# Shore-angling catches in the Tsitsikamma National Park, 1989-1995

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Catch card returns completed by visitors and locals angling in the fishing area of the Tsitsikamma National Park between 1991 and 1995, as well as results of scientific fishing in the whole park between 1989 and 1991 were analysed. Species composition, catch per unit effort (cpue) and seasonality were determined. Seventy-six percent of the 1 147 catch cards suitable for analysis were submitted by visiting anglers, who caught a total of 1 638 fish weighing approximately 1 522 kg during 4 654 angler-hours. This was almost double the 948 fish, weighing about 611 kg, landed during 1 863 angler-hours by local anglers. A total of 709 fish weighing 774 kg was recorded during the 461 scientific fishing angler-hours. The mean annual cpue of visitors was lower than that of locals (35 ± 1 SE vs. 55 ± 3 SE fish/100 angler-hours), while the cpue recorded during the scientific fishing throughout the park was 154 fish/100 angler-hours. Species most frequently caught by visitors were *Sarpa salpa* (22.6 %), *Amblyrhynchotes honckenii* (19.6 %) and *Diplodus sargus capensis* (6.7 %), while the catches of locals were dominated by *S. salpa* (36.7 %), *Boopsoidea inornata* (21.8 %) and *Pomatomus saltatrix* (10.4 %). Outside the open fishing area scientific catches were dominated by *D. sargus capensis* (20 %), *Cheimerius nufar* (13 %), *Pachymetopon grande* (9 %) and *Dichistius capensis* (6 %). Fewer than 2.5 % of the bony fish caught in the fishing area weighed more than 3 kg. Catch rates of most species varied seasonally, with the overall cpue of both visitors and locals peaking between October and April. The cpue in the fishing area of the park was at least 2.5 times lower than that recorded in the De Hoop Nature Reserve and Terrace Bay in the Skeleton Coast National Park. However, the cpue recorded during scientific fishing throughout the Tsitsikamma National Park compared favourably with that recorded in other protected areas.

Keywords: Marine, recreational, fishing, comparison, catch cards, visitors, locals.

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## Introduction

Prior to the proclamation of the Tsitsikamma National Park (TNP), this near pristine coastal area was under the jurisdiction of the Department of Forestry (Robinson 1989). The neighbouring local inhabitants were largely employed by the Department of Forestry and nearby sawmills. They, and visiting anglers, were permitted to collect bait and fish anywhere along the coast, provided they purchased (at a nominal fee) an entrance permit from the local forestry offices. After extensive negotiations between the National Parks Board (NPB) and the then Secretary of the Department of Forestry and his Minister, the TNP was proclaimed in 1964 (Knobel 1989; Robinson 1989). As a consequence of prior arrangement with the Department of Forestry, as well as socio-political pressure, shore-based angling was permitted to continue throughout the park for a further 11 years. The fishing permit system used was similar to that imposed by the Department of Forestry, except that the collection of bait was limited to certain sites,

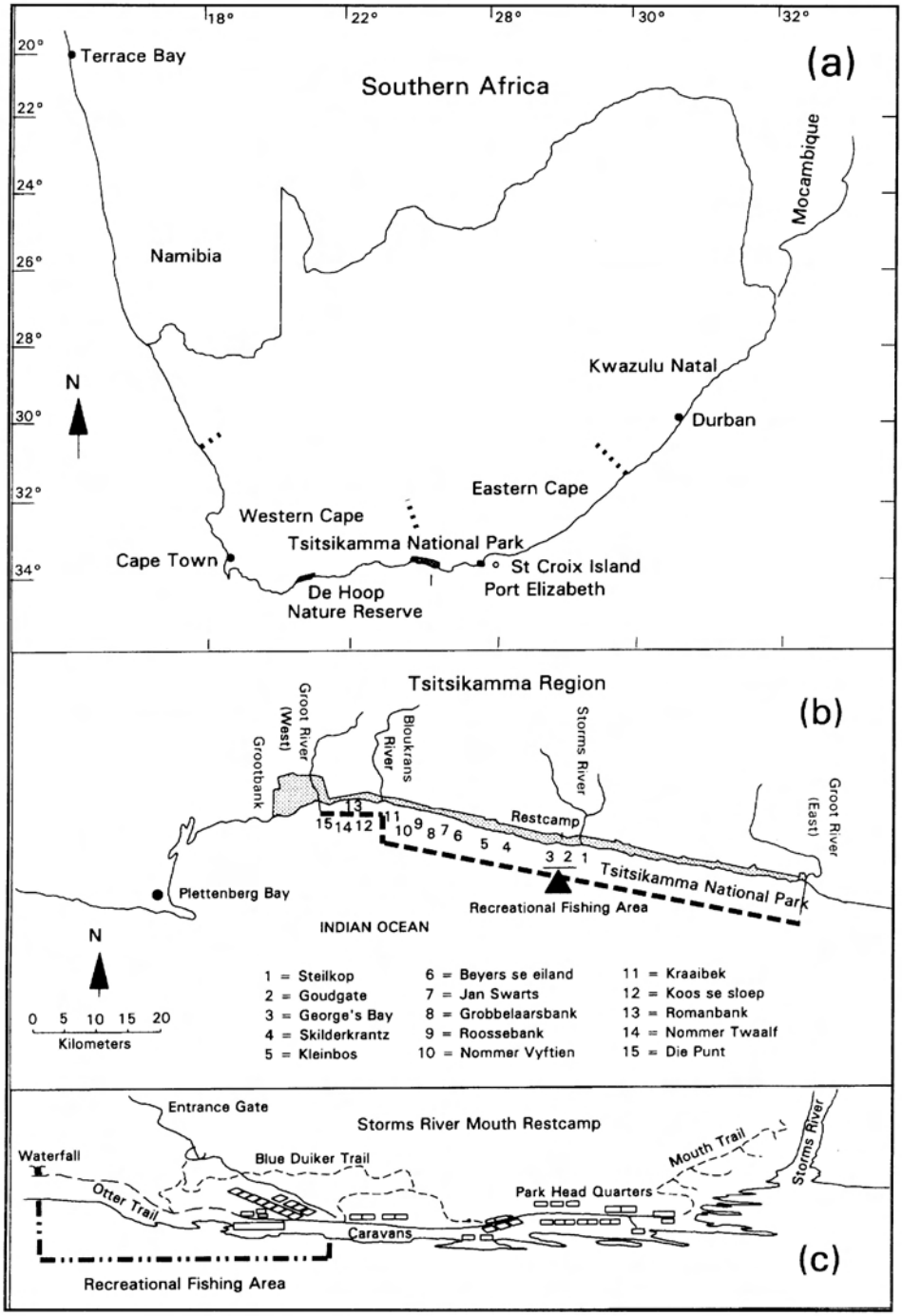


Fig. 1. Maps of (a) southern Africa, (b) the Tsitsikamma region and (c) the Storms River Mouth Restcamp respectively showing the location of research sites mentioned in text, the 15 sites in the Tsitsikamma National Park where angling was allowed between 1975 and 1978, and the current 3 km fishing area.

and offshore angling was apparently prohibited. In 1975 the NPB restricted shore-based angling to 15 sites along the length of the western sector of the park (Fig. 1). Finally in 1978, despite numerous letters and a petition of some 300 signatures from local residents, angling was limited to a single 3 km stretch of coast, extending from the western sector of the Storms River Mouth restcamp to the Waterfall, and the collecting of bait organisms was prohibited. This restriction has been a source of dissatisfaction to local anglers, and in December 1994 the Tsitsikamma Angling Union (TAU) submitted a petition of 344 signatures to the NPB requesting that the whole of the TNP, or significant parts thereof, be opened to local residents for angling. During 1995 and 1996 negotiations were held with the TAU and the NPB, and although the NPB reduced the price of its annual entrance permit for local residents from R135 to R10, anglers are still dissatisfied with the situation.

With the exception of the Storms River restcamp and Groot River (west) areas, most fishing sites in the TNP are accessible only by means of narrow footpaths that zigzag down the high (ca. 180 m), steep coastal escarpment to the shores below. This factor limited past exploitation along the Tsitsikamma coastline and, even prior to 1978, it is unlikely that the park would have been heavily exploited. The current 3 km fishing area borders the main restcamp of the park, and provides both visitors and locals with opportunities to fish. Anglers are prohibited from collecting bait organisms from the rocks, but bait (usually frozen pilchard and squid) is sold from the shop in the restcamp or can be obtained outside the park.

