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THE INFLUENCE OF SITE, SEASON AND DAY OF THE WEEK ON EXPLOITATION OF ROCKY INTERTIDAL BIOTA IN CENTRAL TRANSKEI, SOUTH AFRICA

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Temporal and spatial variations in the pattern and intensity of exploitative use of rocky shores in the densely populated central Transkei region of the south-east coast of South Africa are described. Surveys of intertidal exploiters and their catches were conducted simultaneously on five randomly selected weekdays and weekends per season between June 1995 and June 1996 at Umtata Mouth, Mngcibe and Lwandile. Three-way ANOVAs were used to assess the influence of site, season and day of the week (weekday or weekend) on the density of the three major groups of exploiters: shellfish-gatherers, seaweed-harvesters and bait-collectors, and on the off-take by shellfish-gatherers. The densities of shellfish-gatherers or seaweed-harvesters did not differ between sites, but there were marked differences in the density of bait-collectors and the quantity of organisms removed by shellfish-gatherers. The numbers in all exploiter groups were lowest in winter, because of factors such as inaccessibility caused by rough seas, poor quality of the preferred shellfish and a clash with such agricultural activities as harvesting of maize. The densities of adult shellfish-gatherers and shellfish offtake were both significantly higher on weekdays than at weekends. However, more children gathered shellfish during the weekends and in summer, perhaps attributable to the closure of schools.

Key words: exploitation, rocky shores, temporal/spatial variation, Transkei

Rocky shore communities are subjected to various degrees of disturbance as a result of human recreational and exploitative activities (Underwood and Kennelly 1990, Kingsford *et al.* 1991, Keough *et al.* 1993, Lasiak 1997). Information on the intensity of such disturbances and an understanding of their impacts on individual organisms and communities, and the biotic interactions among organisms, is needed to determine whether rocky shores require management or protection (Underwood and Kennelly 1990). To determine the extent of disturbance requires knowledge of the number of people taking part in various activities and the types and quantities of organisms taken or damaged.

An understanding of the various temporal, spatial and socio-demographic factors likely to influence the nature and intensity of shoreline utilization is also needed (Underwood and Kennelly 1990). Factors such as weekend v. weekday, school holidays v. school terms, season, state of tide, sea and weather conditions, accessibility of the shore in terms of its aspect, slope and degree of wave exposure, and timing of sporting events and social gatherings all need to be taken into consideration (Underwood and Kennelly 1990, Kingsford *et al.* 1991, Lasiak 1997). To avoid overestimating human impact, there is a need to distinguish between people directly affecting organisms on the shore (e.g. shellfish-gatherers and bait-collectors) and those who do not have a direct effect (e.g. walkers and sunbathers).

Studies of the pattern of shoreline utilization along rocky shores in South Africa are scarce. Aerial surveys have been conducted along the Cape Peninsula (van Herwerden *et al.* 1989, van Herwerden and Bally 1989) and along the Transkei coast (Hockey *et al.* 1988). Ground-based surveys have been used to assess temporal and spatial variations in the pattern of shoreline utilization at one locality in southern Transkei (Lasiak 1997), along three shores in central Transkei (Dyantyi 1995) as well as along the entire Transkei coast (Lasiak 1997). Similar methods were used to monitor the harvesting of intertidal organisms along a 30-km strip of rocky coast within the Maputaland Marine Reserve over a seven-year period (Kyle *et al.*1997).

There is increasing concern that the unconstrained manner in which intertidal organisms are exploited in the Transkei may lead to degradation of intertidal resources and to changes in the structure and functioning of the affected communities (Hockey and Bosman 1986). Although the densely populated central region is the area of Transkei presumed to be under the greatest recreational and exploitative pressures (Hockey *et al.* 1988), the magnitude of such disturbances on intertidal assemblages there has not yet been adequately quantified. The primary objective of the present study was to assess the influence of site, season, and day of the week on exploitation effort and intensity in this region. From this information, the degree of human impact can be extrapolated (Underwood and Kennelly 1990).

