education	++	+	–
14. Exploitation	–	++	++
Score	27	22	1

will depend on the weight accorded to any particular criterion.

Marine sanctuaries (affording total protection), marine reserves (protecting the majority of species, but allowing harvesting of selected species) and fishery reserves (protecting only one or a few species of commercial value) fulfil different objectives to different extents. Table I roughly assesses the degree to which each has the potential to fulfil the objectives outlined above. It shows that fishery reserves meet very few of the objectives (because they target a small suite of species). Furthermore, if money and manpower are to be invested in protecting only one or a few commercially important species in a given area, this cannot be a cost-effective way of achieving conservation in the broader sense. As marine sanctuaries and reserves can also serve to protect commercially exploited species, they are far more cost-effective. To maximize the efficiency of a national network of MPAs, the roles of fishery reserves should, wherever possible, be met within marine sanctuaries or marine reserves. The only advantage of marine reserves or fishery reserves over sanctuaries arises if one of the objectives is to permit exploitation of non-protected species within the area. With this single exception, the overall conclusion is that marine sanctuaries satisfy the greatest number of objectives and to the greatest degree, and that both sanctuaries and marine reserves are much more effective than fishery reserves.

This assessment is very rough and does not attempt to evaluate the fulfilment of objectives in terms of predetermined criteria. This is the central goal of the present study, i.e. to develop a methodology that will allow an objective evaluation of MPAs in terms of specified objectives and criteria, as outlined below.

What should COMPARE achieve?

There are three roles that an objective system of evaluation should be able to accomplish:

(i) a comparative evaluation of the degree to which existing MPAs are fulfilling their objectives;
(ii) an objective comparison of the relative merits of alternative areas being proposed as MPAs; and
(iii) an assessment of the effects of changing legislation, or the management or size of an MPA.

How does COMPARE achieve this?

The basis of COMPARE is a table that matches the 14 objectives identified above against the specific criteria 1–17, to generate a series of scores assessing the degree to which the objectives are being met by an existing MPA, or would be met by a new one. Before these criteria are considered there are, however, the five general considerations (A–E above) that need to be addressed, especially when MPAs are being considered for proclamation. Having addressed these, the next step is to focus on the objectives in terms of the criteria.

Figure 1 cross-references objectives to appropriate

PERCENTAGES (F)	TOTALS for CRITERIA (E)	UTILIZATION						FISHERIES MANAGEMENT				PROTECTION				OBJECTIVE / CRITERION
		14. Exploitation	13. Education	12. Low impact recreation	11. Ecotourism	10. Monitoring	9. Research	8. Spawner biomass	7. Adjacent yeild	6. Vulnerable stages (exploited spp.)	5. Reduced fishing mortality	4. Vulnerable stages (all spp.)	3. Rare/endemic species	2. Habitat diversity	1. Biogeography	
70	7		2		1	1	2								1	1.Regionally representative?
12	1							0		0			0		1	2.Not conserved elsewhere?
50	5		1		1	1	1							1		3.Habitat diversity high?
87	7		2			1	2							2		4.Includes fragile habitats?
50	5		1		1	1	1						1			5.Houses rare or endemic spp. ?
50	4						1			1		1	1			6.Protects vulnerable stages?
100	10		2		2	2	2							2		7.Pristine or restorable?
13	1		1		0		0								0	8.Special natural features?
75	12	2	2			2	2	1	1	1	1					9.Supports exploited spp.?
50	2								1	1						10.Supplies adjacent areas?
61	17	1	2	2	1	2	2	1	1	1	0	1	1	1	1	11.Large enough?
78	14		2		1	2	2			2	2	1	1	1		12.Adjacent terrestrial reserve?
93	26	2	2	2	1	2	2	2	2	2	1	2	2	2	2	13.Effective management?
100	8		2	2	2									2		14.Aesthetically appealing?
100	12	2	2	2	2	2	2									15.Accessible to people?
67	4		1	2	1											16.Satisfies social needs?
33	1		1		0		0									17.Preserves historical sites?
	136	7	23	10	13	16	19	4	5	8	4	5	6	11	5	TOTALS for OBJECTIVES (A)
	69	88	82	100	54	80	73	50	63	57	50	63	50	79	50	PERCENTAGES (B)

