Marine recreational fishing: Resource usage, management and research

Editor: Rudy van der Elst

SOUTH AFRICAN NATIONAL SCIENTIFIC PROGRAMMES REPORT NO

167

JANUARY 1990

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Proceedings of a symposium held in East London, 22 and 23 May 1989 under the auspices of the South African Deep Sea Angling Association

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Editor:

Mr R P van der Elst
Oceanographic Research Institute
P O Box 10712
MARINE PARADE
4056

PREFACE

The Symposium on Marine recreational fishing: resource usage, management and research took place on 22 and 23 May 1989 at the East London Museum under the auspices of the South African Deep Sea Angling Association (SADSAA).

The objectives of the symposium were

- to create a greater understanding amongst anglers of the need for conservation, resource management and research;
- to give the scientists a greater understanding of the needs and requirements of the anglers;
- to review the shortfalls and strengths in current research and management programmes of the resource.

To achieve these objectives the programme was divided into the following sections:

- marine recreational fishing in South Africa
- status of the fishery
- target species profiles
- research and data acquisition
- prospects for the future
- management of linefish

The symposium was opened by the Minister of Environment Affairs, Mr G Kotze and the keynote address was delivered by Dr Maumus F Claverie Jr. of the United States of America, a trustee of the International Game Fish Association (IGFA). The symposium was closed by a general discussion on the evaluation of strengths and weaknesses in the current research and management programme.

ABSTRACT

This report contains papers presented at a symposium on marine recreational fishing: resource usage, management and research held on 22 and 23 May 1989 in the East London Museum under the auspices of the South African Deep Sea Angling Association with active involvement of marine linefish scientists.

UITTREKSEL

Hierdie verslag bevat referate wat aangebied is tydens 'n simposium oor seevisvangs vir ontspanning: hulpbronbenutting, bestuur en navorsing wat op 22 en 23 Mei 1989 by die Oos-Londen Museum gehou is onder die beskerming van die Suid-Afrikaanse Diepseehengelvereniging in samewerking met mariene lynviswetenskaplikes.

ACKNOWLEDGEMENTS

Thanks should go to the following:

- The Chairpersons of the various sections who are not listed : Prof M N Bruton (JLBSII), Prof C L Griffiths (UCT), Prof A P Bowmaker (ORI), Dr D E Pollock (SFRI), Dr J H Neethling (CPA) and Dr J H Grobler (NPB).

- Prof M N Bruton (JLBSII), Mr A J Penney (SFRI), Mr R P v d Elst (ORI), and Mr G Winch (SADSAA) who formed a coordinating programme committee.

- Mr G Winch and Mrs A Sparg (SADSAA) who helped in organising the symposium.

- Miss A Schnetler (FRD) who also helped in organising the symposium and compiled the proceedings.

- The East London Museum for hosting the meeting.

- The South African Deep Sea Angling Association (SADSAA) who provided funding for logistical support and the publication costs of the proceedings.

- Caterers: Mrs Pretorius, East London Museum staff, (teas)
Mrs J Els (lunches)

- Social programme: Stellenbosch Farmers' Wineries (SFW)
East London Ski-boat Club
Gonubie Marine Club

- To all the speakers and participants.

ACRONYMS

BNR	Kwa Zulu Bureau of Natural Resources
CIPS	Confederation Internationale de la Peche Sportive
CMAS	Confederation Mondiales Des Activities Subaquatiques
CPA	Cape Provincial Administration
CPUE	Catch per unit effort
CSIR	Council for Scientific and Industrial Research
DIFS	Department of Ichthyology & Fisheries Science, Rhodes University
EFSA	European Federation of Sea Anglers
FADS	Fish Aggregating Devices
FAO	Food & Agriculture Organisation
FL	Fork Length
FRD	Foundation for Research Development
IGFA	International Game Fish Association
ILTA	International Light Tackle Association
IUCN	International Union for the Conservation of Nature
JLBSII	JLB Smith Institute of Ichthyology
NaPB	National Parks Board
NCAU	Natal Coast Anglers Union
nm	nautical miles
NMLS	National Marine Linefish System
NPB	Natal Parks Board
NSB	Natal Sharks Board
ORI	Oceanographic Research Institute
PEM	Port Elizabeth Museum
RU	Rhodes University
SAASSPER	South African Association for Sport Science, Physical Education & Recreation
SAAU	South African Anglers Union
SASBA	South African Ski-Boat Association
SADSAA	South African Deep Sea Angling Association
SAFSA	South African Sport Federation
SAGFA	South African Game Fish Association
SANCOR	South African National Committee for Oceanographic Research
SARSAA	South African Rock and Surf Angling Association
Sefref	Sea Fisheries Research Fund
SFRI	Sea Fisheries Research Institute
SFW	Stellenbosch Farmers' Wineries
SGFC	Sodwana Gamefish Club
SAUU	South African Underwater Union
UCT	University of Cape Town
UPE	University of Port Elizabeth
USA	United States of America
WCS	World Conservation Strategy
WPUU	Western Province Underwater Union

TABLE OF CONTENTS

Preface .... (iii)

Abstract .... (iv)

Uittreksel .... (iv)

Acknowledgements .... (v)

Acronyms .... (vi)

Keynote address
Dr M F Claverie Jr 1

MARINE RECREATIONAL FISHING IN SOUTH AFRICA

Deep sea fishing; structure, economics and tournaments
Mr G Winch 9

Rock and surf fishing
Mr G Köllner.. 13

Light tackle boat angling
Mr B Carrol.. 14

The effect of spearfishing on the marine linefishery in South Africa.
Dr P A Cook.. 16

STATUS OF THE FISHERY

Perspectives on the conservation of linefish
Prof M N Bruton.. 20

Status of the fishery in Natal and Transkei
Mr P A Garratt and Mr R P v d Elst.. 27

The status of the East Cape linefishery
Prof T Hecht.. 31

Long- and short-term catch trends in the South African commercial linefishery
Mr A J Penney.. 38

TARGET SPECIES PROFILES

Problems associated with the management of reef fishes
Dr C D Buxton.. 41

Red steenbras and seventyfour: aspects of their biology and role as predators
Dr M J Smale.. 46

Pelagic gamefish, illustrated by billfish and larger mackerels
Mr R P v d Elst.. 52

Soft substratum fishes, illustrated by kob
Mr R L Tilney.. 55

Coastal migrants, illustrated by geelbek
Mr M H Griffiths.. 60

Yellowtail migration patterns and their management implications
Mr A J Penney.. 63

Has rock and surf fishing in the Southwestern Cape deteriorated?
Mr B A Bennett.. 68

Sharks and rays, illustrated by the blue stingray
Mr P D Cowley.. 71

Estuarine fishes, illustrated by the spotted grunter
Dr A K Whitfield.. 73

RESEARCH AND DATA ACQUISITION

Fundamentals of marine linefish research in southern Africa
Prof T Hecht.. 75

Commercial and recreational data on the national marine linefish system
Mr A J Penney.. 81

Marine fish tagging in South Africa
Mr R P v d Elst & Miss E Bullen 86

PROSPECTS FOR THE FUTURE

The effects of hook size on age-specific selectivity and its consequences for management
Mr B A Bennett & Mr A E Punt.......................... 91

Artificial reefs and FADs
Mr P A Garratt & Mr R P v d Elst.......................... 94

Is reseeding a viable linefish management option?
Prof T Hecht.......................... 98

Marine reserves - prospect for the future
Dr C D Buxton.......................... 102

MANAGEMENT OF LINEFISH

History and basic principles of linefish management in South Africa and elsewhere.......................... 106
Dr D E Pollock

The anglers' view of linefish management and research
Mr G Winch.......................... 109

Problems associated with the implementation of linefish management measures
Mr M M Brokensha 112

Requirements of linefish managers in order to plan future strategies
Mr E A Fearnhead.......................... 114

Funding marine linefish research
Mr R P v d Elst.......................... 116

Brief summary of the general discussion on the evaluation of strengths and weaknesses in the current research and management programme.......................... 120

APPENDIX 1 - Participants.......................... 121

APPENDIX 2 - Listing of common and scientific names of fish discussed during the Symposium 123

Recent titles in this series.......................... 125

KEYNOTE ADDRESS

JUDGE M F CLAVERIE, JR., INTERNATIONAL GAME FISH ASSOCIATION (IGFA)

My talk will focus on three things: first, the need for worldwide change in the ethic or the approach to how fisheries should be managed; second, the importance of the synergistic relationship represented in this symposium; and third, the importance of marine recreational fishing organisations, such as yours, the SADSAA and the IGFA.

ETHICS OF FISHERIES MANAGEMENT

First, the need for change in the ethic of fisheries. Historically, the ethic grew up that the sea contained infinite resources. The international law which evolved from that thought was that, since it was an inexhaustible resource, those who fished in international waters had the absolute right to take as much and in any fashion they wanted. That ethic was adopted by many countries in their own territorial waters. One was South Africa.

The next step in the history of fisheries occurred when it was discovered that fishing mortality could adversely affect the biology of fishery resources. The thought then developed that governing authorities would have the right to limit the take of fisheries if it could be shown that the activities of the fishermen were in fact hurting or had hurt the resources. Therefore, the ethic evolved, and was incorporated into the international law, that if you could prove damage being done to the resource, you could control the use of that resource to prevent biological damage to that resource, I call this ethic the "demonstrated damage" ethic of fishery management. That is where we are today, as far as the mutual approach to management in most areas of the world, including the United States.

Today, the demands for the resource and the technologies to harvest the resource exceed the capabilities of the resource to reproduce and regenerate. This calls for a new biologically-based ethic, which I call "demonstrated safety". We should, I think, retain fishing mortality at historically proven safe levels, until such time as the scientists can assure us that additional take would be safe for the resource itself, and until such time that the managers and fishermen, in concert with the scientists, can assure all that additional take would do no social or economic harm to existing infrastructures relying on the historical take. So, in the future, you must have the "demonstrated safety" approach, rather than the demonstrated damage approach. Note that the concept of social and economic benefit is also introduced.

The problem with demonstrated damage is, simply, that by the time science catches up with the fact that damage has been done it is too late. The graph (Fig 1) shows two factors: landings and total biomass. The lower line shows landings in a relatively unexploited fishery that over the years has generated average landings (shown by the dotted line), then, an increase, or "pulse" in landings; then, a fall to a level much lower than before the pulse.

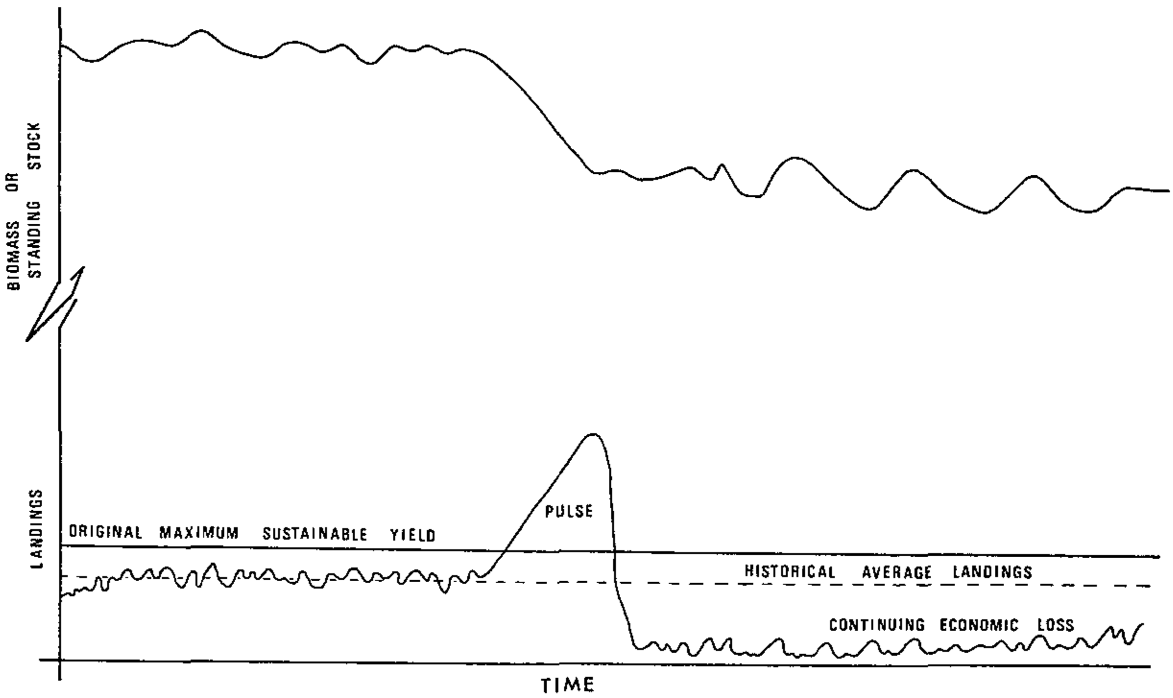

FIG 1: SCHEMATIC REPRESENTATION OF OVERFISHING

The line at the top is the actual biomass, the standing stock. Suddenly there is an increase in take off that biomass. That increased take now goes beyond what we call the maximum sustainable yield; it goes beyond the interest of the savings account and starts stealing into the principle. This reduces the standing stock or the biomass to the point where it will no longer sustain a harvest of the historic proportion. In these situations you either have a legislative or political stoppage of the take, or you have an actual operational stoppage of the take - the fish just are not there any more to be harvested. And you have a drop in landings.