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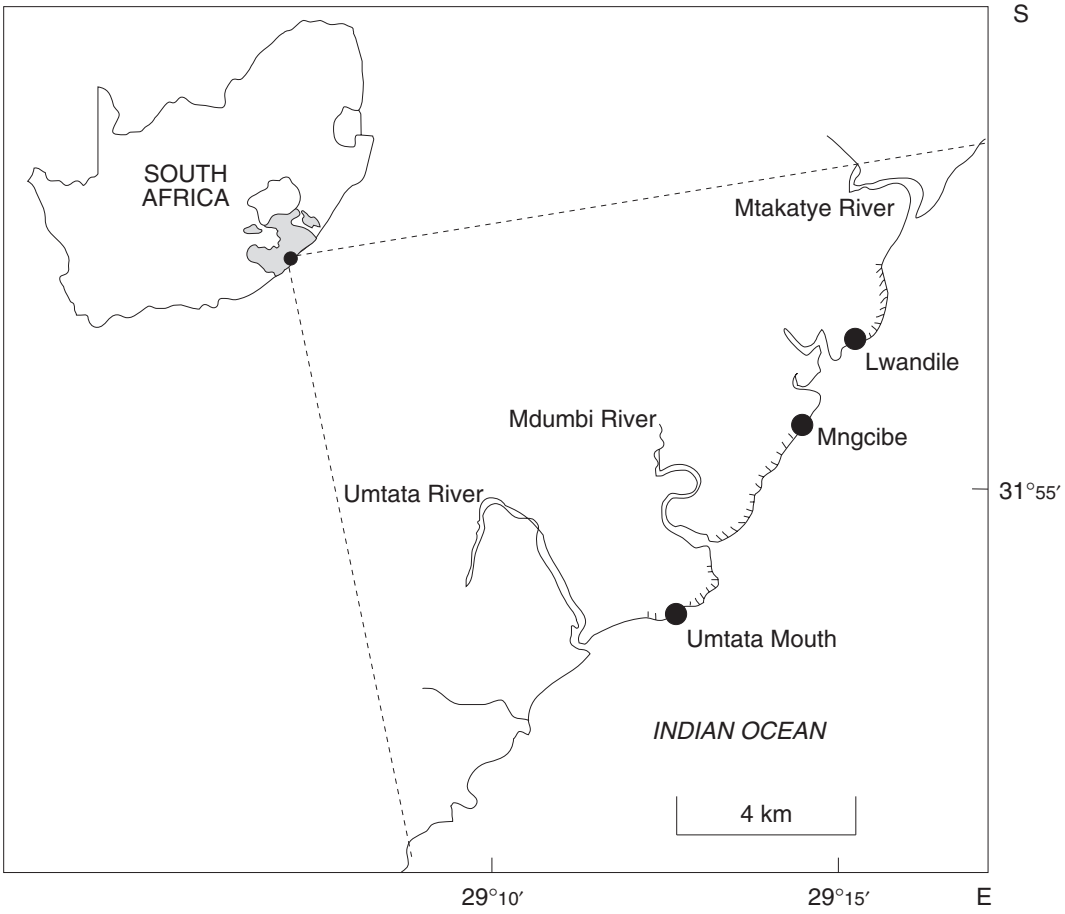

Fig. 1: Map showing the location of the three study sites on the Transkei coast

MATERIAL AND METHODS

The study was conducted simultaneously at three adjacent rocky shores, Lwandile, Mngcibe and Umtata Mouth, in central Transkei (Fig. 1). The individual study sites, of which all are exposed to heavy wave action, are separated by stretches of sandy beaches and river mouths. The substratum at Lwandile consists of a flat, gently sloping sandstone platform, whereas the shore at Umtata Mouth and Mngcibe is made up of inclined sandstone ridges orientated perpendicular to the sea.

To determine the types of activities performed and organisms exploited by people on each shore, structured interviews were conducted by Xhosa-speaking research assistants. Each interviewer covered a stretch of shore approximately 2 km long, within a period of 90–120 minutes. The surveys were conducted during spring low tides on five randomly selected weekdays and weekends in each season. In all, 40 sets of observations were made between June of 1995 and 1996. On each survey day and at each site, the collections made by 10 randomly selected shellfish-gatherers were also weighed with spring balances. The activities observed were categorized according to whether they had a direct effect on intertidal organisms, were more likely to affect subtidal organisms or had no obvious effects on marine organisms. For the purposes of this paper, only those activities that directly affect intertidal organisms will be described.