136	88	21	27	OVERALL TOTALS (C)
69	76	55	61	OVERALL PERCENTAGES (D)

Fig. 1: Matching objectives for MPAs against criteria (performance measures) relevant to their evaluation. In this example, the evaluation has been applied to the existing MPA within the Cape Point Nature Reserve, Western Cape, and the scoring uses a scale of 0-2

criteria: not all criteria are relevant to all objectives. Those which are irrelevant have been blanked out in the table. The easiest way to illustrate the application of the technique is by way of example, and the existing MPA within the Cape Point Nature Reserve has been used as a test case. The degree to which each objective is being fulfilled is scored for each relevant criterion using a ranking of 0 (ineffective), 1 (moderately effective), or 2 (highly effective). So, for example, in terms of Objective 1 (ensuring protection of representative sections of biogeographic regions), Cape Point scored 1 because the MPA lies at the edge of one biogeographic region (the Namaqua Province) and does not extend to cover the adjacent warm temperate Agulhas Province. If the MPA was to be extended to cover the coast of the entire Nature Reserve, a score of 2 would be allocated.

Any scoring system is fraught with difficulties. In the example used here (Fig. 1), equal weight was assigned to all objectives to avoid attaching particular significance to some of them. The scoring system is, however, flexible and can be modified to be more sensitive or emphasize particular objectives if there are biological or political reasons for doing so. For example, Odendaal *et al.* (1995), in evaluating potential MPA sites in north-eastern Madagascar, gave a particularly high weighting to ecotourism potential.

Once the COMPARE matrix has been completed and scores are assigned to all objectives for all relevant criteria, it is possible to obtain a total score on the left-hand side of the table for each criterion or at the bottom for each objective. Obviously, the maximum score that can be reached for a given objective will depend on the number of criteria used to assess it. For example, Figure 1 shows that Objective 1 is evaluated on five criteria for a maximum score of 10, whereas Objective 9 has 13 criteria for a maximum of 26. For this reason, the totals obtained in Row "A" need to be expressed as percentages of the maximum possible score (Row "B"). For similar reasons, the totals for each criterion (Column "E") need to be converted to percentages (Column "F"). For a quick overview of the degree to which the three overarching objectives of protection, fisheries management and utilization are being met, totals and percentages can be obtained for these groups of objectives (Rows "C" and "D"). Therefore, in the present example of Cape Point, the MPA scores an overall 61% for protection of marine biota, 55% for its role in fisheries management and 76% for its provision for human utilization, with an overall aggregate of 69% (Figs. 1, 2a).

All areas fulfil different objectives to different degrees. Nevertheless, the application of the system of scoring in COMPARE not only forces one to consider all the possible objectives that an area might fulfil, but also identifies which are fulfilled to the greatest extent; and it may highlight benefits not even contemplated in the original motivation for an area. The process thereby reduces the bias so often present in motivations by proponents of a particular area, who, often unconsciously, concentrate only on a limited suite of positive features of the area they are championing.

To test drive the ability of COMPARE, it was first employed to ask the question how the rating of Cape Point would change if the MPA was extended to cover both West and East coasts and offshore for one nautical mile. For the expanded MPA, percentage values for protection, fisheries management and utilization increased to 91, 76 and 89% respectively (Fig. 2b). COMPARE was then used to assess Rocher Pan, an existing MPA considered to be of little value for the protection of marine life because it contains a very low habitat diversity and, hence, a low diversity of community types (Emanuel *et al.* 1992). This area yielded respective scores of 25, 8 and 31% (Fig. 2c). Finally, the technique was applied to Somchem, an area in False Bay that has been proposed as an MPA and which has been protected until now: people have been excluded from the area because it lies in the vicinity of an explosives factory. Somchem had respective values of 45, 66 and 41% (Fig. 2d). These results implied that the technique yields realistic relative ratings: "expanding" the Cape Point MPA did improve its ratings and Rocher Pan was accorded low ratings. There was no prior knowledge of how Somchem should score, but the initial guess was that it should produce intermediate scores – which it did.

