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# THE FISHERY FOR WHITE STEENBRAS *LITHOGNATHUS LITHOGNATHUS* OFF THE CAPE COAST, SOUTH AFRICA, WITH SOME CONSIDERATIONS FOR ITS MANAGEMENT

*B. A. BENNETT**

Aspects of the fishery for *Lithognathus lithognathus* around the Cape coast are described and information pertinent to management is presented. Prior to 1960, beach-seining was the most important source of fishing mortality, but angling catches have become increasingly important since then. Total annual catch for the period 1985–1990 is estimated at 30 000–35 000 fish, approximately 70% of which was taken by recreational anglers and 30% by commercial fishermen. In terms of mass, the catch was divided equally between the two fisheries. Long-term catch data indicate major declines. The reported mean annual commercial catch for the period 1983–1991 was only 14% of that for the years 1897–1906. The catch rate of recreational anglers has declined by 90% since the mid 1970s. Modelling of the responses of yield per recruit, spawner biomass per recruit and mean mass to altered fishing mortality ($F$) and age at recruitment into the catch ($t_c$) suggests that the stock is overexploited and that a substantial decrease in $F$ and an increase in $t_c$ would benefit the fishery. It is suggested that benefit would accrue from increasing the minimum size limit to 65 cm (the length at 50% maturity) and restricting the "Russman" seine fishery on the western shores of False Bay to a 4–6 week season. All other restrictions on the commercial fishery ought to revert to the 1989 situation.

Aspekte van die vissery na *Lithognathus lithognathus* om die Kaapse kus word beskryf en inligting ter sake by sy bestuur word aangebied. Voor 1960 was strandseëns die belangrikste bron van bevissingsmortaliteit, maar hengel het sedertdien toenemend belangrik geword. Die totale jaarvangs vir die tydperk 1985–1990 word op 30 000–35 000 vis geraam, waarvan sowat 70% deur sporthengelaars en 30% deur handelsvissers gevang is. Wat die massa betref, was die vangs gelykop tussen die twee visserye verdeel. Langtermynse vangsgegewens dui op groot afnames. Die aangetekende jaarlikse handelsvangs vir die tydperk 1983–1991 was gemiddeld maar 14% van dié vir die jare 1897–1906. Die vangkoers van sporthengelaars het met 90% sedert die middel-1970s afgeneem. Modellering van die reaksies van opbrengs per rekruut, kuitskieterbiomassa per rekruut en van gemiddelde massa op gewysigde bevissingsmortaliteit ($F$) en ouderdom by rekrutering tot die vangs ($t_c$) dui daarop dat die stapel oorbevis word en dat 'n aansienlike vermindering van $F$ en 'n vermeerdering van $t_c$ die vissery tot voordeel sal strek. Daar word aan die hand gedoen dat dit voordelig sou wees om die minimummaatgrootte tot 65 cm (die lengte waarby 50% geslagsrypheid bereik) te verhoog en die "Russman"-seënvissery langs die weskus van Valsbaai tot 'n seisoen van 4–6 weke te beperk. Alle ander beperkings op die handelsvissery moet na die toestand wat in 1989 gegeld het, terugkeer.

Historically, the white steenbras *Lithognathus lithognathus* has been the most important component in the catches of rock-and-surf anglers in the South-Western Cape, constituting approximately 30% of catches documented since 1938 (Bennett 1991). The species also makes up a significant portion of beach-seine catches (Penney 1991) and was occasionally taken in large numbers by purse-seines. Recently, recreational anglers became concerned that catches had declined markedly, a situation that they attributed to commercial beach-seining. Commercial fishermen, on the other hand, denied any recent major declines in their catches and suggested that changes experienced by anglers were due to the exponential increase that has occurred in the numbers of anglers exploiting the surf-zone. There was lack of evidence in support of either argument. As a result, a programme was designed to provide a scientific basis for the resolution of this issue.

The first part of this study, which describes the biology and life history of *L. lithognathus*, was completed recently (Bennett 1993). The main findings were that a high degree of estuarine dependence, confinement of juveniles and subadults to the surf-zone, a large size of maturation and predictable aggregation of mature individuals in areas accessible to fishermen all rendered *L. lithognathus* vulnerable to estuarine degradation and exploitation by fishermen. However, no attempt was made to establish whether this apparent vulnerability had resulted in stock declines.

The present paper contains the results of an investigation of the fisheries for *L. lithognathus* in waters of the Cape Province. Its aims are to establish the past and present importance of the species in catches of commercial and recreational fishermen, and to describe and analyse any long-term changes that may have occurred. The current status of the stock is assessed,

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and measures that could be introduced to ensure its healthy future are suggested.

## METHODS

Documented information concerning historical and recent catches of *Lithognathus lithognathus* around the Cape coast were obtained from a wide variety of sources. The areas and time periods represented and the quality of the different sets of data varied considerably. For this reason, not all data sets could be used in all the analyses undertaken. The sources of information, time periods, areas, sample sizes, types of data and the analyses undertaken are outlined in Table I.

Stock assessments were undertaken according to the procedures recommended by Butterworth *et al.* (1989) and using PC Yield II software (Punt and Hughes 1989). The responses of yield per recruit ($Y/R$), spawner biomass per recruit ($\underline{SB}/R$) and the mean mass of individual fish in the catch ($\overline{W}$) to altered fishing mortality ($F$) and ages at recruitment into the fishery ($t_c$) were examined for different levels of natural mortality ($M$). The growth parameters (a, b, $l_1$ and $l_2$), the constants from the length-mass relationship (A and B) and the age at 50% maturity ($t_m$) that were used in this analysis were from Bennett (1993). Total mortality ($Z$) was estimated from catch curves by the method described by Butterworth *et al.* (1989) and natural mortality ($M$) was estimated using the relationships of Pauly (1980) and Rikhter and Efanov (1977). Fishing mortality ($F$) was obtained by subtracting $M$ from $Z$.

## RESULTS AND DISCUSSION

### The commercial beach-seine fishery

LONG-TERM TRENDS

The first data concerning catches of white steenbras in South Africa are provided by Gilchrist (1898–1904,

Table I: The origins of the information concerning *Lithognathus lithognathus* in the marine environment on which this study is based. Included are the data sources, the time periods, the areas they represent, the sample sizes and the different types of data provided

| Source | Period | Area | Sample size | Data |
|---|---|---|---|---|
| | | *Marine beach-seining* | | |
| Commercial catch returns (Gilchrist 1989–1904, 1906, 1907) | 1897–1906 | Entire Cape Province | 230 611 | Annual total catch, interannual variation, spatial variation, long-term trends, importance in catch |
| Private commercial catch records | 1951–1968, excluding 1953–1957 and 1966 | Northern coast of False Bay | 23 881 | Annual total catch, interannual variation, long-term trends, catch frequencies, importance in catch |
| Private commercial catch records | 1977–1987 | Northern coast of False Bay | 31 922 | Annual total catch, interannual variation, long-term trends, catch frequencies, importance in catch |
| Commercial catch returns SFRI (unpublished) | 1983–1991 | Entire Cape Province | 28 188 | Annual total catch, interannual variation, spatial variation, long-term trends, importance in catch |
| This study | 1989–1991 | Simon's Bay | 1 278 | Annual total catch, catch frequencies |
| This study | 1989–1991 | Northern coast of False Bay | 1 033 | Annual total catch, catch frequencies |
| | | *Marine shore-angling* | | |
| Club records | 1938–1991 | False Bay | 4 615 | Trends in *cpue*, mean size trends, catch frequencies, importance in catch |
| Catch cards (Coetzee *et al.* 1989) | 1959–1982 | Eastern Cape Province | 788 | *Cpue*, mean size trends, importance in catch |
| Research angling Bennett (unpublished) | 1984–1991 | De Hoop marine reserve | 469 | Trends in *cpue*, catch frequencies |