Three-way ANOVAs were used to establish the influence of site, season and type of day (weekend v. weekday) on the mean numbers of shellfish-gatherers,

Table I: Mean numbers of various groups of shore-users observed per kilometre of shore at the three sites

User-group	Mean number			
	Lwandile	Mngcibe	Umtata Mouth	Overall
Shellfish-gatherers	7.1	9.6	11.4	9.4
Seaweed-harvesters	1.0	0.3	1.4	0.9
Bait-collectors	1.1	3.0	1.4	1.8
People affecting intertidal organisms	9.2	12.9	14.2	12.1
Shell-collectors	0.3	0.2	0.1	0.2
Sunbathers	1.7	0.1	3.0	1.6
Walkers	2.1	1.0	1.1	1.4
People not affecting organisms	4.1	1.3	4.2	3.2
Aquarists	0.5	0.5	0.1	0.4
Divers	1.7	0.3	0.4	0.8
Spearfishers	0.3	1.4	0.2	0.6
Anglers	5.3	4.0	6.3	5.2
People affecting subtidal organisms	7.8	6.2	7.0	7.0
Total number of people	21.1	20.4	25.4	22.3

seaweed-harvesters and bait-collectors observed per kilometre of shore. Prior to these analyses, the raw data were tested for heterogeneity of variances by means of Cochran's test (Underwood 1997). Heterogeneity of variances was generally removed by subjecting the data to either a square-root or log transformation. In the few instances where variances could not be stabilized by transformations, the ANOVAs were carried out on untransformed data. This procedure is recommended where data are balanced and samples are relatively large (Underwood 1997). *Post-hoc* multiple comparisons using Tukey's honestly significant difference (HSD) test were carried out on all factors and interactions showing significant ($p < 0.05$) *F*-ratios (StatSoft 1995).

RESULTS

Overall pattern of shoreline utilization

Ten different activities were observed at the three study sites, shellfish-gathering, seaweed-harvesting, bait-collecting, shell-collecting, collection of fish for aquaria, spearfishing, diving, sun-bathing, walking and angling. People who directly affected intertidal organisms were the most common group of shore-users (mean = 12.1 km^{-1}), followed by those who affected subtidal organisms (mean = 7.0 km^{-1}) and those who did not have any obvious effects on marine organisms (mean = 3.2 km^{-1}; Table I). The mean number of people who directly affect intertidal organisms was highest at Umtata Mouth (14.2 km^{-1}), followed by Mngcibe (12.9 km^{-1}) and Lwandile (9.2 km^{-1}). The most common activity was shellfish-gathering, followed by bait-collecting and seaweed-harvesting (Table I).

Table II: Significance of *F*-ratios derived from a three-way ANOVA examining the influence of site, season and day of the week (weekday v. weekend) on the mean numbers of shellfish-gatherers, seaweed-harvesters and bait-collectors

Source of variation	Shellfish-gatherers	Seaweed-harvesters	Bait-collectors
Site	ns	ns	**
Season	*	***	**
Day	*	ns	ns
Site × Season	ns	ns	ns
Site × Day	ns	ns	ns
Season × Day	ns	ns	ns
Site × Season × Day	ns	ns	ns

ns = not significant
* = $0.01 < p < 0.05$
** = $0.001 < p < 0.01$
*** = $p < 0.001$

More people affected subtidal organisms at Lwandile (mean = 7.8 km^{-1}) than at Umtata Mouth (mean = 7.0 km^{-1}) or Mngcibe (mean = 6.2 km^{-1}). Anglers were the most common shore-users in this group (Table I). The mean number of people who did not have any obvious effects on marine organisms was highest at Umtata Mouth (4.2 km^{-1}), followed by Lwandile (4.1 km^{-1}) and Mngcibe (1.3 km^{-1}). Sunbathers were the most common shore-users in this group (Table I).

The mean numbers of shellfish-gatherers observed per kilometre of shore at Lwandile, Mngcibe and Umtata Mouth were 7.1, 9.6 and 11.4 respectively (Table I). Although there were no significant differences in the mean numbers of shellfish-gatherers among sites, season and day of the week both had a significant influence on their numbers (Table II, Fig. 2). Shellfish-gatherers were significantly fewer in winter (5.0 km^{-1}) than in summer (10.2 km^{-1}) or autumn (12.8 km^{-1}), and were more active on weekdays (9.9 km^{-1}) than at weekends (8.8 km^{-1}).