Recent studies have shown the potential importance of marine reserves in fisheries management (Roberts & Polunin 1991; Bennett & Attwood 1991, 1993a, 1993b; Bennett *et al.* 1994; Buxton & Smale 1989), and the NPB management is currently evaluating the implications of permitting angling in the TNP. This study, based on 'voluntary' catch returns of fishermen, assessed the catch composition, catch per unit effort and seasonality of catches of both visitors and locals in the 3 km fishing area, between January 1991 and December 1995. The results were compared with those of other studies to provide insights into the fish resources of the park and possible affects of angling in the park. The study also complements other surveys of shore-based angling along the South African coast, namely: Penrith & Loutit (1982) for Namibia, Bennett (1991), Bennett & Attwood (1993a) and Bennett *et al.* (1994) for the Western and South-Western Cape, Coetzee & Baird (1981), Coetzee *et al.* (1989) and Clarke & Buxton (1989) for the South-Eastern Cape, and Joubert (1981) for KwaZulu-Natal.

## Study area

The TNP is situated in the southern Cape between Plettenberg Bay (50 km) and Humansdorp (80 km) (Fig. 1). The 59 km long marine protected area, from Groot River (east) (34°04'S, 24°12'E) to Groot River (west) (33°59'S, 23°34'E), initially extended 0.9 km offshore. In 1983 the seaward boundary east of the Bloukrans River was extended to 5.6 km offshore (Fig. 1), and in 1996, after the completion of this study, the marine protected area was extended westward to include the nearshore region between Groot River (west) and Grootbank (34°00'S, 23°30'E) (Government Gazette No. 17073 of 4 April 1996). With the exception of a relatively small sandy beach at Groot River (west), the shoreline of the park is rocky, comprised of ridges and interlying troughs running parallel to the coast. These rocky ridges extend into the subtidal region, which quickly reaches depths of > 20 m. The interlying troughs or gullies are generally filled with sand and boulders. Wave action is turbulent and the exposed rocky intertidal zone generally has dense stands of red-bait (*Pyura stolonifera*), brown mussels (*Perna perna*), barnacles (*Octomeris angulosa* and *Chthamalus dentatus*), as well as calcareous algae.

## Methods

During the study period (1991–1995) gate-guards of the National Parks Board were instructed to issue each group of fishermen passing through the official entrance gate of the Storms River restcamp with a free angling permit and a catch card, and to request them to deposit completed cards at the gate before exiting the park. Large notice boards, urging fishermen to support this research programme, were erected at two prominent sites near the beginning of the angling area. Furthermore, weighing centres were constructed at these two sites and at the exit gate of the park. Each centre had a wooden shelf on which to write, a compartment stocked with extra catch cards, a ball-point pen and a 25 kg Original Rebüre scale. Two of these centres displayed illustrations and the common names of 27 fish species frequently caught in the TNP. Angling catch cards used were issued by the Oceanographic Research Institute, as part of the National Marine Linefish System. The information requested on the cards included: date, fishing locality, fishing start and end time, number of anglers in the party, town of residence, and numbers and mass of each fish species caught.

Several problems were encountered in the collection of data, namely:

(i) Only a very small proportion of the persons entering the park were fishermen, and it was difficult to keep the gate-guards in a routine of issuing and collecting catch cards.

(ii) Occasionally the supply of cards at distribution boxes were depleted and not immediately replaced.

(iii) More than 20 % of the cards issued were not returned, or inadequately completed.

(iv) A few local anglers entered the park illegally and did not complete catch cards.

(v) The spring balances at the weighing centres were inaccurate below 1 kg, and most anglers merely estimated the mass of small specimens. The weights of inedible fish species, such as sharks and barbel, were also usually estimated as these fish were generally discarded immediately after being landed.

(vi) Although species identification charts were available, identification of cartilaginous species was often inaccurate.

Only cards which had all the data components, with the exception of mass, were analysed. To determine the species from the common names given by anglers, reference was made to work by Smith & Smith (1966), Buxton & Smale (1984) and Burger (1990), as well as the scientific fishing catches in the TNP. The mass contribution of individual fish to the overall catch was assessed as follows. In the case of large species (where weights of individuals could vary greatly) the values documented on the cards were used (Table 1), and where no mass was provided the mean mass recorded for that species during that year was applied. With smaller species, the mean masses recorded during the scientific fishing (see below) and by Coetzee & Baird (1981) were applied (Table 1).

Data from visitors (persons residing > 40 km from the Storms River mouth) were analyzed separately from those of locals. Unfortunately, data collected between May 1993 and August 1993 (79 cards) which distinguished between the two groups were lost, and the data for this time period were omitted from most analyses. Analytical procedures included the determination of:

(i) percentage contribution, in terms of numbers and mass, of each species to the reported annual catch,

(ii) reported monthly and annual fishing effort (angler-hours),

(iii) reported monthly and annual catch per unit effort (cpue), in terms of both number and mass of fish caught per 100 angler-hours,

(iv) relationship between angling effort and cpue using Spearman rank correlation (Zar 1984).

In addition to the above information, fishing details from scientific shore-angling in the park, undertaken between 1989 and 1991, were also used. Scientific fishing was undertaken at various localities between Storms River Mouth to Romanbank (Fig. 1), in all types of weather conditions, and targeted *D. sargus capensis* and *D. cervinus hottentotus* for the study of their biology (Mann 1992). The areas fished were rocky and all fish caught were recorded. Details similar to those on the catch cards were noted.

To provide historical information on catch composition, data found in TNP files (1964–1965) were extracted. Records covered catch data from 23 sites within the park, but information on fishing effort and catches of cartilaginous fish were almost invariably absent. Therefore, cpue could not be determined.

Surface sea temperatures in the Storms River area were measured daily at 08:00 and 14:00 using a mercury or alcohol thermometer between January 1991 and March 1993, thereafter at 08:00, 14:00 and 20:00 with a thermistor.

## Results

A total of 1 421 catch cards was collected during the study period, of which 19 % were discarded, because the angling details were incomplete. Of the 1 147 catch cards available for analysis, 866 cards (76 %) were submitted by visitors and the rest were completed by local anglers. Visiting anglers landed a total of 1 638 fish weighing approximately 1 522 kg during 4 654 angler-hours, almost double the 948 fish, weighing about 611 kg, caught during 1 863 angler-hours by locals.

During 92 scientific fishing outings a total of 461 angler-hours was recorded, and the 709 fish caught weighed 774 kg. In the historic data, a total of 826 fish weighing 2 183 kg was recorded.

### *Catch composition*

Twelve species of cartilaginous fish (Chondrichthyes) and 28 species of bony fish (Osteichthyes) were caught by visitors, compared to only 6 cartilaginous species and 23 bony fish species recorded by locals (Table 1).

The most important species, numerically, in the mean annual catch (1991–1995) of visitors were *Sarpa salpa* (22.6 %), *Amblyrhynchotes honckenii* (19.6 %) and *Diplodus sargus capensis* (6.7 %). All other species contributed < 5 % individually to the total catch (Table 1). In the case of locals, the limited data (8 returns) for 1995 were omitted from the calculations, and the mean annual (1991–1994) catch was dominated by *S. salpa* (36.7 %), *Boopsoidea inornata* (21.8 %) and *Pomatomus saltatrix* (10.4 %) (Table 1). *Sarpa salpa, B. inornata* and *A. honckenii* are all small fish species (Van der Elst 1981). Fewer than 2.5 % of the bony fishes caught by both visitors and locals weighed > 3 kg, with the largest being a 10 kg *Sparodon durbanensis*. By weight, the most important species in the mean annual catch of visitors were *Triakis megalopterus* (9.4 %), *Carcharhinus obscurus* (8.0 %), *Dichistius capensis* (7.0 %) and *P. saltatrix* (6.0 %). The mean annual catch of locals (by weight) was dominated by *P. saltatrix* (18.5 %), *S. salpa* (12.1 %), *Mustelus* spp.(11.2 %), *B. inornata* (7.5 %) and *D. capensis* (7.4 %) (Table 1 ).

Anglers generally regard Chondrichthyes (sharks and rays), Tetraodontidae (puffers) and Clinidae (clinids) as 'trash fish', and these are usually discarded or occasionally used as bait (Clarke & Buxton 1989; *pers. obs.*). 'Trash fish' formed a markedly greater component of the visitors' catch than that of the locals (32 % vs. 6 % of the total numbers and ca. 50 % vs. 24 % of the total mass).

A total of 26 bony fish species and 8 cartilaginous fish species were recorded during the scientific fishing within and outside the fishing area (Table 2). Catch composition in the open fishing area was similar to that recorded on the catch cards (*S. salpa* 39 %, *Lisa richardsonii* 15 %, *Diplodus sargus capensis* 13 %). Outside the open fishing area scientific catches were dominated by *D. sargus capensis* (20 %), *Cheimerius nufar* (13 %), *Pachymetopon grande* (9 %) and *D. capensis* (6 %).