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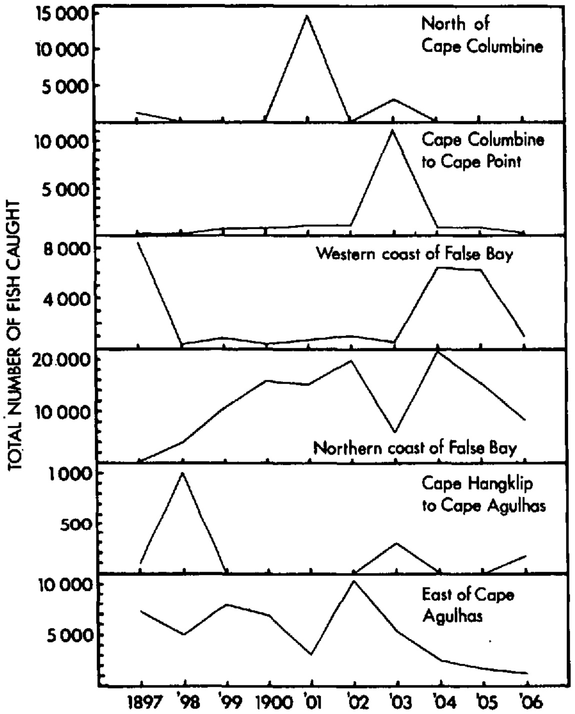


Fig. 1: Estimated annual catch of *Lithognathus lithognathus* recorded from six areas of the Cape Province between 1897 and 1906 (data from Gilchrist 1898–1904, 1906, 1907)

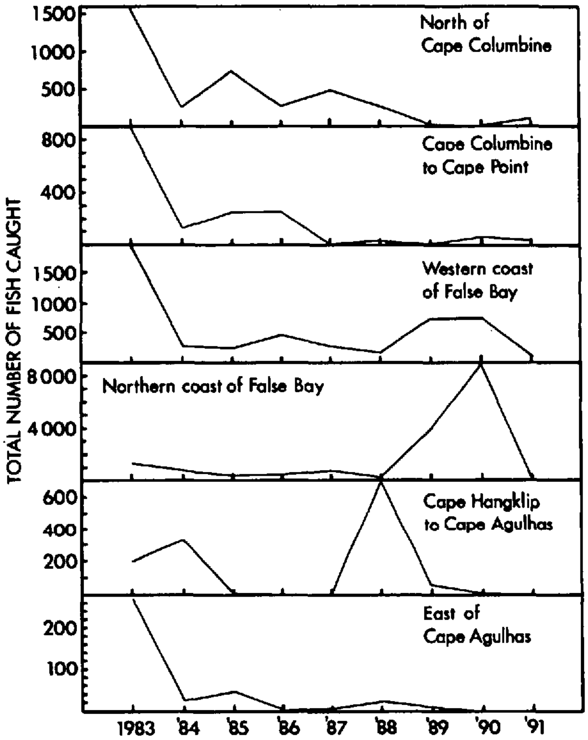


Fig. 2: Annual catch of *Lithognathus lithognathus* reported from six areas of the Cape Province between 1983 and 1991 (unpublished data from the Sea Fisheries Research Institute)

1906, 1907) for the years 1897–1906. These data are estimates of total catch made at some 20 localities around the entire coast of the Cape Province. Although it is probable that the majority of fish reflected in these returns were caught in beach-seines, catches made by other techniques, including gillnets and handlines, are also included.

Catches at all localities were highly variable over the 10 years covered by the returns, as illustrated by time-series of catches in which data are grouped into six regions of the coast (Fig. 1). The only patterns to emerge were that total catches in different regions were markedly different, annual catches varied dramatically over the period sampled, and there was no correspondence between years of good and poor catches in the different regions.

The compulsory catch returns for the years 1983–1991 that were submitted by beach-seine permit holders to the Sea Fisheries Research Institute (SFRI) are the only other data available concerning commercial catches around the Cape Province. These data also indicate considerable interannual variability and differences in total catch between regions (Fig. 2). However, a trend of decreasing catches over the period is evident in four of the six regions (north of Cape Columbine, Cape Columbine to Cape Point, the western coast of False Bay and east of Cape Agulhas). In these regions, 1983 was a year of high catches but declines are evident thereafter, with 1991 being a poor year in all areas. The degree to which the declines are attributable to decreasing stock size is unknown, but it is probable that progressively more stringent restrictions placed on beach-seining over this period also had a negative effect on catches.

Two other data sets concerning commercial catches of white steenbras are available. Both are private records of beach-seiners operating along the northern coast of False Bay and provide estimates of total catch for the years 1951–1968 and 1977–1987 respectively. These data show only that interannual variation was large (Fig. 3a, b).

Comparisons between the mean annual catches in the data sets from different periods are possible, but great care needs to be exercised when interpreting differences. The mean annual catches in the six different areas of coast for the periods 1897–1906 and 1983–

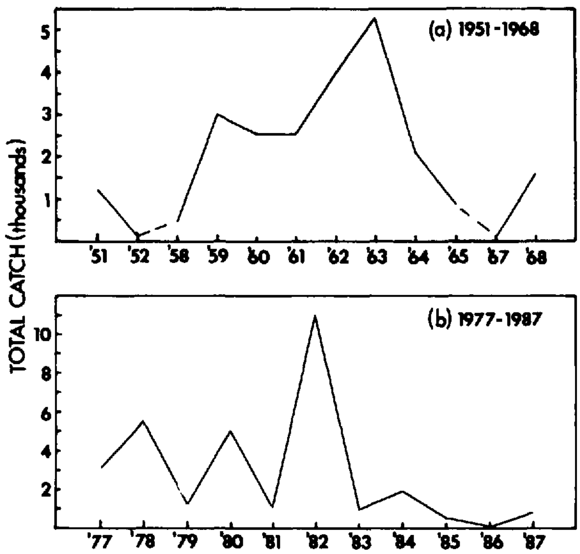


Fig. 3: Annual catch of *Lithognathus lithognathus* from the northern coast of False Bay recorded by beach-seine permit-holders during the periods (a) 1951–1968 and (b) 1977–1987

1991 are given in Table II. Considerable differences between areas during both periods are evident, the largest catches being made along the northern coast of False Bay. The relative proportions of the total catch in each region were similar during both periods, with the notable exception that catches from east of Cape Agulhas were considerably lower during the later period. Mean annual catches in all areas were considerably smaller over the period 1983–1991 than in 1897–1906, the later catches being between 1 and 22% of the earlier ones. Overall the catch apparently declined by some 86%.

Comparisons of the relative abundance of the different species caught by beach-seining along the northern shore of False Bay are possible from the data available. Gilchrist's (1898–1904, 1906, 1907) data for Muizenberg show that, in terms of numbers, *L. lithognathus* (3,77%) was the fourth most important contributor to total catch. However, in terms of mass it was the third most important species (19,37%). The three post-1950 data sets indicate a substantial decline in the importance of *L. lithognathus* relative to the earlier period. The contribution by number of *L. lithognathus* to catches declined from 0,57% (1951–1968) to 0,43% (1977–1987) and then to 0,19% (1983–1991), whereas in terms of mass it fell from 6,93% to 6,00% and then to 2,62%.