The seaweed *Gelidium* was collected mainly for sale by women and young girls. The mean numbers of seaweed-harvesters per kilometre of shore at Lwandile, Mngcibe and Umtata Mouth were 1.0, 0.3 and 1.4 respectively. Season was the only factor that had a significant influence on the mean number of seaweed-harvesters (Table II); it was highest in autumn (Fig. 2).

Bait was collected mainly by men and boys, either for fishing or for the capture of rock lobster *Panulirus homarus.* The major bait organisms taken were redbait

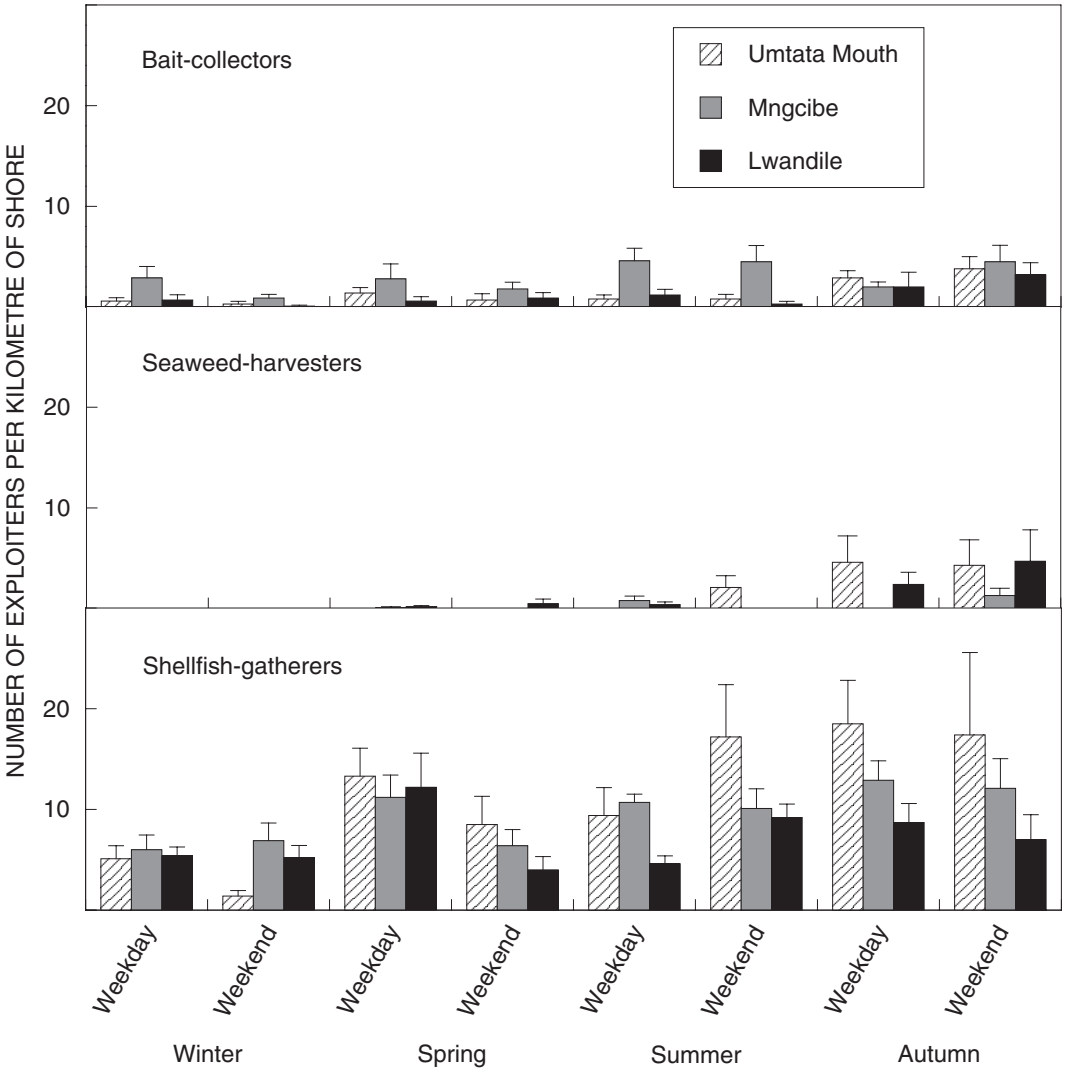

Fig. 2: Temporal variations in the mean numbers (+*SE*) of bait-collectors, seaweed-harvesters and shellfish-gatherers observed per kilometre of shore at each of the three study sites