Fish catches recorded in the TNP during 1964 and 1965 are summarised in Table 3. During 46 days, 98 fish (> 450 g) weighing 266 kg were caught in the Storms River area. The most commonly caught species were *P. saltatrix* (20 %), *Lithognathus lithognathus* (18 %), *Sparodon durbanensis* (13 %) and *Argyrosomus japonicus* (13 %). Twenty-six percent of these fish weighed 3 kg or more, with the largest fish being a 15 kg *S. durbanensis*. By weight, the most important species were *S. durbanensis* (42 %), *P. saltatrix* (14 %), *L. lithognathus* (14 %) and *A. japonicus* (12 %). These catches differed markedly from those recorded at other sites within the park, where *D. capensis* was the most important species in terms of numbers (39–53 %) and usually mass as well (29 –51 %, Table 3).

Table 1

*Annual catch composition and catch rate (per 100 angler hours) of visitors (above) and locals (below) recorded from the fishing area of the TNP between 1991 and 1995. Species are arranged in phylogenetic order according to Smith and Heemstra (1986), and values (recorded or means from scientific fishing) used to calculate mass of fish caught are given. Numerical and mass (in brackets) contributions are expressed as percentage of total annual catch, and values for locals excludes the limited data of 1995*

| Species | Mass used | Nos weighed | 1991 Nos | 1991 Mass | 1992 Nos | 1992 Mass | 1993 Nos | 1993 Mass | 1994 Nos | 1994 Mass | 1995 Nos | 1995 Mass | Mean Nos | Mean Mass |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHONDRICHTHYES | | | | | | | | | | | | | | |
| Carcharhinidae | | | | | | | | | | | | | | |
| *Carcharhinus brachyurus* | Rec | | 0.2 | (0.0) | 0.7 | (2.1) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.2 | (0.4) |
| Bronze shark | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| *Carcharhinus limbatus* | Rec | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 1.4 | (8.2) | 0.3 | (1.6) |
| Blacktip shark | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| *Carcharhinus obscurus* | Rec | | 0.0 | (0.0) | 0.2 | (0.7) | 0.4 | (1.5) | 0.7 | (14.3) | 0.7 | (23.4) | 0.4 | (8.0) |
| Grey or dusky shark | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| *Mustelus* spp. | Rec | | 0.4 | (1.7) | 0.7 | (4.6) | 1.1 | (3.3) | 0.0 | (0.0) | 2.2 | (5.3) | 0.9 | (3.0) |
| Speareye, houndshark | | | 0.7 | (10.2) | 0.0 | (0.0) | 0.4 | (17.3) | 2.2 | (17.5) | | | 0.8 | (11.2) |
| *Triakis megalopterus* | Rec | | 0.6 | (2.7) | 1.4 | (12.9) | 0.7 | (0.8) | 1.8 | (30.6) | 0.0 | (0.0) | 0.9 | (9.4) |
| (Spotted) Gully shark | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| Sharks (unidentified) | Rec | | 5.7 | (32.4) | 2.0 | (17.1) | 1.5 | (5.4) | 0.4 | (1.4) | 0.7 | (8.8) | 2.0 | (13.0) |
| | | | 0.9 | (13.9) | 0.0 | (0.0) | 0.0 | (0.0) | 4.3 | (14.7) | | | 1.3 | (7.1) |
| Scyliorhinidae | | | | | | | | | | | | | | |
| *Haploblepharus edwardsii* | 0.87 | 25 | 1.8 | (2.1) | 1.6 | (1.4) | 2.2 | (2.7) | 2.2 | (1.5) | 2.2 | (1.5) | 2.0 | (1.8) |
| # *Haploblepharus fuscus* | | | 0.7 | (0.9) | 0.0 | (0.0) | 0.4 | (0.5) | 0.0 | (0.0) | | | 0.3 | (0.4) |
| Shyshark or Skaamoog | | | | | | | | | | | | | | |
| *Poroderma africanum* | 3.88 | 13 | 0.2 | (1.0) | 0.9 | (3.6) | 0.0 | (0.0) | 0.7 | (2.2) | 0.0 | (0.0) | 0.4 | (1.4) |
| Striped dogfish | | | 0.7 | (4.0) | 0.0 | (0.0) | 0.0 | (0.0) | 2.2 | (9.5) | | | 0.7 | (3.4) |
| *Poroderma pantherinum* | 2.03 | 17 | 0.0 | (0.0) | 0.2 | (0.5) | 0.0 | (0.0) | 0.7 | (1.2) | 0.7 | (1.2) | 0.3 | (0.6) |
| Leopard shark or catshark | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| Odontaspididae | | | | | | | | | | | | | | |
| *Eugomphodus taurus* | Rec | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.7 | (2.9) | 0.1 | (0.6) |
| (Spotted) ragged tooth shark | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| Rajidae | | | | | | | | | | | | | | |
| *Raja clavata* | Rec | | 0.0 | (0.0) | 0.2 | (0.9) | 0.0 | (0.0) | 0.4 | (1.1) | 0.0 | (0.0) | 0.1 | (0.4) |
| (Thornback) skate | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| Rhinobatidae | | | | | | | | | | | | | | |



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Table 1 (continued)

| Species | Mass used | Nos weighed | 1991 Nos | 1991 Mass | 1992 Nos | 1992 Mass | 1993 Nos | 1993 Mass | 1994 Nos | 1994 Mass | 1995 Nos | 1995 Mass | Mean Nos | Mean Mass |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Rhinobatos annulatus* | 1.92 | 12 | 1.6 | (4.1) | 0.7 | (1.3) | 2.2 | (5.9) | 9.6 | (14.3) | 0.7 | (1.1) | 2.9 | (5.4) |
| (Lesser) sandshark | | | 0.0 | (0.0) | 0.0 | (0.0) | 1.7 | (4.4) | 0.0 | (0.0) | | | 0.4 | (1.1) |
| OSTEICHTHYES | | | | | | | | | | | | | | |
| Ariidae | | | | | | | | | | | | | | |
| *Galeichthys feliceps* | 0.78 | 15 | 1.6 | (1.7) | 0.7 | (0.5) | 3.3 | (3.6) | 12.9 | (7.8) | 2.2 | (1.4) | 4.1 | (3.0) |
| (Sea) barbel or catfish | | | 0.7 | (0.0) | 0.0 | (0.0) | 2.5 | (2.7) | 0.0 | (0.0) | | | 0.8 | (0.9) |
| Serranidae | | | | | | | | | | | | | | |
| *Epinephelus marginatus* | 1.19 | 8 | 1.4 | (2.2) | 1.4 | (1.6) | 0.4 | (0.6) | 0.0 | (0.0) | 0.7 | (0.7) | 0.8 | (1.0) |
| *# Acanthistius sebastoides* | | | 0.7 | (1.2) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.2 | (0.3) |
| Rockcod or koningklip | | | | | | | | | | | | | | |
| Pomatomidae | | | | | | | | | | | | | | |
| *Pomatomus saltatrix* | 1.08 | 20 | 2.3 | (3.5) | 10.9 | (11.9) | 8.0 | (12.2) | 0.7 | (0.6) | 2.2 | (1.9) | 4.8 | (6.0) |
| Elf or shad | | | 2.0 | (3.4) | 16.7 | (36.3) | 23.0 | (34.2) | 0.0 | (0.0) | | | 10.4 | (18.5) |
| Haemulidae | | | | | | | | | | | | | | |
| *Pomadasys commersonnii* | Rec | | 0.0 | (0.0) | 0.2 | (0.1) | 0.4 | (1.8) | 1.1 | (0.7) | 0.0 | (0.0) | 0.3 | (0.5) |
| Spotted grunter | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| *Pomadasys olivaceum* | Rec | | 0.0 | (0.0) | 0.2 | (0.1) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | <0.1 | (<0.1) |
| (Piggy) gorrie | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| Sparidae | | | | | | | | | | | | | | |
| *Boopsoidea inornata* | 0.24 | 24 | 0.2 | (0.1) | 2.3 | (0.6) | 1.1 | (0.4) | 4.8 | (0.9) | 0.0 | (0.0) | 1.7 | (0.4) |
| Fransmadam, dik-/ peuloog | | | 22.1 | (8.3) | 15.6 | (7.6) | 16.7 | (5.5) | 32.6 | (8.8) | | | 21.8 | (7.6) |
| *Cheimerius nufar* | 1.28 | 78 | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 1.8 | (1.8) | 0.0 | (0.0) | 0.4 | (0.4) |
| Santer | | | 0.0 | (0.0) | 0.5 | (1.3) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.1 | (0.3) |
| *Chrysoblephus cristiceps* | 0.65* | 29 | 0.2 | (0.2) | 0.0 | (0.0) | 0.0 | (0.0) | 0.7 | (0.4) | 0.0 | (0.0) | 0.2 | (0.1) |
| Dageraad | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| *Chrysoblephus laticeps* | 1.35 | 11 | 2.1 | (4.0) | 0.7 | (0.9) | 1.1 | (2.1) | 2.6 | (2.7) | 2.9 | (3.2) | 1.9 | (2.6) |
| Roman | | | 2.4 | (5.1) | 2.1 | (5.7) | 2.5 | (4.7) | 2.2 | (3.3) | | | 2.3 | (4.7) |
| *Cymatoceps nasutus* | Rec | | 0.6 | (0.9) | 0.2 | (1.0) | 0.4 | (0.5) | 0.7 | (0.2) | 0.0 | (0.0) | 0.4 | (0.5) |
| Poenskop | | | 0.7 | (1.8) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.2 | (0.4) |
| *Diplodus cervinus hottentotus* | 1.00 | 32 | 1.2 | (1.6) | 0.9 | (0.9) | 1.5 | (2.1) | 0.7 | (0.6) | 0.7 | (0.6) | 1.0 | (1.1) |