Now you have a reduced biomass, and you have a new maximum sustainable yield level which is much lower than the original maximum sustainable level, or, if there was no original yield, a level much lower than the level that could have been sustained had you timely limited the take based on good science.

The economic loss is the difference between what could have been continually harvested and what now can be continually harvested. United States scientists now tell us that in certain species, notably those bottom fish along the eastern seaboard of the United States, the economic loss to the commercial fisheries alone has totalled millions of dollars a year. This is what I call "pulse overfishing".

The modern commercial fleets have the capability of pulse overfishing one species after the other. We have seen in the United States and the common market nations the construction of so called multi-purpose commercial fishing vessels that can overfish species A and then move to species B, and then to species C; by the time they get to species X, they hope that species A has naturally regenerated itself. Unfortunately, many of these species are long lived finfish, and they do not regenerate themselves in your lifetime or mine. For example, it may take thirty years to rebuild redfish stock.

This is where we are today, due to the fact that our management systems and our scientific capabilities do not stop the increase in take of fish until it is too late. And that is the story of every fishery that I have watched being overfished in recent years. Demonstrated damage doesn't legislatively or administratively control the situation until you are on the other side of the curve. One of my friends calls this "management after depletion" MAD and that is the term that has stuck. It is a waste, it is unfortunate, and it is short sighted.

POSSIBLE CONFERENCE MISSION

The next thing that I would like to touch on is how this conference - and what it stands for - is going to help solve these problems. Figure 2 illustrates the theory of this conference. There are three arms in the fisheries arena: the management arm, the research arm and the using arm, the fishermen. There is a close relationship, a synergistic relationship, among the three. In order for the system to function, the fishermen must communicate with the managers, the fishermen and the scientists must communicate very closely, the scientists and the managers must communicate. This gives the triangle-shaped relationship shown in Figure 2. I've drawn a circle around this triangular relationship indicating that the goal should be conservation of some sort.

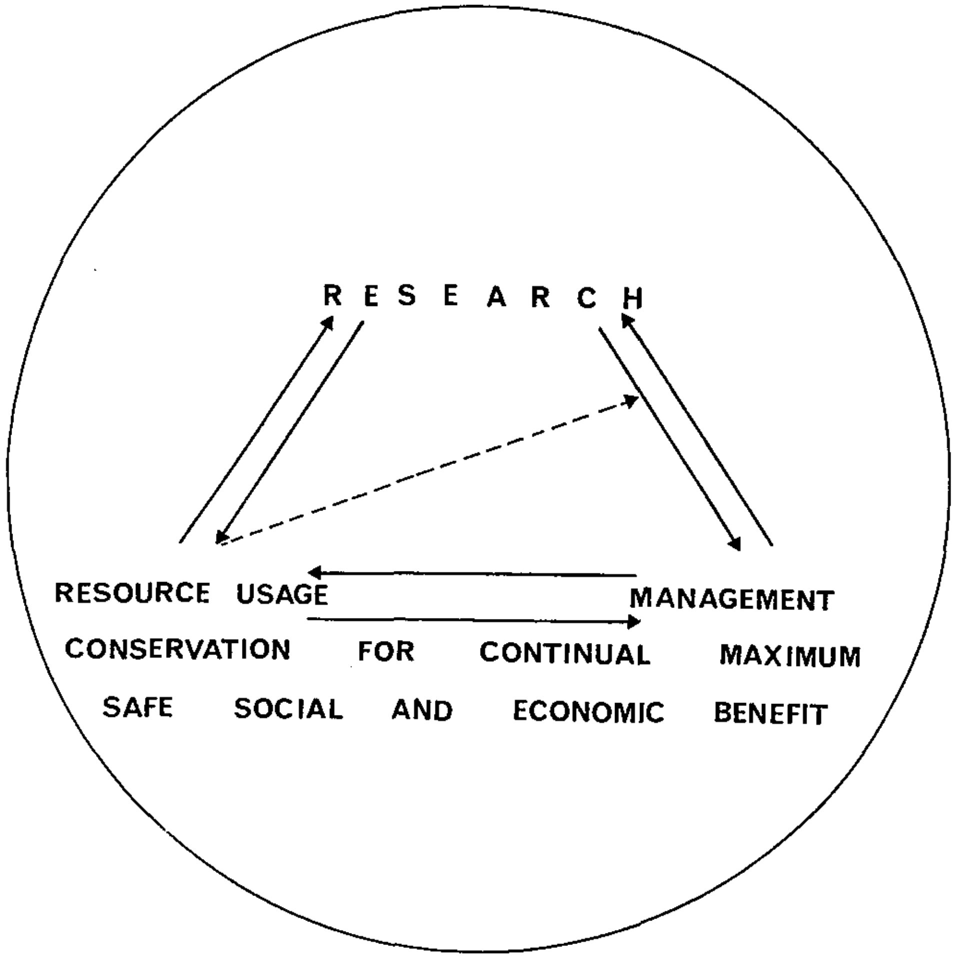

FIG 2 INTERDEPENDENCE OF FISHERMEN, SCIENTISTS AND RESOURCE MANAGERS

I have noted that conservation should not just be for the short-term but must be for the continual, maximum, safe, social and economic benefit to all the nation. In fact, that is my translation of what I read to be your fishery management policy. And it is the translation of what most written fishery management policies are around the world. But the actual execution of these policies is not always according to the words on paper.

In the United States we have the Federal theories expressed in our 200 mile zone act, the Magnusen Fishery Conservation and Management Act. We have had a heck of a time explaining to those who are administering the programme that conservation is different from management. You can manage a species to take all of them within three years and there will be none left, that is a management programme. But if you are going to do it on a conservation basis, it is for the continual use for long-term benefit. As the recreational fishermen explain it: so our children and grandchildren can have the pleasure of catching these fish. As the commercial industry explains it: so that we don't have to go out of business or restructure our whole capital investment every so often in order to switch to a different species. And as the managers explain it: so that the nation can continually recognise the maximum social and economic benefits from the biologically safe exploitation of the fishery resources.

It follows that if fishery resources are properly and timely conserved and managed, the nation will realise the highest social and economic benefits from the use of the fishery resources.

That is what I think this conference is about. And that, in a nutshell, is what is absolutely needed in order to assure the present and future availability of fishery resources for the benefit of all. Social benefit covers those who are involved in the taking of the fish, or benefit from the taking or attempted taxing of the fish. Economic benefit is looked at as how a community makes money: its tax base, industry, and contribution to gross national product from the use of the fishery resource.

What is important here today is that the marine recreational fishing organisations should (and this conference is the first formal attempt to do so) see to it that the three components work together to accomplish proper and timely scientifically based conservation and management.

Science is the keystone of the triangle. The recreational fishermen needs to learn the language of fisheries science and to work with the scientists. There are two types of research: fishery dependent and fishery independent research. The information on which fishery dependent research is based comes from the fishermen. For instance, there is a lot of information that has come from the commercial fisheries throughout the years, because they land for sale and that can and has been tracked. The United States has records on commercial landings from the 1800's: simple fishery dependent data.

We were lucky in the United States offshore recreational fishery. In the mid 60's, when we began fishing offshore Louisiana for billfish, we recorded our catch data. Those fish were then aged by scientists using the bony parts of the fish we provided. The relationship between the scientific community and the angling community was such that the scientific community obtained very valuable information and the angling community grew up in the ethic of giving that information to the scientific community.

We first started keeping information on what fish we were catching and what was in their stomachs, figuring if we knew what they were eating we could better bait them. We were then told by one of the scientists who passed through, Dr Gene Nakamura, that if we also kept the effort data it would be more useful to science. So we immediately started recording how long we were trolling to catch these fish. Because of this, we have some very good research data, which has paid off for us in the Gulf of Mexico. Based on the catch records we kept, the Japanese tuna longline fleet agreed to stay out of the Gulf of Mexico during the summer billfishing months.

There is another relationship between resource users and researchers that requires attention: the question of funding fishery research. Research conducted on scientific vessels is expensive as is information from the satellite systems. This sort of research, as does all other research, requires money. It is up to the resource users, who are the first direct beneficiaries of proper science and management, to see that research needs are properly funded. You should, politically or however, see to it that there is adequate funding for research so that research is useful, meaningful and timely.

As you can see, you need a strong relationship between the resource users, and the researchers. Our New Orleans Big Game Fishing Club has a resident port sampler at our dock at all times we are fishing - our ringmasters. He translates the sheets that we use to record our daily fishing activities from our language into the government language that goes into the computers. He weighs, measures and sexes every fish that is brought to the dock. He handles the tagging information on the fish that are tagged. He saves hard parts for the scientists. We have had the same man for twenty years so we have a standardised data base out of our club's system which is very valuable. We work hand in hand with the scientists.

You should also encourage scientists to maintain a relationship with management. There is no sense in scientists doing too much pure research; there has to be adequate applied research. From what I have heard on this trip, you need studies on the social and economic value of the recreational fisheries to select communities and to the Republic.

We found this out in Louisiana. There was much argument when we had to reduce the fishing mortality on redfish. Redfish was a species in trouble because it was over-exploited, the typical pulse overfishing curve. We had to legislatively control the fishing. The commercials trooped to the legislature to tell everyone how they would not be able to feed their families if their fishing for redfish was reduced. Lo and behold, the industry dependent on recreational fishing - the bait sellers, the boat docks, the marines, the boat manufacturers - also trooped to the legislature and said if the recreational fishermen were cut off they would not be able to feed their children either. Our State University had conducted a study on the economic value to Louisiana of the marine recreational fishery. This helped carry the day. Those legislators who to that point in history had been notoriously commercial fishing oriented said, ah ha, the shoe also fits on the other foot.

When you get an overfished situation everyone suffers. Not only me, the recreational fisherman. It is also the person I buy everything from. And that, as it has turned out in the United States, is a huge industry, measured in billions of dollars. Just in the State of Louisiana we are up to a billion dollars per year of value to the State from the recreational salt water fishery. This is a much higher value on those few species that we share with the commercial fisheries than the commercial uses of those same species. There are a lot of species that the commercials harvest that the recreationals are not too terribly interested in, and that makes the total commercial numbers more valuable.

Management is a whole different arena because it is something that is fairly new. Imposed limits and other restrictions on fishermen historically are new. One of the pleasures of recreational fishing is getting away from restrictions and limitations and reports and whatever else you have to do in your daily business life. You go fishing to get away from all of that. Fishing requires concentration which forces your mind away from daily worries. That's part of the pleasure. So you really don't want to be involved in a process that would force into your fishing activities just what you are avoiding. But management needs to know how to manage the fishermen, and needs the cooperation of the fishermen in management.

IMPORTANCE OF ORGANISATIONS

Suppose fishermen could not fish if they were wearing white hats. You might get a regulation compelling the use of white hats unless management knew that that would destroy the whole fishery. There has to be communication between anglers and management. In the United States, the angling conservation organisations, the Gulf Coast Conservation Association, the United Sports Fishermen, the National Coalition for Marine Conservation, and others, have gathered together and approached the agencies that manage fish and have established a relationship with them. The angling and recreational fishing side of the story, is being heard, and being reacted to. Those of you who read *Saltwater Sportsman* know that the recreational sector is asking for so-called parity. Parity doesn't mean 50% of the fish; it means 50% of the representation in those arenas that make decisions on how fish are taken - the research, development and management arenas. There is a growing relationship there which will benefit the fishery.

The relationship between management and research is one that is very close because a great deal of research funding comes from the management agency. Information needed to manage the fish is communicated from the managers to the scientists. When the scientists come up with the basic information, it has to be reviewed by management, who often require additional answers.

Let me give you an example. Let's suppose the scientists said that on species A the maximum take per year should be a million pounds; this is within the safety guidelines specified. Then management asks: "historically how many pounds have been taken by this fishery and how many pounds have been taken by that fishery?" Science gets that information back to them. Next comes the information on the options necessary to reduce the fishing mortality to the million pounds from previous or present levels, or those necessary to keep it at that poundage. What is often missing, but none the less important, is information on the social and economic impacts of the various options.

Probably the commercial fishery would like to fish full steam while they can so that they can be efficient. In other words, once they fuel and ice up their vessels they can go catch as many fish as they want. But when they reach their annual quota, that is the end of it. This is why the commercial fishery usually opts for an annual quota system.

The recreational fishery may prefer to spread out their fishing among themselves and over time with low bag limits, or reduced bag limits. Scientists have to advise among the various options by saying, "if you want to fish year round on a recreational bag limit, the bag limit should be thus", or "if you want to have a large bag limit, you can do so by introducing size windows, i.e., you have to throw back all of the fish below or above a certain size."

The scientists give to management the instruments that the managers can use in cooperation with the resource users to manage the resource, to impose the restrictions on the fishermen.

What then happens is that if the fishermen believe the science upon which the restriction is based is good, they will cooperate in the restriction. This is a problem in the United States. Fishermen are not totally aware of fishery independent information. Fishermen know they lie to the scientists. Therefore, they think the scientists do not have good information. Our commercial fishermen have testified in the legislative process that they report only about 10% of their actual landings. The recreational fishermen tend to overstate their catch, so their statistics are about 125% to 500% of their actual landings. The scientists will admit this, but it is numbers on a piece of paper and that is what the managers are stuck with.