To test whether COMPARE yields consistent results when used by different people, 10 independent people were asked to apply it to Cape Point (existing and "expanded" MPAs) and to Rocher Pan. The results are summarized in Figures 2(a–c) and demonstrate that there was considerable uniformity in rating.

Who should use COMPARE?

Two different groups of people should be involved in the process of assessing MPAs, and for different purposes. The first group comprises members of the public who wish to recommend that an area be considered for proclamation as an MPA. At present, no guidelines exist to inform people of how a potential MPA will be assessed. COMPARE can be used to inform the public of both the system and the criteria used in taking decisions about proposed MPAs. It will also stipulate the information that will be required before an application can be considered. This process will assist enormously in gathering the necessary

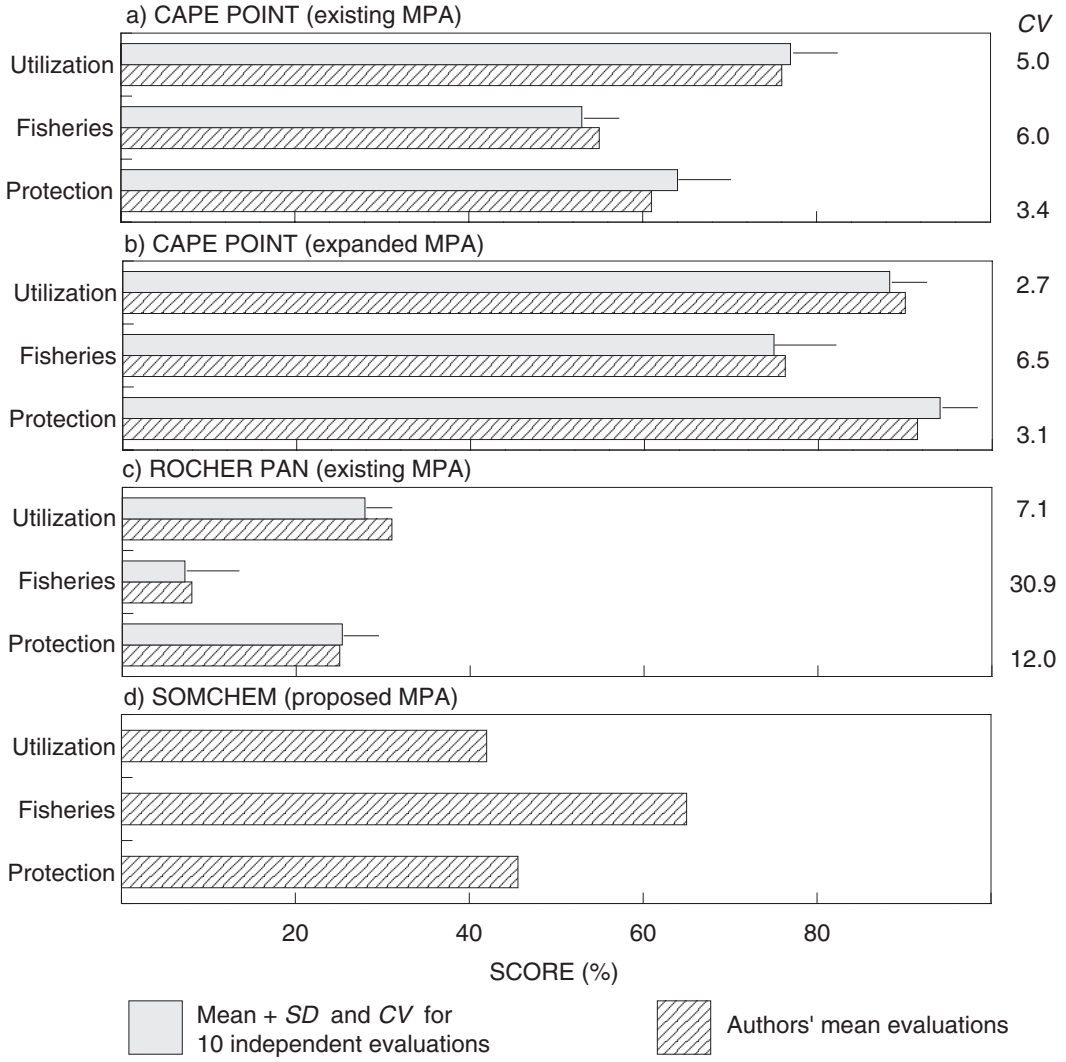

Fig. 2: (a) Evaluations obtained for the existing MPA at Cape Point when COMPARE was applied in consultation with two fisheries scientists (our mean evaluations) and an analysis of the variance in scores obtained for the same MPA by 10 independent evaluators using the same technique. Results are shown as mean + *SD*. and the coefficient of variation (*CV*, expressed as a percentage). (b,c) As 2a, for an expanded MPA at Cape Point and the existing MPA at Rocher Pan. (d) Mean evaluation of the proposed Somchem MPA in False Bay

data on which decisions have to be made. It will also serve as a means of education and consultation.

Once applications have been received, a second group of people will become involved, namely the authorities who have to take decisions about the proclamation or deproclamation of MPAs. To provide these people with objective assessments, a standing task group of experts should employ COMPARE to derive comparative rankings for the MPAs in question. This same group could use COMPARE to evaluate the success of existing MPAs or to determine the gains or losses arising from changes to existing MPAs. It should be stressed that such evaluations should not be undertaken by a single person, because a certain degree of subjectivity is inevitable in assigning rankings. The concordance between different users of the system

in this study was, however, promising.

What are the benefits of COMPARE?

In the past, many MPAs in South Africa have been created because of *ad hoc* local pressure. Even those MPAs such as Tsitsikamma Coastal National Park, which have been motivated on rational grounds, were never compared with alternatives in a systematic manner. Recently, there have been attempts to use complementarity analyses for MPA selection. Most of these have targeted terrestrial systems, and are based on presence/absence data. The analysis of estuarine waterbirds in South Africa by Turpie (1995) is one of the few studies that has