Table 1 (continued)

| Species | Mass used | Nos weighed | 1991 Nos | 1991 Mass | 1992 Nos | 1992 Mass | 1993 Nos | 1993 Mass | 1994 Nos | 1994 Mass | 1995 Nos | 1995 Mass | Mean Nos | Mean Mass |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zebra or bontrok | | | 0.9 | (1.4) | 0.5 | (1.1) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.3 | (0.6) |
| *Diplodus sargus capenis* | 0.60 | 133 | 3.5 | (2.9) | 6.8 | (4.1) | 10.2 | (8.7) | 5.2 | (2.4) | 7.9 | (3.9) | 6.7 | (4.4) |
| Blacktail, kolstert or dassie | | | 0.4 | (0.4) | 2.6 | (3.2) | 1.7 | (1.4) | 15.2 | (10.3) | | | 5.0 | (3.8) |
| *Gymnocrotaphus curvidens* | 0.79* | 12 | 0.6 | (0.6) | 0.9 | (0.7) | 0.0 | (0.0) | 0.4 | (0.2) | 0.0 | (0.0) | 0.4 | (0.3) |
| Janbruin | | | 3.5 | (4.4) | 1.6 | (2.5) | 0.4 | (0.5) | 0.0 | (0.0) | | | 1.4 | (1.8) |
| *Lithognathus lithognathus* | 1.23 | 13 | 1.8 | (3.0) | 2.3 | (3.4) | 3.3 | (5.7) | 1.5 | (1.4) | 11.5 | (11.5) | 4.1 | (5.0) |
| Sand/white steenbras (>08kg) | | | 1.5 | (3.0) | 0.5 | (1.3) | 1.7 | (2.8) | 10.9 | (15.0) | | | 3.6 | (5.5) |
| *Lithognathus mormyrus* | 0.40 | 14 | 1.4 | (0.7) | 3.6 | (1.3) | 2.5 | (1.4) | 6.3 | (1.9) | 2.9 | (0.9) | 3.3 | (1.3) |
| Sand/white steenbras (<08kg) | | | 0.7 | (0.4) | 0.5 | (0.4) | 0.0 | (6.0) | 0.0 | (0.0) | | | 0.3 | (1.7) |
| *Pachymetopon grande* | 1.54 | 55 | 0.8 | (1.6) | 0.5 | (0.7) | 2.5 | (5.6) | 1.1 | (1.3) | 1.4 | (1.8) | 1.3 | (2.2) |
| Hottentot or bronze bream | | | 2.4 | (5.9) | 3.1 | (9.7) | 0.4 | (0.9) | 2.2 | (3.8) | | | 2.0 | (5.1) |
| *Petrus rupestris* | Rec | | 0.2 | (0.3) | 0.0 | (0.0) | 1.1 | (2.3) | 0.0 | (0.0) | 0.0 | (0.0) | 0.3 | (0.5) |
| Red steenbras | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| *Rhabdosargus holubi* | 0.46 | 29 | 4.7 | (3.0) | 5.7 | (2.7) | 5.1 | (3.3) | 3.3 | (1.2) | 3.6 | (1.3) | 4.5 | (2.3) |
| Cape/white stumpnose | | | 1.5 | (1.3) | 1.0 | (1.0) | 0.8 | (0.5) | 0.0 | (0.0) | | | 0.8 | (0.7) |
| *Sarpa salpa* | 0.20 | 77 | 25.5 | (7.0) | 10.0 | (2.0) | 26.5 | (7.5) | 19.2 | (3.0) | 31.7 | (5.1) | 22.6 | (4.9) |
| Strepie | | | 48.9 | (15.5) | 52.1 | (21.0) | 28.5 | (7.8) | 17.4 | (3.9) | | | 36.7 | (12.1) |
| *Sparodon durbanensis* | Rec | | 2.9 | (3.7) | 3.9 | (6.9) | 3.3 | (3.7) | 1.1 | (0.6) | 1.4 | (1.5) | 2.5 | (3.3) |
| Musselcracker or biskop | | | 1.3 | (5.3) | 0.0 | (0.0) | 1.3 | (4.6) | 4.3 | (8.6) | | | 1.7 | (4.6) |
| *Spondyliosoma emarginatum* | 0.24 | 6 | 0.6 | (0.2) | 1.8 | (0.4) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.5 | (0.1) |
| Steentjie | | | 0.9 | (0.3) | 0.0 | (0.0) | 10.9 | (0.0) | 0.0 | (0.0) | | | 2.9 | (0.1) |
| Coracinidae | | | | | | | | | | | | | | |
| *Dichistius capensis* | 1.70 | 41 | 2.7 | (6.4) | 3.6 | (6.3) | 4.4 | (10.5) | 2.2 | (2.9) | 6.5 | (8.9) | 3.9 | (7.0) |
| Galjoen | | | 4.4 | (11.8) | 2.6 | (8.9) | 2.1 | (4.9) | 2.2 | (4.2) | | | 2.8 | (7.4) |
| *Dichistius multifasciatus* | Rec | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.7 | (0.5) | 0.1 | (0.1) |
| Banded galjoen | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| Scorpididae | | | | | | | | | | | | | | |
| *Neoscorpis lithophilus* | 0.50 | 3 | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) |
| Stonebream or stinkvis | | | 0.2 | (<0.1) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | <0.1 | (<0.1) |
| Sciaenidae | | | | | | | | | | | | | | |
| *Argyrosomus japonicus* | Rec | | 0.8 | (2.8) | 0.7 | (1.2) | 1.1 | (3.3) | 0.0 | (0.0) | 0.7 | (2.1) | 0.7 | (1.9) |
| Kabeljou or kob | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |



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Table 1 (continued)

| Species | Mass used | Nos weighed | 1991 Nos | 1991 Mass | 1992 Nos | 1992 Mass | 1993 Nos | 1993 Mass | 1994 Nos | 1994 Mass | 1995 Nos | 1995 Mass | Mean Nos | Mean Mass |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mugilidae | | | | | | | | | | | | | | |
| *Liza richardsonii* | 0.19 | 17 | 0.0 | (0.0) | 1.4 | (0.3) | 1.1 | (0.3) | 2.2 | (0.3) | 0.7 | (0.1) | 1.1 | (0.2) |
| Southern mullet | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.4 | (0.1) | 0.0 | (0.0) | | | 0.1 | (<0.1) |
| Clinidae | | | | | | | | | | | | | | |
| *Clinus* spp. | 0.10 | 1 | 4.5 | (0.6) | 1.1 | (0.1) | 0.0 | (0.0) | 3.3 | (0.3) | 0.0 | (0.0) | 1.8 | (0.2) |
| | | | 0.0 | (0.0) | 0.5 | (0.1) | 0.4 | (0.1) | 4.3 | (0.5) | | | 1.3 | (0.2) |
| Tetraodontidae | | | | | | | | | | | | | | |
| *Amblyrhynchotes honckenii* | 0.22 | 5 | 30.2 | (9.1) | 31.6 | (7.0) | 13.5 | (4.2) | 10.7 | (1.8) | 12.2 | (2.2) | 19.6 | (4.9) |
| Blaasop, puffer or tobie | | | 2.2 | (0.8) | 0.0 | (0.0) | 4.2 | (1.3) | 0.0 | (0.0) | | | 1.6 | (0.5) |
| Fish unidentified | Rec | | 0.0 | (0.0) | 0.0 | (0.0) | 1.5 | (0.4) | 0.7 | (0.1) | 0.7 | (0.1) | 0.6 | (0.1) |
| | | | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | 0.0 | (0.0) | | | 0.0 | (0.0) |
| TOTAL | Visitors | | 513 | (373.88) | 440 | (433.96) | 275 | (194.06) | 271 | (349.33) | 139 | (171.22) | 327.6 | (304.49) |
| TOTAL | Locals | | 458 | (288.63) | 192 | (95.2) | 239 | (173.89) | 46 | (40.89) | 13 | (12.37) | 233.8 | (149.65) |
| EFFORT | Visitors | | 1618.9 | | 1089.0 | | 790.37 | | 747.0 | | 409.0 | | 930.8 | |
| EFFORT | Locals | | 959.3 | | 359.8 | | 423.4 | | 72.9 | | 47.3 | | 587.8 | |
| CARDS | Visitors | | 303 | | 220 | | 121 | | 141 | | 81 | | 173.2 | |
| CARDS | Locals | | 139 | | 49 | | 72 | | 13 | | 8 | | 68.3 | |
| TOTAL CPUE | Visitors | | 31.7 | (23.1) | 40.4 | (39.9) | 34.8 | (24.6) | 36.3 | (46.8) | 34.0 | (41.8) | 35.4 | (35.2) |
| TOTAL CPUE | Locals | | 47.7 | (30.1) | 53.4 | (26.5) | 56.4 | (41.1) | 63.1 | (56.1) | | | 55.1 | (38.4) |
| BONY FISH CPUE | Visitors | | 28.4 | (12.9) | 36.9 | (22.2) | 32 | (19.7) | 30.3 | (15.6) | 30.8 | (20.0) | 31.7 | (18.1) |
| BONY FISH CPUE | Locals | | 46.4 | (21.4) | 53.4 | (26.5) | 55 | (32.0) | 57.6 | (32.6) | | | 53.1 | (28.1) |