The managers have to know how to adjust. We have created an infrastructure so there is a formal interplay between them all in the United States. The Conservation and Management Act that I told you about introduced eight regional fishery management councils. I was a member of one for a while and I am still a chairman or member of council advisory panels. These councils are composed of commercial fishermen, actual people with fish smell on their hands, and recreational fishermen, actual people, like me, with fish smell on their hands. Each coastal state's department or agency has a representative and the national agency has a representative on the council. Those councils generate the fisheries management plan that the Secretary of Commerce, who is the equivalent of a Minister in South Africa, implements through regulation. The implementation of the regulations themselves is a lengthy public process in our country, which I understand is not the case here.

You must realise that enforcement is not a reality at sea. It's too expensive. So you must have peer pressure to substitute for enforcement through cooperation. This is done by having the fishermen understand and participate in the process so that when the end result comes in the form of regulations, they will cooperate in following those regulations.

That outlines and touches on the importance of the synergistic relationship among these three components: science, management, fishermen - all three of which are featured at this symposium.

CONCLUSION

Your participation and enthusiasm is heartwarming to me because it is the beginning of what is needed. It proves the willingness of the scientists, the managers, and the anglers to work together to address and solve the resource problems of the fisheries for the benefit of all. You will find, surprisingly, that even the commercial vs recreational fights can be minimised if everybody understands that management is based on science and that everybody is being treated fairly.

I encourage you to be diligent. Time can be very short for the resource with these new highly efficient gears that are available and time can be very long on implementing new management regimes. This we have certainly learned in the United States. I hope you can learn from our mistakes in time to save your fisheries from overfishing.

When it is over, you should each be glad that you attended this symposium. You should even be proud that you were here for this, the first of this type of meeting, bringing together the three components of fishery conservation and management for the future benefit of all.

DEEP SEA FISHING; STRUCTURE, ECONOMICS AND TOURNAMENTS

MR G WINCH, SOUTH AFRICAN DEEP SEA ANGLING ASSOCIATION (SADSAA)

HISTORY

Pre and Post World War II :

In the years preceding and immediately after World War II recreational fishing at sea was done almost entirely from commercial line fishing boats. In many cases the boats operated with commercial fishermen crews during the week and then took recreational trippers out on the weekend on a charter basis. Bait and tackle was provided in some areas but not others and the catch was either sold by the recreational or kept for his own use.

The nature of these boats restricted this type of recreational fishing to harbour operation and long stretches of coast were rarely visited. The following harbours were mostly used: all the False Bay harbours (Simonstown, Kalk Bay, Gordons Bay, Hermanus), Mossel Bay, Knysna, Port Elizabeth, Port Alfred, East London and Durban.

Post War

The early 1950's saw the advent of privately owned deep sea fishing boats, usually 10 metres plus in length with inboard diesels. These were most evident at Simonstown and Durban. A club was formed in 1956 at Simonstown - The SA Marlin and Tuna Club and was followed by the Natal Deep Sea Rod and Reel Club (Durban) and the eventual formation of the SA Game Fishing Association (SAGFA) in 1962. This Association was mainly involved with the larger harbour operated private fishing vessels.

Right after the war a new boating phenomenon appeared - the ski-boat. The design was based on the original Crocker Surf Ski, used for riding the waves and surf rescues, and hence the name Ski-Boat - nothing to do with water skiing.

Ski-boats were first launched in 1945 in Durban and as the designs improved so they spread south to East London in 1950 and Port Elizabeth and Cape Town in 1954. Clubs were started in various centres:

Durban Ski-boat Club	- 1947
East London Ski-boat Club	- 1953
Cape Boat and Ski-boat Club	- 1967

The SA Ski-boat Association (SASBA) was formed in 1965 after three years of talking!

The mid 1960's saw the evolution of the Ski Boat to a highly seaworthy, sophisticated craft. Sizes expanded from the original $4^1/_2$ - 5 metres to seven and eight metres. Ranges increased and new launch sites developed to the stage where they were rarely more than 80 km apart.

During the 1980's many anglers had dual membership of both SAGFA and SASBA clubs and it became obvious that a merger was the right way to go. Eventually in 1987 the two Associations merged and the SA Deep Sea Angling Association was formed.

Another boating phenomenon appeared in the 1980's - the inflatable craft - known to all as the rubber duck. These craft rapidly replaced the small 4 m ski-boat and in 1988 were accepted for membership of SADSAA affiliated clubs.

While there has been an incredible proliferation of recreational boats in the years since the war one must not lose sight of the contribution made to the national economy in the form of boat and tackle industries, holiday accommodation, bait industries, etc. The capital investment alone is conservatively estimated at nearly R150 million!

STRUCTURE

SA Deep Sea Angling Association - Affiliations

SAAU - SA Anglers Union - Coordinating body
EFSA - European Federation of Sea Anglers - Tournaments
ILTA - International Light Tackle Association - Tournaments
IGFA - International Game Fishing Association - World records
- Ethical rules
- Conservation

SASF - SA Sports Federation - Coordinating body

Management - EXCO		**NON-EXCO**
President	Resource Management Officer	Selectors
V President	Safety Officer	Trustees
Secretary	Records Officer	
Treasurer	Public Relations Officer	
Tournament Director		

Council meetings - Provincial delegates and EXCO

Voting Qualified vote (1 per 500 members) except for elections. EXCO have no vote in elections.

PROVINCES	CLUBS	REGISTERED MEMBERS	CLUB HOUSES	BOATS	LAUNCH SITES
<u>INLAND</u>					
S. Transvaal	5	721	2	495	-
W. Transvaal	2	149*	-	72	-
N. Transvaal	7	602*	-	135	-
E. Transvaal	9	604*	5 + (3)	148	-
Transvaal	7	230	1 + (2)	130	-
Far North Transvaal	3	69	-	35*	-
Orange Free State	4	197	(1)	59	-
Griquas	2	40	-	18	-
<u>COASTAL</u>					
Natal	44	2 876	15 + (2)	1 200	44 +
Transkei	1	190	-	82	10
Border	8	492	3 + (2)	300	9
E. Province	9	418	4	480	10
S. Cape	6	563	2 + (1)	362	10
W. Province	7	1 113	4 + (3)	403	11
Namibia	5	59	2	25	3
TOTALS	119	8 323	38 + (14)	3 944	97

ECONOMICS

Estimated value (Conservative)	**Quantity**	**Value (Rands)**
- Boats and trailers Allow R30 000 each	3 944	R 118 320 000
- Tow vehicles Allow R8 000 each Allow 40%	1 578	R 12 624 000
- Fishing tackle Allow R1 000 per boat	3 944	R 3 944 000
- Club houses Estimated on individual basis	38	R 12 500 000
	TOTAL	R 147 388 000

Note: It is estimated that in the Western Province there are 2000 additional non-club ski-boats.

TOURNAMENTS

Inhibiting factors

Factors which reduce the impact on the resource.

- Line strains (trend to lighter lines) points system.
- IGFA rules.
- Fixed hours 0700 - 1400.
- Minimum size/mass.
- Tag and release.
- Accent on gamefish.
- Weather and conditions (blow-outs are a very big factor).

Tournaments - Current

Internationals
- ± Every second year in South Africa
- ± Four invites to overseas tournaments annually

Nationals

- Billfish	- Zululand venues
- Tuna	- Western Cape venues
- General Gamefish	- Any venue
- Bottomfish	- Border, East Cape, Transkei venues

- Ladies	- General gamefish
- U 21	- General gamefish
- Juniors	- General gamefish / bottomfish

Interprovincials

- Bottomfish	- 1 only. Any venue
- General gamefish	- 3 only. Any venue

Interclubs
- Variety : usually 2/3 days.

Club days
- Saturdays and/or Sundays (monthly)

Bonanza (not under the auspices of SADSAA)
- Charity : Umhlanga
- Sponsored : J & B
Jefferies Bay Time Share

ROCK AND SURF FISHING

MR G KÖLLNER, SA ROCK & SURF ANGLING ASSOCIATION, (SARSAA)

Organised angling started in South Africa some 75 years ago, initially in response to requests from the authorities in charge of harbours who wanted some organisation to be responsible for the many anglers who frequented the harbour walls and piers for their recreation and to catch something for the pan.

The first club formed in the Western Cape was in 1933 at the breakwater in Table Bay harbour and named The Table Bay Angling Club. This method of control was so effective that not long after the breakwater was open to club members only. This prompted other clubs to form and they then obtained the same privileges. The same procedure was used in all provinces in the early days of angling.

Clubs did not find it necessary to form themselves into provincial bodies until the late forties. The first inter-provincial contest was organised in conjunction with the Van Riebeeck Festival in 1952 and was held in Cape Town. Catches of 100 white stumpnose and galjoen per man per day were not exceptional.

The South African Anglers Union (SAAU) was not formed until 1949 and consisted of only casting, and rock and surf angling. The other facets gained affiliation as time went by.

Rock and surf angling in South Africa is practised by many thousands of people but due to the fact that you need not be registered; or need a permit to fish, these anglers need not belong to clubs and the real numbers will never be known. In Europe where every angler must be registered, you find that the British Federation of Sea Anglers have a registered membership of more than 1.5 million. Der Deutscher Verein Sportfisher has an even bigger membership. The South African Rock and Surf Angling Association (SARSAA) has a registered membership of 6 100 anglers belonging to 151 clubs and 15 provincial unions.

SARSAA was formed in 1974 and has been functioning since then as the sole controlling body of rock and surf angling in South Africa. They form part of the SAAU and are affiliated to the European Federation of Sea Anglers (EFSA) and Confederation Internationale de la Peche Sportive (CIPS) and also the International Game Fish Association (IGFA). These bodies control international angling. In spite of sport boycotts and political interference, we have managed to maintain contact with other angling nations and have had two overseas trips and eight tours to South Africa involving nine countries, viz England, Scotland, Ireland, Denmark, Holland, Austria, Western Germany, France and Spain.

Being a non-spectator sport it is very difficult to interest sponsors, therefore we blame the lack of funds on the fact that we have not had more international participation. We frown on the idea of sending anglers to international competitions only because they can afford it.

We have designed a system of merit coupled to participation in three national championships. Our philosophy is that the lucky angler could get to the top with one good fish over a day's fishing but over twelve days fishing luck plays only a very small part.

Our sport lends itself excellently to leisure time utilisation, but unfortunately we often experience the contrary. Large areas of the coast are legally or illegally closed by local authorities or vehicles on beaches are summarily prohibited without consulting or involving the persons concerned. We feel that a satisfactory system can be worked out in consultation with the right persons. You will find that it is not the angler who causes damage to dunes and beaches but by persons driving beach-buggies or motorcycles on beaches that are not involved in angling.

Rock and surf angling is a multi million rand industry, investments are made in fishing tackle and 4 X 4 vehicles while providing recreation at various stages for many thousands of South Africans who do good liaison work in other countries. We therefore feel that a forum should be formed so that our voice can be heard when it concerns us, and not that we must read in the daily newspaper that this beach or that area has been closed to us. Rock and surf anglers do not want access to beaches frequented by the general public - we are only interested in those areas where the general public cannot get to and we can only get to it by kilometres of footslogging and carrying our gear and on the way back a fish or two. We are looking forward to a national strategy on beach control with proper consultation with the angling bodies concerned and not control by quasi-conservationists and local authorities who stand to gain nothing by their actions and in the process deprive many sportsmen of their pleasure.

South African rock and surf angling is becoming more and more conservation conscious. At a recent international tournament not a single fish was killed. All were carefully weighed and put back in the sea alive. Our visitors from England and Scotland assured us that in this respect we were far ahead of our overseas compatriots.

Further I wish to stress that very few natural baits are used during our competitions because we mostly fish for sharks and consequently use sardines for bait.

It is not fiction when I say that often I have seen a 10 kg kob and a 3 kg galjoen being tagged and returned to the water. There are no commercial rock and surf anglers in our setup.

LIGHT TACKLE BOAT ANGLING

MR B CARROL, S A LIGHT TACKLE BOAT ASSOCIATION

INTRODUCTION

Light tackle angling was started in the early sixties, with anglers fishing from harbour walls, estuaries and boats, using any line but only a thin 8 lb breaking strain trace.

In 1966, Dr Cyril Goldberg and Co. challenged Eastern Province to a competition. At the time Eastern Province were the strongest province fishing from boats on inland waters using 12 to 15 lb line to catch tiger, and they readily accepted the challenge. Eastern Province were confident that they could beat Natal, as nobody could catch fish with "cotton". Dates were set for the Easter weekend 1966. Eastern Province would use their normal line and Natal restricted to light weight 8 kg breaking strains.

A team consisting of Dr Cyril Goldberg, Arthur Osborne and Jim Hindman left Natal to do battle in Port Elizabeth. The anglers participating had a lot of fun, with Natal being the victors. At a meeting held in Port Elizabeth that weekend, it was decided that a national body of light tackle boat anglers be formed and that we would hold an interprovincial competition in Port Elizabeth in March 1967. Since then we have fished the national championships according to the initial format in March every year with the exception of 1974, when due to fuel restrictions we could only fish in October. At the annual general meeting in March, 1975, it was decided that every alternate year we would fish in fresh water. This, as far as many of the coastal anglers were concerned, was the end of light tackle boat angling, for who wanted to fish with pap?