incorporated abundance data into a complementarity analysis of relevance to marine conservation. Although objective and quantitative, complementarity analysis focuses only on a select suite of biological attributes. In complex decision-making, and especially where choices may lead to conflict or controversy, the underlying reasoning is important, not only in defending current decisions, but also in ensuring that future decisions can be made in a consistent way. COMPARE incorporates biological, management and social objectives and has several other advantages which improve the rigour of MPA assessment:

(i) Evaluators are compelled to consider all possible objectives, therefore eliminating bias.
(ii) Sufficient data must be available to allow a defensible evaluation.
(iii) The method generates a semi-quantitative summary of the pros and cons of a particular area and thereby pinpoints the reasons for a decision.
(iv) Analysis of the objectives will identify key issues that need resolution if an MPA is to be created, e.g. land disputes or fishing rights.
(v) The development of Management Plans (of which very few exist for current MPAs – Robinson and de Graaff 1994) will be guided by the list of objectives. COMPARE highlights those objectives which a particular MPA is most suited to satisfying.

CONCLUSIONS

In an African context, South Africa is well endowed with MPAs. Despite this, many lack management plans or clear objectives and there is no system in place for the objective evaluation of either existing or proposed MPAs. The methodology proposed here (COMPARE) allows an objective and semi-quantitative means of MPA evaluation and comparison, based on the matching of objectives against relevant criteria. It also results in defensible decisions because it forces evaluators to define clearly the reasons for those decisions. It also compels and guides the formulation of management plans. COMPARE represents a considerable advance over the *status quo* and its products could be used in a decision-making expert system.

ACKNOWLEDGEMENTS

This study was supported by funding to both authors from the Foundation for Research Development, SANCOR and the University of Cape Town Research Committee. The study emerged from a SANCOR task group charged with an examination of MPAs and their efficacy in South Africa. We gratefully acknowledge considerable input from Dr L. Hutchings as Chairman and Mr C. G. Attwood (both of the Sea Fisheries Research Institute) as the driving force of the task group. Drs M. T. Agardy (World Wildlife Fund, U.S.A.) and T. Sandwith (KwaZulu-Natal Nature Conservation Services) made helpful comments on an earlier draft.

LITERATURE CITED

AGARDY, M. T. 1994a — Closed areas: a tool to complement other forms of fisheries management. In *Limiting Access of Marine Fisheries: Keeping the Focus on Conservation.* Gimbel, K. (Ed). Washington D.C.; Centre for Marine Conservation and World Wildlife Fund: 197–204.