Differences in the way catches were reported and in the severity of catch restrictions during the four periods need to be taken into account when attempting to compare the data. At the time when the Gilchrist data were collected, there were no restrictions on any of the fisheries and fear of the "taxman" was the only likely pressure on the netters to under-report their catches. The data for the period 1951–1968 were obtained from the pay books of an operator who was not obliged to submit catch returns. These data are likely to be accurate for the occasions recorded (even though small fish are unlikely to have been noted), but when total catch was small records were not kept, so that total catch was underestimated. The 1977–1987 data, also from the private records of a commercial operator, were meticulously kept and provide an accurate record of catches made. However, these data were from the period during which beach-seining activities became strictly controlled. In 1983, seining at night was prohibited, a closed season was implemented, minimum sizes were increased and net lengths were limited. At the same time, the catching of white steenbras and other species was prohibited in all areas except Walker Bay and False Bay, and the number of beach-seine nets permitted to operate in False Bay was reduced by approximately 75%. These restrictions could be interpreted as having

Table II: Reported mean annual seine-net catches (numbers) of *Lithognathus lithognathus* from six areas of the Cape Province for the years 1897–1906 and 1983–1991. The figures in parentheses are the percentage contribution of each area's catch to the total catch. The catches during the years 1983–1991 are also expressed as a percentage of the catch during the years 1897–1906

| Area | Mean annual catch (numbers) | | | | Catch during the period 1983–1991 as a percentage of that during the years 1897–1906 |
|---|---|---|---|---|---|
| | 1987–1906 | (%) | 1983–1991 | (%) | |
| North of Cape Columbine | 1 893 | (8) | 374 | (12) | 20 |
| Cape Columbine to Cape Point | 1 665 | (7) | 179 | (6) | 11 |
| Western coast of False Bay | 2 548 | (11) | 557 | (18) | 22 |
| Northern coast of False Bay | 11 648 | (51) | 1 848 | (59) | 16 |
| Cape Hangklip–Cape Agulhas | 879 | (4) | 145 | (5) | 16 |
| East of Cape Agulhas | 4 429 | (19) | 44 | (1) | 1 |
| All areas | 23 061 | | 3 147 | | 14 |

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both positive and negative effects on catches of white steenbras, but the reduced catches after 1982 suggest that the overall effect was negative.

Catch returns submitted to the SFRI for the years 1983–1991 document the period after the suite of restrictions was imposed in 1983, but additional restrictions were imposed during this period. A closed season was implemented, the use of "Russman" nets (sinking seine-nets usually set >500 m offshore) was prohibited, rope lengths were restricted and certain areas were closed to netting. The marked declines in catches between 1983 and 1984 in the areas north of Cape Point and east of Cape Agulhas (Fig. 2) reflect the fact that it was illegal to net white steenbras in those areas after 1983. In the areas where it remained legal to catch this species, it is likely that permit-holders under-reported catches for fear of further restriction.

## ESTIMATED TOTAL CATCH

Varying degrees of under-reporting of catches in all the commercial data sets ensure that they are minimum estimates of total catch. While there is no way of quantifying the magnitude of under-reporting in data prior to 1989, comparisons between catch rates observed during the present study and recent catch returns permit estimates of total catch and an assessment of the accuracy of reporting.

The average catch per haul of *L. lithognathus* in 15 hauls undertaken in Simon's Bay on the west coast of False Bay during the open season between December 1990 and December 1991 was 74 fish. These experimental catches were the only legal ones made, because the use of "Russman" nets and long ropes was illegal from the beginning of 1990. The catch of more than 1 000 fish in only 15 hauls casts some doubt on the returns received by SFRI for the period 1983–1989, when the mean annual reported catch was only 589 fish (Fig. 2). This lower catch suggests an annual effort of only eight hauls at the 1990–1991 catch rate. If effort at this site (Mackerel Beach in Simon's Bay) was at the more likely level of 15 hauls per month over the six-month open season, a mean annual catch in the region of 6 500 fish might be expected. The accuracy of this estimate is difficult to assess because the extent to which more frequent seining during former commercial operations was likely to reduce catch per haul is unknown. Also unknown is the degree to which the 1991 data reflect an "average" year. Because of these uncertainties it is possible that the estimate of 6 500 fish is high. However, two other sites are represented in the catch returns, neither of which were sampled in 1990 or 1991. The potential total catch for the region is therefore likely to have been considerably higher, even though effort and catch per unit effort (*cpue*) would have been lower in the other two areas. Therefore, an annual catch of 5 000–7 000 *L. lithognathus* (40–56 tons) is not unlikely. This suggests that only one-tenth of the catch from the western shores of False Bay has been reported.

Catches from the northern shores of False Bay appear to have been reported more accurately. Data for the period 1983–1987 can be extracted from the detailed private records for 1977–1987 and compared with the SFRI returns for the same period. The private records show that 5 100 fish were caught over the five-year period, a mean catch of 1 020 fish per year. There were two permit-holders operating in the area, but the one for which no data are available operates in the western portion and catches only approximately 10–20% of the overall catch of *L. lithognathus* for northern False Bay. This indicates a total catch of 1 100–1 200 fish per year for the period 1983–1987. The SFRI data for the same period show that average annual catches of 741 fish were reported. When one considers that many of the fish recorded in the private records would not have been retained because of their small size, the reported average appears to be reasonably accurate. Higher annual catches in the area were recorded in private records prior to 1983 and in the SFRI data for 1989 and 1990. They were not considered in the above analysis because reported and actual catches could not be compared. However, these larger catches suggest that a realistic estimate of the potential mean annual catch for the period 1985–1990 is in the region of 2 000 fish.

## CATCH FREQUENCIES

Three of the data sets for the northern coast of False Bay (1990–1991, 1977–1987 and 1951–1968) are sufficiently detailed to examine the frequency at which catches of different numbers of fish were made (Fig. 4). The data for 1990–1991 reflect every white steenbras in the 163 hauls examined. Nearly all these fish were <30 cm long and of no commercial interest. Almost half the hauls contained no white steenbras, almost 80% less than five and none more than 100 fish. Catches of different sizes contributed similarly to the total catch.