**Key** Rec = Recorded * = Coetzee (1# less abundant species, but odd specimens may have been included in data).

*Catch per unit effort*

The number of catch cards successfully completed and submitted each year decreased steadily from 442 in 1991 to 89 in 1995. Despite this decrease, the recorded annual cpue remained fairly constant, with that of visitors ranging from 32–40 fish/100 angler-hours ($\bar{x}$ = 35 fish/100 angler-hours), while that of locals (between 1991–1994) varying from 48 to 63 fish/100 angler-hours ($\bar{x}$ = 55 fish/100 h). The mean cpue in terms of weight was 35 (± 4 SE) kg/100 angler-hours and 38 (± 6 SE) kg/100 angler-hours for visitors and locals respectively (Table 1). No relationship was apparent between the number of cards analysed and the annual cpue.

The average cpue for the scientific fishing throughout the park was 154 fish/100 angler-hours and 188 kg fish/100 angler-hours, and was much higher than those recorded on the catch cards from the fishing area.

*Seasonality*

The monthly fishing effort of visiting anglers fluctuated markedly, with peak values recorded during April, July and December or January, months coinciding with the major provincial school holidays. In the case of local anglers, trends were less distinct, but fishing effort generally peaked in summer and early winter (Fig. 2). Sea temperature appeared to have little influence on fishing effort (Fig. 2).

In the case of visitors, peaks in monthly cpue (numbers and mass of fish per 100 angler-hours) for all species combined were generally asynchronous with highs in monthly fishing effort (Fig. 2), while correlations between effort and cpue were extremely poor (Spearman Rank Coefficient $r < 0{,}11$, $P > 0.42$, $n = 56$). The data for locals gave a better correlation between effort and cpue ($r < 0{,}47$, $0{,}006 < P > 0{,}003$, $n = 44$), suggesting that fish catches may have influenced the fishing effort of locals. For both visitors and locals the highest cpue were usually recorded between October and April. This pattern was reflected in the seasonality of catches of the abundant species (Fig. 3). The highest mean monthly cpue of *A. honcksenii* (visitors), *S. salpa*, *B. inornata* and *P. saltatrix* were between October and April. Only *D. capensis* was caught almost exclusively during winter.

Seasonality in the scientific fishing and the historical data were not analysed, because of the limited time scale of the records.

## Discussion

Only a small proportion of the more than 120 000 persons visiting the Storms River rest camp annually (NPB records) fished in the park (*pers. obs.*; angling card returns). The steady decrease in the number of cards returned each year during the study period (442–89) was probably a result of the following: (i) a decline in the motivation of the gate guards to ensure that all anglers leaving the park submit completed angling cards; (ii) increased apathy amongst locals toward completing cards; and (iii) abnormally cold sea temperatures during 1994 and 1995 (Fig. 2), which discouraged angling. Despite this variation in the number of card returns, the recorded annual cpue remained fairly constant, with the catch of visitors averaging 35 fish/100 angler-hours (35 kg/100 h), and that of locals (between 1991–1994) averaging 55 fish/100 angler-hours (38 kg/100 h).

Forty-seven percent of the visiting anglers lived more than 50 km away from the coast, and, therefore, may be considered to be relatively inexperienced in the specialised form of fishing required in the park, where the coast is rocky and the sea extremely turbulent. Most visitors appeared to fish primarily for recreation. Conversely, several of the local anglers fished to supplement their diet, targeting small edible fish, which are generally easier to catch than larger specimens. Visitors caught a greater diversity of fish than the locals (40 vs. 29 species), probably because of the greater fishing effort (4 654 h vs. 1 863 h), the relative inexperience of the anglers in targeting for specific species and

Table 2
*Species caught during scientific fishing in the Tsitsikamma National Park 1989 - 1991. Percentage contribution by number and mass*

| Species | Fishing area | | Rest of the park | |
|---|---|---|---|---|
| | % Nos | % Mass | % Nos | % Mass |
| CHONDRICHTHYES | | | | |
| *Mustelus mustelus* | 0.9 | 12.3 | 0.5 | 3.2 |
| *Triakis megalopterus* | 0.0 | 0.0 | 0.3 | 4.8 |
| *Haploblepharus spp.* | 5.5 | 11.3 | 3.7 | 2.6 |
| *Poroderma africanum* | 0.0 | 0.0 | 2.2 | 7.0 |
| *Poroderma pantherinum* | 1.8 | 8.2 | 2.5 | 4.2 |
| *Rhinobatos annulatus* | 0.0 | 0.0 | 2.0 | 3.2 |
| *Myliobatis aquila* | 0.0 | 0.0 | 0.5 | 2.3 |
| OSTEICHTHYES | | | | |
| *Conger wilsoni* | 0.9 | 2.1 | 0.0 | 0.0 |
| *Galeichthys feliceps* | 1.8 | 3.6 | 2.2 | 1.4 |
| *Epinephelus marginatus* | 0.0 | 0.0 | 1.3 | 1.3 |
| *Acanthistius sebastoides* | 0.0 | 0.0 | 0.2 | <0.1 |
| *Pomatomus saltatrix* | 5.5 | 12.3 | 2.4 | 2.1 |
| *Boopsoidea inornata* | 2.8 | 1.5 | 3.5 | 0.7 |
| *Cheimerius nufar* | 0.0 | 0.0 | 13.3 | 13.8 |
| *Chrysoblephus laticeps* | 0.0 | 0.0 | 1.8 | 2.0 |
| *Cymatoceps nasutus* | 0.0 | 0.0 | 1.7 | 1.9 |
| *Diplodus cervinus hottentotus* | 0.0 | 0.0 | 5.0 | 4.3 |
| *Diplodus sargus capensis* | 12.7 | 14.1 | 20.0 | 10.2 |
| *Lithognathus lithognathus* | 0.9 | 0.5 | 2.0 | 2.2 |
| *Lithognathus mormyrus* | 0.9 | 1.0 | 2.0 | 0.7 |
| *Pachymetopon grande* | 0.0 | 0.0 | 8.7 | 11.0 |
| *Petrus rupestris* | 0.0 | 0.0 | 1.2 | 4.8 |
| *Rhabdosargus holubi* | 8.3 | 6.6 | 3.4 | 1.4 |
| *Sarpa salpa* | 39.2 | 14.4 | 5.7 | 1.2 |
| *Sparodon durbanensis* | 0.9 | 0.2 | 1.7 | 1.1 |
| *Spondyliosoma emarginatum* | 0.0 | 0.0 | 1.0 | 0.2 |
| *Dichistius capensis* | 3.7 | 6.2 | 6.2 | 9.3 |
| *Neoscorpis lithophilus* | 0.0 | 0.0 | 0.5 | 0.2 |
| *Argyrosomus japonicus* | 0.0 | 0.0 | 0.8 | 0.9 |
| *Atractoscion aequidens* | 0.0 | 0.0 | 2.4 | 1.7 |
| *Liza richardsonii* | 14.5 | 5.7 | 0.2 | <0.1 |
| *Clinus superciliosus* | 0.0 | 0.0 | 0.2 | 0.1 |
| *Amblyrhynchotes honckenii* | 0.0 | 0.0 | 0.8 | 0.5 |

the lack of detail on the catch cards of local anglers. However, the mean annual cpue of the visitors was 35 % lower than that of the local anglers (35 + 1 SE vs. 55 + 3 SE fish/ 100 angler-hours), and a greater proportion of their catch (32 % vs. 6 %) was comprised of "trash" fish, such as sharks, rays, puffers and clinids. Clarke and Buxton (1989) recorded a similar trend in the Port Elizabeth region in that non-club anglers had a lower cpue and caught proportionally fewer desirable fish than club anglers.