AGARDY, M. T. 1994b — Advances in marine conservation: the role of marine protected areas. *TREE* **9**: 267–270.

ARNTZ, W. E., BREY, T., TARAZONA, J. and A. ROBLES 1987 — Changes in the structure of a shallow sandy-beach community in Peru during an El Niño event. In *The Benguela and Comparable Ecosystems*. Payne, A. I. L., Gulland, J. A. and K. H. Brink (Eds). *S. Afr. J. mar. Sci.* **5**: 645–658.

BALLANTINE, W. J. 1991— Marine reserves for New Zealand. *Bull. Leigh Lab. Univ. Auckland.* **25**: 1–196.

BENNETT, B. A. and C. G. ATTWOOD 1991 — Evidence for recovery of a surf-zone fish assemblage following the establishment of a marine reserve on the southern coast of South Africa. *Mar. Ecol. Prog. Ser.* **75**(2&3): 173–181.

BOEHLERT, G. W. 1996 — Biodiversity and the sustainability of marine fisheries. *Oceanography* **9**(1): 28–35.

BRANCH, G. M., BAIRD, D., COCHRANE, K., MOOLA, Z., ZULU, P., BUTTERWORTH, D., SOWMAN, M. and P. WICKENS 1996 — Review of access rights options for South Africa. Final Report of the Access Rights technical Committee to the Fisheries Policy Development Working Committee, Cape Town; FPDC: 70 pp.

BRANCH, G. M. and C. A. MORENO 1994 — Intertidal and subtidal grazers. In *Rocky Shores: Exploitation in Chile and*

South Africa. Siegfried, W. R. (Ed.). Berlin; Springer: 75–100.

BUXTON, C. D. and M. J. SMALE 1989 — Abundance and distribution patterns of three temperate marine reef fish (Teleostei: Sparidae) in exploited and unexploited areas off the Southern Cape coast. *J. appl. Ecol*. **26**: 441–451.

CASTILLA, J. C. and L. R. DURÁN 1985 — Human exclusion from the rocky intertidal zone of central Chile: the effects on *Concholepas concholepas* (Gastropoda). *Oikos* **45**: 391–399.

CLARK, C. W. 1996 — Marine reserves and the precautionary management of fisheries. *Ecol. Applic.* **6**(2): 369–370.

COOPER, J., WILLIAMS, A. J. and P. L. BRITTON 1984 — Distribution, population sizes and conservation of breeding seabirds in the Afrotropical region. In *Status and Conservation of the World's Seabirds*, Croxall. J. P., Evans, P. G. H. and R. W. Schreiber (Eds). *Tech. Publ. I.C.B.P.* **2**: 403–419.

DAVIDSON, R. J. and W. L. CHADDERTON 1994 — Marine reserve site selection along the Abel Tasman National Park coast, New Zealand: consideration of subtidal rocky communities. *Aquat. Conserv.* **4**: 153–167.

DE FONTAUBERT, A. C., DOWNES, D. R. and T. S. AGARDY 1996 — *Biodiversity in the Seas: Implementing the Convention on Biological Diversity in Marine and Coastal Habitats.* Gland, Switzerland; World Conservation Union (IUCN): vii + 82 pp.

DIXON, J. A., SCURA, L. F., and T. VAN'T HOF 1993 — Meeting ecological and economic goals: marine parks in the Caribbean. *Ambio* **22**(2&3): 117–125.

DYE, A. H. 1988 — Rocky shore surveillance on the Transkei coast, southern Africa: temporal and spatial variability in the balanoid zone at Dwesa. *S. Afr. J. mar. Sci.***7**: 87–99.

DYE, A. H., BRANCH, G. M., CASTILLA, J. C. and B. A. BENNETT 1994 — Biological options for the management of the exploitation of intertidal and subtidal resources. In *Rocky Shores: Exploitation in Chile and South Africa*. Siegfried, W. R. (Ed). Berlin; Springer: 131–154.

EICHBAUM, W. M., CROSBY, M. P., AGARDY, M. T. and S. A. LASKIN 1996 — The role of marine and coastal protected areas in the conservation and sustainable use of biological diversity. *Oceanography* **9**(1): 60–70.