The other two data sets cover longer time periods and therefore may be a more accurate reflection of the fishery. The data for the years 1977–1987 show nearly all white steenbras caught over the period, although it is likely that small catches of undersized fish that were not retained were not recorded. In contrast, the data for the period 1950–1967, which were extracted from pay books, do not contain information on small fish or small catches, where the fish were thrown back, kept as "fries", or lumped with other more abundant species

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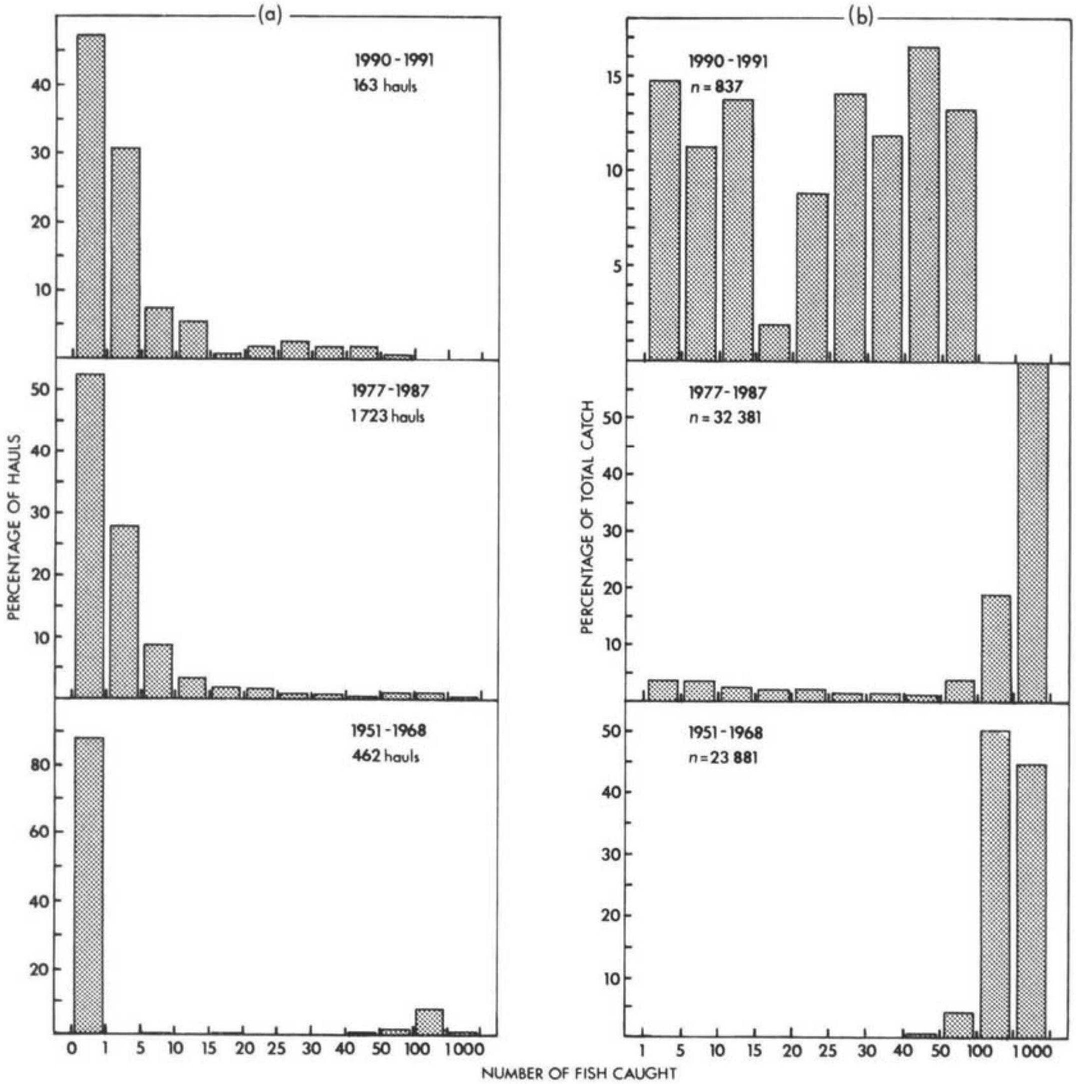


Fig. 4: (a) Percentage of seine hauls on the northern coast of False Bay in which catches of different numbers of fish were made, and (b) percentage of the total catch contributed by catches of different numbers of fish. Data are shown for three different time periods

for sale. These differences in the precision with which data were recorded are reflected in the frequencies at which catches of different numbers of fish were made (Fig. 4). In the period 1977–1987, more than half the hauls contained no steenbras. The number of hauls recording fish decreased for increasing numbers of fish caught. Only 2% of hauls caught more than 50 fish and 0,3% more than 1000. In the period 1951–1968, the majority of hauls caught no steenbras, but more than 50 were recorded in 11% of hauls and more than 1 000 in 1,3% of hauls. The data for these two time periods are similar in terms of the proportion of the total catch that is contributed by catches of different numbers of fish. In both cases, the overwhelming majority (approximately 90–95%) of the total catch was made by the few hauls of more than 100 fish.

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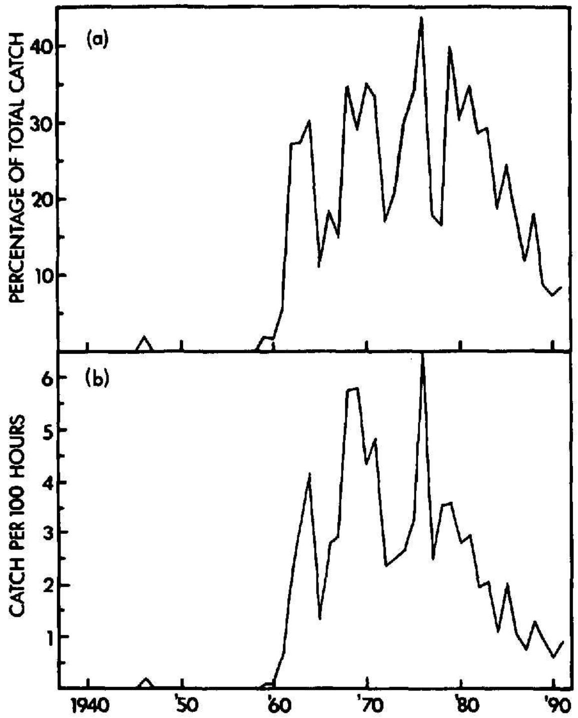


Fig. 5: (a) Annual percentage contribution to the total catch and (b) catch per unit effort of *Lithognathus lithognathus* for recreational anglers in the South-Western Cape, 1938–1991

## The recreational shore-angling fishery

### LONG-TERM TRENDS

A number of angling clubs in the South-Western Cape have held competitions at regular intervals over the years. Some have maintained detailed records of the number of hours fished and the number and mass of each species caught. In some cases these records date back several decades (Bennett 1991). The results presented here were extracted from such records. These are available for several clubs for the period since about 1970, and one, the Liesbeeck Park Angling Club, has time-series dating back to 1938, with only a short break during the latter part of World War II.

Significant catches of white steenbras have been made only since 1960, when anglers started to concentrate their effort in habitats favoured by the species, primarily along the northern coast of False Bay and in the Melkbosstrand and Betty's Bay areas. Within a year of their appearance in the catches, white steenbras were providing almost 30% by mass of the total catch made by club anglers (Fig. 5a). Although catches fluctuated, white steenbras continued to be important (providing up to 43% of catches) until the late 1970s, whereafter their contribution started a sustained decrease. In 1990 and 1991, the last years of the data series, white steenbras contributed only 8% of catch mass.

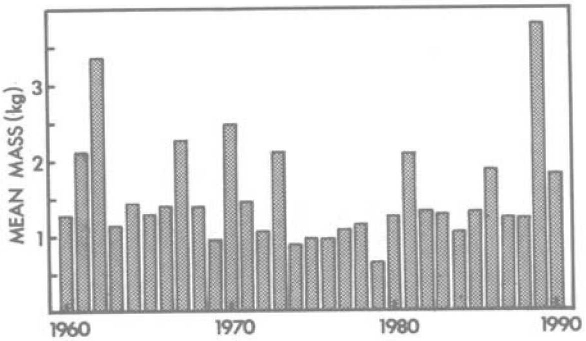


Fig. 6: Mean size of *Lithognathus lithognathus* in the catches of recreational anglers in the South-Western Cape, 1960–1990

The *cpue* of white steenbras followed a similar trend to that of their contribution to the total catch (Fig. 5b). It increased from zero in 1958 to maxima of approximately 6 fish·100 $h^{-1}$ in 1968, 1969 and 1976. After 1976, *cpue* decreased to only 0,7 fish·100 $h^{-1}$ in 1990, a decline of almost 90% over the past 15 years.