Pyura stolonifera, patellid limpets *Cellana capensis,* keyhole limpets *Fissurella* spp., mussel worms *Pseudonereis variegata* and gastropods *Burnupena* spp. There were marked spatial and seasonal differences in the mean numbers of bait-collectors (Table II); the value was higher at Mngcibe (3.0 km^{-1}) than at Umtata Mouth (1.4 km^{-1}) or Lwandile (1.1 km^{-1}). The mean number of bait-collectors did not differ between Umtata Mouth and Lwandile, and it was significantly higher in autumn (3.0 km^{-1}) than in winter (0.9 km^{-1}) or spring (1.3 km^{-1}).

Profile of shellfish-gatherers

At all three study sites more females than males collected shellfish, and adults were more active than children, except at Lwandile. There were significant spatial and seasonal differences in the numbers of adult collectors (Table III). Umtata Mouth attracted more than twice the mean number of adult collectors (8.4 km^{-1}) than did Lwandile (3.2 km^{-1} – Fig. 3). The mean number of adult collectors was significantly lower in winter (3.0 km^{-1}) than in autumn (8.3 km^{-1}), but there were

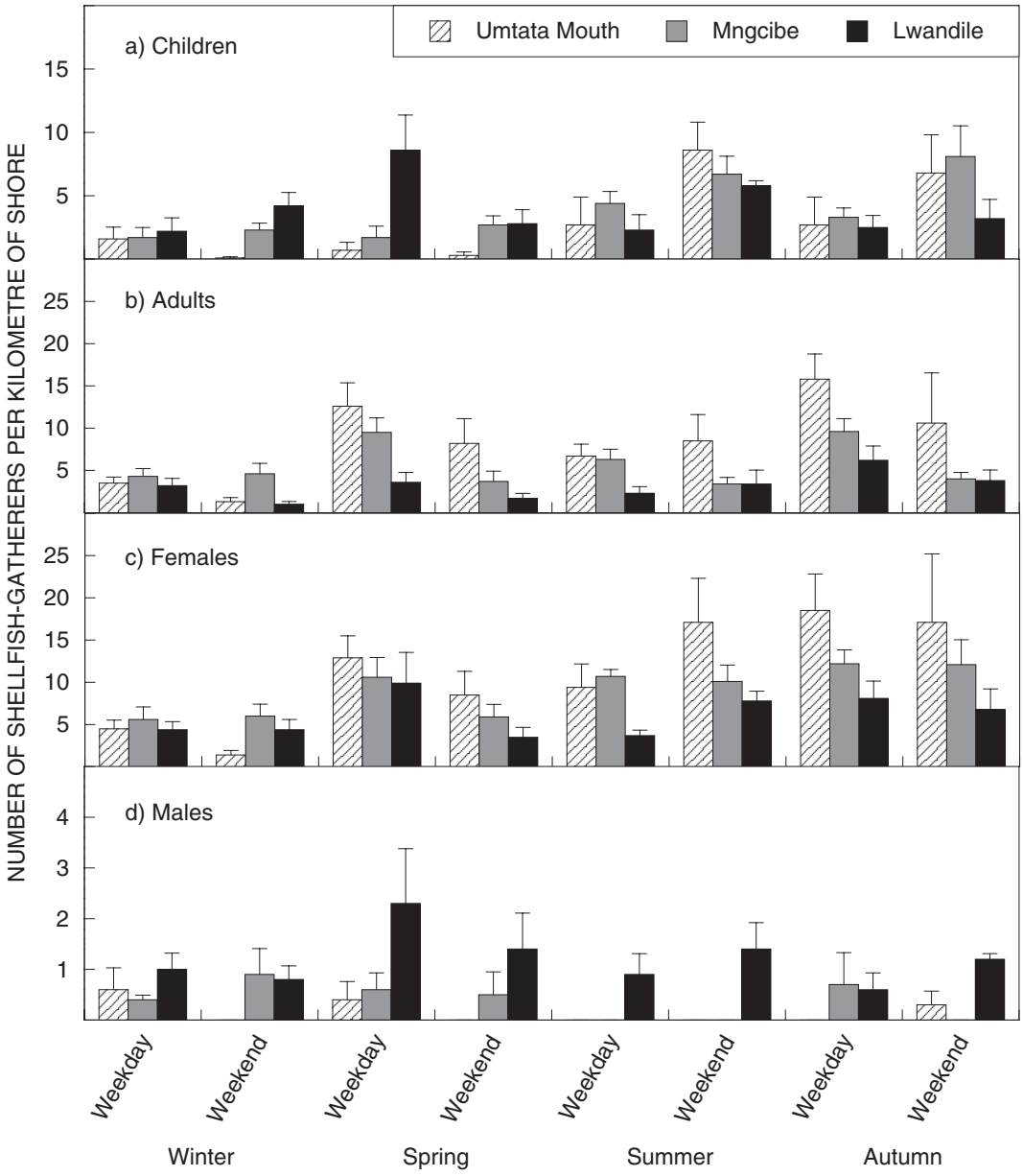

Fig. 3: Temporal variations in the mean numbers (+*SE*) of (a) children, (b) adults, (c) female and (d) males observed gathering shellfish per kilometre of shore at each of the three study sites

no significant differences between the other seasons. A significant interaction between site and type of day was also evident (Table III).

Site, season and type of day all had a significant effect on the mean number of child shellfish-gatherers (Table III). The mean number of child shellfish-gatherers was significantly lower at Umtata Mouth (3.0 km^{-1}) than at Lwandile (4.0 km^{-1}) or Mngcibe (3.9 km^{-1}), and it was significantly higher in summer (5.1 km^{-1}) than in winter (2.0 km^{-1}) or spring (2.8 km^{-1}). Child

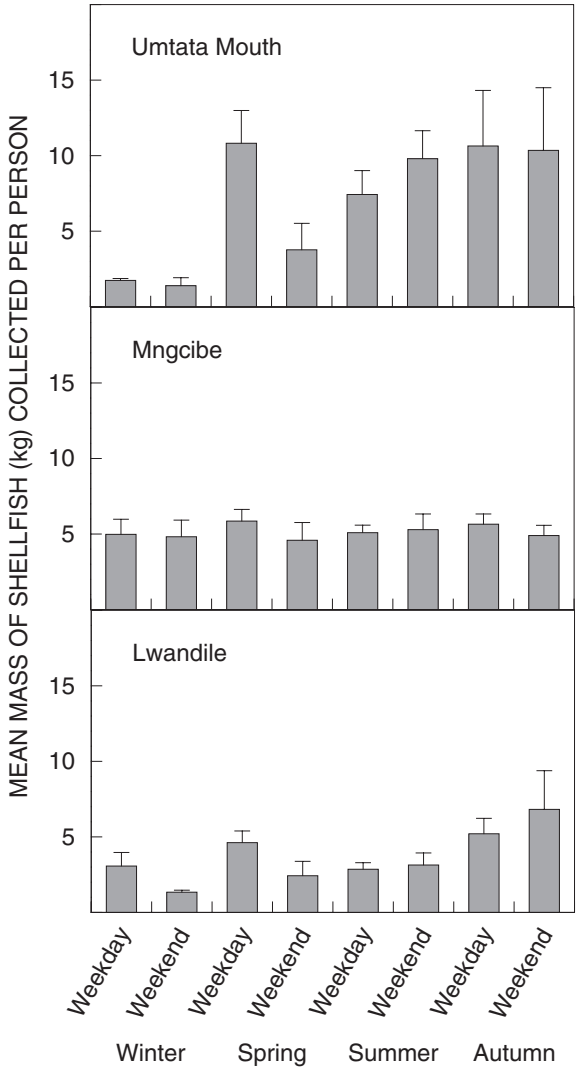

Fig. 4: Temporal variations in the average quantity (+*SE;* kg wet mass) of shellfish collected per person at each of the three study sites

shellfish-gatherers were more numerous at weekends (mean = 4.3 km^{-1}) than during weekdays (mean = 2.9 km^{-1}).

