

South African Estuaries and Their Importance to Fishes

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In this article environmental conditions typical of South African estuaries are contrasted with those of marine inshore waters in order to emphasize that estuarine fishes comprise a specialised component of the marine fauna. The life cycle of estuarine fishes is described and related to important physical and biological characteristics of estuaries. The fish fauna is divided into six categories according to the extent of their dependence on estuaries. This is followed by discussion of the effects of estuarine degradation on these groups. It is concluded that continuing degradation will result in a decline in South Africa's estuarine fish fauna and consequently in recreational angling, in the yield of high-protein food and in economic activities dependent upon this natural resource. It is recommended that higher priority be accorded to the conservation of estuaries in the face of development projects that impinge on this environment.

South Africa's estuaries represent an extremely valuable national resource which is increasingly threatened by urban, industrial and agricultural development. Whereas development goals and conservation ideals can sometimes be reconciled, this is the exception rather than the rule and in the past development has all too often been unsympathetic to the environment and resulted in permanent damage to South African estuaries. Perhaps one of the reasons for this is that the case for conservation has not been sufficiently clearly stated.

There are many reasons for conserving estuaries, not the least of which is their recreational value and it is in this respect that fish and fishing are particularly significant. The authors of this article are specialists in the study of estuarine fish and are consequently able to present an authoritative statement on South African estuaries, their

importance to fishes and the need for greater attention to be given to their conservation.

Basic facts about the estuarine environment and estuarine fishes

Conditions in South African estuaries differ markedly from those that prevail in the sea. The marine inshore waters adjoining the Republic's 3000-km coastline is typified by turbulent wave action, a lack of sheltered shores, and by a narrow continental shelf on the east and south-east coasts. In contrast, the estuarine environment is very much smaller in area, is typically calm, sheltered and shallow, as well as being subject to greater variation in salinity, turbidity and temperature. As a result, South African estuaries represent a specialised environment¹ and of a total of approximately 1500 species of fishes found on the continental shelf, fewer than 100 species are able to make use of our estuaries.

The life cycle of most of these species involves the spawning by adults at sea, often close inshore and in the vicinity of estuary mouths. Egg and larval development also take place at sea, but there is a mass migration into estuaries by small juveniles when they are approximately 15 mm and upwards in length. This instinct for migration is very marked and during late winter, spring and early summer millions of fish fry enter estuaries, where the high temperatures and rich food supply favour rapid growth, and where they are also protected from most marine predators.²⁻⁵ Juveniles spend vary-

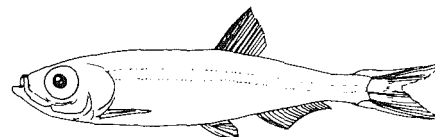
ing lengths of time in estuaries, but generally migrate back to sea with the onset of adolescence, which often occurs at an age of about a year. These sub-adult fish tend to inhabit marine inshore areas, where they join the adult spawning populations once they become mature.⁶ Adult fish increase in abundance seasonally when they enter estuaries to feed. At these times of the year they are readily accessible to sport anglers and constitute a valuable recreational and food resource⁷⁻⁹ (e.g. during the famous grunter 'run').

From the foregoing it is obvious that the migration of fish in and out of estuaries is dependent upon each estuary being in contact with the sea, either through a permanently open mouth, or via a mouth which opens naturally at certain times of the year in response to seasonal rains and other environmental factors. It is also clear that fish benefit from the rich feeding-grounds provided by estuaries, and that human disruption of this function can degrade estuaries to the point where they are of little value to fishes. Particularly significant are the submerged aquatic plants and the vegetation supported by the adjacent wetlands, both of which supply much of the plant detritus basic to the estuarine food web.^{3,10-12}

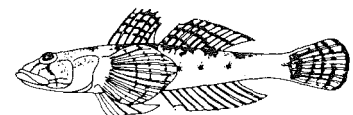
How dependent are these fish on estuaries?

From research conducted in estuaries, biologists have long maintained that the most important role of this environment as regards fish populations is the provision of nursery grounds for juveniles. Recent studies have examined this role in more detail and have sought to show whether these fishes also utilize nursery grounds at sea. It is important to know this, because it tells us whether the survival of South African populations of these species is dependent on estuaries.