Changes in the mean mass of white steenbras caught during the years 1960–1990 are presented in Figure 6. In most years mean mass was about 1,2 kg, with a minimum of 0,7 kg in 1979 and a maximum of 3,8 kg in 1989. There was no apparent trend despite an increase in the minimum size restrictions from 0,45 to 0,50 kg in 1970 and then to 40 cm (785 g) in 1984.

Similar data concerning recreational catches of white steenbras in the eastern Cape Province between 1959 and 1982 (Coetzee *et al.* 1989) show that their contribution to the total catch varied between 0,5 and 14%, but there was no obvious trend over the period (Fig. 7a). The mean mass of fish in the catch increased gradually from approximately 1,8 to 3,0 kg (Fig. 7b), the only major departure from this trend being in 1968, when a mean mass of 12 kg was recorded. The trend may have been attributable to an increase in the minimum size of fish recorded, to some change in the selectivity of the anglers, or to an increase in the mean size of fish in the population.

Research angling on the De Hoop coast, which com-

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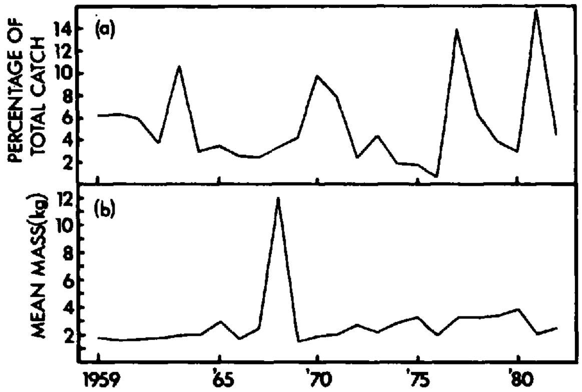


Fig. 7: (a) Percentage contribution to total catch and (b) mean mass of *Lithognathus lithognathus* in the catches of recreational anglers, 1959–1982 (data from Coetzee *et al.* 1989)

menced in 1984 and continued after the declaration of the marine reserve in 1986, resulted in the capture of 469 white steenbras by the end of 1991. Trends in *cpue* at Koppie Alleen in the reserve at 1–2 month intervals throughout this period are shown in Figure 8. During the first year of sampling, only one white steenbras was caught in 1 131 angler hours. Between mid 1985 and the end of 1989, *cpue* fluctuated primarily between 0 and 3 fish·100 h$^{-1}$, with the frequency of zero values declining throughout the period. During 1990 and 1991 all catches were >2,8 fish·100 h$^{-1}$. At Lekkerwater, a site in the reserve with a history of minimal exploitation by recreational and commercial fishermen, catch rates after May 1988, when sampling commenced, averaged 7,1 fish·100 h$^{-1}$. These data suggest that the declaration of the marine reserve may have had a beneficial effect on white steenbras (Bennett and Attwood 1991).

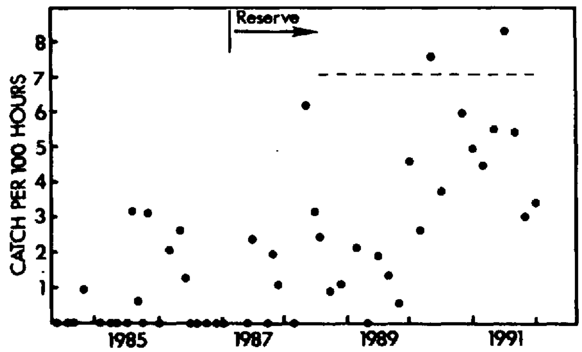


Fig. 8: Shore-angling catch per unit effort of *Lithognathus lithognathus* on the De Hoop coast between May 1984 and December 1991. The area was declared a marine reserve in December 1987. The horizontal dashed line represents the mean catch rate at Lekkerwater, a site with a history of minimal exploitation

ESTIMATED TOTAL CATCH

No estimates of the total recreational catch of *L. lithognathus* have previously been made for any areas of the coast. A rough estimate is possible from the available *cpue* data and an estimate of total effort. Mean values of *cpue* reported from the Eastern Cape by Coetzee *et al.* (1989) and Clarke and Buxton (1989) were 0,55 and 0,28 fish·100 h$^{-1}$ respectively. In the South-Western Cape, *cpue* has averaged approximately 1,0 fish·100 h$^{-1}$, whereas at De Hoop in the Southern Cape, values of 0,5–7,0 fish·100 h$^{-1}$ have been recorded. The last value probably represents the upper limit of catch rates, because it was recorded in an area of the De Hoop marine reserve that had been completely protected for a number of years following a history of minimal exploitation owing to its inaccessibility. It is difficult to extrapolate these figures accurately, but an overall *cpue* for *L. lithognathus* between Transkei and the South-Western Cape of 0,75 fish·100 h$^{-1}$ is probably not unreasonable.

To estimate total effort over the area is even more difficult. Limited unpublished data for the South-Western and Southern Cape suggest a total effort expenditure of 6,3 angler-hours·km$^{-1}$ and, for the purposes of this study, it is assumed that this quantity of effort is applied throughout the 1 600 km of coast over which the species is caught. Other data with which to compare this estimate are few. Clarke and Buxton (1989) recorded a total of 4 613 angler-hours over 17,5 km on 120 days between August 1985 and August 1986, i.e. 2 angler-hours·km$^{-1}$·day$^{-1}$. As the mean time of their randomized sampling was midday, total effort was approximately double, i.e. 4 angler-hours·km$^{-1}$·day$^{-1}$. On the Natal coast, Joubert (1981) encountered an average of 8,4 anglers over 767 patrols of 10,57 km, i.e. 0,8 anglers·km$^{-1}$. The average time that these patrols were conducted was approximately 10:30, by which time anglers had each fished for five hours. From this information and again doubling for the time of observation, a total effort of 8 angler-hours·km$^{-1}$·day$^{-1}$ may be assumed. Bennett and Attwood (1991) estimated an annual expenditure of 31 179 angler-hours on the 14 km of beach between Koppie Alleen and Skipskop on the Cape south coast during 1984 and 1985. This would translate to an effort of 6,1 angler-hours·km$^{-1}$·day$^{-1}$. The only other published data concerning angling effort on the South African coast is that of Van Herwerden and Griffiths (1989) for the north-western corner of False Bay, adjacent to Cape

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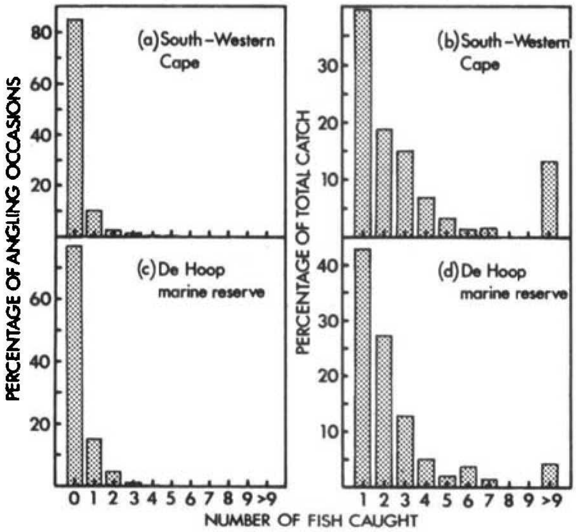