Although visitors generally fished for recreation and locals for food, the species most frequently caught by both groups was the

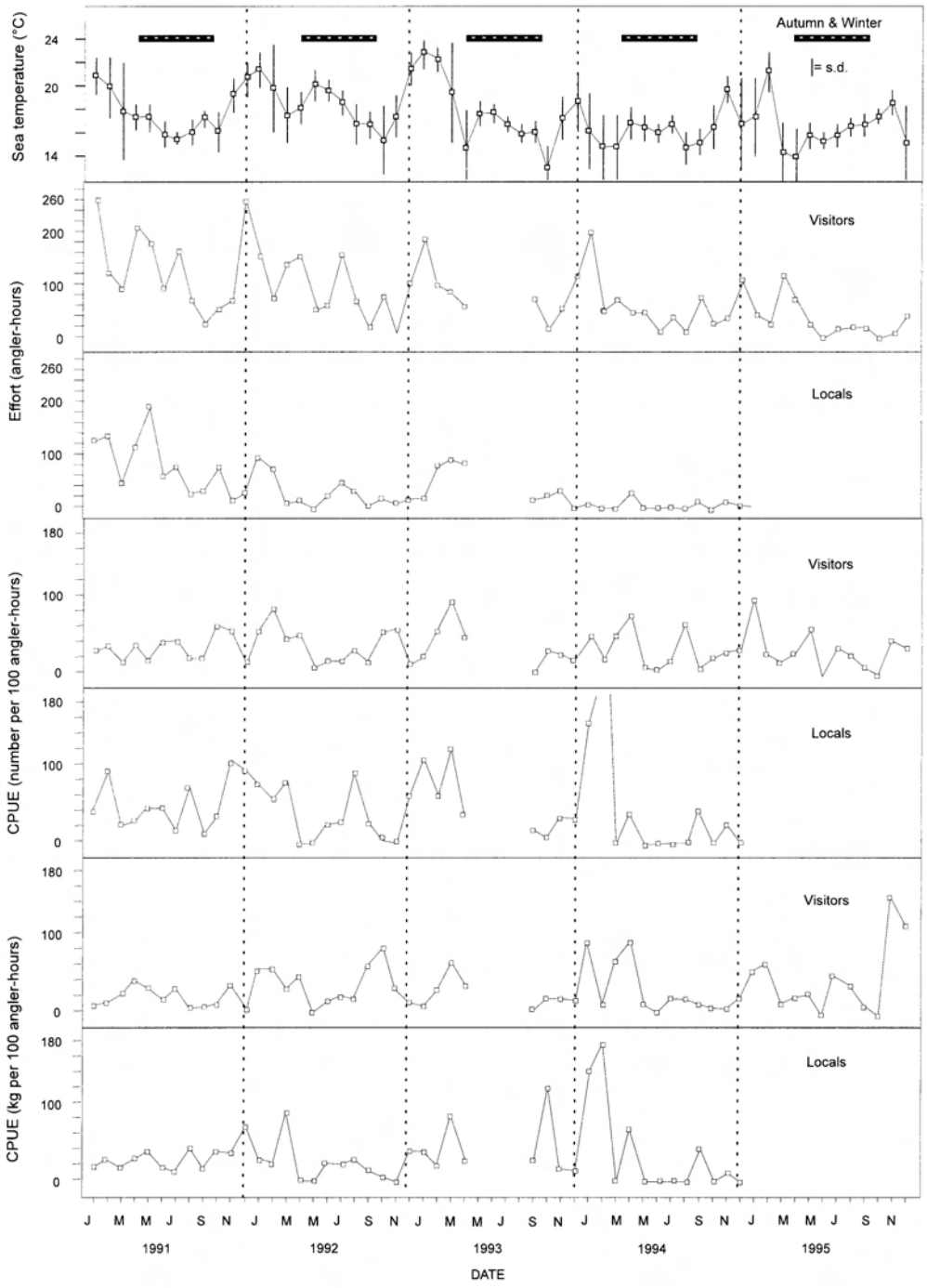


Fig. 2. Monthly variations in the mean and standard deviation (SD) in sea temperatures, as well as the overall fishing effort and catch per unit effort (cpue) of visitors and locals in the angling area of the Tsitsikamma National Park during the study period.

Table 3

*Percentage numerical and mass contribution of the more common species (>450 g) to the total catches recorded by land-based anglers at various sites in the Tsitsikamma National Park during 1964 and 1965. Mass value given in brackets*

| Species | Storms River (fishing area #) | | Geelhoutbos | | Flip se bank | | Jan Swarts | | Bloukrans | | Further 18 sites | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % Nos | % Mass | %Nos | %Mass | %Nos | % Mass | %Nos | %Mass | %Nos | %Mass | %Nos | %Mass |
| *Pomatomus saltatrix* | 20.4 | (13.8) | 1.2 | (1.1) | 4 | (4.0) | 1.3 | (0.8) | 2.4 | (1.1) | 7.0 | (2.7) |
| *Dichistius capensis* | 9.2 | (4.7) | 40.0 | (46.1) | 39 | (34.5) | 53.2 | (50.7) | 45.2 | (37.4) | 48.3 | (29.3) |
| *Pachymetopon grande* | 1.0 | (0.7) | 24.7 | (31.1) | 13 | (16.4) | 3.8 | (4.5) | 13.3 | (12.8) | 7.4 | (5.8) |
| *Argyrosomus japonicus* | 13.3 | (12.2) | 1.2 | (0.7) | 21 | (18.9) | 2.5 | (3.1) | 8.4 | (10.7) | 4.4 | (4.0) |
| *Diplodus sargus capenis* | 9.2 | (3.5) | 4.7 | (3.1) | 8 | (5.8) | 12.7 | (9.9) | 9.0 | (5.2) | 4.4 | (1.3) |
| *Sparodon durbanensis* | 13.3 | (41.5) | 17.6 | (5.4) | 2 | (6.1) | 2.5 | (4.3) | 4.2 | (12.9) | 13.4 | (37.6) |
| *Rhabdosargus holubi* | 1.0 | (0.2) | 3.5 | (4.6) | 0 | (0.0) | 1.3 | (2.3) | 6.6 | (7.4) | 1.7 | (1.3) |
| *Lithognathus lithognathus* | 18.4 | (13.5) | 0.0 | (0.0) | 2 | (5.8) | 6.3 | (6.1) | 3.6 | (3.9) | 1.7 | (2.4) |
| Total contribution | 85.8 | (90.2) | 92.9 | (92.1) | 89 | (91.6) | 83.5 | (81.7) | 92.8 | (91.3) | 88.3 | (84.4) |
| Total nos (mass) recorded | 98 | (266.5) | 85 | (276.8) | 100 | (377.2) | 79 | (258.3) | 166 | (708.9) | 298 | (740.7) |

**Key:**! = sites situated close to Beyers se eiland (Fig. 1).
# = includes the 2 km section immediately east of the current angling zone.

small *S. salpa*, comprising 22.6 % and 36.7 % of the total catches respectively. The small hook size and pilchard bait used by many anglers in this area would tend to target these smaller species. *Sarpa salpa* and *B. inornata* were the most abundant species observed during shallow (0–25 m) underwater transects in the park (Buxton & Smale 1984). These two species respectively comprised in the order of 47 % and 18 % of the suprabenthic fish counted in both subtidal gullies and on shallow coralline dominated reefs (Burger 1990).

Lack of experience, poor selection of angling sites and fishing tackle by visitors probably contributed to the prevalence of the unpopular puffer *A. honckenii* in their catches. This dominance of *A. honckenii* caused the overall catch of visitors to differ from that recorded in other areas along the South African coast (Table 4). However, two of the three most frequently caught species by local anglers, *S. salpa* and *P. saltatrix*, were the most dominant species numerically in the catches of shore-based fishermen in the Port Elizabeth area (Clarke and Buxton 1989) and at select sites along the KwaZulu-Natal coast (Joubert 1981). The catch composition of locals was also similar to that from St Croix in that *P. saltatrix* and *B. inornata* were important species numerically (Table 4; Coetzee & Baird 1981). Comparisons with sites to the west of the TNP were more difficult, because of discrepancies in sampling techniques (Table 4). At the De Hoop Nature Reserve the smallest hook used was a size #1 and fish less than 24 cm were seldom caught (Bennett and Attwood 1993a), while the three angling clubs studied in the South-Western Cape enforced a minimum size limit of between 450 g and 500 g (Bennett *et al.* 1994). These restrictions would exclude most specimens of *S. salpa*, *B. inornata* and *A. honckenii* from the catches.