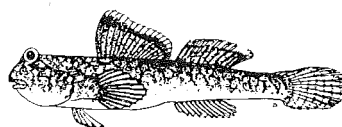
The search for nursery grounds at sea was concentrated on the Cape south and south-west coasts, and supplemented by research in Natal. It involved sandy-beach seine net-



Estuarine roundherring



Knysna sandgoby



Mudhopper



Knysna seahorse

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Fig. 1. Examples of Category I fish, which are dependent on estuaries for their entire life cycles.

Table 1. Fishes associated with South African estuaries.

Category I: Truly estuarine species, dependent on estuaries for entire life cycle.

| Species | Common name | Utilization |
|------------------------------------|--|-------------|
| <i>Caffrogobius multifasciatus</i> | prison-goby, tronk-dikkop | prey |
| <i>Caffrogobius natalensis</i> | baldy, kaalkop | prey |
| <i>Clinus</i> sp. nov. | Bot river clinid | prey |
| <i>Gilchristella aestaurius</i> | estuarine roundherring, rivier-rondeharing | prey |
| <i>Gobionellus keiensis</i> | Kei river goby | prey |
| <i>Hippocampus capensis</i> | Knysna Seahorse, Knysna-seeperdjie | prey |
| <i>Periophthalmus sobrinus</i> | kingfin mudhopper, grootvin modderspringer | prey |
| <i>Psammogobius knysnaensis</i> | Knysna sandgoby, Knysna-sanddikkop | prey |

Category II: Species dependent on estuaries during juvenile phase of life cycle.

| Species | Common name | Utilization |
|----------------------------------|--|---------------|
| <i>Acanthopagrus berda</i> | river bream, slimjannie | angling, food |
| <i>Ambassis gymnocephalus</i> | bald glassy, kaalkop-glasvis | prey |
| <i>A. natalensis</i> | slender glassy, slank glasvis | prey |
| <i>A. productus</i> | longspine glassy, langstekel-glasvis | prey |
| <i>Caranx sexfasciatus</i> | bigeye kingfish, grootoog-koningvis | angling, food |
| <i>Chanos chanos</i> | milkfish, melkvis | food, prey |
| <i>Elops machnata</i> | ten-pounder, tienponder, springer | angling, food |
| <i>Hyporhamphus capensis</i> | Knysna halfbeak, Knysna-halfbek | prey |
| <i>Lichia amia</i> | leervis | angling, food |
| <i>Lithognathus lithognathus</i> | white steenbras, witsteenbras | angling, food |
| <i>Liza macrolepis</i> | largescale mullet, grootskub-harder | food, prey |
| <i>Monodactylus argenteus</i> | Natal moony, Natalse maanvis | food, prey |
| <i>M. falciformis</i> | Cape moony, Kaapse maanvis | food, prey |
| <i>Mugil cephalus</i> | flathead mullet, platkop-harder | food, prey |
| <i>Myxus capensis</i> | freshwater mullet, varswaterharder | food, prey |
| <i>Pomadasys commersonni</i> | spotted grunter, spikkel-knorder | angling, food |
| <i>Rhabdosargus holubi</i> | Cape stumpnose, Kaapse stompneus | angling, food |
| <i>R. sarba</i> | Natal stumpnose, Natalse stompneus | angling, food |
| <i>Terapon jarbua</i> | thornfish, doringvis | angling, prey |
| <i>Thyrssa vitrirostris</i> | orangemouth glassnose, oranjelbelglasvis | food, prey |
| <i>Valamugil cunnesius</i> | longarm mullet, langarm-harder | food, prey |
| <i>V. robustus</i> | robust mullet, wilde harder | food, prey |

Category III: Species whose juveniles occur mainly in estuaries, but are also found at sea.

