**ASSESSMENT OF RESOURCE AVAILABILITY AND SUITABILITY FOR  
SUBSISTENCE FISHERS IN SOUTH AFRICA, WITH A REVIEW OF  
RESOURCE MANAGEMENT PROCEDURES**

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The availability of resources and their suitability for subsistence and small-scale commercial fishers in South Africa were assessed and appropriate options for the management of resources recommended. Assessment of current resource utilization and recommendations for future subsistence and/or small-scale commercial use were based on information gathered during a nationwide survey of 144 subsistence fishing communities in South Africa and a review of relevant published and unpublished literature. Current patterns of resource use in three regions of the coast (West, South and East coasts) revealed that most true subsistence fisheries occur in the eastern half of the country. These fisheries are primarily focused on invertebrate species found on intertidal rocky shores and sandy beaches, or in estuaries. Fish are harvested by rod or handline, netting or traditional fishing methods (fishtraps, spearing, baited baskets). No "new" or previously underutilized resources were identified as suitable for subsistence fishing in any of the three regions. The potential for several new small-scale commercial fisheries was identified, but the need to retain certain resources for subsistence fisheries (rather than converting them to small-scale commercial fisheries) was evident in certain areas. Resources with high commercial value were not considered suitable for subsistence fishing, but rather for the introduction of small-scale commercial fisheries. The overall management strategy for the subsistence sector, which is currently in the process of being developed, must ensure sufficient flexibility to be able to take into account regional and site-specific requirements. It will also need to develop co-management structures, protect traditional fishing practices, avoid user conflict and provide for no-take areas, all within the framework of sustainable resource utilization.

Key words: estuarine resources, fisheries management, intertidal resources, subsistence fisheries, subtidal resources

In the past, subsistence fishers had little or no legal access to South African marine resources, because the methods of harvesting and the quantities required did not conform to conditions set for recreational or commercial permits. Most subsistence activities were therefore deemed illegal, and fishers found themselves classified as an "informal sector" or as poachers. This situation changed in 1998 when the White Paper on Fisheries, which outlined the new fisheries policy for South Africa, recognized subsistence fishing for the first time (Anon. 1997). The subsequent Marine Living Resources Act (MLRA) of 1998 provided a definition of subsistence fishing and thereby legislatively recognized this fishing sector along with commercial and recreational fisheries (Anon. 1998). The new Marine Fisheries Policy for South Africa, embodied in the MLRA, strongly supported the precautionary principle (Cockcroft and Payne 1999). Although careless generalization in applying the precautionary

principle can lead to economic and social chaos in fisheries, reasonable interpretation offers the opportunity for sustainable fisheries (Garcia 1994). One of the major challenges emanating from the MLRA is therefore to balance the requirements for sustainable utilization of resources with that of equity (fair and broadened access) and stability within all fishing sectors recognized by the Act. Several factors contribute to the considerable challenge faced in developing a system of management for the subsistence sector, including the very broad definition of subsistence fishing given in the MLRA, depressed economic conditions (and therefore elevated levels of unemployment), and unrealistic expectations that nearshore marine resources are the key to poverty alleviation in coastal communities.

Because of the complexity, sensitivity and importance of putting an overall management strategy in place for the subsistence sector, a Subsistence Fisheries Task Group (SFTG) was appointed by the Chief Director:

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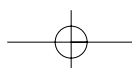
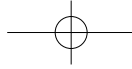


Table 1: Current and recommended use of resources along the west, south and east coasts of South Africa. R, S, SSC and C denote recreational, subsistence, small-scale commercial and large-scale commercial use respectively. Sources: literature cited in the text, plus Wynberg and Branch (1991, 1994), Griffiths (2000), Lamberth (2000b), van Zyl (2000) and Hutchings (2001). Dashes denote that species that species that do not occur in the region

Parameter	West Coast		South Coast		East Coast	
	Current	Recommended	Current	Recommended	Current	Recommended
Rocky shore intertidal						
Limpets <sup>1</sup>	R, S	R, S, SSC*	–	–	–	–
<i>Cymbula granatina</i>						
<i>Scutellastra argenvillei</i>						
Other limpet species	–	–	R, S	R, S	R, S	R, S
Polychaete bait worms	R, S	R, S	R, S	R, S	R, S	R, S
<i>Gunnarea capensis</i>						
<i>Marphysa sanguinea</i>						
<i>Pseudonereis variegata</i>						
Mussels						
<i>Choromytilus meridionalis</i>	R, S	R, S	R, S	R, S		
<i>Mytilus galloprovincialis</i>	R, S	R, S, SSC*	R, S	R, S		R, S
<i>Perna perna</i>	–	–	R, S	R, S*	R, S	R, S*
Oysters						
<i>Saccostrea cucullata</i>	–	–	R, S	R, S	R, S	R, S
<i>Striostrea margaritacea</i>	–	–	R, S, SSC	R, S, SSC*	R, S, SSC	R, S, SSC*
Winkles <sup>2</sup>	R, S	R, S	R, S	R, S, SSC	R, S	R, S
<i>Oxysteles sinensis</i>						
<i>Turbo cidaris</i>						
Rock lobsters						
<i>Jasus lalandii</i>	C, R, S	C, R, SSC	C, R, S	C, R, SSC	–	–
<i>Panulirus homarus</i>	–	–	R, S	R, S	R, S	R, S
Abalone						
<i>Haliotis midae</i>	C, R, S	C, R, SSC	R, S	R, SSC	–	–
Octopus						
<i>Octopus vulgaris</i>	–	–	R, S	R, S, SSC	R, S	R, S
Redbait						
<i>Pyura stolonifera</i>	R, S	R, S	R, S	R, S, SSC	R, S	R, S
Other intertidal rocky-shore invertebrates <sup>6</sup>	R, S	R, S	R, S	R, S	R, S	R, S
Kelps and seaweed						
<i>Gelidium</i> spp.	–	–	SSC	SSC	SSC	SSC
<i>Gracilaria verrucosa</i>	SSC	SSC	–	–	–	–
<i>Ecklonia maxima</i>	SSC	SSC	–	–	–	–
<i>Laminaria pallida</i>	SSC	SSC <sup>7</sup>	–	–	–	–
Estuarine invertebrates						
Mud/sandprawns <sup>3</sup>	R, S	R, S, SSC*	R, S	R, S, SSC*	R, S	R, S, SSC*
<i>Callinassa kraussi</i>						
<i>Upogebia africana</i>						
Other benthic bait	–	–	R, S	R, S	R, S	R, S
<i>Arenicola loveni</i>						
<i>Solen capensis</i>						
Penaeid prawns	–	–	R, S	R, S	C, R, S	C, R, S
Estuarine crabs						
<i>Scylla serrata</i>			R, S	R, S	R, S	R, S
Other species			S	S	S	S
Sandy-beach invertebrates						
Subtidal invertebrates <sup>4</sup>						
<i>Bullia laevis</i>	–	SSC	–	–	–	–
<i>Ovalipes trimaculatus</i>						