Well, with this in mind, the first national championship was fished at Loskop dam in 1976, and it was an outstanding success. As predicted, the coastal provinces did not do so well but as angling expertise improved over the years, so coastal anglers improved at inland venues and *vice versa*. So much so that in 1988, the nationals held at the Bloemhof dam were won by South West Africa, with Border coming third. Just to show that there were no hard feelings, Northern Transvaal took second position at the 1989 nationals held at Langebaan, and they were unlucky not to win.

It is felt that alternating inland and coastal angling has improved the versatility of all anglers. These anglers can now be moved from fresh water to salt water with no detrimental effect to their angling ability.

About six years ago the South African Light Tackle Boat Coastal Association was formed so that every year both inland and coastal competitions are fished. These are well attended and prove to be a good training ground for our Provincial anglers. The top eight anglers at both inland and coastal competitions are then selected to fish against each other at one coastal and one inland venue. The anglers are split up, one inland and one coastal angler in each boat, thus giving anglers the opportunity to learn from each other. From this event we select our National team.

Springbok teams for international participation are selected whenever possible. These teams are also selected on a merit basis using the past four years results as a major criteria with the selection.

TACKLE

Over the years tackle has improved, lines have got thinner and we have had to change from 8 lb line (with a diameter of .30 mm to .28 mm) to 4 kg IGFA class line. Random tests taken from time to time ensure that anglers continue to use the correct line diameter.

Finance and Membership

The S A Light Tackle Boat Association is one of the smallest facets of the SAAU and has a membership of only 3858 members, with a boat ownership of 1750. Nevertheless the value of this fishery is considerable.

At a boat replacement value of R18 500 it would be +R32 million
R15 500 it would be +R26 million
R12 500 it would be +R21 million
R10 000 it would be +R10 million

As most members have skiboats with two motors plus all safety and other equipment, these figures are very conservative.

Tow vehicles could have a total cost of R51 million at a replacement value of R30 000. It would be almost impossible to estimate fuel and repair costs on a yearly basis, these costs must be astronomical. One rod and reel costs an average of R300, and every angler has at least six of each, giving a total value of + R7 million. Terminal tackle (i.e. line, hooks, etc) costs an angler ± R150 per year - total cost to all anglers almost R600 000 per year.

The total invested value of this recreational fishing facet is thus seen to be about R100 million.

THE EFFECT OF SPEARFISHING ON THE MARINE LINEFISHERY IN SOUTH AFRICA

DR P A COOK, SA UNDERWATER UNION (SAUU)

INTRODUCTION

Whilst the term "fishing" has a romantic and attractive connotation - the term "spearfishing" has a considerably less attractive image. When thinking of spearfishing one tends to think of the aspects of a "blood sport" or of "hunters", and at a recent national championship spearfishermen were labelled as "murderers".

I would consider this image of spearfishermen to be unfair for a number of reasons. In fact, I would content that spearfishermen are the most conservation minded of all anglers. My justification for this contention is as follows:

- By virtue of the manner in which they practice their sport they have to be in close contact with the marine environment. They see the underwater environment and most of them appreciate it in a way that other anglers may not. Many spearfishermen are fierce conservationists.

- They are the most restricted and regulated of all anglers, some of these regulations being self-imposed (see later).

- It is the most difficult of all types of angling in terms of fitness requirement, deep diving, long swims, long periods of water exposure.

- It is the most dangerous of all types of angling - danger from sharks, drowning, exposure, etc.

STRUCTURE OF SPEARFISHING IN SOUTH AFRICA

This is complicated by the fact that spearfishermen are both anglers and divers, thus members of two unions (Fig 1). Each union and international body has its own separate functions.

S.A.A.U.

- Liaison between angling bodies
- Liaison with sports federation
- Springbok colours

C.M.A.S.
|
S.A.U.U.

- International liaison
- International competitions
- Liaison with government bodies
- Policy decisions - diving
- Financial administration

S A SPEARFISHING FEDERATION

- Competition organization
- Rule formulation
- Team selection
- Coordination between provinces

FIGURE 1: THE ORGANISATION OF SPEARFISHING IN SOUTH AFRICA

REGULATIONS FOR SPEARFISHERMEN

Spearfishermen are subject to all regulations pertaining to other anglers plus additional ones, many of which were self imposed by the South African Underwater Union. These regulations are summarised in Figure 2.

HUNTING METHODS	-	No aqualungs
	-	No explosives (eg. powerheads)
	-	No gaffs, batons, hand spears
LICENCING	-	None in Cape Province Licence in Natal since 1974 (SAUU would prefer uniform licence system)
BAG LIMITS	-	All normal regulations <u>Plus</u> 2 per species per day in competitions (all species) No brindle bass, potato bass, parrot fish or wrasse
SIZE	-	Minimum Natal - 2 kg Cape - 1 kg Poenskop - 5 kg Red steenbras - 5 kg Leervis (Garrick) - 3 kg
PROHIBITION ON SELLING	-	No individual sales Exemption for national competitions

FIGURE 2: REGULATIONS AND RESTRICTIONS FOR SPEARFISHING

N.B. Many regulations were self-imposed e.g. spearfishermen are restricted to shooting two of any one species per day. The reason for imposing this restriction, in addition to its conservation value, was to eliminate the element of luck of a diver hitting a shoal and shooting lots of the same species.

Considering the accusation that spearfishermen are "fish murderers" and that they are "stripping the reefs of fish" it is pertinent to examine some statistics. These are gained mainly from competitions held either by WPUU or by national championships.

Figure 3 lists the most commonly speared fish in the Cape region and indicates that the number of fish taken by spearfishermen is very low.
It could, of course, be argued that this does not take into account casual divers for whom we have no records but it must be remembered that the statistics are for the best spearfishermen in the country.

Most commonly speared fish
Western Province
(Statistics from W P Competitions 1978 - 1989)

SPECIES	MEAN NO. PER YEAR
1. Roman	80.8
2. John Brown	77.6
3. Hottentot	66.5
4. Butterfish (two-tone fingerfin)	43.2
5. Galjoen	36.5
6. Parrot Fish (knifejaw)	33.6
7. Bank Steenbras	23.3
8. Red Stumpnose	19.3
9. Bronze Bream	17.9
10. Dassie (Blacktail)	17.8
11. Wildeperd (Zebra)	17.8
12. Yellowtail	11.9
13. Musselcracker (Brusher)	11.6
14. Red Steenbras	11.3
15. Milkfish (Jutjaw)	8.8

Note: The figures are total number of fish speared in all Western Province competitions averaged for all years 1978-1989

FIGURE 3: MOST COMMONLY SPEARED FISH

A second set of interesting statistics are those for results compared on a year to year basis over the past ten years or so. If it were true that spearfishermen are "stripping the reefs" and leading to their destruction as claimed by some then it should follow that there should be a gradual decline in factors such as number of species caught, number of fish shot per man hour fished, kg of fish shot per man hour fished, etc.

Figure 4 shows the total number of species caught over the various years. This indicates that there has not been a real decline in numbers. Whilst we accept that there could be a number of possible explanations of this, e.g. spearfishermen could be getting better or using more sophisticated equipment, it must be remembered that the method of fishing has remained essentially the same.

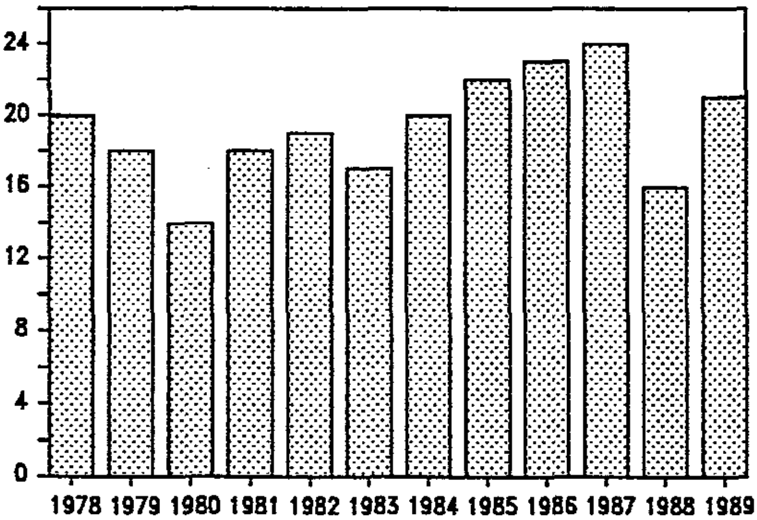

FIG 4: TOTAL NUMBER OF SPECIES CAUGHT

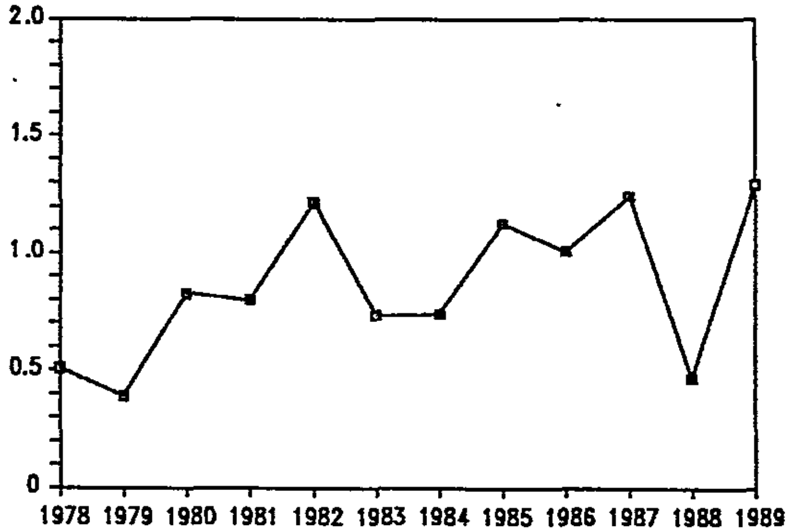

FIG 5: NUMBER FISH PER MAN PER HOUR

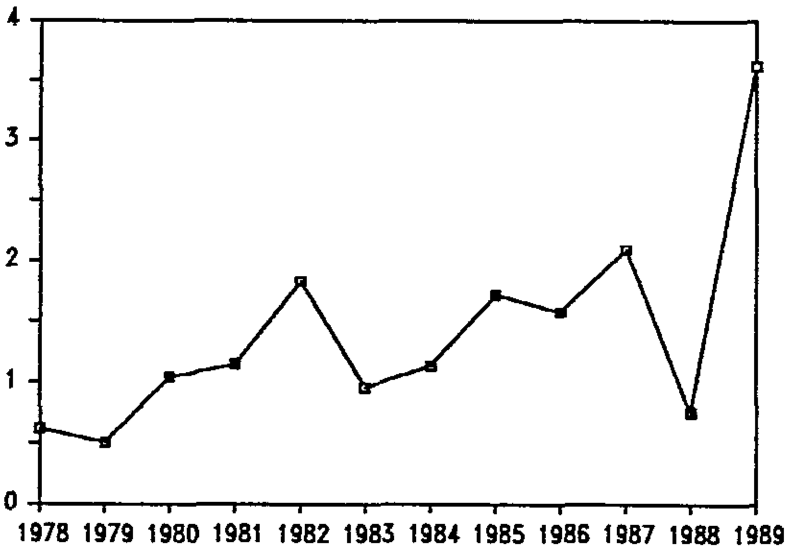

FIG 6: KG FISH PER MAN HOUR

Figure 5 shows that the total number of fish shot per man hour has also not declined. In this case it could be argued that spearfishermen are now shooting just as many fish but that the fish are now smaller. Figure 6, however, indicates that this is not so. The total weight of fish shot per man hour fished is still about the same as ten years ago. If anything, in fact, there appears to have been a gradual increase in the weight of fish shot per man hour.

CONCLUSION

Spearfishing is alive and well but we dispute the accusations levelled against us. Many of our fellow anglers who use conventional fishing methods ask us why we bother to spearfish when so many regulations are in force against us. I would answer that spearfishermen are sportsmen, involved in one of the most difficult, dangerous and physically demanding of all sports. I believe that they have a right to practice their sport. I believe that we as spearfishermen, presently the most strictly regulated of all anglers, have the right to make the statement that we support whatever conservation measures are considered necessary but that such measures should be aimed at the conservation of a particular species or stock and not at the reservation of that species or stock for the exclusive use of some particular pressure group.

PERSPECTIVES ON THE CONSERVATION OF LINEFISH

PROF M N BRUTON, JLB SMITH INSTITUTE OF ICHTHYOLOGY

INTRODUCTION

By way of introduction I would like to say how pleasant it is to be in a forum with anglers and commercial fishermen to discuss the one interest we all have in common - fishes, and particularly the long-term sustainable use of fishes. I come from an Institute with a long tradition of collaboration with anglers, starting with JLB and Margaret Smith and extending to the present staff and students. Our famous 'Sea Fishes' book was written with the angler in mind, and our Society of Friends of the Institute, ICHTHOS, was established in order to promote communication between anglers and scientists. The objectives of the Ichthyology Institute are to contribute to the understanding and promote the wise use and long-term management of marine and freshwater fishes, and we welcome the opportunity to work with anglers in achieving these objectives.

WHAT IS CONSERVATION?