Fig. 9: (a, c) Percentage of angler-days on which catches of different numbers of fish were made and (b, d) percentage of the total catch contributed by daily catches of different numbers of fish. Data are representative of club anglers in the South-Western Cape and research angling in the De Hoop marine reserve

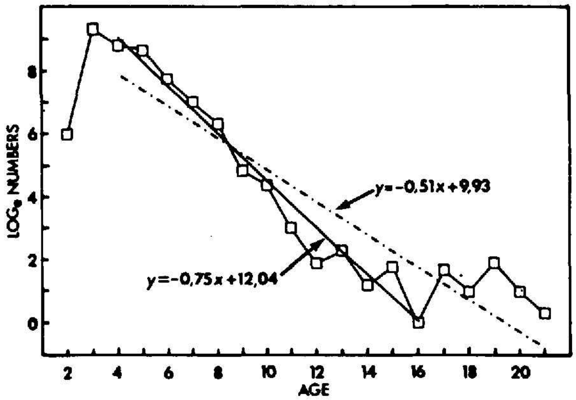


Fig. 10: Numbers of *Lithognathus lithognathus* caught at age by recreational anglers. Two estimates of total mortality ($Z$) are derived from the data, first by fitting a regression to all ages greater than the age at full recruitment (3 years), and second by fitting a regression to the steepest part of the curve (ages 3–16 years)

Town. They noted an average of 16 anglers·km$^{-1}$ during their shore surveys. If it is assumed that those anglers spent an average of four hours fishing, then effort can be estimated at 64 angler-hours·km$^{-1}$·day$^{-1}$. These four estimates of effort were all made between 6 and 12 years ago. Given that angling effort is doubling approximately every 12 years (Van der Elst 1989), the current estimate of 6,3 angler-hours·km$^{-1}$·day$^{-1}$ for the coast of the Cape Province is not unreasonable.

The information presented above provides some basis for the calculation of a total annual catch of *L. lithognathus*. If *cpue* is 0,75 fish·100 h$^{-1}$ and average effort is 6,3 angler-hours·km$^{-1}$·day$^{-1}$ over the 1 600 km range of *L. lithognathus*, total catch can be estimated at approximately 28 000 fish per year.

### CATCH FREQUENCIES

Two data sets were of use in analysing catch frequencies of recreational shore-anglers: club anglers targeting edible species in the South-Western Cape prior to the imposition of the bag limit (Fig. 9a, b); and research anglers in the De Hoop marine reserve (Fig. 9c, d). Both groups did not catch white steenbras on 77–85% of outings. On only 10–15% of occasions did they catch one fish, and the frequency of larger catches decreased with increasing catch size. More than five fish were caught on 0,5–2,6% of angler-days. Approximately 40% of the total catch was made on days when only one fish was caught and 45% was provided by daily bags of 2–5 fish. Larger daily catches, although infrequent, were relatively important, providing 10–20% of the total catch.

## Stock assessment

Catch-at-age data for the recreational shore-angling fishery was used to construct a catch curve (Fig. 10), from which an estimate of total mortality was obtained. These data were the most representative of the age structure of the population as a whole. They were also the only data representative of a large area of coast and were collected over a sufficiently long time to eliminate short-term effects of recruitment variability. The catch curve indicates values of $Z$ of approximately 0,5–0,7 which, when provision is made for an estimate of $M$ of 0,20, indicates $F$ values in the range 0,3–0,5. For this reason, the responses of $Y/R$, $SB/R$ and $\overline{W}$ to $F$ were modelled for a range of $F$ values up to 0,5. When the responses of parameters to $t_c$ were investigated, a conservative estimate of $F = 0,25$ was used.

Parameters used in the models were a = 0,441; b = –1,297; $l_1$ = 205,7; $l_2$ = 997,8; $t_m$ = 6; $t_c$ = 4; A = 1,67 × 10$^{-5}$; B = 2,948; $M$ = 0,2; $F$ = 0,25. The analyses revealed that $Y/R$ and $SB/R$ were sensitive to variations in $M$ (Figs 11, 12). At $t_c$ = 4 (the observed age of recruitment), predicted $Y/R$ and $SB/R$ are reduced by approximately 35% if estimated $M$ is increased by 0,05, and increased by 50% if it is decreased by 0,05.

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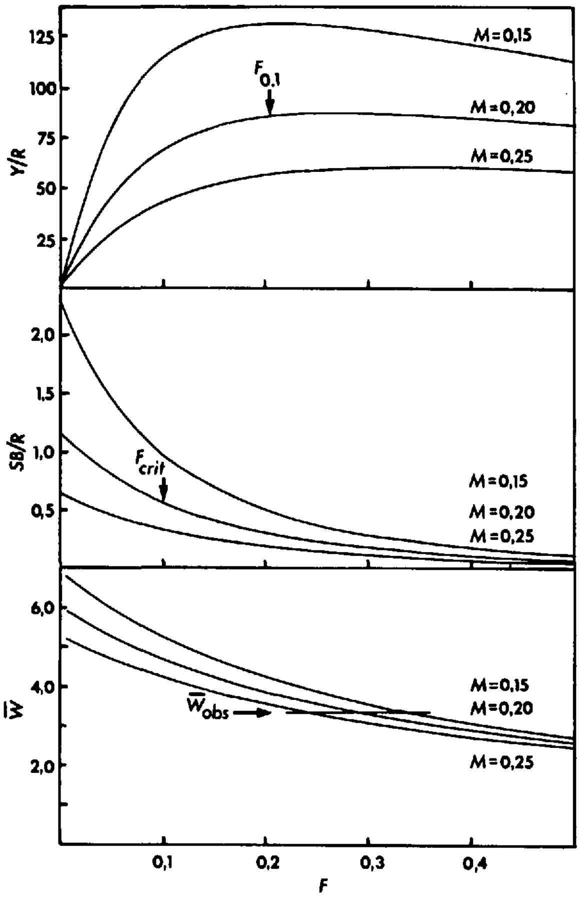


Fig. 11: Dependence of yield per recruit ($Y/R$), spawner biomass per recruit ($SB/R$) and mean mass ($\overline{W}$) for *Lithognathus lithognathus* on fishing mortality ($F$) for three choices of natural ($M$) mortality. $\overline{W}_{obs}$ is the current mean mass of the catch