(continued)



(Table 1: continued)

Parameter	West Coast		South Coast		East Coast	
	Current	Recommended	Current	Recommended	Current	Recommended
Bivalves <i>Donax serra</i>	R, S, SSC	R, S, SSC	R, S	R, S, SSC*	–	–
Other crabs/mole crabs	–	–	–	–	R, S	R, S
Fish						
Estuarine gillnet and seine-net	SSC	SSC	–	–	S	S
Estuarine trap-fishery	–	–	–	–	S	S
Shore-based rod and handline fishery <sup>5</sup>	R, S	R, S	R, S	R, S	R, S	R, S
Non-motorized marine boats; rod and handline	S	S	–	–	R	R
Marine gillnet and seine-net fisheries	SSC	SSC	–	–	SSC	SSC

<sup>1</sup> Small-scale commercial fishery for intertidal populations of these species on the West Coast

<sup>2</sup> Small-scale commercial fishery for subtidal populations of these species on the South Coast

<sup>3</sup> Small-scale commercial bait-fishery directed at intertidal populations of these species in selected estuaries and/or harbours

<sup>4</sup> Small-scale commercial fishery using hoopnets directed at these species on the West Coast

<sup>5</sup> Recreational permit restrictions apply; may not sell fish on recreational list

<sup>6</sup> Exclusions – *Ornithochiton salihafui*

<sup>7</sup> Beach-cast collection only

\* Separate zones for small-scale commercial, recreational and subsistence activities

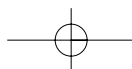
Marine & Coastal Management (MCM) of the Department of Environmental Affairs and Tourism. The SFTG consisted of natural and social scientists, managers and community representatives (Harris *et al.* 2002a). The objectives of the SFTG were to identify subsistence fishers, the areas in which they operate, their patterns of resource use, economic status, perceptions and needs. The SFTG was also tasked with providing advice on the definition of subsistence fishing, the nature of resources suitable for their use and the systems appropriate for the management of this sector.

Sustainable exploitation, a central tenet of the MLRA, requires sound resource management. South African commercial and recreational fisheries are managed using output controls (limiting the amount or numbers caught or landed) and/or input controls (limiting numbers of participants or effort units). Other management tools include minimum size limits, closed seasons, closed areas, gear restrictions and a ban on the retention of gravid or berried females of certain species. Because subsistence fisheries were not formally recognized prior to 1998, no specific management systems were developed for them and they were largely dealt with by enforcing regulations applicable to recreational fisheries.

The SFTG recognized four fishing sectors – subsistence, small-scale commercial, large-scale commercial and recreational – the first two of which form the focus of this paper. The definition of subsistence fishers advocated by the SFTG (see Branch *et al.*

2002a) draws on the facts that they are poor people, who personally harvest the resources and consume most of the catch or sell it locally. They live close to where they harvest and use inexpensive low-technology gear. In the present context an important part of the definition is that “the resources they harvest generate only sufficient return to meet the basic needs of food security”. By contrast, commercial fishers work for profit not consumption, usually employ staff, and harvest resources that have high value or occur in large quantities. The SFTG distinguished small-scale commercial fishers from large-scale industrial fishers on the grounds that the former live near the coast, have had a long-standing dependence on fishing, are personally involved in the hands-on operation of fishing and are small in scope. Most often they fish on easily accessible nearshore resources. These characteristics form an important backdrop to the present paper.

The central aim of this study was to assess resource availability and suitability for subsistence and small-scale commercial fishers in South Africa and to recommend appropriate options for the management of the resources. This paper forms part of a suite of publications (Branch *et al.* 2002a, b, Clark *et al.* 2002, Harris *et al.* 2002a, b, Hauck *et al.* 2002), which outline the process followed by the SFTG in developing recommendations for the management of subsistence fisheries, reviews the current status of subsistence fishing in South Africa and recommends definitions and management strategies.