The contribution of *D. sargus capensis* to the catches recorded in the fishing area of the TNP was low, when compared to most other sites studied in southern Africa (Table 4). *Diplodus sargus capensis* was recorded almost exclusively at depths of less than 15 m in the park, apparently being restricted

Table 4

*Species contributing (by number) more than 10 percent of the catches recorded at various sites along the southern Africa coast. Included are source of the data, method of sampling, fishing limitations, percentage of the catch averaging less than 450 g, and the time period over which the data was collected ( Table modified from Bennett & Attwood 1993a )*

| Most westerly site | | | | | | | | | Most eaterly site |
|---|---|---|---|---|---|---|---|---|---|
| **Site** | Terrace Bay | S.W. Cape | De Hoop Nature Res. | Tsitsikamma National Park | | | Port Elizabeth | St Croix Isl. | Kwazulu Natal |
| **Reference** | P&L 1982 | B&A 1993a B,A&M 1994 | B&A 1993a | This study | This study | This study | C&B 1981 | C&B 1981 | J 1981 |
| **Sampling method** | Angler catch card | Angling records | Scientific sampling | Visitor catch card | Locals catch card | Scientific sampling | Pers. obs. | Pers. obs. | Pers. obs. |
| **Limitation** | Edible fish | Fish > 450g hook > 1# | Bait | Bait | Bait | Bait | - | - | - |
| **% of catch < 450 g** | <1 | 0 | <1 | 51 | 65 | 24 | 56 | 33 | >40 |
| **No. of spp (teleosts)** | c. 10 | 32 | 27 | 27 | 22 | 26 | 26 | 35 | 76 |
| **Time period** | 1980 | 1938-92 | 1984-92 | 1991-95 | 1991-95 | 1989-91 | 1985-86 | 1975-78 | 1975-77 |
| **Abundant species** | **Numerical percentage contribution to total catch** | | | | | | | | |
| *Sarpa salpa** | - | (0) | (0.1) | 22.6 | 36.7 | 11 | 21.5 | (5.1) | 20.4 |
| *Pomatomus saltatrix* | - | (2.9) | (0.2) | (4.8) | 10.4 | (2.8) | 30.3 | 20.3 | 22.7 |
| *Diplodus sargus capensis* | 27 | 12.9 | 33.5 | (6.7) | (5.0) | 19 | 18.4 | 13.4 | 9.2 |
| *Boopsoidea inornata** | - | (0) | (<0.1) | (1.7) | 21.8 | (3) | (0) | 14.6 | (1.4) |
| *Amblyrhynchotes honckenii** | - | (0) | (<0.1) | 19.6 | (1.6) | (1) | (0.2) | (0) | (0) |
| *Cheimerius nufar* | - | (0) | (0.0) | (0.4) | (0.1) | 11 | (0) | 21.3 | (<0.1) |
| *Pomadasys olivaceum* | - | (0) | (<0.1) | (<0.1) | (0) | (0) | (0.2) | (0) | 19.7 |
| *Dichistius capensis* | 60 | 24.7 | 56.7 | (3.9) | (2.8) | (6) | (0.2) | (0.4) | (0.1) |
| *Lithognathus lithognathus* | - | 29.5 | (2.1) | (4.1) | (3.7) | (1.8) | (1.0) | (0) | (<0.1) |
| *Argyrosomus spp.* | (5) | 10.3 | (0.6) | (0.6) | (0) | (1) | (0.8) | (0.1) | (0.6) |
| Catch rate (nos/100hrs) | 150 | c. 10 | 194 | 24 | 50 | 154 | 29 | 84 | 22 |

**Key**

B&A 1993a = Bennett & Attwood 1993a.
B,A & M 1994 = Bennett, Attwood & Mantel 1984.
C&B 1989 = Clarke & Buxton 1989.
C&D 1981 = Coetzee & Baird 1981.
J 1981 = Joubert 1981.
P & L 1982 = Penrith & Loutit 1982.
* = small size species

primarily by food requirements (Mann 1992). The terrain within the open fishing area is fairly unsuitable for *D. sargus capensis* as the coast shelves off quickly, thereby limiting the habitat available for this species. However, *D. sargus capensis* occurs in considerable numbers in shallower areas elsewhere in the park, as this species comprised 20 % of the catch made outside the fishing area and 13 % of the suprabenthic fish recorded during visual censuses in subtidal gullies in the park (Burger 1990).

Numbers of teleost species recorded in the catches of shore-based anglers around southern Africa increased eastwards from Namibia to KwaZulu-Natal (Bennett & Attwood 1993a). The species composition recorded from the angling area in the TNP is similar to that (26–28 species) recorded from De Hoop Nature Reserve (Bennett and Attwood 1993a), False Bay (Bennett 1991) and the Port Elizabeth area (Clarke & Buxton 1989). These sites are all situated in the Warm Temperate South Coast Biogeographical Province (Emanuel *et al.* 1992).

The average cpue of visitors (35 fish/100 angler-hours) was 35 % lower than that of locals (55 fish/100 angler-hours). However,

the mean cpue recorded during scientific angling was 154 fish/100 angler-hours. This higher cpue corresponds with those recorded in other protected areas along the coast, namely those in the De Hoop Nature Reserve (194 fish/100 angler-hours, Bennett and Attwood 1993a), in the Terrace Bay region (150 fish/100 angler-hours, Penrith and Loutit 1982) and on St. Croix Island (84 fish/100 angler-hours, Coetzee and Baird 1981). All of these areas are protected from severe exploitation as access to St. Croix Island was restricted to a limited number of anglers on one weekend a month, the De Hoop Nature Reserve is closed to angling and the relatively small angling area of Terrace Bay is situated within the Skeleton Coast National Park (Bennett & Attwood 1993a).

The low cpue recorded in the fishing area require further discussion. Although the cpue of visitors (35 fish/100 angler-hours) was higher than those recorded in heavily exploited areas, such as KwaZulu-Natal (22 fish/100 angler-hours, Joubert 1981), the Port Elizabeth region (29 fish/100 angler-hours, Clarke & Buxton 1989) and the False Bay area (7–29 and 8–12 fish/100 angler-hours, Bennett 1991, Bennett & Attwood 1993a, Bennett *et al.* 1994), the fact that this fishing area is in the centre of a marine park suggests that it should produce a considerably higher cpue. However, the following factors are probably responsible for the low cpue recorded in the fishing area of the TNP. Visitors to the TNP are generally not experienced in fishing deep water, rocky areas. Furthermore, the angling area is extremely difficult to fish especially during rough weather and anglers regularly lose large amounts of terminal tackle. The upwelling events common along the south eastern Cape coast appear to be prevalent in the Storms River area (Schumann *et al.* 1982), which may influence the abundance of fish in this region (Buxton & Smale 1989; Hanekom *et al.* 1989). As the area has never been closed to exploitation, it is possible that larger resident species have been removed.

The small contribution of fish larger than 450 g found in this study was also surprising. However, angling data from 1964 and 1965 (Table 3) and from the scientific fishing in the park during 1989–1990 (Table 2) suggest that catches in the Storms River region are atypical of the rest of the TNP. Species (> 450 g) most frequently recorded in the fishing area during the 1964-65 period were *P. saltatrix*, *L. lithognathus*, *A. japonicus* and *S. durbanensis*. Adults of these species undertake spawning migrations (Van der Elst 1981; Buxton & Clarke 1991; Bennett 1993a; Griffiths & Hecht 1996), and regularly leave the protection of the park. Elsewhere along the South African coast catches of *P. saltatrix* (Van der Elst 1976, 1989) and *L. lithognathus* (Bennett 1991, 1993) have declined markedly since the mid 1960s, and the poor catches of these species during the study period were probably a consequence of a general decline in fish stocks. The abundance of *A. japonicus* and *S. durbanensis* along the south-east Cape is difficult to determine, because of long-term cyclic trends in the angling catches (Coetzee *et al.* 1989). However, these species are likely to be highly susceptible to overexploitation, because they are slow growing, long-lived (> 30 yrs) species, which are reproductively inactive for at least the first five years of their lives (Griffiths & Hecht 1996; Buxton & Clarke 1991). Furthermore, *S. durbanensis*, has a very limited distribution range, being endemic to South Africa where it is found primarily over relatively shallow water reefs (Buxton & Clarke 1991).