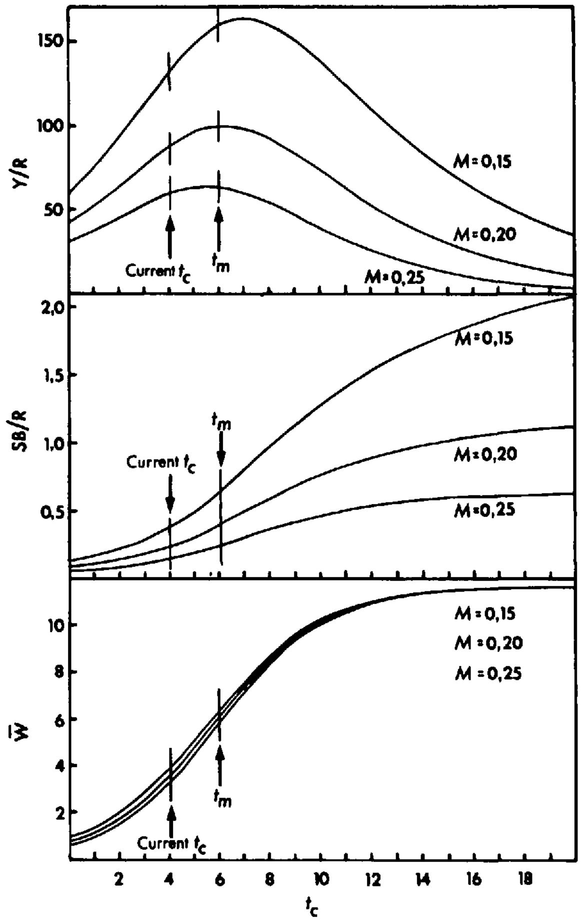


Fig. 12: Dependence of yield per recruit ($Y/R$), spawner biomass per recruit ($SB/R$) and mean mass ($\overline{W}$) for *Lithognathus lithognathus* (assuming a value of $F$ of 0,25) on age at first capture ($t_c$) for three choices of natural mortality ($M$). $t_m$ is the age at which 50% of the fish attain sexual maturity

However, $\overline{W}$ changes by <10% over the same range of $M$. The effects on $Y/R$ and $SB/R$ of varying $M$ illustrate the importance of obtaining accurate estimates of $M$. In the results presented hereafter, the effects of varying $F$ and $t_c$ are described at constant $M = 0,2$, in other words for the middle curve of each group given in Figures 10 and 11. Close agreement between the two estimates of $M$ (0,20 and 0,21) obtained from the relationships of Pauly (1980) and Rikhter and Efanov (1977) respectively provides some confidence in this estimate.

Fishing mortality over the range 0,15–0,5 had a relatively small effect on $Y/R$, but a substantial effect on $SB/R$ (Fig. 11). Reducing $F$ from 0,25 to 0,15 reduced $Y/R$ by only 13%, whereas increasing it to 0,5 provided no improvement. The predicted result of reducing $F$ from 0,25 to 0,15 was a doubling of $SB/R$, whereas increasing $F$ to 0,5 reduced $SB/R$ by 68%. $F_{0,1}$ ($F$ when the rate of increase of $Y/R$ is one-tenth the maximum rate) was 0,16 and $F_{crit}$ ($F$ when $SB/R$ is half its maximum) was 0,09. In other words, both were considerably less than the current estimated range for $F$ of 0,3–0,5, indicating that a considerable reduction in $F$ would benefit the stock. However, reductions to $F_{crit}$ would require $F$ to be reduced to less than 30% of its estimated current value. The $\overline{W}$ of the catch was also sensitive to changes in $F$. The predicted difference in $\overline{W}$ between $F$ values of 0,15 and 0,5 was

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1,8 kg (12 cm), i.e. approximately one year of growth.

$Y/R$, $SB/R$ and $\overline{W}$ were all sensitive to changes in $t_c$ (Fig. 12). The predicted optimum $Y/R$ at a conservative estimate of $F$ of 0,25 was achieved at $t_c = 6$ years, which corresponded to $t_m$. Greater or smaller values resulted in reductions of $Y/R$. At $t_c = 4$, the 1992 value, $Y/R$ is approximately 85% of the optimum. $SB/R$ might also be substantially increased by increasing $t_c$. The model suggests that, if $t_c$ was increased from 4 to 6, a 60% improvement in $SB/R$ might be expected. Similarly $\overline{W}$ might increase from 3,6 to 6,1 kg if $t_c$ was increased by 2 years. If the more-realistic values of $F$ of 0,3–0,5 had been used in this analysis instead of the conservative $F = 0{,}25$, then the predicted benefits of increasing $t_c$ would be even greater.

## A comparison of the fisheries

There are three separate fisheries for *L. lithognathus*: recreational shore-angling, commercial beach-seining in the surf-zone and commercial "Russman" seining in deeper water. These fisheries differ substantially in a number of ways. Angling, for example, occurs throughout the range of the species and effort has increased markedly over the years. In contrast, beach-seining for *L. lithognathus* was formerly widespread but, in August 1992, was confined to limited areas in False Bay. "Russman" seining, which was always confined to False Bay, is now illegal in all areas. The fisheries are also different in terms of the overall importance of *L. lithognathus* in the catches, the total catch of the species, the seasonal patterns of catches, the frequency at which catches of different sizes are made and the size composition of the catch. These differences are important considerations for the management of the species and mean that their relative impacts on the stock are difficult to assess.

Judging from the information available, it is likely that beach-seining was the major source of fishing mortality for *L. lithognathus* during the early years of the fishery, and that shore-angling was relatively insignificant. However, since the late 1950s, improved tackle and access to the seashore, as well as increasing affluence of the population and leisure time, has ensured that the impact of angling has increased. The recreational catch has probably been double the commercial catch, in terms of numbers, since about 1985. In terms of mass, the contributions of the commercial and recreational sectors to the total catch of *L. lithognathus* have been approximately equal in recent years. This indicates that both sectors of the fishery are likely to have been responsible for the observed stock declines. Both should be restricted if overexploitation is to be curtailed.

One sector of the fishery for *L. lithognathus* that could not be considered in this analysis because of an almost complete lack of information was purse-seining. A large catch of possibly as much as 300 tons was taken in False Bay in 1982. It resulted in an outcry by other fishermen and the general public. As a result, no *L. lithognathus* have been landed by purse-seiners since then. The extent of purse-seine catches prior to 1982 could not be established, but it appears that sporadic catches were made by one or two boats from about 1950. However, it is unlikely that these earlier catches approached the level of 1982, when an apparently increased availability of *L. lithognathus* in False Bay attracted additional boats, resulting in the high catch.

## Evaluation of management options

The models suggest that a substantial reduction in fishing mortality is required if the stock is to recover from its present overexploited state. For example, a reduction of $F$ to approximately 30% appears necessary to attain values of spawner biomass per recruit that are 50% of pristine levels. A number of options are available for the limitation of $F$. These include bag limits, size limits, closed seasons, closed areas, gear restrictions and prohibition on sales. Not all these restrictions can be practically applied to the three fisheries, and the relative effects of different degrees of restriction will vary between them. Various restrictions have already been applied. An evaluation of the present and potential effects of regulatory measures is, however, possible.

### BAG LIMIT

Although the bulk of the total catch (>60%) of anglers is made up of infrequent small catches of 1–2 fish, larger catches are made. The present daily bag limit of five fish per person is likely to reduce the total catch by 10–15%. It will only limit catches on <2% of angler-days. This is based on information for the period prior to 1985, when the bag limit was imposed, and on experimental catches in a marine reserve. Catch rates in exploited areas have declined since then, and the bag limit is likely to have even less effect at present. Further, given that angling effort is increasing exponentially, bag limits will need to decrease as effort increases.

Daily bag limits are not practical for the control of treknet catches if the total catch is not to be reduced drastically. The reason for this is that a large portion (>80%) of the total catch is made on occasions when >100 fish per haul are caught. These catches are very infrequent, often occurring at intervals of more than a

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year. For example, data for the years 1977–1987 show that, to allow an annual catch of 50% of the mean annual catch, the bag limit would have to be approximately 500 fish. This is clearly impractical, because the time taken to count these fish out of the net would ensure mortality of excess fish. An annual quota would also be unsatisfactory, because large interannual variability would mean that the quota would frequently not be caught.