**MATERIAL AND METHODS**

Identification and assessment of resources for use by subsistence or small-scale fishers will clearly depend on the definition of such fishers. The definitions and criteria of Branch *et al.* (2002a) were used as the basis for assessing whether resources were suitable for

the subsistence and/or small-scale commercial sectors. The criteria used to identify resources suitable for subsistence fishers included: sufficient accessibility to allow personal harvest using low-technology gear without motorized or sailing boats; close proximity to where the subsistence fishers reside (i.e. within 20 km); personal sale of catches (beyond consumption needs but within legal limits, and within 20 km of capture).

Table II: Recommended resource management options (X) for subsistence and small-scale commercial fisheries along the west, south and east coasts of South Africa. A = Total Allowable Catch (TAC), B = effort control, C = closed areas, D = bag limits, E = size limits, F = closed seasons and G = harvest/fishing method restrictions. Dashes denote management option inappropriate; blank cells denote resource absent from region

Category	West Coast							South Coast							East Coast							
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	
Rocky-shore intertidal																						
Limpets <sup>1</sup>	X	X	X	X <sup>6</sup>	-	-	X	-	X	X	X <sup>7</sup>	-	-	X								
<i>Cymbula granatina</i>																						
<i>Scutellastra argenvillei</i>																						
Other limpet species	-	-	-	-	-	-	-	-	X	X	X <sup>7</sup>	-	-	-	-	X	X	X <sup>7</sup>	-	-	-	-
Polychaete worms	-	X	X	X <sup>7</sup>	-	-	X	-	X	X	X <sup>7</sup>	-	-	X	-	X	X	X <sup>7</sup>	-	-	-	X
Mussels	-	X	X	X <sup>7</sup>	-	-	X	-	X	X	X <sup>7</sup>	-	X	-	-	X	X	X <sup>8</sup>	-	-	-	X
Oysters																						
Winkles <sup>2</sup>	-	X	X	X <sup>7</sup>	-	-	X	-	X	X	X <sup>6</sup>	-	-	X	-	X	X	X <sup>7</sup>	-	-	-	X
<i>Oxysteles sinensis</i>																						
<i>Turbo cidaris</i>																						
Other rocky-shore invertebrates <sup>11</sup>	-	X	X	X <sup>7</sup>	X <sup>9</sup>	-	X	-	X	X <sup>7</sup>	X <sup>9</sup>	X	-	X	-	X	X	X <sup>7</sup>	X <sup>9</sup>	-	-	X
Spiny lobsters																						
<i>Jasus lalandii</i>	X	X	X	-	X	X	X	X	X	X	-	X	X	X								
<i>Panulirus homarus</i> <sup>12</sup>																						
Abalone																						
<i>Haliotis midae</i>	X	X	X	-	X	X	X	X	X	X	-	X	X	X	-	-	-	-	-	-	-	-
Octopus																						
<i>Octopus vulgaris</i>	-	X	X	X <sup>7</sup>	-	-	X	-	X	X	X <sup>6</sup>	-	-	X	-	X	X	X <sup>7</sup>	-	-	-	X
Kelps and seaweed	-	X	X	-	-	-	X	-	X	X	-	-	-	X	-	X	X	-	-	-	-	X
Estuarine invertebrates																						
Mud/sandprawns <sup>3</sup>	-	X	X	X <sup>6</sup>	X <sup>9</sup>	-	X	-	X	X	X <sup>6</sup>	X <sup>9</sup>	-	X	-	X	X	X <sup>6</sup>	X <sup>9</sup>	-	-	X
<i>Callinassa kraussi</i>																						
<i>Upogebia africana</i>																						
Other benthic bait organisms	-	-	-	-	-	-	-	-	X	X	X <sup>7</sup>	X <sup>9</sup>	-	X	-	X	X	X <sup>7</sup>	X <sup>9</sup>	-	-	X
Penaeid prawns																						
Mud crab																						
<i>Scylla serrata</i>																						
Other estuarine crabs	-	-	-	-	-	-	-	-	X	X	X <sup>7</sup>	X	-	X	-	X	X	X <sup>7</sup>	X <sup>9</sup>	X	X	X
Sandy-beach invertebrates																						
Subtidal invertebrates <sup>4</sup>																						
<i>Bullia laevis</i>	-	X	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ovalipes trimaculatus</i>																						
Bivalves																						
<i>Donax serra</i>	-	X	X	X <sup>6</sup>	X <sup>9</sup>	-	X	-	X	X	X <sup>6</sup>	X <sup>9</sup>	-	X	-	-	-	-	-	-	-	-
Crabs/mole crabs																						

(continued)

(Table II: continued)

Category	West Coast							South Coast							East Coast						
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
Fish																					
Estuarine net-fishery	-	X	X	-	-	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-	X
Estuarine trap-fishery	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	X
Shore-based rod and handline fishery <sup>5</sup>	-	X	X	X <sup>7</sup>	X <sup>9</sup>	X <sup>10</sup>	X	-	X	X	X <sup>7</sup>	X <sup>9</sup>	X <sup>10</sup>	X	-	X	X	X <sup>7</sup>	X <sup>9</sup>	X <sup>10</sup>	X
Non-motorized boats	-	X	X	X <sup>7</sup>	X <sup>9</sup>	X <sup>10</sup>	X	-	-	-	-	-	-	-	-	X	X	X <sup>7</sup>	X <sup>9</sup>	X <sup>10</sup>	X
Marine rod																					
Handline fishery																					
Marine gillnet and seine-net fisheries	-	X	X	-	-	-	X	-	-	-	-	-	-	-	-	X	X	-	-	-	X