EMANUEL, B. P., BUSTAMANTE, R. H., BRANCH, G. M., EEKHOUT, S. and F. J. ODENDAAL 1992 — A zoogeographic and functional approach to the selection of marine reserves on the west coast of South Africa. In *Benguela Trophic Functioning*. Payne, A. I. L., Brink, K. H., Mann, K. H. and R. Hilborn (Eds). *S. Afr. J. mar. Sci.* **12**: 341–354.

GRIFFIS, R. B. and K. W. KIMBALL 1996 — Ecosystem approaches to coastal and ocean stewardship. *Ecol. Applic.* **6**(3): 708–712.

HOCKEY, P. A. R. and A. L. BOSMAN 1986 — Man as an intertidal predator in Transkei: disturbance, community convergence and management of a natural food resource. *Oikos* **46**(1): 3–14.

HOCKEY, P. A. R. and G. M. BRANCH 1994 — Conserving marine biodiversity on the African coast: implications of a terrestrial perspective. *Aquat. Conserv.* **4**: 345–362.

HOCKEY, P. A. R. and C. D. BUXTON 1989 — Conserving biotic diversity on southern Africa's coastline. In *Biotic Diversity in Southern Africa*: *Concepts and Conservation*. Huntley, B. J. (Ed.). Cape Town; Oxford University Press: 289–309.

HOCKEY, P. A. R., BOSMAN, A. L. and W. R. SIEGFRIED 1988 – Patterns and correlates of shellfish exploitation by coastal people in Transkei: an enigma of protein production. *J. appl. Ecol.* **25**: 353–363.

HOCKEY, P. A. R., NAVARRO, R. A., KALEJTA, B., and C. R. VELASQUEZ 1992 — The riddle of the sands: why are shorebird densities so high in southern estuaries? *Am. Naturalist* **140**: 961–979.

HUGHES, G. R. 1974 — The sea turtles of south-east Africa. 1. Status, morphology and distributions. *Investl Rep. oceanogr. Res. Inst. S. Afr.* **35**: 144 pp.

IUCN 1992 — Caracas action plan. In *Plenary Session and Symposium Papers of the IVth World Congress on National Parks and Protected Areas, Caracas, Venezuela.* Gland, Switzerland; World Conservation Union (IUCN): 301–310.

IVANOVICI, A. H. (Ed) 1984 — *Inventory of Declared Marine and Estuarine Protected Areas in Australian Waters* **2**. *Spec. Publ. Aust. natl Parks Wildl. Serv.* **12**: 424 pp.

JONES, P. J. S. 1994 — A review and analysis of the objectives of marine nature reserves. *Ocean cstl Mgmt* **24**: 149–178.

KELLEHER, G. and R. KENCHINGTON 1990 — Political and social dynamics for establishing marine protected areas. *Nat. Resour.* **26**(2): 31–38.

KELLEHER, G. and R. KENCHINGTON 1991 — *Guidelines for Establishing Marine Protected Areas*: *a Marine Conservation and Development Report.* Gland, Switzerland; World Conservation Union (IUCN): 79 pp.

LASIAK, T. A. and J. G. FIELD 1995 — Community-level attributes of exploited and non-exploited rocky infratidal macrofaunal assemblages in Transkei. *J. expl mar. Biol. Ecol.* **185**: 33–53.

MARGULES, C. [R.] and M. B. USHER 1981 — Criteria used in assessing wildlife conservation potential: a review. *Biol. Conserv.* **21**: 79–109.

MORTON, B. 1996 — Protecting Hong Kong's marine biodiversity: present proposals, future challenges. *Environ. Conserv.* **23**(1): 55–65.

NOAA 1995 — *Florida Keys National Marine Sanctuary Draft Management Plan/Environmental Impact Statement*. **1**. *Management Plan.* Washington, D.C.; National Oceanic and Atmospheric Administration/U.S. Department of Commerce: ii + 323 pp.

NORSE, E. A. (Ed) 1993 — *Global Marine Biological Diversity: a Strategy for Building Conservation into Decision Making.* Washington, D.C; Island Press: 383 pp.