MINIMUM SIZE LIMIT

A minimum legal size limit of 40 cm is currently in force. This limit is considerably smaller than the size at which 50% of the *L. lithognathus* population matures (65 cm) and means that fish are legally exploitable for at least two years before they become reproductively active. Analysis of the responses of *Y/R*, *SB/R* and $\overline{W}$ show that all three would be markedly improved by increasing the age (size) at which individuals are recruited into the fishery. Increasing the minimum size to 65 cm would result in substantial reductions in the number of fish caught legally, because approximately 72% of the total catch by recreational and commercial fishermen is immature. In the South-Western Cape, 89% of the catch by recreational anglers and 77% of the beach-seine catch from the northern shores of False Bay are fish <65 cm. It is only in the "Russman" catches that immature fish are rare. Despite the fact that increasing the minimum size limit to 65 cm is likely to result in a marked reduction in the catches of two of the three branches of the fishery in the short term, likely long-term benefits could justify such a change.

CLOSED SEASON

The annual migrations undertaken by mature fish result in a marked seasonality of catches observed in some areas and indicate that a closed season could be used to reduce catches. For example, a six-week closed season between mid July and the end of August on the Transkei coast would almost completely eliminate white steenbras from catches of anglers there. Similarly, an extended winter closed season would be effective in the Eastern and South-Eastern Cape. Closed seasons in the eastern portion of the range of the species are probably unnecessary at present because catches of mature fish in that area are small relative to the total catch.

The majority of mature fish are caught in "Russman" nets from the western shores of False Bay during summer. This netting is subject to a closed season during winter, which is almost completely ineffective because most fish are then in the eastern area of their range. However, a summer closed season on the "Russman" fishery would be highly effective. From the data available it appears that shoals of mature white steenbras arrive in False Bay in October and depart in April. The majority of the catch is made between November and March, when there is little variation in mean monthly catches. This indicates that, if fishing was confined to a 10-week open season during this period, approximately 50% of the potential annual catch would be made. A catch reduction of at least this magnitude is desirable to promote stock recovery because the majority of the overall catch of mature fish is made by this fishery.

There are no clear seasonal trends in total catch made by beach-seining along the northern shores of False Bay. Therefore, there is no particular period in which a closed season would be effective. Smaller fish are more commonly caught during winter and spring, which is the present closed season, but most are already protected by minimum-size legislation. Larger individuals are taken during late summer. Given that the beach-seine catch is small relative to the overall total, there is no present need for a closed season.

CLOSED AREA

Data from De Hoop suggest that marine reserves are beneficial in allowing increased abundance of immature fish, which appear to be resident in particular areas. The number, placement and minimum size of reserves necessary to provide protection for white steenbras against rapidly increasing angling effort is unknown. It is unlikely that the currently protected areas are sufficient, especially so because the adults are migratory. The closure of specific areas in the Eastern Cape and Transkei, where migratory adults are most vulnerable to capture, would reduce the angling catch of mature individuals. However, this is not considered necessary because catches by anglers in this area are small relative to the commercial catch of the same size-classes.

Commercial netting is already restricted to False Bay, and most historical catches in this area were made over <4 km of shoreline. The closure in 1989 of 1 km of shore centred on the mouth of the Eerste River (historically the hub of the catching area) is likely to result in a 75% reduction in the total catch of mature fish from the northern shore of False Bay. Almost the entire catch of mature fish from the western shores of False Bay were made from Fish Hoek and Mackerel beaches and Long Beach in Simon's Bay.

GEAR RESTRICTION

The rapid increase in angler catches after about 1950 may be related to the arrival and increased use of the prawn pump. This allowed the efficient capture of sand prawns and bloodworms, which are the most

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effective bait for *L. lithognathus*. A ban on the use of this method of bait collection could result in a marked reduction in the efficiency with which anglers could catch the species. Another way in which the efficiency of anglers could be reduced is by limiting the use of vehicles on beaches. This is already occurring in some areas and reduced catches of white steenbras should result.

There are a number of restrictions on the gear that beach-seiners are permitted to use. The current limitation of rope and net lengths has probably reduced the efficiency of beach-seining along the northern shore of False Bay to some extent. However, it is on the western shores, where the use of ropes longer than 200 m and of sinking "Russman" nets has recently been banned, that gear restrictions are most acutely felt. The ban has effectively eliminated *L. lithognathus* from catches in the area.

## CONCLUSIONS

The preceding results clearly show that catches of *Lithognathus lithognathus* have declined and that the stock is overexploited. This state of affairs is attributable to the activities of both recreational and commercial fisheries. A number of restrictions have been implemented over the years. Recreational fishermen are currently limited to a daily bag of five fish, and a minimum size applies to both recreational and commercial catches. Commercial catches are subject to a number of additional restrictions, the most important of which are: netting is limited to seven operators on about 10 km of beach in False Bay; there is a six-month closed season; netting at night is prohibited; nets may not exceed 275 m in length; and the hauling ropes may have a maximum length of 200 m along the western shores and 400 m on the northern shores of False Bay.

An evaluation of present and potential management measures for the fishery as a whole indicates that a highly effective combination of restrictions could be imposed if substantial catch reductions were considered desirable. Current restrictions ensure that *L. lithognathus* has been almost completely eliminated from seine-net catches along the western shores of False Bay. Prior to the limitation on rope lengths in 1990, these may have accounted for approximately 25% of the total number and almost half the mass of the national catch. Similarly, the closure in 1990 of a 1 km stretch of beach centred on the Eerste River has probably reduced catches from the northern shores of False Bay by 75%. On the other hand, recreational anglers have not been greatly affected by the bag limit which applies to them.

Differences in the relative severity of restrictions on the commercial and recreational sectors of the fishery raise questions concerning their fairness. From the results presented above, it is apparent that anglers catch two-thirds of the total catch in terms of numbers and approximately half in terms of mass. The relative "value", in its broadest sense, of one fish or 1 kg to the two different sectors of the fishery, and the "harm" to the other fishery, or to the stock, of these units of catch are unknown. However, it is clear that *L. lithognathus* cannot be considered an exclusively "angling species", because it was an important component of the commercial catch long before it became an important contributor to catches of shore-anglers.

On face value, it appears that fishing mortality should be reduced to 20–30% of the levels of the past few years. The most practical way of achieving a reduction of this magnitude in the recreational fishery and the seine-net fishery along the northern shore of False Bay would be to increase the minimum size limit to 65 cm. Such an option seems particularly attractive because it could provide a degree of reproductive protection to the stock in the face of high and increasing angling effort. Indeed, if a larger size limit were to be introduced, some other measures designed to restrict catches of *L. lithognathus* could be relaxed. For instance, the current bag limit on anglers could be abandoned, because it is so seldom effective, and restrictions on beach-seine catches could revert to those in force between 1985 and 1990. The most important concession here could be to reopen areas in the vicinity of river mouths. Some relaxation of the restrictions on the "Russman" net fishery on the western shores of False Bay may also be justifiable. On the basis that a 70–80% reduction in catches from levels in the years 1985–1990 is necessary, a short open season of 4–6 weeks during midsummer, with no restriction on rope lengths, warrants consideration.

The management measures suggested above should result in a reduction of catches to 20–30% of levels in the years 1985–1990 in all sectors of the fishery. This should allow the stock to recover from its present overexploited state to sustain catches into the future. However, it must be stressed that, unless such proposed restrictions are strictly enforced and the rate of estuarine degradation is halted, the future for *L. lithognathus* is bleak.

## ACKNOWLEDGEMENTS

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