| Species | Common name | Utilization |
|--------------------------------|---|---------------------|
| <i>Carcharhinus leucas</i> | Zambesi shark, Zambesihaai | angling, food |
| <i>Gerres acinaces</i> | smallscale pursemouth, kleinskubplooibek | food, prey |
| <i>G. filamentosus</i> | threadfin pursemouth, sweepvinplooibek | food, prey |
| <i>G. oblongus</i> | oblong pursemouth, langwerpige plooibek | food, prey |
| <i>G. oyena</i> | slenderspine pursemouth, slankstekelplooibek | food, prey |
| <i>G. rappi</i> | evenfin pursemouth, gelykvin-plooibek | food, prey |
| <i>Hepsetia breviceps</i> | Cape silverside, Kaapse spierinkie | prey |
| <i>Heteromycteris capensis</i> | Cape sole, Kaapse tongvis | prey |
| <i>Liza alata</i> | diamond mullet, diamant-harder | food, prey |
| <i>L. dumerili</i> | groovy mullet, keepharder | food, prey |
| <i>L. tricuspidens</i> | striped mullet, streep-harder | angling, food, prey |
| <i>Ophisurus serpens</i> | sand snake-eel | prey |
| <i>Pomadasys hasta</i> | javelin grunter, spies-knorder | angling, food |
| <i>Pristis pectinata</i> | largetooth sawfish, grootand-saagvis | angling, food |
| <i>Rhabdosargus thorpei</i> | bigeye stumpnose, grootoog-stompneus | angling, food |
| <i>Scomberoides lysan</i> | doubledotted queenfish, dubbelgekolde koninginvis | angling, food |
| <i>Solea bleekeri</i> | blackhand sole, swarthand-tongvis | prey |
| <i>Sphyrna barracuda</i> | great barracuda, groot barrakuda | angling, food |
| <i>S. jello</i> | pickhandle barracuda, piksteel-barrakuda | angling, food |

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ting,¹³ rotenone poisoning of intertidal rocky-pool ichthyofauna, near-shore sampling using beam trawls, try-nets and plankton nets, as well as SCUBA surveys of the ichthyofauna of sub-tidal reefs down to 30 m. In addition, a small-mesh trawling survey was conducted in the depth range

6–90 m between Algoa Bay in the east (33°53'S, 26°28'E) and St Sebastian Bay (34°06'S, 29°09'E) in the west.¹⁴

The inshore trawling survey revealed the occurrence of 12 species of estuarine-associated fishes over soft substrates and the SCUBA survey an additional four species

over rocky bottoms on the Cape south coast.¹⁴ These valuable new data together with the results of other near-shore research currently being prepared for publication, have enabled the authors to divide South Africa's fish fauna associated with estuaries into six categories according to the extent of

Continued from previous page.

Category IV: Species whose juveniles occur mainly at sea, but are also abundant in estuaries.

| Species | Common name | Utilization |
|------------------------------------|--|---------------------|
| <i>Argyrosomus hololepidotus</i> | kob | angling, food |
| <i>Arothron immaculatus</i> | blackedged blaasop, swartrand-blaasop | prey |
| <i>Caffrogobius nudiceps</i> | barehead goby, blesdikkop | prey |
| <i>Caranx ignobilis</i> | giant kingfish, reus-koningvis | angling, food |
| <i>Crenimugil crenilabis</i> | fringelip mullet, fraiingbek-harder | food, prey |
| <i>Diplodus sargus</i> | blacktail, dassie | angling, food |
| <i>Hemirhamphus far</i> | spotted halfbeak, gevlekte halfbek | prey |
| <i>Hilsa kelee</i> | kelee shad, kelee-haring | prey |
| <i>Johnius belengerii</i> | minikob, mini-kob | prey |
| <i>Leiognathus equulus</i> | slimy, slymvis | prey |
| <i>Liza richardsoni</i> | southern mullet, suiderlike-harder | food, prey |
| <i>Lutjanus fulviflamma</i> | dory snapper, | angling, food |
| <i>Omobranchus woodii</i> | kappie blenny, kappie blennie | prey |
| <i>Pelates quadrilineatus</i> | trumpeter, trompeter | food, prey |
| <i>Platycephalus indicus</i> | bartail flathead, (river gurnard), balkstert-platkop | angling, food |
| <i>Pomatomus saltatrix</i> | elf | angling, food |
| <i>Pranesus pinguis</i> | hardyhead silverside, klipkop-spierinkie | food, prey |
| <i>Rhabdosargus globiceps</i> | white stumpnose, witstompneus | angling, food |
| <i>Sarpa salpa</i> | strepie | angling, food |
| <i>Scomberoides commersonianus</i> | largemouth queenfish, grootbek-koningvis | angling, food |
| <i>Sillago sihama</i> | silver sillago, silwer sillago | angling, food, prey |
| <i>Stolephorus commersoni</i> | tropical anchovy, tropiese ansjovis | prey |
| <i>S. holoden</i> | thorny anchovy, doring-ansjovis | prey |
| <i>Syngnathus acus</i> | longnose pipefish, langneus-pypvis | prey |
| <i>S. djarong</i> | belly pipefish, boepens-pypvis | prey |
| <i>Tachysurus feliceps</i> | sea catfish, seebaber | angling, food |
| <i>Tylosurus leiurus</i> | needlefish, naaldvis | angling, food |
| <i>Valamugil buchanani</i> | bluetail mullet, bloustert-harder | food, prey |