*Dichistius capensis* and to a lesser extent *P. grande* were abundant in catches made elsewhere in the park during the mid 1960s (Table 3), but they were relatively uncommon in catches in the fishing area both during the mid 1960s and early 1990s (Table 1 & 3). These species appear to be confined to

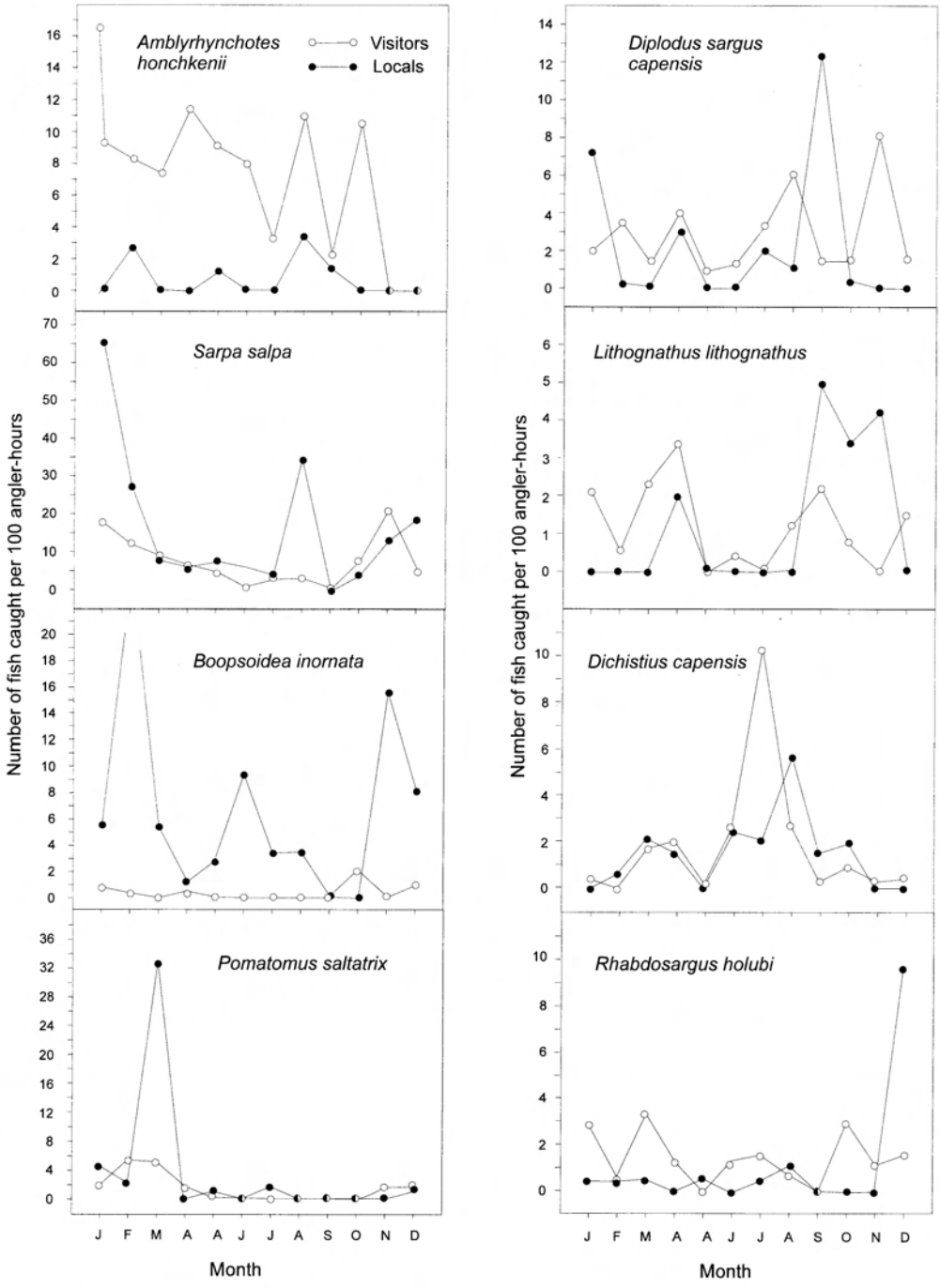


Fig. 3. Mean monthly catch rates of the more common fish species caught by visitors and locals in the angling area of the Tsitsikamma National Park.

fairly shallow water (Buxton & Smale 1984; Bennett & Griffiths 1986; Buxton & Clarke 1992), and tagging studies have shown *D. capensis* (Bennett *et al.* 1989 in Bennett & Attwood 1991) and *P. grande* (Cowley & Hecht 1997) to be resident in small areas (< 3 km of shore) for long periods. The habitat selection and highly resident nature of these fish may partly account for the low catches in the fishing zone (Table 1) and the infrequent sightings of these species during visual surveys in the Storms River region (Buxton & Smale 1984). Furthermore, the low numbers of these resident species caught in the fishing area maybe a result of localised overfishing, as both species are relatively slow growing and vulnerable to overexploitation (Bennett & Griffiths 1986; Buxton & Clarke 1992; Bennett & Attwood 1991). *D. capensis* and *P. grande* were commonly seen in subtidal gullies and over shallow reefs elsewhere in the park (Mann 1992), and were fairly frequently caught in the catches made during scientific fishing, which targeted *D. sargus capensis* and *D. cervinus hottentotus* (Table 2).

Temporal and spatial variations in the relative abundance of the various fish species in the TNP are difficult to discern, because cartilaginous species were omitted from the records of the mid 1960s, while the scientific fishing targeted the relatively small *D. sargus capensis* and *D. cervinus* hottentotus. The contribution of teleosts to the catches of competitive shore anglers in KwaZulu-Natal decreased markedly between the late 1950s and early 1980s, while that of the less desirable cartilaginous species increased (Van der Elst 1989). The percentage contribution in terms of numbers (3 %–11 %) and mass (23 %– 45 %) of cartilaginous species to the overall catches of both visitors and locals in the fishing area was higher than that (2% & 15%) recorded from shore-angling catches in the Port Elizabeth area (Clarke & Buxton 1989). However, this discrepancy was probably largely due to the fact that pilchard and chokka were generally the only bait available to anglers in the TNP.

Although the data from the fishing area do not show convincing evidence of the role of the park in the protection of fish resources, the considerably higher cpue and the increased contribution of larger species recorded during the scientific fishing elsewhere in the park suggests that the TNP is providing protection for shore-angling species. The cpue recorded in the TNP, even within the fishing area, was higher than that recorded in exploited areas elsewhere in the south eastern Cape. This is despite the fact that the angling area in the park has never been closed to exploitation.

The major species caught in the fishing area of the TNP during this study (*S. salpa*, *A. honckenii*, *D. sargus capensis*, *B. inornata* and *P. saltatrix*) are fairly abundant species found over a wide distribution range along the South African coast (Van der Elst 1981; Smith & Heemstra 1986; Van der Walt 1996). They are generally small species and are common throughout the park. These factors, together with the fact that a only a small area of the park east of Groot River (west) is open to exploitation (5 %), the low number of fishing outings recorded in the area (< 516 per year) and the steady cpue over the past 5 years, suggest that the impact on the resource is probably sustainable. However, there are numerous other factors that should be considering when evaluating the possibilities of permitting angling to continue in the park. Firstly, fishing is in conflict with the objectives of a national park, which includes the preservation of marine animal and plant life (National Parks Act of 1976; Government Gazette, 28 April 1976, No 5096), and, therefore, sets a precedent for other harvesting activities. Secondly, in a recent survey McGrath *et al.* (1996) estimated that < 6 % of the recreational anglers in South Africa have incomes below the poverty-line and that angling increases the income of these households by only about 10 % Therefore, the economic benefit, to the local community, of angling in the current fishing zone is likely to be relatively small. Moreover, relatively few people appear to use fishing facilities in the park, because,

during 1991 (the year with the highest number of catch returns), less than one percent of the approximately 121 500 persons that visited the park submitted catch returns (NPB unpubl. records), despite the regular issuing of cards at the entrance gate. Anglers, therefore, contribute little to the financing of the park through entrance fees and purchases. In fact, discarded bait and plastic bags left by anglers probably adversely affect the wilderness experience of numerous hikers walking the first 3 km of the Otter Trail, a trail which generates approximately R0.7 m in gross revenue per annum (NPB unpubl. records). It is the revenue of non angling visitors which largely enables the TNP to employ 115 permanent staff members and, therefore, make a significant contribution towards the gross domestic product of the Tsitsikamma region.

Finally, the TNP is likely to play an important role in the conservation of recreational fish stocks in the southern Cape, because:

(i) The catch restrictions (such as minimum size and bag limits) imposed in 1985 (Government Gazette No. 9543 of 31 December 1984) do not appear to adequately protect shore-angling species along the South-Western Cape (Bennett *et al.* 1994), and the number of shore-anglers along the South African coastline is increasing annually (Bennett 1992).

(ii) Marine protected areas have enormous potential for use in fisheries management. Bennett & Attwood (1991) recorded a 4 to 5-fold increase in the cpue of *D. capensis* and *D. sargus capensis* within 2 years of the establishment of the De Hoop Nature Reserve, and more gradual recoveries for four other sparids *L. lithognathus*, *D. cervinus*, *S. dubanensis* and *Rhabdosargus holubi*. Furthermore, Bennett & Attwood (1993b) estimated that during the early 1990s approximately 11 000 *D. capensis* dispersed out of the De Hoop Nature Reserve annually, thereby improving the fishing in the adjacent exploited areas.

(iii) Only about eight marine reserves in South Africa provide some protection for shore-angling fish species (Anon 1995), and the TNP is the largest of these (Hockey & Buxton 1989).

The above factors suggest that it would be ecologically preferable to close the TNP to all angling, and that this ruling would not have a major impact on the subsistence of the local communities.

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