To most people nature conservation is something which game rangers do in game reserves i.e. a rather irrelevant activity which is conducted mainly for the benefit of foreign tourists. It is also thought by many that nature conservation is anti-development and anti-utilisation, but this is not the case at all. Conservation is defined by the International Union for the Conservation of Nature (IUCN) as 'the management of the human use of the biosphere so that it may yield the greatest sustained benefit to present generations while maintaining its potential to meet the needs of future generations'. A central goal of conservation is therefore to keep options open, and it is not only desirable but in fact essential for our future survival.

Mankind has reached a point in his evolution at which he has the power to affect, for better or for worse, the present and future state of all life on the planet. The problem is not only the sheer numbers of human beings and their rapid rate of increase, but the careless way that they are using the resources of the planet. Modern technology and the `toys' of recreation now provide the means of upsetting the delicate web of life to such an extent that the consequences are no longer just regional but also global, such as in the case of the greenhouse effect and the ozone gap.

The scale and horror of this abuse is shown by some of these facts:

- widespread disruption of weather patterns, resulting in more frequent floods, droughts and other natural disasters;

- global warming which could cause parts of the ice caps to melt and the sea level to rise several metres, flooding coastal cities;

- the rate of extinction of species has risen to about 100 per day, according to the well-known conservationist Norman Myers, which is about 1000X higher than the natural rate. Furthermore, only 1.7 of the 5 to 30 million animal species on earth have been described, which means that many will go extinct before we even know about them. With respect to fishes, about 100 new species are described each year and it is estimated that as many as 20 to 30% of deep sea fishes may not as yet have been discovered. We cannot afford to lose them before we even know what they are;

- the sharply reduced abundance or reduced size of once common and large organisms, especially fishes.

The ironical point is that environmental degradation is not an essential prerequisite for progress as there is clearly an alternative route towards a more harmonious relationship with nature, but there seems to be an unawareness, even an apathy, on the part of many people that their individual deleterious actions could be any relevance. The problem is that the sum of all these individual actions adds up to a ruinous assault on the biosphere.

Fortunately, there is an increasing awareness now that the solution of the environmental crisis will depend not so much on technological or scientific advances, or on the decisions of committees, but on an awakening of each individual's awareness of the need for conservation, and in particular of his ethical responsibility as a temporary custodian of the biosphere for future generations. Part of the solution to the environmental crisis thus lies in the hands of concerned individuals.

A STRATEGY FOR RESOLVING THE ENVIRONMENTAL CRISIS

In adopting a strategy to play our part in resolving the environmental crisis, we cannot do better than follow the guidelines set out by the IUCN (1980) in the World Conservation Strategy (WCS). The WCS is intended to stimulate a more focused approach by all individuals to the management of living resources through the achievement of three objectives:

- to maintain essential ecological processes and life-support systems, such as the nursery functions of estuaries, coastal wetlands and subtidal areas, the exchange of nutrients between rivers and the sea, and between the surf zone and the offshore zone, all of which can be severely affected by pollution, poorly planned coastal engineering and overfishing. To maintain essential ecological processes, we have to understand them and this is a difficult and expensive process. Researchers, resource managers and anglers need to work closely together to accomplish this difficult task;

- to preserve genetic diversity, on which the functioning of many of the above systems and processes depends. This is necessary both as insurance and as an investment in the future, especially to keep open future options. Diversity is threatened mainly by habitat destruction and overexploitation. It should also be emphasised that diversity occurs in three ways: number of different species, number of different life styles (e.g. through sex reversal, different phenotypes) and the richness of species interactions. All three need to be maintained;

- to ensure the sustainable utilisation of species and ecosystems, especially those which support major recreational and commercial fisheries. Overfishing is the main threat here.

The <u>main obstacles</u> to the achievement of these objectives are:

- the belief that conservation is a limited sector activity instead of an essential action of every human being;

- the failure to integrate conservation and development;

- destructive development, due to inadequate planning with only short-term goals. We must, for instance, be careful not to overcapitalise a fishery and them use that as an excuse to overexploit the resource;

- the lack of a capacity to conserve, due to inadequate legislation and enforcement, a lack of coordination among enforcing agencies, a lack of involvement of individual laymen and a lack of knowledge;

- lack of support for conservation, due to a lack of awareness of the benefits of conservation;

- lack of conservation-based development, especially in the informal sector of the economy;

I would strongly recommend that every angling club and commercial fishing operation should have a copy of the World Conservation Strategy and should be familiar with its requirements.

SOME NEW PERSPECTIVES

In South Africa we have a wide variety of ways of protecting line fishes, such as catch limits, closed seasons, formal and informal marine reserves, and we have a complex multi-species fishery with at least 150 species along about 3000 km of coastline. We also have commercial and semi-commercial fishermen, and competitive and non-competitive anglers and spearfishermen, and they come from a variety of cultural groups with different objectives and which operate variably within the law. One may well ask: how can we possibly regulate such a complex fishery for the long-term good of all participants? To me there is only one way in which we can do so, and that is by making the participants part of the solution as opposed to part of the problem. I get the impression that there is in many quarters a feeling that the fisherman and angler is being unfairly bombarded with regulations and restrictions which interfere with his right to use a common property resource. His reaction is sometimes to defy those regulations, and when he does obey them it is more to avoid prosecution than because of a conservational commitment. But I strongly suspect that this does not reflect the true attitude of the angler who is basically a person with a strong empathy for the natural environment. But if this is the case, one may ask: have we not overregulated the fishery? Should we not rather charge the fisherman and the angler with the protection of their own resource and thus allow them to exercise their natural conservational instincts? After all, we all know that the more responsibility one is given, the more responsible one becomes.

Other papers in these proceedings will deal with specific conservation problems which need to be addressed with respect to our line fishes. I would like to discuss four issues which, while not necessarily the most important, are often ignored and do need to be addressed:

- Our studies on the biology of the important line fish species must focus more on critical aspects of their life history which allow us to make predictions about their responses to man-induced changes e.g. increases in mortality rates and changes in food availability. We should therefore concentrate on studying what is relevant and not what is easiest to study due to the ready availability of material. In addition to the study of anglers' catches, which are a very important source of data, we must work with the angler to obtain a more detailed knowledge of the whole fish community.

  An example of a topic which we need to study in more detail is the consequence of the removal of top predators and other vulnerable species from a reef ecosystem. The kinds of species which are most vulnerable to selective reduction are the ones with the following characteristics: relatively uncommon, large individual size, high in the food pyramid, low dispersal powers, producing relatively few offspring, relatively long-lived, specialised and frequently dependent on other species in mutualistic or commensal relationships (Norton 1986). These species have typically evolved in complex communities and are dependent for their survival on the continued existence of the other species and on the diversity of the interrelationships between them. The loss of species from these highly interrelated communities is therefore likely to cause a cascade of further extinctions or reductions. Furthermore, when a specialist species is removed from an ecosystem, its place is not usually filled by another specialist species as their respective specialisation are usually too narrow for them to be interchangeable. Instead, the specialist species is usually replaced by a generalist species, which is quite often of less use to man (Bruton 1989).

These generalist species are typically good colonisers with characteristics which are opposite to those of the specialist species which they have replaced, i.e. they are common, relatively small, have high dispersal rates and produce many offspring, and they have short generation times. They also do not engage in as many mutualistic interactions with other species. What has happened therefore, is that a complex system which has taken 100s of 1000s of years to evolve has become greatly simplified, and the reef has been overtaken by the animal equivalent of weeds. What is worse is that these animal weeds may become so dominant that even strong conservation measures may not be able to remove them, as has frequently occurred on land.

In order to overcome this sort of disaster, we need to have a good knowledge of the fish species which are sensitive to exploitation and also a handle on how the whole reef community is reacting to exploitation. We need more money and more adequately trained people to do this properly, so that we can stop doing lucky dip research and spend more time underwater in the habitat of the fishes, using modern diving equipment including the use of underwater habitats and research submersibles.

- Lack of knowledge about fishermen and anglers and their motives. This is equivalent to studying a predator-prey system without studing the predator (Attwood 1988). We need to carry out detailed studies on the habits and motivations of anglers and information may be of even more use to the management of the fishery than further information on the fishes themselves.

  When we consider that conservation is a human activity carried out for human benefit, why are we so reluctant to focus on people when we conduct research? Maybe it is because, as biologists, we feel incompetent to study humans. If so, we need to employ sociologists on our research programmes, but we must start integrating human behaviour more into our fishery models.

- We need to rationalise the number of competitions (=tournaments) which are being held each year. The number of competitions which are held needs to be decided by some national body, in consultation with local angling organisations where the competition will be held, taking into account some measure of the extent to which the targeted stock can still be exploited over and above the legitimate yield which the non-competitive angler is allowed. In some years or in some localities we may have to have fewer or no competitions in order to allow the stocks to recover. When the fuel crisis was at its worst, angling competitions were stopped - surely the crisis of our fish stocks is sufficiently severe for us to consider similar actions, at least in some places and for parts of the year? Furthermore, the new type of bonanza competitions, while they may raise money for worthy causes, are surely an unacceptable form of commercialisation of a fragile resource?

An interesting study done by two American researchers (Fedler & Ditton 1988) from the University of Maryland and Texas A & M University analysed the reasons why people fish and the amount of satisfaction they obtained from their fishing experiences. They found that non-competitive anglers rated aspects of the fishing experience other than just catching lots of big fish higher than did competitive anglers. The aspects which were rated most highly were: interacting with nature, relaxation and escaping the daily routine. The non-competitive angler was also found to fish more frequently and was more satisfied with his most recent fishing trip.

I think that we should at least establish the impact which competitions are having on the resource relative to noncompetitive angling before we go any further.

- Another aspect which is worrying me and which Dr L J V Compagno in particular has been campaigning against for some time is the attitude of anglers towards cartilaginous fishes. Sharks and rays are some of the most highly evolved animals on earth with a career lasting over 400 million years. They have survived many major extinctions and seen many other animal groups come and go. Sharks are the lions, jackals and eagles of the sea and have a very important role to play in marine ecosystems. Why then are sharks and rays treated as if they are unwanted vermin which we must rid the sea of at all costs? Many sharks are relatively high in the food chain, being predators, and they are vulnerable to baited hooks, and there seems to be no limit to the level at which they are being exploited. We have already witnessed in Natal the consequences of the removal of large numbers of sharks from coastal ecosystems. Although it is likely to be an unpopular viewpoint, I would like to call for a new and more rational attitude towards sharks by the angling community.

- The impact of visiting anglers. I have often heard the complaint that local anglers establish informal conservation measures, such as marine reserves or catch limits, in order to conserve their own stocks, but then have these voluntary conservation measures overturned by flocks of visiting anglers who have no particular concern for the future of the local fish stocks. To me, more credence should be given to these voluntary actions by local angler groups, and consideration should be given to establishing nature conservancies on the edge of the sea as has already been done on land on farms in Natal and in the Eastern Cape.

My overall feeling on the conservation of line fish stocks is that we have an excellent although small group of line fish researchers and that they are receiving superb support from organised anglers. Unfortunately, the managers are thin on the ground (especially in the Cape) and there does seem to be a need here for more funds to be made available for field staff. The most important new requirement is a change of attitude of the three groups - the anglers, researchers and managers -

towards one another and towards the resource. The managers need to control the resource taking into account the needs of the anglers, and the anglers need to control their activities taking into account the needs of the resource. I am thus not so much in support of deregulation as in more devolution of authority to organised anglers, perhaps along the lines of the Regional Fishery Management Councils in the USA (Branson 1987), but for recreational fisheries. But in order to accept new responsibilities, anglers need to be well organised. They cannot afford to have a large component of their fraternity unregistered, not affiliated to clubs and not participating in joint research and management exercises. One way to achieve this may be to make it compulsory for all anglers to be licenced. Anglers also need to have a strong unified, national body which represents all facets of their hobby and which publishes a well-edited, authoritative magazine that fairly represents the views of all anglers and spearfishermen. Fortunately a well-organised infrastructure does exist for anglers in South Africa, and it is now up to them to obtain the support of unaffiliated anglers so that they can jointly present a powerful and concerned front to the conservation and management authorities. Once this kind of management by 'controlled rights' has been achieved, the future of the line fish resource in South Africa will be assured.

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STATUS OF THE FISHERY IN NATAL AND TRANSKEI

MR P A GARRATT & MR R P v d ELST, OCEANOGRAPHIC RESEARCH INSTITUTE

INTRODUCTION

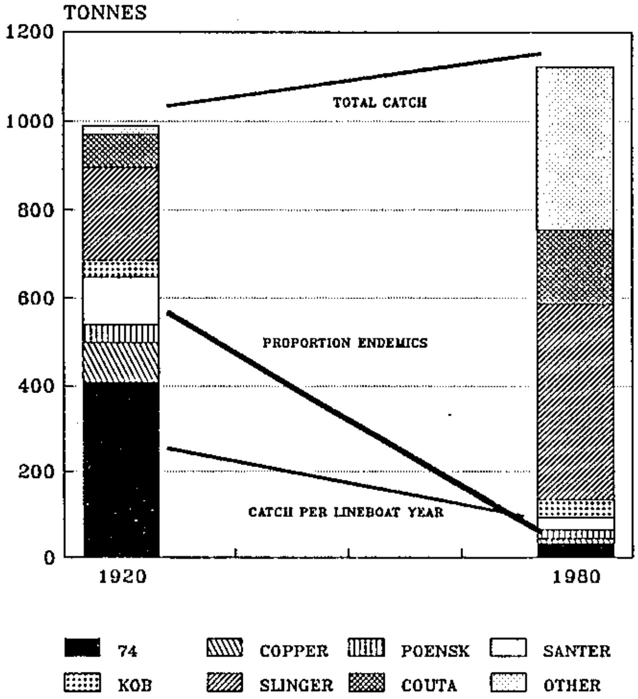
Assessing the status of a fishery is never a straight forward task and usually follows a number of distinct steps or events. Initially there are the opinions of fishermen. Perhaps not too scientific, but often accurate and informative. After all, who needs science to tell fishermen their catch is deteriorating! Numerous examples of such initial assessment exist, perhaps the seventyfour (*Polysteganus undulosus*) and the elf (*Pomatomus saltatrix*) are best examples where Natal fishermen first drew attention to the status of the resource. The next phase usually follows preliminary scientific investigations where the biology and catch rates of individual species are studied. This helps to identify vulnerable life stages and allows for the formulation of preliminary management strategies. While these may not necessarily be perfect, such early and timeous assessment of the fishery may prevent its collapse.