<sup>1</sup> Small-scale commercial fishery directed at intertidal populations of these species on the West Coast  
<sup>2</sup> Small-scale commercial fishery directed at subtidal populations of these species on the South Coast  
<sup>3</sup> Small-scale commercial bait-fishery based on these species in selected estuaries, lagoons and/or harbours  
<sup>4</sup> Small-scale commercial fishery (using hoopnets) directed at subtidal populations of these species on the West Coast  
<sup>5</sup> No sale of fish on recreational list  
<sup>6</sup> Subsistence fishers will be allowed to collect recreational bag limits for own use but not for sale, whereas small-scale commercial operators will be allocated a specified bag limit and/or TAC, which may be sold  
<sup>7</sup> Recreational bag limits apply  
<sup>8</sup> Subsistence bag limit to be set at appropriate level of fishing mortality ( $F = 0.4 \text{ year}^{-1}$ )  
<sup>9</sup> Recreational size limits apply  
<sup>10</sup> Relevant closed seasons apply  
<sup>11</sup> Exclusions – *Ornithochiton salihafui*  
<sup>12</sup> No sale in KwaZulu-Natal

Resources were considered more suitable for small-scale commercial fisheries if their value was such that they were better used to generate income than for personal consumption, and they were nearshore and therefore sufficiently accessible to be harvested by small, medium or micro-enterprises. Any resources that were rare or endangered, or incapable of sustaining a fishery, were excluded from consideration for harvesting of any kind.

Assessment of current resource utilization and recommendations for future subsistence and/or small-scale commercial use were based on information gathered during a nationwide survey of subsistence fishing communities in South Africa. Eight Regional Fieldworkers were deployed around the coast and relevant information (including resource usage) was obtained during formal and informal interviews conducted in 147 fishing communities (Clark et al. 2002). This information was combined with a review of relevant published and unpublished literature, including reports specifically commissioned by MCM to examine the status of resources and their suitability for subsistence fishing (van Zyl 2000).

## RESULTS

Because there are biogeographic differences in the

availability of resources (Emanuel et al. 1992, Griffiths and Branch 1997), and in patterns of resources use (Branch et al. 2002b, Clark et al. 2002), the results are presented on a regional basis for the West, South and East coasts (see Clark et al. 2002 for the location of regions). Invertebrate species are grouped on an ecosystem/community level, whereas fish species are broadly grouped under the fishing methodology used within various ecosystems (Tables I, II). Where necessary, species were listed within these broad categories.

Examination of current patterns of resource use in the three regions (Table I) revealed that the bulk of true subsistence fishers live on the East Coast (Clark et al. 2002). They focus primarily on invertebrate species found in the intertidal regions of rocky shore, estuarine and sandy beach ecosystems. In addition, fish species are harvested by rod/handline, netting and traditional fishing methods (fishtraps, spearfishing, baited baskets). Well-established, small-scale commercial fisheries include those targeting oysters, seaweeds and white mussel, and the marine beach-seine netting operations.

The recommendations for future use (Table I) and concomitant management (Table II) of potential marine resources for subsistence and/or small-scale commercial fisheries were derived from a review of all information available (independent research, published literature, commissioned studies and interaction with fishing communities). Of particular importance is the

fact that no "new" or previously under-utilized resource was identified as suitable for subsistence fishing in any of the three regions. Although the potential for several new small-scale commercial fisheries was identified, the need to retain certain fisheries as subsistence (rather than converting them to small-scale commercial) was highlighted in certain areas. Resources with high commercial value were not considered suitable for subsistence fishing and the introduction of small-scale commercial fisheries for these species was strongly advocated. A more detailed review of recommendations is dealt with on a regional basis.

### West Coast

Relatively few subsistence fishers were identified along the West Coast. However, those present were centred at small coastal communities dotted along the coastline. Rocky-shore, estuarine and sandy-beach intertidal invertebrates and marine linefish are harvested by subsistence fishers on a limited scale. The invertebrates are collected by hand and/or by traditional methods (e.g. "dipsticking" for West Coast rock lobster *Jasus lalandii*), whereas marine linefish are caught by rod or handline from small rowboats or dinghies (usually factory-owned). With two exceptions, participation in these subsistence fisheries should remain at current levels. The exceptions are West Coast rock lobster and abalone *Haliotis midae*, which are recommended for use by small-scale fishers in addition to industrial fisheries, and not for use by subsistence fishers – despite the fact that "subsistence" permits have been allocated for these resources in the past.

Estuarine gillnet fisheries in the Olifants and Berg rivers, which are essentially small-scale commercial operations, should remain so in the future. However, concern over the number of participants in these fisheries has been expressed (Lamberth 2000a, Hutchings and Lamberth 2002) and, at the least, no further increase in netting effort should be allowed.