The number of male shellfish-gatherers differed among sites but not among seasons or types of day (Table III). Their mean numbers were significantly higher at Lwandile (1.1 km^{-1}) than at Umtata Mouth (0.2 km^{-1}) or Mngcibe (0.4 km^{-1}). The mean number of female shellfish-gatherers was significantly lower

Table III: Significance of *F*-ratios derived from a three-way ANOVA examining the influence of site, season and day of the week (weekday v. weekend) on the mean numbers of adults, children, males and females gathering shellfish

Source of variation	Adults	Children	Males	Females
Site	*	***	***	ns
Season	*	*	ns	*
Day	ns	*	ns	*
Site×Season	ns	*	ns	ns
Site×Day	**	ns	ns	ns
Season×Day	ns	ns	ns	ns
Site×Season×Day	ns	ns	ns	ns

ns = not significant
* = $0.01 < p < 0.05$
** = $0.001 < p < 0.01$
*** = $p < 0.001$

in winter (4.4 km^{-1}) than in summer (9.8 km^{-1}) or autumn (12.5 km^{-1}), and it was significantly higher on weekdays (9.3 km^{-1}) than at weekends (8.5 km^{-1}; Fig. 3). The number of female shellfish-gatherers did not differ among sites.

Quantity of shellfish collected per person and day

The mass of shellfish collected per person per trip differed significantly among sites and seasons (Table IV). It was greater at Umtata Mouth (7.0 kg) than at Mngcibe (3.7 kg), but there was no difference between the offtake at these sites and that at Lwandile (5.2 kg; Fig. 4). Significantly less shellfish was collected per person in winter (mean = 2.9 kg) than in summer (mean = 5.6 kg) or autumn (mean = 7.3 kg).

The daily offtake of shellfish per kilometre of shore differed significantly among sites and seasons, but not between weekdays or weekends (Table IV, Fig. 5). Greater mean quantities of shellfish were taken at Umtata Mouth (137.6 kg) than at Mngcibe (30.8 kg) or Lwandile (55.9 kg), and more in autumn (141.9 kg) than in winter (18.9 kg).

DISCUSSION

At spring low-tides, the majority (>80%) of visitors to rocky shores in Transkei are engaged in exploitative activities (Hockey *et al.* 1988, Dyantyi 1995, Lasiak 1997). The average densities of 17.0–21.2 km^{-1} shore-exploiters observed during the present study is similar to that noted at the same sites by Dyantyi (1995); 15.7–27.5 km^{-1} of shore. Both estimates are considerably higher than the mean number of shore-exploiters

Table IV: Three-way ANOVA showing the influence of site, season and day of the week (weekday v. weekend) on the mean mass of shellfish collected daily per person and mean mass of shellfish (offtake) collected daily per kilometre of shore

Source of variation	Personal offtake	Offtake per km of shore
Site	**	***
Season	***	**
Day	ns	ns
Site × Season	*	*
Site × Day	ns	ns
Season × Day	ns	ns
Site × Season × Day	ns	ns

ns = not significant
* = $0.01 < p < 0.05$
** = $0.001 < p < 0.01$
*** = $p < 0.001$

(5.9 km^{-1}) recorded in southern and northern Transkei (Lasiak 1997). Although the densities of exploiters observed in central Transkei are similar to estimates from the Cape Peninsula in the Western Cape, this group made up only 6% of the shore-users (17.4 km^{-1}) at the latter site, and consisted mainly of anglers and bait-collectors (Van Herwerden *et al.* 1989). In central Transkei, the most common shore-users observed during spring low-tides were shellfish-gatherers, followed by anglers and bait-collectors. This suggests that most of the exploitation along the Transkei coast is for subsistence purposes, whereas the shores of the Western Cape are used primarily for recreation (Van Herwerden *et al.* 1989).

The present study showed no significant spatial differences in mean densities of shellfish-gatherers or seaweed-harvesters in central Transkei, but there were differences in the densities of bait-collectors, Mngcibe being the most visited shore. This may be because the capture of rock lobster is more popular in that area, or that the local fishermen at Mngcibe are more dependent on bait collected from the shore than are the predominantly white anglers at Umtata Mouth and Lwandile. The present observation that densities of shellfish-gatherers, seaweed-harvesters and bait-collectors are lowest in winter and highest in autumn is similar to the finding of Dyantyi (1995). However, that author found no temporal differences in numbers of bait-collectors. The number of seaweed-harvesters in southern Transkei was lower in winter than in summer (Lasiak 1997).