Various methods can determine the status of linefish stocks more precisely. Because fish are not easily seen and thus inaccessible to direct census techniques, most methods involve indirect techniques based on the analysis of catches. As natural fluctuations occur, it is preferable to assess landings made over many years. In most fisheries good records of past catches are either not available or are not in a form which permits direct year to year comparison. Natalians, however, are fortunate to have had several conscientious fisheries officers in earlier years. Their accurate catch statistics at the time now provide us with an indication of gross trends in the fishery and an assessment of the present status of Natal's linefish. If we assume catch per unit effort (CPUE) to be a reasonable indicator of fish abundance and species composition of catches to reflect the quality then the following provides a measure of the status of the resource.

Offshore fishery

Analysis of offshore catches made in Natal and Transkei are primarily based on commercial landings as these represent a long-term data set with a reasonably consistent index of effort (Fig 1) (v d Elst and de Freitas 1988).

During the period 1900-1986, the number of fishermen actively employed in the commercial fishery increased moderately (Fig 2). In contrast, the sportfishery commenced relatively late but since 1975 it's growth has been exponential. Of further significance is the post-war improved efficiency of fleets, largely attributable to echo sounders, improved navigation and modernised fishing equipment. For the first time fishermen could detect what was below and were thus able to target on shoals of fish such as the seventyfour.



Poenskop includes Scotsman

FIG 1: SCHEMATIC OVERVIEW OF CHANGES IN THE OFFSHORE FISHERY (AFTER VAN DER ELST 1988)

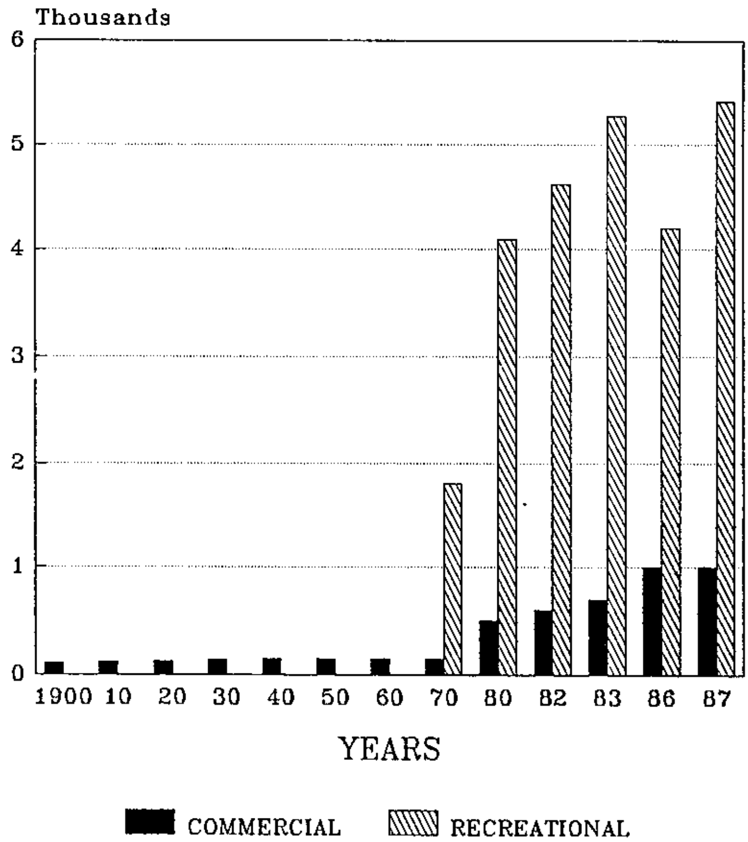


FIG 2: TREND IN NUMBER OF BOAT FISHERMEN ACTIVE IN OFFSHORE COMMERCIAL AND SPORT FISHERIES IN NATAL

Progressively the CPUE declined, especially for those species that were most valued (v d Elst 1988). While a conventional Natal lineboat (Garratt 1985) with a compliment of 20 would harvest 300 tonnes per year during the 30's, a similar years's fishing in the 80's produced no more than 30 tonnes (Fig 1). Such a reduced CPUE clearly lowered the financial viability of fishing and many commercial fishermen either changed to more economic ski-boats or left the fishery altogether.

The situation is further complicated by the multi-species nature of the Natal fishery resulting in a switch in targeting from one species to another as stocks are depleted. The seventyfour is a good example of this, constituting the bulk of catches during the first part of this century, but seldom seen today. Instead it has been replaced by the less desirable slinger *Chrysoblephus puniceus*. This and other trends have resulted in significant changes in species composition over the years. These are clearly evident in Figure 1, in which all the larger, more desirable and plentiful fish such as seventyfour, poenskop *Cymatoceps nasutus*, Scotsman *Polysteganus praeorbitalis* and red steenbras *Petrus rupestris* now constitute an almost insignificant proportion of catches. These changes not only underline the gravity of the situation but also significantly reduce the chances of landing trophy fish, an important management objective in recreational fisheries.

A further complication involves the phenomenon of sex change during a fish's life, usually from female to male, as in the slinger when it reaches a size of 350-370mm (Garratt 1985). The significance of this may not be fully understood but it is certain to affect a fishery which is based on such species. Already the reduction in size of slinger caught along the Natal coast has resulted in fewer males (only 5% in the population) with virtually none along the South Coast at all. It is not yet known if these males can adequately fertilise sufficient eggs to sustain future stocks. If not, then we may well be entirely dependent on southern Mozambique populations for recruitment to our slinger stocks - not a desirable situation.

Inshore fishery - rock and surf

An excellent set of historic data is available to document the status of the inshore recreational fishery in Natal. The number of anglers fishing from Natal's shores has increased enormously although there is considerable variation from year to year, thought to reflect the general state of elf *Pomatomus saltatrix* fishing along the coast. The overall annual increase in angling effort is considerably higher than the national population growth rate, indicating that angling along our shores is becoming more popular each year.

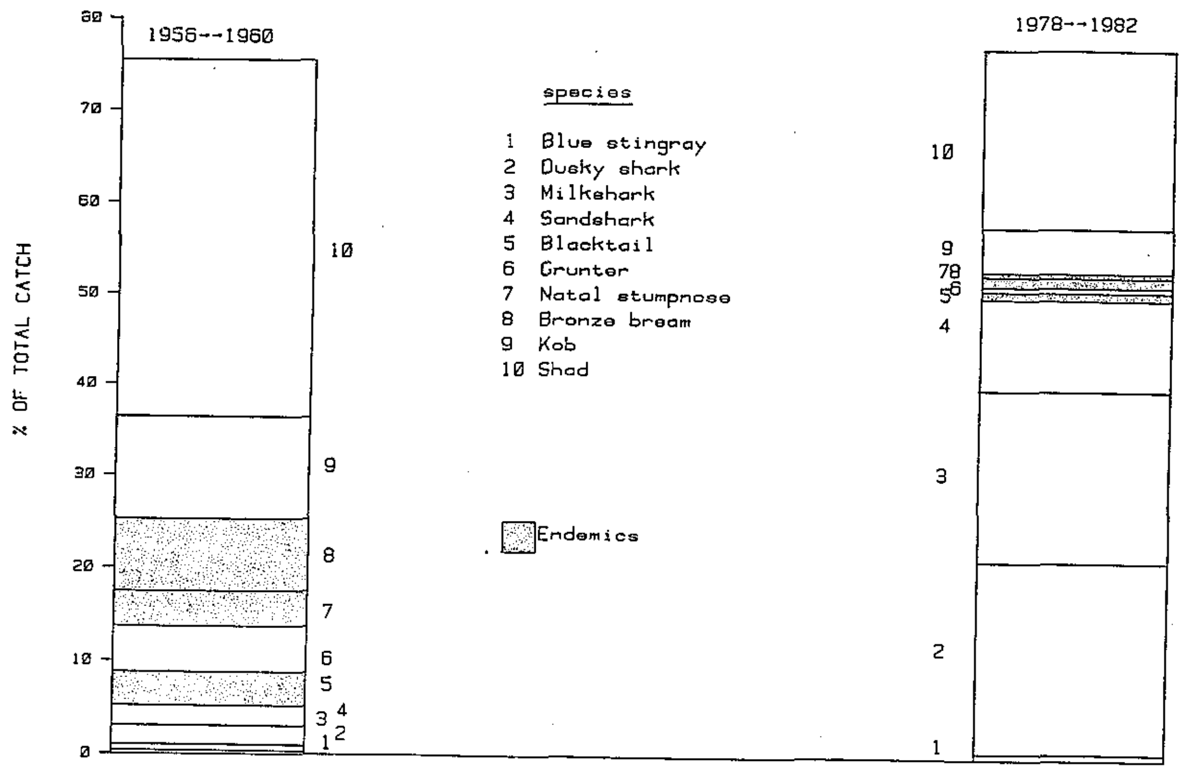


FIG 3: SCHEMATIC OVERVIEW OF SPECIES COMPOSITION OF SHORE CAUGHT FISH (AFTER VAN DER ELST & DE FREITAS, 1988)

During this period of increased fishing effort, the CPUE of many species declined, especially those of principal target fish such as the elf, much to the alarm of anglers and researchers. Changes in the species composition of catches similar to those experienced offshore were also noted. In earlier years a large proportion of the catch comprised such prized fish as elf, kob, bronze bream, Natal stumpnose and spotted grunter (Fig 3). Today catches mostly comprise stingrays and small sharks, far less desirable to the angler. In analysing these various declining trends it is noted that certain groups of fishes have been more severely depleted than others. This is especially true of endemic, estuarine associated and inshore reef species, clearly emphasising the greater vulnerability of these groups.

CONCLUSIONS

Natal is situated in a sub-tropical region, washed by warm low-nutrient waters, has a narrow continental shelf and few reefs, all factors that limit the total size of its fish resources. The great species diversity of its fishes, high levels of endemism and generally slow growth rates, make Natal's fishes inherently vulnerable to exploitation. Take this scenario and subject it to increased fishing pressure and it is hardly surprising that the status of both offshore and inshore resources are not what they used to be. Falling CPUE and negative changes in species composition indicate a serious state of affairs. If the rule that a CPUE decline exceeding 50% indicates over-exploitation is accepted here, then it must be concluded that most of the endemics are in an alarming state.

Despite this bleak status of the Natal linefishery there is some optimism for the future. Management action in 1976 to protect the elf appears to have been successful, giving hope that other species can benefit likewise. Better scientific understanding enhances our ability to offer good advice on reinstating some species to their former importance to anglers. Finally it will be the support of fishermen themselves that will dictate the future. The resource has to be divided amongst an ever increasing army of anglers.

Wise management should secure an optimal catch for all.

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THE STATUS OF THE EAST CAPE LINEFISHERY

PROF T HECHT, DEPARTMENT OF ICHTHYOLOGY AND FISHERIES SCIENCE, RHODES UNIVERSITY

INTRODUCTION

Before discussing the present status of the linefishery in the eastern Cape, it is necessary to define a linefishery. According to Schmied (1983) a linefishery, in its entirety, consists of the resource base, the users, the support industries and the research and management organisations. Permit me to comment briefly on each of the components.

The resource base

This is obviously the most critical requirement of any fishery. In order for a linefishery to exist at all we need an adequate supply of desirable fish. The type of available fishery resources and the 'health' and abundance of the various stocks will dictate to a large degree the types of fishing opportunities (commercial and recreational). Fish represent a natural and renewable resource and must be available for man's judicious use now and in the future. Fish stocks show a remarkable resilience to exploitation but a critical point does exist beyond which the stocks simply cannot recuperate.

The users

In South Africa, as elsewhere, the user communities consist of recreational and commercial fishermen. To a large extent the goals of these two user groups differ. On the one hand the commercial fisherman is dependent on the resource for a living, while on the other hand the recreational fisherman uses the resource 'purely' for sport and recreation. Because both user groups exploit a common resource, but with different objectives, there exists a certain degree of conflict. This conflict needs to be assessed and understood and brought into the ultimate resource management equation. At present and except perhaps in Natal, the scientific community is first and foremost dependent on commercial fishermen for data and specimens. However, if we wish to make any contribution towards the sustained management of the resource the involvement of the recreational fisherman in matters scientific is crucial. It is also necessary for all user groups to develop a greater conservation ethic.