The potential for three new small-scale commercial fisheries was identified in this region (Table I), two targeting rocky-shore invertebrate species and one directed at the subtidal populations of two sandy-beach invertebrates. Limpets *Cymbula granatina* and *Scutellastra argenvillei* could support a small-scale commercial fishery in the rocky-shore intertidal zone between Kleinsee and the Olifants River on the West Coast. Harvesting should be done by hand and minimum size limits of 60 mm for *C. granatina* and 75 mm for *S. argenvillei* should be applied. At these size limits, catches of around 28 tons (whole mass including the shell) for *C. granatina* and 21 tons for *S. argenvillei*

are considered sustainable for this area (Raubenheimer 1991, Eekhout *et al.* 1992, Bustamante *et al.* 1994). A fishery targeting the alien Mediterranean mussel *Mytilus galloprovincialis* also has small-scale commercial potential. Harvesting of that species may even be essential to prevent it from out-competing *S. argenvillei*, because it invades space cleared after the removal of *S. argenvillei*. Zonation to avoid potential conflict between subsistence, recreational and small-scale commercial utilization may be required. A small-scale commercial fishery has already been recommended for subtidal populations of the whelk *Bullia laevis* and crab *Ovalipes trimaculatus*, which co-occur on sandy substrata along the West Coast. An experimental fishery targeting these species in the early 1990s (MCM, unpublished data) showed that baited hoopnets deployed from small, motorized skiboats were the most successful strategy for harvesting.

A small-scale commercial fishery for kelp already exists (Griffiths and Branch 1997, Anderson *et al.* in press), and it has the potential for expansion and for beneficiation of the product. *Ecklonia maxima* can sustain both live-cut and beach-cast operations, but live-cutting of *Laminaria pallida* should not be permitted.

An important recommendation is that resources such as West Coast rock lobster and abalone, which have high commercial value and support well-established commercial fisheries, are not suited for subsistence fishing. These resources are, however, suited to small-scale commercial fisheries that can operate nearshore by hoopnetting for lobster or diving for abalone. Although forming part of the commercial sector, small-scale operations should be managed separately from large-scale industrial fishing, and the former are seen as an important avenue for granting access to new entrants.

The potential for expansion of a small-scale commercial bait-fishery targeting white mussel *Donax serra* was recognized (Farquhar 1995). However, the expansion of this fishery to include harvest for human consumption may be limited; these bivalves accumulate toxins from red tides, which can cause mass mortalities of white mussels (Horstman 1981, Pitcher and Calder 2000). The potential for small-scale commercial bait-fisheries targeting sandprawns *Callinassa kraussi* and mudprawns *Upogebia africana* is limited on the West Coast, given the small number of estuaries and embayments and the relatively few recreational anglers found there. However, there may be potential for such bait fisheries in the Berg and Olifants estuaries. Prawn pumps would be the only method of harvesting permitted and a daily small-scale commercial bag limit would apply, to avoid the adverse effects of harvesting described by Wynberg and Branch (1991, 1994).

### South Coast

Clear west-to-east gradients in the use of subsistence resources and participation in subsistence fisheries were apparent on the South Coast. This was evident in increasing numbers of subsistence fishers, a gradual increase in the diversity of resources used (linked to biogeographic trends) and increased poverty levels from west to east. Rocky-shore and sandy-beach invertebrates are moderately used by subsistence fishers in the west but heavily used in the eastern region. Estuarine environments are particularly heavily utilized (Cowley 2000). Although the true subsistence fisheries in this region should be recognized and maintained at current levels, the increasing illegal use of gillnets in the estuaries (often ascribed to subsistence fishers, but actually the activity of relatively well-off poachers) is of concern and must be halted.

Four new potential small-scale commercial fisheries (additional to the existing small-scale commercial oyster fishery) were identified along the South Coast (Table I). A subtidal small-scale commercial fishery targeting the gastropod *Turbo cidaris* (with *Oxysteles sinensis* as a bycatch) was recommended for specific areas along the South Coast. This boat-based fishery could use the same management zones and operate in the same way as the commercial abalone fishery, with only one diver permitted to operate per boat per day. Total Allowable Catches (TACs) for both species could be allocated in each designated fishing zone and species-specific minimum size limits could apply throughout the fishery. At a minimum size limit of 40 mm, TACs of about 119 tons (whole mass) for *T. cidaris* and 13 tons for *O. sinensis* are considered sustainable (Pulfrich and Branch 2002).

The establishment of small-scale commercial bait fisheries targeting prawns *C. kraussi* and *U. africana* was recommended in some of the estuaries on the South Coast. Permanently open estuaries situated in or near cities, large towns and coastal resorts are considered the most suitable sites for these small-scale bait fisheries (Cowley 2000). Minimum size and daily bag limits would apply and collection by hand-held prawn pumps would be the only method of harvesting permitted. Small-scale commercial estuarine gillnetting should not be permitted on the South Coast because of the threat it poses to recreational species (Hutchings and Lamberth 2002).

The potential for small-scale commercial fisheries targeting subtidal populations of the common octopus *Octopus vulgaris* and intertidal populations of species such as red-bait *Pyura stolonifera* and white mussels was recognized for the South Coast. The proposed octopus fishery would use pots (rather than traps) de-

ployed from boats (Smith and Griffiths 2002), so eliminating the bycatch of other commercially exploited species in the area (e.g. rock lobster and certain fish species). A redbait fishery would be based on both beach-cast material and live harvest. Live harvesting would be restricted to removal of flesh only, leaving the test attached to the substratum. The harvesting of white mussels from the intertidal areas of sandy beaches (Schoeman 1996) would require restrictions on harvest methods (e.g. collection by hand only), zonation to avoid user conflict and careful consideration of possible impacts of vehicles on beaches.