Category V: Species whose juveniles occur at sea, but sometimes stray into estuaries.

Approximately 100 species of marine inshore fishes fall into this category.

Category VI: Miscellaneous species not dependent on estuaries.

(a) Freshwater species whose juveniles sometimes stray into estuaries. A total of 14 species fall into this group.

(b) Other species. A total of 11 species fall into this group. Some breed in both estuaries and fresh water (e.g. *Glossogobius giurus*, tank goby, tenk-dikkop; *Oreochromis mossambicus*, Mocambique tilapia, blou-kurper).

their dependence upon them. The species included in each category, their common names and an indication of whether they are utilized for angling, for human food or as prey by larger fish and bird predators, are set out in Table 1.

Category I comprises eight species which are dependent upon estuaries for their entire life cycles. Severe degradation of South African estuaries could threaten the extinction of these fishes in our waters.

These species are all small in size and include gobies, a mudhopper, a whitebait, and the Knysna seahorse (Fig. 1). Although of no direct significance for angling or food, they are eaten by predatory fish and birds. As a result they form an important part of the estuarine food web and losses in population or their extinction would have adverse ecological consequences. The reduced abundance of larger predatory angling fish in estuaries would be one such consequence.

Category II comprises 22 species which are dependent on estuaries during the juvenile phase of their life cycles and whose survival in South African waters is determined by the existence of ecologically viable

estuaries along our coast. Angling fish in this category (Fig. 3) are the spotted grunter, white steenbras, leervis, ten-pounder, Cape and Natal stumpnoses, a kingfish and the river bream. These fish also constitute a valuable food resource, as do an additional nine non-angling species that include the

milkfish and five species of mullet (Fig. 2). The remaining species are not directly exploited by man but are integral to the food web and are preyed upon by larger angling fish.

Category II also includes an additional four species that are dependent upon

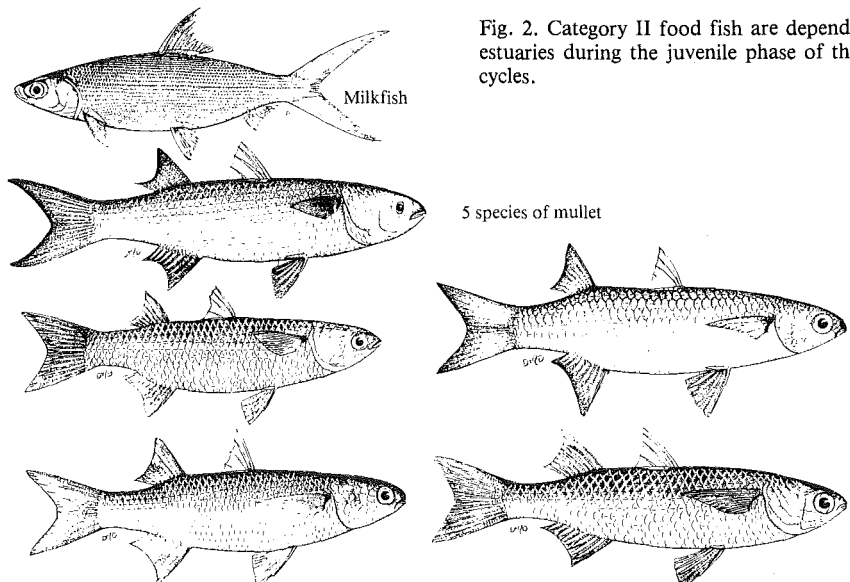


Fig. 2. Category II food fish are dependent on estuaries during the juvenile phase of their life cycles.