Support industries

These include tackle manufacturers and shops, boat builders, boating and vehicle accessory equipment, retail outlets, the bait industry, tournament sponsors, etc.

Research and management organisations

These organisations although linked, serve different functions. The research organisations are responsible for initiating and undertaking basic and applied conservation orientated research. On the basis of the results the research scientists are responsible for the making of recommendations for the conservation of the stocks. Management is then responsible for assessing the socio-economic impact of such recommendations as well as assessing the feasibility of implementation, with particular reference to control measures, and ultimately are responsible for the implementations of the regulations, as promulgated either by the Minister of Environment Affairs or by Provincial authorities.

STATUS OF THE EASTERN CAPE LINEFISHERY

It is extremely difficult to comment on the status of the eastern Cape linefishery as a whole. Nevertheless there is good information for some regions which give an indication of what is happening in the area. This information is largely of recent origin and is primarily contained in theses and reports to research funding agencies, and several publications *inter alia* Smale & Buxton (1985), Coetzee, Baird and Tregoning (1987), Buxton (1987), Clarke (1987), Griffiths (1987), plus our own work on the commercial and recreational fishery in the Port Alfred/Kenton area (Hecht & Tilney, in press). Much of the information contained in these theses and reports will appear in the primary literature within the next year or two.

Before I turn to the status of the resource I should like to comment briefly on the support industries and the user communities. Based on a recent telephonic survey of the support industries it was concluded that the support industries are flourishing and growing throughout the region. This growth could possibly be an indication that the numbers of recreational ski-boat anglers and rock and surf anglers in the region are increasing.

It has been calculated that the participation in recreational shore and ski-boat angling, on a national basis, is growing at a rate of ca. 6% per annum (van der Elst, 1988). Unfortunately, we have no information on a regional basis but based on the national average, coupled with the results obtained from the above survey, we can assume with reasonable confidence, that the user community in the eastern Cape is also in a growth phase.

Smale and Buxton (1985) present data on the value of the recreational fishery in the eastern Cape and Border (Kei River Mouth to Jeffreys Bay) for 1983. The capital investment was estimated to be in the region of R17 million. The estimated annual running costs of one club alone in Port Elizabeth (PEDSAC) was estimated at R1.09 million/year. Also the number of recreational boats in the area increased by a factor of 1.6 between 1975 and 1982. In 1983 there were some 645 club boats, plus another estimated 200 non club affiliated ski-boats.

Unfortunately, apart from Smale and Buxton's data in the area we have no continuity of information upon which to estimate the growth of the recreational industry nor the landings of recreational vessels. The commercial user group has also grown in the South East Cape, particularly since the advent of the squid fishery in 1984 in the Port Elizabeth, Jeffreys Bay, St Francis and Plettenberg Bay fishing areas (Augustyn and Smale, 1989).

An analysis of the commercial catch returns by regions (along the eastern seaboard) indicates that the eastern Cape based linefishery in 1988 was the biggest contributor (see Table 1).

TABLE 1: The 1988 commercial catch by regions (excluding squid) and an indication of the most important species within each region

Region	Number of boats	Catch (Kg)	Species (order of priority)
Natal	106	634 126	slinger, santer, couta, rockcods
Transkei	17(?)	37 884(?)	red and black steenbras, couta
SE Cape	311	947 577	carpenter, panga, kob
S Cape	412	723 297	kob, carpenter, geelbek

All commercial catch return data were kindly made available by Chris Wilke, Sea Fisheries Research Institute, Cape Town

It is tempting to speculate that the influx of squid boats is responsible for the high total landings in the South East Cape area. Whatever the reason the South East Cape commercial fishery is the largest on a regional basis and therefore warrants dedicated research.

The commercial catches in the South East Cape region over the last four years are shown in Table 2. Considering the decline in catch per unit of effort the bottom line, irrespective of the 'health' of the stocks, is that the slice of the cake is inevitably becoming smaller for the individual participant.

TABLE 2: Changes in the South East Cape linefish catch 1985 - 1988

Year	Number of boats	Days	Catch	Catch/boatday
1985	244	7 814	655 697	84
1986	371	13 603	938 055	69
1987	308	12 539	1 012 843	81
1988	311	15 702	947 577	60

A more detailed examination of the fishery at Port Alfred shows similar declining trends (see Figs 1 and 2). Considering that the Port Alfred fishery is the largest in the South East Cape (see Table 3) the recorded trends would probably be a fair reflection of what is going on in the region as a whole. However, it has to be born in mind that the data shown in Figures 1 and 2 do not take into consideration the catch and effort of the recreational fishermen. These data are still being assimilated and analysed.

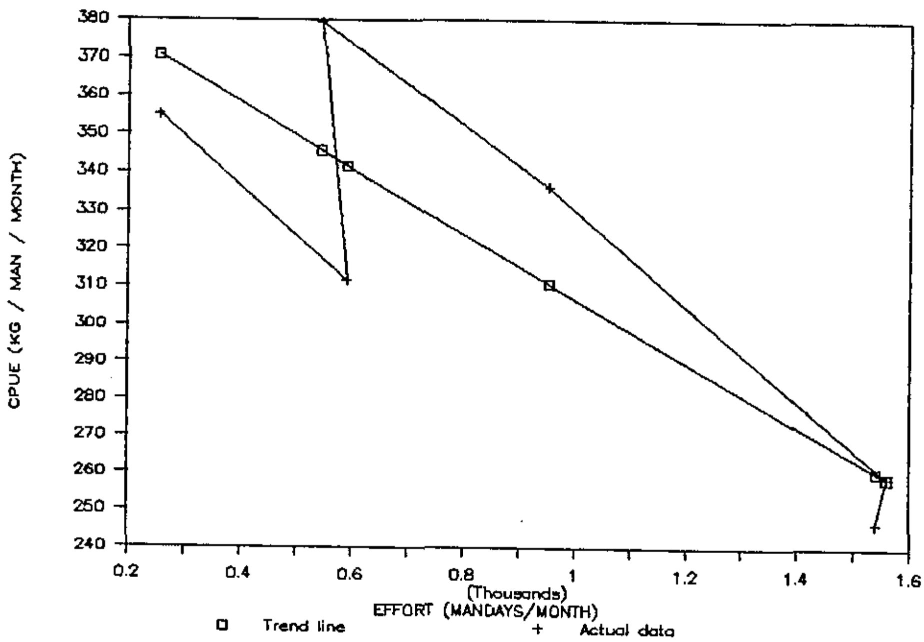

FIG 1: CATCH VS CATCH PER UNIT EFFORT
Port Alfred (1982-1987)

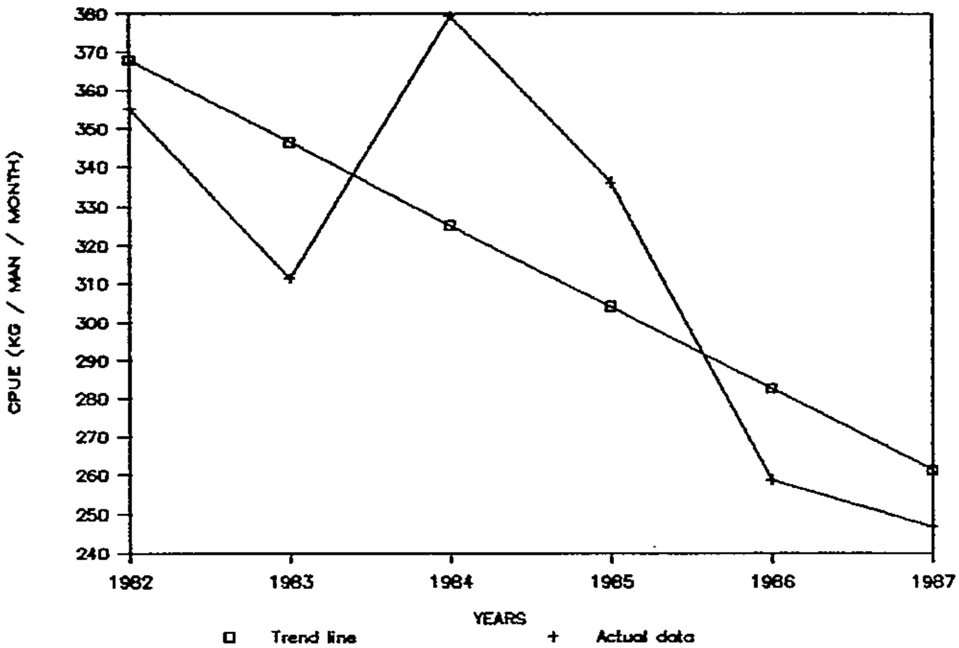

FIG 2: CATCH PER UNIT EFFORT OVER TIME
Port Alfred (1982-1987)

TABLE 3: The 1988 commercial catch, the number of boats and the number of fishing days in the South East Cape Region

Fishery	Boats	Days	Catch (excluding squid) in kg's
East London	38	942	101 073
Port Alfred	75	4 174	441 647
Port Elizabeth	109	2 136	271 255
Jeffreys Bay	218	8 450	136 386
Plettenberg Bay	218	6 141	211 433
Mossel Bay	74	1 917	133 136

Apart from these gross changes discussed and shown above, Table 4 (from Hecht and Tilney, in press) shows the more subtle changes in the fishery since the early 1940's. Perhaps the most telling points are the changes in the species composition, the extension of the fishing grounds, the increasing depth at which fish are being caught and the decrease in the hook size.

The overall conclusion is that while catches are presently still satisfying the demands of the commercial and recreational fishermen the future of the linefishery cannot be guaranteed unless:

- there is an even greater research effort than at present (the constraints of which are discussed by R P v d Elst in his paper on research funding - this volume);

TABLE 4: A SUMMARY OF TRENDS IN THE COMMERCIAL LINEFISHERY AT PORT ALFRED AND KENTON-ON-SEA, 1943-1988

YEAR	PORT ALFRED NO OF BOATS	KENTON-ON-SEA NO OF BOATS	CATCH	EFFORT	HOOK SIZE	DEPTH (m)
1943	3	1	Principal species: dageraad, poenskop and yellowbelly rockcod. No market for panga, carpenter. Kob and geelbek only in season.	2-5 hrs/day	6/0 to 12/0	30-50
1945	?	1	Mainly dageraad, poenskop and yellowbelly. Kob and geelbek in season. No market for carpenter.	2-3 hrs	9/0	30-50
1949	3	1	Mostly sparids, market found for kob, although boats still moved away from kob shoals.	?	9/0	30-50
1952	6	1	Mainly large dageraad (ca 3.5 kg) and other sparids, geelbek and kob in season, but boats still move away from dense kob shoals.	4-5 hrs	6/0	30-60
1960	6	3	Mainly dageraad and other sparid species. Kob, panga, carpenter only on demand.	6 hrs	6/0	30-60
1961			Large fishing companies start to buy all species. All species caught were now landed.			
1962	?	22	Still mainly sparids but also kob, panga and carpenter.	8 hrs	6/0	30-60
1967	10	0	Kenton fishery collapses, all operators bankrupt. All species landed at Port Alfred, but now mainly kob and large carpenter.	8 hrs	4-6/0	20-60
1971	3	5	Port Alfred fishery partially collapsed.			
1980	13	5	Mainly kob, carpenter, panga. Catches of other sparids greatly reduced.	8 hrs	4-6/0	35-100
1984	16	6	Same as in 1980.			
1988	24	6	Mainly kob, carpenter, panga. Catches of other sparids negligible.	8 hrs	3-6/0	35-120

- the two user communities become more conservation conscious;
- information on linefish research is disseminated by scientists to the user communities, and
- recreational fishermen become aware of the importance of submitting catch returns. (The catch card system works in Natal and there is no reason why it should not work elsewhere.)

To a certain extent the commercial fishermen's present saving grace is the law of supply and demand, which ultimately determines the price he obtains for his catch. However, a point can easily be reached whereby consumer resistance does not warrant further effort. Similarly the recreational fishermen might find himself in a position where his returns (in terms of recreation, relaxation, sport and enjoyment) on his investment is simply not worthwhile. Considering the overall commercial and recreational benefits of shore and deepsea linefishing to the South African community there needs to be a concerted effort by the user communities to become more conscious of the delicate nature of this resource.

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LONG- AND SHORT-TERM CATCH TRENDS IN THE SOUTH AFRICAN COMMERCIAL LINEFISHERY

MR A J PENNEY, SEA FISHERIES RESEARCH INSTITUTE (SFRI)

The status of a fishery is usually evaluated by comparing catches with those made in the past, preferably some time ago when fishing effort was relatively low and the stock concerned was considered to be healthy. Fishermen themselves often talk about "the good old days" and reflect on the "good years" and "bad years" of a particular fishery. A sequence of such comparisons provides a catch trend, used by both researchers and fishermen to obtain some measure of the status of the fishery. For example, consistent decreases in catches are often the first sign of a decline in fish stocks. However, natural variation in annual recruitment, often unrelated to fishing effort, can cause short-term trends to present a markedly different picture from those over a longer period.