### East Coast

This coast, which biogeographically includes the whole of KwaZulu-Natal and the northern Transkei region of the Eastern Cape Province, is where most subsistence fishers reside. Intertidal shellfish resources have been utilized as a source of sustenance by the coastal people of the Transkei region for centuries. Archaeological evidence from ancient and contemporary shell middens shows that the suite of species targeted has remained the same over generations of indigenous people in Transkei (Lasiak 1993). The most important or sought-after of these resources is the brown mussel *Perna perna*, followed by various limpet and other gastropod species, redbait and octopus. Oysters and East Coast rock lobster *Panulirus homarus* are largely harvested for sale to recreational fishers, cottage owners and hotels. The resources most commonly used by subsistence and recreational fishers in the Transkei are fully utilized in most areas and severely overutilized in certain locations (Hockey and Bosman 1986, Lasiak and Dye 1989, Lasiak 1991, Fielding et al. 1994). Possibly as much as 75% of the annual intertidal production of shellfish in the Transkei is utilized for subsistence purposes, and many areas are barely able to support existing levels of exploitation (Fielding et al. 1994). Exploitation of intertidal rocky-shore invertebrates is a traditional practice in this region and cannot therefore simply be regulated against. Education, co-management, appropriate and easy-to-understand regulations (e.g. an overall bag/weight limit on a basket of resources rather than species-specific limits) and redirection of effort to non-consumptive uses of coastal resources are all required if the resources are to be given opportunity to recover to more productive levels. The judicious use of marine protected areas and/or no-take zones are also considered vital for the recovery of these resources.

Subsistence fisheries targeting mudprawns and sandprawns, mud crabs *Scylla serrata* and *Sesarma meinerti*,

swimming prawns and linefish occur in many Transkei estuaries. Participation in these fisheries should be maintained at current or reduced levels. Small-scale commercial bait fisheries for mud- and sandprawns could, however, be considered in specific estuaries. The use of prawn pumps as the only means of harvest, small-scale commercial daily bag limits, minimum legal size limits and zonation (to avoid user group conflict) should be used to manage these fisheries. Gillnetting and seine-netting, whether aimed at fish, mud crabs or swimming prawns, should not be allowed in such estuaries. The small-scale commercial harvesting of seaweed *Gelidium* spp. is considered sustainable at current harvest levels and should continue as such.

Although much of the harvesting of rocky-shore and sandy-beach intertidal invertebrates in southern and central KwaZulu-Natal is by recreational and/or small-scale commercial fishers, the bulk of subsistence harvesting is between Mapelane and Richards Bay on the north coast and within the Maputaland Marine Reserve. Brown mussels, redbait, limpets, oysters, whelks, chitons and urchins are the main organisms targeted in the rocky intertidal areas, whereas mole crabs *Emerita austroafricana* and *Hippa ovalis* and ghost crabs *Ocypode* spp. are harvested on sandy beaches. Available evidence (Kyle *et al.* 1997a, b, Tomalin and Kyle 1998, Beckley *et al.* 1999) suggests that overall subsistence harvesting (rocky-shore and sandy-beach invertebrates) within the reserve is stable at current levels, although it is uncertain whether harvesting is occurring at optimal levels. Formal recognition of subsistence fishers must include those currently active in the fisheries. Mussel stocks are either fully exploited or overexploited in most areas. A fishing mortality ( $F$ ) of 0.5 year<sup>-1</sup> (based on available midshore stocks) appeared sustainable in an experimental mussel fishery (Harris *et al.* in press), and it is conservatively recommended that a level of fishing mortality equivalent to  $F_{0.4}$  (based on midshore stocks) be the initial aim of the mussel subsistence fisheries in KwaZulu-Natal, until further research data are available.

Fish, swimming prawns, mangrove mudcrabs and sandprawns and mudprawns are harvested by subsistence fisheries in the estuaries of KwaZulu-Natal. Fish are harvested using rods or handlines, nets and traditional methods such as fishtraps in Kosi Bay. The traditional use of fishtraps in Kosi Bay is sustainable at current levels (Kyle 2000a) and every effort should be made to retain the traditional nature of this fishery. While the legal use of nets by existing traditional fishers in specific estuaries (Kosi Bay, St Lucia) is recommended at reduced levels (Kyle 2000b), the use of gillnets or seine-nets to harvest fish, swimming prawns and/or mud crab in other estuaries should not be permitted.

There is potential for small-scale commercial bait fisheries targeting sand and/or mud prawns in certain estuaries, embayments or harbours. Prawn pumps should be the only method of harvesting. Commercial daily bag limits and zonation (to avoid user-group conflict) should be used to manage these fisheries. Potential for a limited small-scale commercial bait-fishery using cast nets in specified areas in the sea was also identified (Beckley *et al.* 2000). Small-scale commercial fisheries targeting the subtidal populations of organisms such as oysters, octopus, redbait, East Coast rock lobster and urchins are not recommended because there are insufficient scientific data on subtidal stocks of these species at present. Further, these subtidal stocks may be important reservoirs for the replenishment of intertidal stocks (Lasiak 1991).