ODENDAAL, F. J., KROESE, M. and JAOMANANA 1995 — *The Strategic Plan for the Management of the Coastal Zone of the Masoala Peninsula, Madagascar. Madagascar Working Paper No. 4.* Cape Town; Eco-Africa Consultants: 214 pp.

POLUNIN, N. V. C. and C. M. ROBERTS 1993 — Greater biomass and value of target coral-reef fishes in two small Caribbean marine reserves. *Mar. Ecol. Prog. Ser.* **100**: 167–176.

PRESSEY, R. L., HUMPHRIES, C. J., MARGULES, C. R., VANE-WRIGHT, R. I. and P. H. WILLIAMS 1993 — Beyond opportunism: key principles for systematic reserve selection. *Trends Ecol. Evol.* **8**(4): 124–128.

QUINN, J. F., WING, S. R. and L. W. BOTSFORD 1993 — Harvest refugia in marine invertebrate fisheries: models and applications to the red sea urchin, *Strongylocentrotus franciscanus*. *Am. Zool*. **33**: 537–550.

RABE, F. W. and N. L. SAVAGE 1979 — A methodology for the selection of aquatic natural areas. *Biol. Conserv.* **15**: 291–300.

RICARD, C. A., McLACHLAN, A. and G. I. H. KERLEY 1994 — The effect of vehicular and pedestrian traffic on dune vegetation in South Africa. *Ocean cstl Mgmt.* **23**: 225–247.

ROBINSON, G. A. and G. DE GRAAFF 1994 — *Marine Protected Areas of the Republic of South Africa.* Pretoria; National Parks Board: xxx + 202 pp.

SALM, R. and A. PRICE 1995 — Selection of marine protected areas. In *Marine Protected Areas: Principles and Techniques for Management.* Gubbay, S. (Ed.). London; Chapman & Hall: 15–31.

SAUER, W. H. H., SMALE, M. J. and M. R. LIPIŃ SKI 1992 — The location of spawning grounds, spawning and schooling

behaviour of the squid *Loligo vulgaris reynaudii* (Cephalopoda: Myopsida) off the Eastern Cape coast, South Africa. *Mar. Biol*. **114**(1): 97–107.

SCHULZ, R. and M. STOCK 1993 — Kentish plovers and tourists: competitors on sandy coasts? In *Disturbance to Waterfowl on Estuaries*. Davidson, N. and P. Rothwell (Eds). *Bull. Wader Study Gp* **68.** Spec. Iss.: 83–91.

TEGNER, M. J., BASCH, L. V. and P. K. DAYTON 1996 — Near extinction of an exploited marine invertebrate. *Trend Ecol. Evol* **11**(7): 278–280.

TISDELL, C. and J. M. BROADUS 1989 — Policy issues related to the establishment and management of marine reserves. *Coast. Mgmt* **17**: 37–53.

TURPIE, J. K. 1995 — Prioritizing South African estuaries for conservation: a practical example using waterbirds. *Biol. Conserv.* **74**: 175–185.

TURPIE, J. K., BECKLEY, L. E. and S. M. KATUA (in preparation) — Biogeography of South African coastal ichthyofauna and the selection of priority areas for conservation.

USHER, M. B. 1986 — Wildlife conservation evaluation: attributes, criteria and values. In *Wildlife Conservation Evaluation*. Usher, M. B. (Ed.). London; Chapman & Hall: 3–44.

VAN DER ELST, R., BRANCH, [G.] M., BUTTERWORTH, D., WICKENS, P. and K. COCHRANE (1997) — How can fisheries resources be allocated . . . who owns the fish? In *Developing and Sustaining World Fisheries Resources: The State of Science and Management. Proceedings of the Second World Fisheries Congress, Brisbane, 1996*. Hancock, D. A., Smith, D. C., Grant, A. and J. P. Beumer (Eds). Collingwood, Australia; CSIRO: 307–314.

WALLACE, J. H., KOK, H. M., BECKLEY, L. E., BENNETT, B. [A.], BLABER, S. J. M. and A. K. WHITFIELD 1984 — South African estuaries and their importance to fishes. *S. Afr. J. Sci.* **80**(5): 203–207.