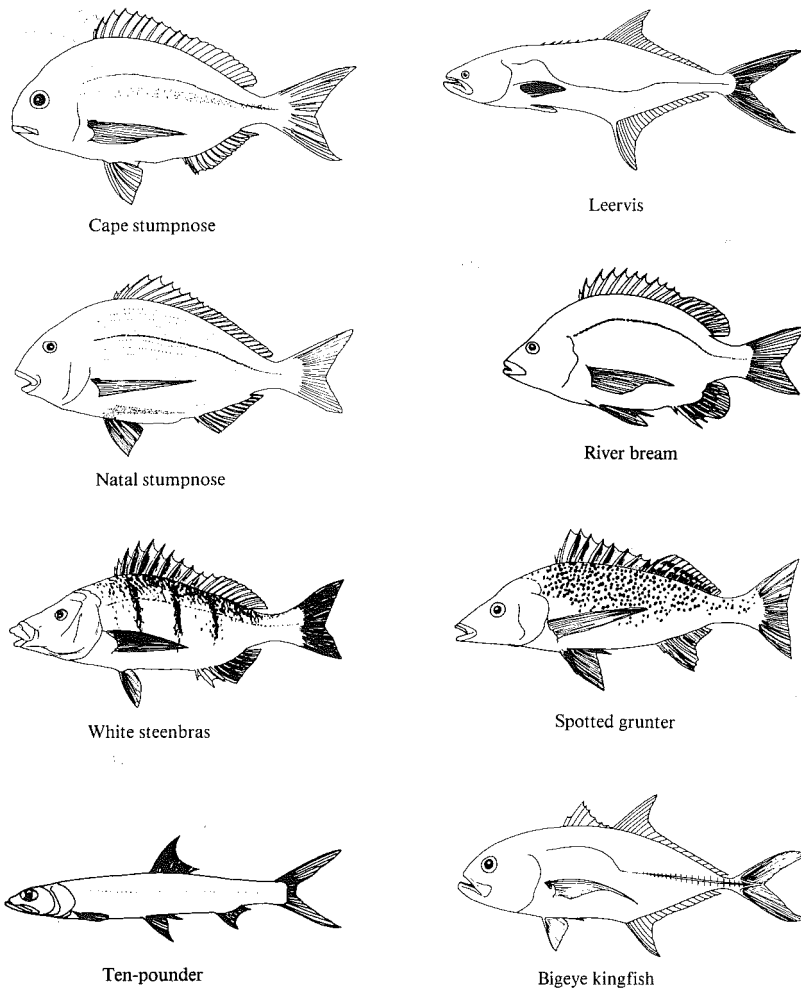


Fig. 3. Category II angling fish are dependent on estuaries during the juvenile phase of their life cycles.

estuaries for short periods during their life cycles. These are the freshwater eels, whose small elvers pass through estuaries in their migration from the sea into South African rivers, and which again occur in estuaries as adults during their migration back to sea to spawn (Fig. 4). The degradation of our estuaries would have serious consequences for these eel populations.

Category III includes 19 species whose juveniles are found mainly in estuaries but also at sea (Fig. 5). As a result these species are not entirely dependent on estuarine nurseries and, although they would survive in South African waters if extensive estuarine degradation occurred, their

numbers would be drastically reduced. Angling species comprise a grunter, a stumpnose, a barracuda, a queenfish, a shark and a sawfish. Food fish include five species of pursemouth and three species of mullet, which are also taken by predatory fish and birds.