The decrease in exploiters along the Transkei coast in winter has been attributed to the inaccessibility of the shore as a result of rough seas, to the poorer condition of the preferred shellfish species, and to clashes with agricultural activities, such as harvesting maize

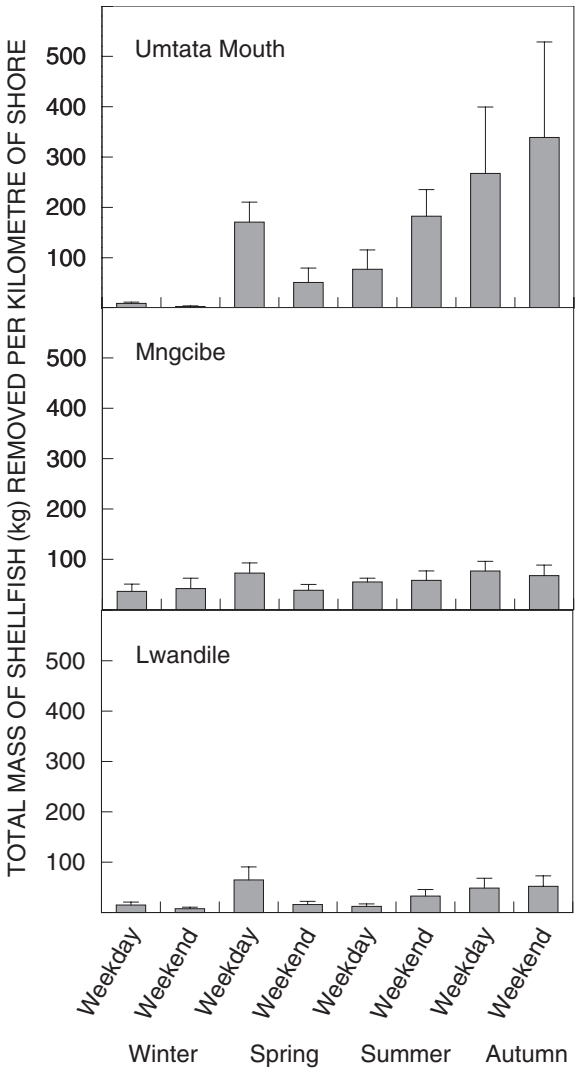

Fig. 5: Temporal variations in the mean quantity of shellfish removed daily per kilometre of shore at each of the three study sites

(Lasiak 1993). Lasiak (1992, 1993) noted that shellfish gathering was more intense during summer when crop cultivation was expected to take precedence. The increase in the number of exploiters in summer may be attributed to an increase in human activity in the coastal zone as a result of the summer holidays, finer weather and more favourable sea conditions. The autumn peak in activity could be because people have more time to visit the shore when crops are

ripening. Alternatively, there may be a greater demand for shellfish resources then because of the depletion of the previous year's maize reserves. This contrasts with the situation in northern KwaZulu-Natal, where subsistence agricultural activities take preference over shellfish-gathering in summer (Kyle *et al.* 1997).

Shellfish-gatherers were the only group of intertidal exploiters to differ in numbers between weekdays and weekends, adults being more active on weekdays. This difference may be because social gatherings such as ceremonies, rituals, church services and meetings ("*iimbizo*") are held at weekends, and people therefore have less time to visit the shore. Conversely, children gathered shellfish more often during the weekend, most likely because of schools being closed then. Van Herwerden *et al.* (1989) found that, in the Cape Peninsula, use of the shore was more intense on weekdays during the holiday season, but highest over weekends out of season.

The quantity of shellfish collected per person per trip in central Transkei is comparable to estimates obtained previously from other areas of the Transkei. Bigalke (1973) estimated that each collector removed on average 4.8 kg of shellfish and Siegfried *et al.* (1985) reported that, on average, 6 kg (wet mass) of mussels were collected per person at Nqabara. As is the case here, Dyantyi (1995) reported greater collecting effort in summer than in winter. Bigalke (1973) suggested that smaller quantities of shellfish were collected in winter because of the inaccessibility of the shore at that time of year compared to the more favourable sea conditions in summer. Mills (1985) suggested that the increase in population density and demand for seafood from tourists during summer may increase the intensity of exploitation.

Given that most visitors to the rocky shores in the Transkei engage in exploitative activities, the biota on the shores are likely to be impacted by human disturbance. Although the shores in the central region are subjected to similar levels of exploitation to shores elsewhere in Transkei, the fact that the region supports a much lower biomass of harvestable molluscs than the other regions (Fielding *et al*. 1994) suggests that it is likely to be the most heavily impacted.

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