## DISCUSSION

This synthesis is the most comprehensive overview to date of current and potential uses of marine resources by subsistence fishers and small-scale commercial fishers in South Africa. However, it is not the first review examining the suitability of marine resources for subsistence use along the South African coast. Recognition of the immediate need for some form of relief for subsistence fishers during the development of the new Fisheries Policy (which eventually led to the Marine Living Resources Act of 1998) resulted in an investigation into interim relief measures for subsistence fishers (van der Elst *et al.* 1996). The intent of that study was to provide short-term or interim relief for the then loosely defined "subsistence" sector. The recommendations presented here were based on long-term sustainable utilization by subsistence and small-scale commercial fishers; sectors that have now been clearly defined (Branch *et al.* 2002a). Despite these differences in approach, the two studies are in general agreement. Van der Elst *et al.* (1996) noted that, although a variety of resources could potentially be exploited by subsistence fishers, most were already intensively harvested, many in excess of their sustainable yield. Similarly, the findings of the present review were that there are no "new" or previously under-utilized resources suitable for subsistence fishing in any of the three regions of the South African coast. The retention and formal recognition of many of the established subsistence fisheries, some at current levels and others at reduced levels of participation, are recommended. The potential for several new small-scale commercial fisheries was, however, identified. With appropriate allocation of fishing rights for these resources and careful formulation of management plans



and permit conditions, such fisheries could produce sustainable benefits to local communities in excess of those from uncoordinated subsistence harvests. The rapid development of suitable management plans for small-scale commercial fisheries (especially those for West Coast rock lobster and abalone) are therefore a priority. The decisions about what portion of the available TAC to allocate to the various fishing sectors and who qualifies for participation in a fishery are generic problems in fisheries management (Bailey and Jentoft 1990, van der Elst et al. 1997). It is strongly urged that the principle of recognizing and establishing small-scale commercial fisheries be used to redress equity imbalances arising from South Africa's former fisheries policy.

The process by which the recommendations contained in this review were derived was in keeping with many of the tools recommended for successful implementation of the precautionary principle. These included: use of the best scientific evidence available; a risk-averse stance; a holistic view of the resources within their environment; and prior consultation with fishers (Garcia 1994). In short, if the resource could not be fished sustainably and without collateral environmental damage, it was not considered suitable for subsistence or small-scale commercial exploitation. These principles were, however, not strictly applied when considering recommendations for the traditional or long-standing subsistence fisheries along the coast. Although some of those fisheries are both sustainable (at current levels of participation) and employ ecologically acceptable traditional fishing methods (e.g. fishtraps in Kosi Bay), many are heavily depleted (e.g. shellfish harvested on the Transkei coast). Others are under threat as a result of expanded poaching or failure of fishers to comply with regulations (Beckley et al. 1999, Hauck 1999, Hauck and Sweijd 1999). Traditional fisheries are not only important as sources of food, but also as important cultural activities, and should be respected as such. Every effort should be made to ensure that the traditional fisheries that are operating on a sustainable basis remain so in the future. Successful current management methods must be maintained, and innovative management options (including co-management arrangements) have to be developed to improve the status of depleted resources in certain areas.

Although the scope of this paper was to examine resource management tools that could be used to ensure sustainable harvesting by subsistence fishers, some general comment is warranted on the requirements necessary for an effective overall management strategy for this sector. A cohesive strategy is urgently required and its development and implementation are the responsibility of MCM.

### Regional considerations

Resource-specific management frameworks in South Africa have, in the past, often been rigid and unable or slow to adapt to unusual situations. While the national protocol covering overall management of subsistence fishing in South Africa must be integrated with existing management frameworks, sufficient flexibility must be ensured to take into account regional and site-specific requirements. Geographical differences in population density, type and status of the resources harvested, traditional requirements, available scientific and socio-economic information and management and enforcement capacity all make management flexibility imperative. For instance, in KwaZulu-Natal there are relatively good scientific data, management plans (including the current development of Operational Management Procedures) are well developed, and there are adequate levels of enforcement and monitoring capacity. This means that the management of subsistence fisheries in that province may differ from what is practical in the Eastern Cape. For example, whereas species-specific daily bag limits may be appropriate and enforceable in certain subsistence invertebrate fisheries in KwaZulu-Natal, an overall limit on a suite or basket of resources may be more practical and enforceable in the Transkei. Specific overriding national management requirements, such as a ban on the harvesting of the rare and endangered chiton *Ornithochiton salihafui*, could be regionally instituted where required. Site-specific management of subsistence and/or small-scale commercial fisheries may also be appropriate in certain areas. Small-scale commercial bait-fisheries in selected estuaries would be a good example.

Whereas regional and site-specific management is appropriate for many resources accessed by subsistence fishers, those supporting well-established, high-value fisheries are better suited to management on a national level. The high commercial value of West Coast rock lobster and abalone make such resources ideal candidates for small-scale commercial operations rather than subsistence fisheries. The management and enforcement problems experienced during the recent interim introduction of a subsistence fishery for West Coast rock lobster (MCM unpublished data) supports this contention. Any regional or site-specific differences in the management approach to those fisheries would only compound these problems. Similarly, subsistence fisheries targeting marine linefish species in South Africa should be managed on a uniform basis. Recent research has shown that even the so-called resilient marine linefish species are being severely over-exploited (Griffiths 2000) and new regulations pertaining to commercial and recreational fishers are

Table III: A comparison between the methods of management appropriate for subsistence and small-scale commercial fisheries