Category IV comprises 28 species whose juveniles are found mainly at sea, but are also abundant in estuaries. Although estuaries are not essential for their survival, these areas do make a contribution to the adult stocks because juveniles that grow up in estuaries migrate to sea to join the breeding populations.

Some of the better known angling species

in this category are the kob, elf, blacktail, white stumpnose, giant kingfish and large-mouth queenfish. An additional 11 species are also of value as human food, while the remaining 11 prey species are not directly utilized by man.

Category V consists of approximately 100 species whose juveniles occur at sea and sometimes stray into estuaries. For these fish the estuarine environment is of no particular significance.

Category VI comprises 25 species which are associated with fresh water and whose juveniles are seldom found in estuaries. These areas are consequently of no significance to the survival of these fishes.

The above analysis of the dependence of fish on estuaries can be summarised as follows:

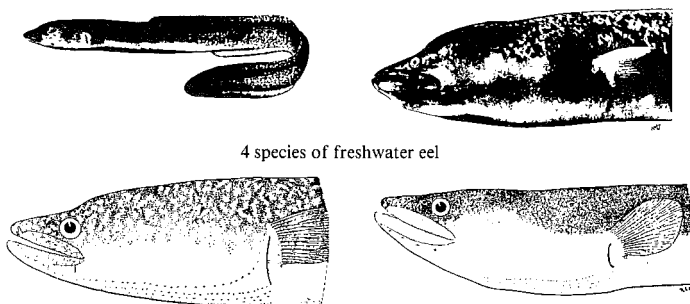
| Category | No. of species | Relationship to South African estuaries |
|----------|----------------|--|
| I | 8 | Dependent on estuaries during entire life cycle. |
| II | 22 | Dependent on estuaries during juvenile phase of life cycle. |
| | 4 | Dependent on estuaries during migration between rivers and the sea. |
| III | 19 | Largely, but not entirely, dependent on estuaries during juvenile phase of life cycle. |
| IV | 28 | Benefit from, but only partially dependent on, estuarine nursery areas. |
| V | c. 100 | Stray into estuaries from the sea, not dependent on estuaries. |
| VI | 25 | Miscellaneous species not dependent on estuaries. |

From this summary it is apparent that 81 species of fish are wholly or partially dependent on South African estuaries.

Discussion

Of the 81 species which depend on estuaries, 29 are taken by anglers and an additional 21 species are suitable for human food. Unfortunately, estuarine and marine inshore catch statistics for these species are not available, and the potential catch is also unknown. Consequently, we are unable to assess the value of the catch to the South African economy.

Equally important to consider is the rand value of activities associated with angling for sport in estuaries, such as the manufacture of boats, sales of outboard motors, fishing tackle, protective clothing and bait, the hire of accommodation, the sale of local real estate, and so on. Also relevant but even more difficult to quantify in monetary terms is the benefit of fishing as a healthy, outdoor recreational activity which provides relaxation and escape from the tensions of modern urban life.



4 species of freshwater eel

Fig. 4. Category II includes the eels which depend on estuaries when they migrate between South African rivers and the sea.

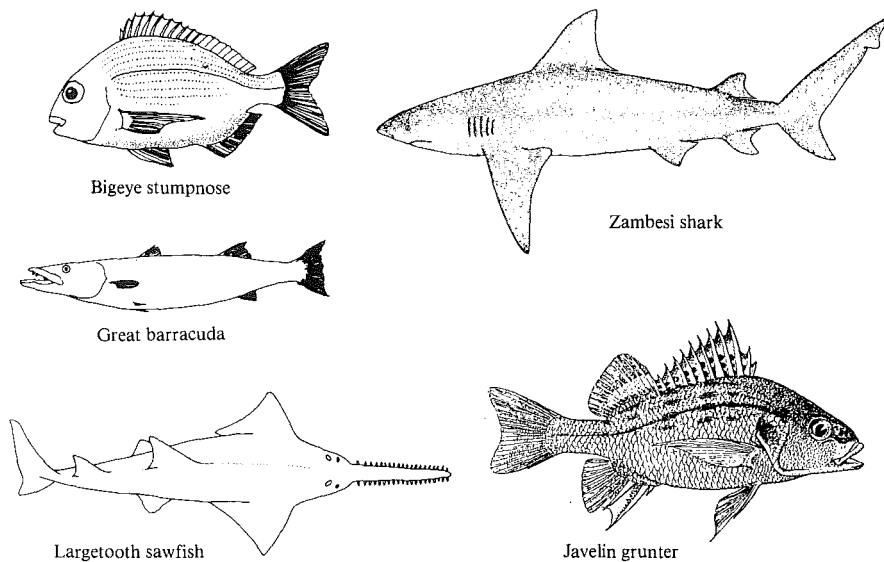


Fig. 5. Category III angling fish are largely dependent on estuaries during the juvenile phase of their life cycles.

Although it is not possible to place a value on these various factors, estuarine fish are undoubtedly of great significance to the national economy. Furthermore, as this resource is largely dependent on estuaries, it is in the national interest to manage estuarine systems so as to maintain their biological productivity and ecological diversity. This means that conservation of estuaries must be accorded a high priority when assessments are made of the merits of proposed development projects, many of which have quantifiable short-term benefits, but may cause degradation of the estuarine environment and its fauna in the longer term.

The relevance of the above is emphasized by the fact that extensive degradation of South African estuaries has already taken place,^{13,14} as a result of ignorance of and disregard for the consequences of man's activities in and around these sensitive systems. One common practice known to be detrimental to the fish fauna involves the artificial opening of estuary mouths, thereby interfering with the natural cycle of migration of juveniles into their nursery areas, and in their premature release to the sea. Another particularly detrimental practice involves encroachment onto wetlands adjacent to estuaries by agriculture, industry and transport systems, thus reducing the amount of plant detritus available to the base of the estuarine food web, and consequently reducing the size of the fish populations that can be supported. The impairment of normal tidal water exchange and the damming of flood waters by embankments and bridges also have adverse ecological consequences for estuaries, and consequently for their fishes.

We predict that if these and other forms of degradation continue there will be a continuing decline in the biological viability of South Africa's estuaries. The fish fauna will

consequently become increasingly impoverished, it will provide less food and fewer opportunities for recreation for our growing population. The fishing tackle, boating, accommodation and real estate industries will also suffer.

The financial and material support of the following organisations in the preparation of this article is gratefully acknowledged: The South African National Committee for Oceanographic Research of the CSIR; the Universities of Cape Town and Port Elizabeth; the Port Elizabeth Museum and the South African Nature Foundation. The assistance and encouragement given by Dr Allan Heydorn and by Professor George Branch in the planning stages of research into the occurrence of nursery grounds at sea, is also gratefully acknowledged. We are grateful to Mr Rudy van der Elst for advice concerning aspects of the Natal inshore ichthyofauna.

Workshop on Rehabilitation after Brain Injury

A problem of growing urgency in South Africa, that of the rehabilitation of brain-injured young adults, will move a step nearer to solution with the visit in July of Dr George Prigatano, Director of the Brain Injury Rehabilitation Program at the Presbyterian Hospital in Oklahoma City, USA. He will lead a workshop, the first of its kind to be held in South Africa, on the treatment and employment of brain-injured persons and will deliver the keynote address at a congress organised by the S.A. Brain and Behaviour Society. The congress will be held at the University of South Africa, Pretoria, on July 2 and 3 and the workshop will follow from July 4 - 7 at the Edenvale Hospital.

The workshop is expected to give a major impetus to the efforts already being made to resolve

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the fast-growing clinical and social problems posed by young survivors of brain injury sustained in, for example, car and motor cycle accidents, military action, and as a result of diseases such as strokes and cancer. Psychologists, medical practitioners, speech and occupational therapists, nursing sisters and social workers are among the professionals who will attend. A group of South African neuropsychologists will present individual case studies in illustration of the locally developed rehabilitation programme.

Those interested in registering for the workshop and/or the congress should write to 'Congress', Institute for Behavioural Sciences, P.O. Box 392, Pretoria 0001. Additional information is available from Dr Victor Nell, the workshop convenor at (011) 802-8183.