Methods	Subsistence	Small-scale commercial
<i>TAC</i>	Not appropriate	Essential in most cases
<i>TAE</i>	Not viable	Alternative to <i>TAC</i>
Bag limits	Normal means of setting limits	Usually inappropriate
Size limits	Generally inappropriate	Often necessary to protect pre-reproductive stages
Gear restrictions	Used to reduce bycatch of juveniles or other species	Often necessary to protect pre-reproductive stages
Zonation of coast	Can be used to grant exclusive rights or prevent conflicts between sectors	Potentially useful, but seldom used in practice
Reseeding of juveniles	Applicable to sessile rocky-shore species, e.g. mussels	Only likely to be viable for abalone
Fully protected reserves	Essential for biodiversity conservation and stock protection	Essential for biodiversity conservation and stock protection. Especially important for intertidal and near-shore ecosystems
Closed periods or seasons	Impractical; denies continuous access to resources	Useful to protect spawning aggregations or to avoid disturbance of reproduction
Restrictions on: where sold where harvested who harvests	Yes: within 20 km Yes: within 20 km of residence Yes: must be personal or by family	No No: but must live close to coast No: may employ staff
Permit-holders	Individuals or registered members of community	Company owners or community cooperatives
Co-management	Preferred management style; strong reliance on community	Preferred management style, but stronger input by managing authority
Monitoring	Often done by community	Done by authorities

imminent (M. H. Griffiths, MCM, pers. comm.). Given the depleted nature of linefish stocks it is recommended that the same regulations on fish apply to both subsistence (rod and handline) and recreational fishers. Recreational fishers are, however, not permitted to sell their catch, whereas subsistence fishers should be allowed to sell species that have not been decommercialized (i.e. are not on the non-saleable recreational species list of the MLRA).

### Management options

Fisheries managers can call on a wide range of management procedures in their attempts to limit fishing to sustainable levels and to yield close to optimal levels of harvest. These often differ in their efficacy in subsistence versus small or large-scale commercial fisheries, as summarized in Table III.

The most widely used tool to limit fishing to sustainable levels is to set a *TAC* or, in cases where this is impractical, to limit the Total Allowable Effort (*TAE*). Both are widely employed to manage commercial fisheries, including small-scale commercial operations. However, they are inappropriate in most subsistence fisheries, which tend to involve large numbers of in-

dividuals operating in an uncoordinated manner. In such cases, bag limits are more applicable.

The imposition of size limits is extremely important if it will protect undersize (pre-reproductive) individuals, but it is only practical if the method of harvesting allows pre-selection of the size of individuals caught, or if undersized individuals can be released back into their natural environment unharmed. It is seldom practical or desirable to set size limits for subsistence fisheries. For example, whereas the regulations regarding the non-sale of fish on the recreational list should be applied uniformly, the regulations regarding recreational minimum size limits and daily bag limits cannot be applied to subsistence net- and trap-fisheries. Nets kill whatever they capture and size limits and bag limits are meaningless under such conditions. Although the use of nets in certain traditional fisheries is recognized, every effort should be made to ensure that netting effort does not increase. A clear national management policy restricting the use of gillnets and seine-nets in estuaries by any fishing sector is recommended. Limits can be set on the total effort (number of nets) or the type of gear used (mesh size or tool dimensions). These measures can reduce the unwanted bycatch of juveniles or of non-target species. The efficacy of such measures has been demonstrated in experiments with

different tools used to harvest mussels. For example, using screwdrivers rather than broad-bladed bush knives reduces unwanted catches of juvenile mussels by 70% (Harris *et al.* in press). A more innovative approach is to encourage the reseedling of unwanted juvenile mussels on the shore (Dye and Dyantyi 2002).

Management protocols should also strive to avoid user-conflict, and the use of zonation to separate fishing sectors is recommended where necessary. The operation of recreational and/or subsistence fisheries within marine protected areas is a contentious issue. Although the historical rights of traditional fisheries to harvest within some zones of marine protected areas are recognized, the implementation of core no-take zones within protected areas is imperative. The development or expansion of small-scale commercial fisheries should, however, not be allowed within marine protected areas.

Closed seasons can validly be used for two ends: to limit effort and to protect breeding individuals that are disturbed by the act of harvesting or become vulnerable because they aggregate to breed. Just because a species is known to have a specific breeding season is not sufficient reason to close a fishery at that time. Whether an individual is caught before, during or after the breeding season makes no difference to its future reproductive output. On the other hand, if harvesting disturbs uncaught individuals and prevents them from breeding (e.g. in bird colonies), this should be considered justifiable grounds for a closed season. Closed seasons are particularly problematic for subsistence resources. Subsistence fishers depend on a continuous supply of food, and they usually harvest suites (or "baskets") of species. Attempts to impose closed seasons are likely to be both futile and an indefensible curtailment of vital needs.

International experience has shown that community co-management is essential for the sound management of subsistence fisheries (Pomeroy 1994, Pomeroy and Carlos 1997). National subsistence-management protocols should recognize, support and use existing co-management structures, and develop such structures where they do not exist. The expertise and goodwill generated by successful community co-management initiatives, such as those in the Sokhulu mussel-harvest project (Harris *et al.* in press), the Olifants River net-fishery (Sowman *et al.* 1997), and other studies (see review by Hauck and Sowman 2001) should form the basis for future management initiatives in these areas.

The recommendations contained in this review are based largely on biological grounds. If the precautionary principle contained within the new MLRA is to be realized, it is vital that sound management, monitoring and enforcement procedures are in place at all levels (local, regional and national) prior to the formalization of existing subsistence fisheries or the com-

mencement of any new small-scale commercial fisheries. Failure to do so would in all likelihood doom these infant fisheries to overexploitation and eventual closure, to the cost of the people who require them most.

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