LONG-TERM TRENDS IN THE LINEFISHERY

Although the linefishery is widespread along the coast, it is not coordinated by larger fishing companies. Catch and effort data collection has therefore lagged behind our larger purse-seine and trawl fisheries, a national data collection system only being introduced for commercial linefishermen in 1985. As a result, there are very few data on past catches with which to compare those of today, particularly for long-term trend determination. Fortunately, however, one good data set exists from almost 80 years ago. In 1910, a major national census was conducted following the formation of the Union of South Africa. Largely as a result of the efforts of the government biologist, Dr J D F Gilchrist, this census included a survey of fishing harbours and collection of data on catches of the major linefish species. A comparison between the 1910 catch data and summaries for 1988 (Fig 1) clearly shows many of the linefish management problems facing us today.

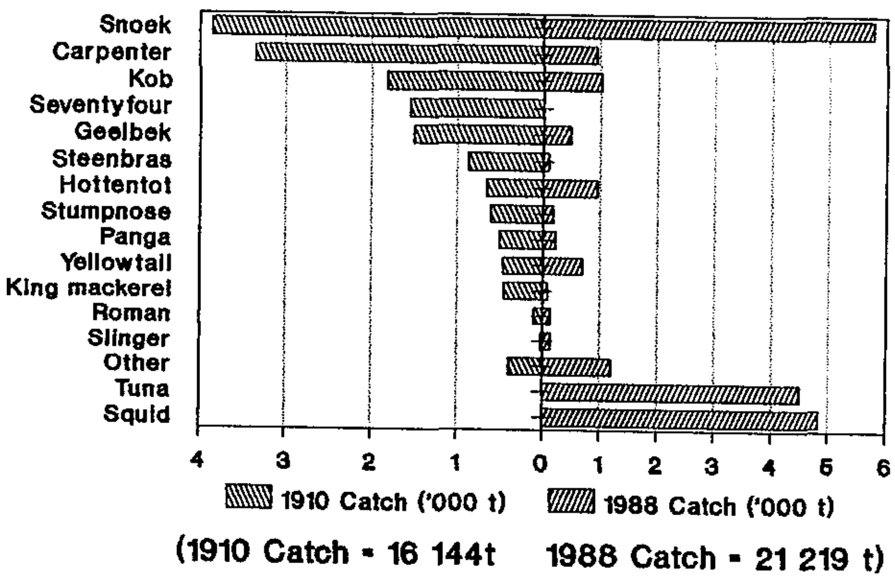

FIG 1: A COMPARISON BETWEEN TOTAL REPORTED COMMERCIAL LINEFISH CATCHES IN 1910 AND 1988

The total reported 1988 catch of 21 219 tonnes was 30% higher than that in 1910. However, if one excludes the catches of tuna and squid, which were not caught in 1910, the 1988 linefish catch is only three quarters of that in 1910. Combined with the fact that the number of boats and fishermen has increased almost tenfold in the intervening period, it is clear that overall catch rates have decreased alarmingly. The main species caught has always been snoek and the 1988 catch was actually higher than in 1910. However, catches of all the other important target species were markedly lower. For example, carpenter used to contribute almost as much to catches as did snoek but, together with panga, this species has declined rapidly following large catches by both linefishermen and inshore trawlers.

Although recent catches of kob and geelbek were the best in many years, they were also far lower than those in 1910. As a result, effort has shifted on to the once unpopular yellowtail, to the extent that this has become the main summer target species in the Cape Agulhas area. A similar shift of effort has occurred in Natal, where poor catches of seventyfour and king mackerel, once the main species sought, have only been partially compensated for by increased catches of the less popular slinger and santer. Catches of many of our endemic redfish, such as dageraad, red steenbras and red stumpnose, have also declined markedly, only those of Roman remaining relatively stable. The catch per man and mean size of all these fish, including Roman, has also decreased sharply as a result of the high mortality of slow-growing adults.

To compensate for these declining catches, fishermen have turned their attention to many "other" species not targeted on in the past. Hottentot catches have increased markedly on the west coast and species such as steentjie, Fransmadam, jacopever, gurnard, barbel and sharks make an increasing contribution to the catch. However, the main shift in effort has occurred to the relatively new fisheries on tuna, mainly albacore off the West Coast, and squid off the southeastern Cape. This has provided some relief for other species, but holds a further inherent threat for the linefishery. Although currently targeting for tuna and squid, these fishermen remain involved in the linefishery and have invested in larger, more sophisticated craft carrying an-increased number of crew. Should the squid or tuna resources decline seriously, there could again be a sudden increase in effort on linefish as these boats return to the linefishery.

SHORT-TERM TRENDS IN THE LINEFISHERY

It is clear that total catches and catch rates of many linefish species have declined substantially since 1910. However, fishermen are inclined to compare their catches only with those of the past few years and this can produce a very different, often misleading, picture. For example, the snoek catch has increased fairly steadily following the poor catches in the mid-1980's (Fig 2) with the 1987 catch of 7 364 tonnes being the best for many years.

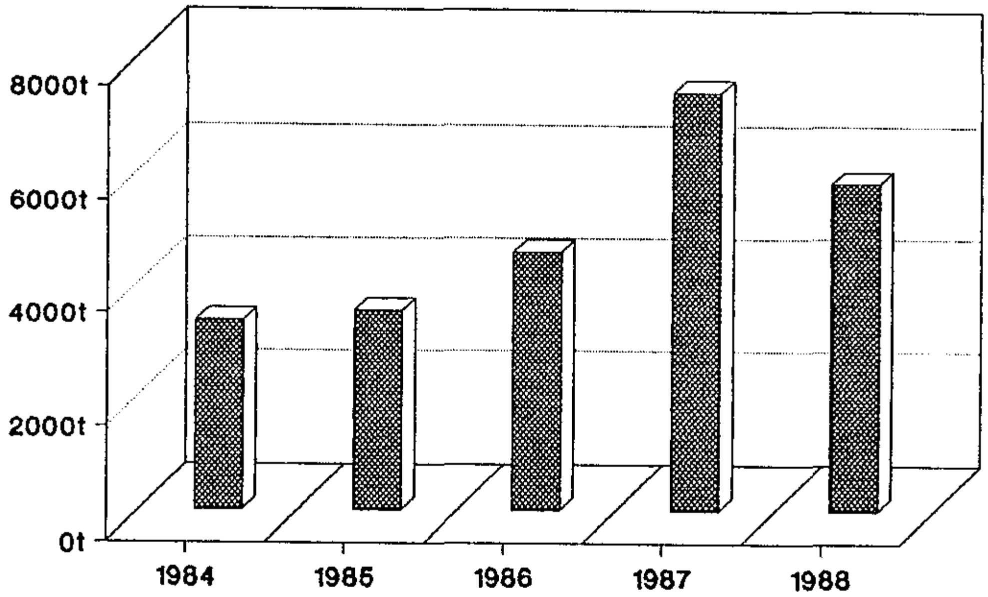

FIG 2: TOTAL REPORTED COMMERCIAL LINE CATCHES OF SNOEK FROM 1984 TO 1988

The snoek is a wide-ranging species migrating far beyond our waters and catches appear to be related more to weather patterns and shoal availability than to our own linefishing efforts. It must therefore be expected that catch trends will fluctuate greatly from year to year, often without indicating much about the status of the stock at all. Catches of a number of other linefish species have similarly increased over the past five years (Fig 3), but for different reasons. Like the snoek, the yellowtail is a fairly wide-ranging fish, but the increase in catches of this species has resulted from a real improvement in the yellowtail stock since the spawning of a strong year class in 1982. In contrast, most indicators suggest that both the kob and geelbek stocks are still seriously depressed, despite the recent improved availability of shoals inshore in the southwestern Cape.

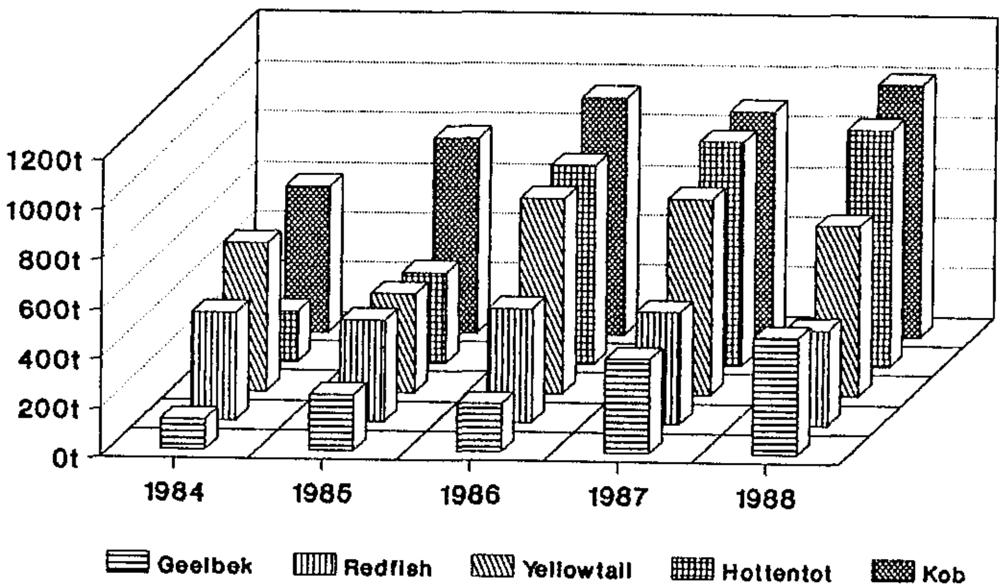

FIG 3: TOTAL REPORTED COMMERCIAL LINE CATCHES OF A NUMBER OF IMPORTANT LINEFISH SPECIES FROM 1984 TO 1988

One of the major causes for concern among both researchers and fishermen is the decline in catch rates and mean sizes of most of our endemic, reef-dwelling redfish, such as Roman, dageraad, red steenbras and red stumpnose. Despite the marked declines in catch per man, total redfish catches have remained fairly constant or, in the case of Roman, actually increased as a result of the continuous increase in effort on these species. However, this steady catch trend is certainly not an indicator of a stable stock size. The effect of effort escalation is most noted in the rapid increase in catches of Hottentot on the west coast. As a result of increased targeting for this species, catches have almost doubled, but this increasing trend indicates that the stock is being placed under increasing pressure and is less secure than it was in the past.

INTERPRETATION OF CATCH TRENDS

The above differences in long- and short-term trends and the various reasons for recent increased catches of important linefish species show that catch trends must be interpreted with caution before management decisions are based thereon. The biology of the species must be adequately understood to recognise natural fluctuations in stock sizes due to migration patterns or recruitment fluctuations. The nature of the fishery itself must also be well understood to recognise the effects on catch trends of effort increases or switching of effort to other target species. In particular, however, data series should extend far enough back to reflect real long-term changes in response to fishing effort increases. It is only with all this information available that fishermen and fisheries managers can guard against either over-pessimistic reaction to catch declines or over-optimistic increases in fishing effort in response to short-term increases in availability.

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PROBLEMS ASSOCIATED WITH THE MANAGEMENT OF REEF FISHES

DR C D BUXTON, DEPT OF ICHTHYOLOGY AND FISHERIES SCIENCE, RHODES UNIVERSITY

Management options for reef fish in South Africa are embodied in four methods: size limits, bag limits, closed seasons and restricted access.

Current legislation in South Africa imposes a minimum size limit on most of the important reef species. One objective is to maintain the breeding stock by preventing the capture of too many young fish before they have had a chance to spawn. A second objective may also be to promote maximum yield of that kind of catch which is regarded as most desirable, eg marketable or trophy fish. This second option does not imply an improvement or maintenance of the condition of the fishery. Setting of minimum sizes requires a thorough knowledge of total mortality, ie fishing plus natural mortality, and the resilience of the stock, ie decreased egg production offset by increased juvenile survival.

The main purpose of introducing <u>bag limits</u> is to control the number of fish that a fisherman may take per unit time, usually per day but in the case of commercial operators it includes quotas. Current legislation in South Africa provides a maximum bag of 10 fish/man/day in the recreational fishery with a further limit of only 5/man/day for certain reef fishes. The desired effect of bag limits is again to maintain catch at a level where sustained yield is ensured through the protection of the parent stock. The success of the method requires an understanding of catch and effort, stock size and the biology of the species.

The third method, <u>closed seasons</u>, is used primarily to reduce total effort in the fishery. Frequently fish are protected during a vulnerable portion of their life cycle, usually the breeding season, when aggregation and migration of many species leads to the so called 'runs' in the fishery. Under such conditions recruitment is improved by the protection of breeding fish.

The fourth method is to prevent fishing either by <u>closing an area</u> or by limiting participants, for example, the number of commercial operators. Closing an area to fishing may be permanent or temporary. Temporary closure is designed specifically to reduce catch and to allow the stock to recover to some predetermined level. Permanent closure, in addition to this, is designed to maintain a breeding stock sufficient to seed adjacent areas that have become incapable of doing so themselves through over-exploitation of adult fishes. Fundamental to the understanding of such processes is a knowledge of the movements and migrations of adults and the dispersive ability of eggs, larvae and juveniles. Marine reserves also have wider implications which are dealt with in the section on marine reserves elsewhere in this document.

In a multi-species, multi-user fishery such as that for reef fishes in South Africa we need to recognise two separate methods in the management of the fish. Firstly, control of effort for commercial operators (in addition to quotas if necessary) and secondly control of catch by recreational anglers. In other words the number of participants in the commercial sector can be effectively limited but in the recreational sector the number of fish caught must be limited because it is a common property resource.

With this as a background one can highlight some important considerations in the management and exploitation of reef fishes.

- **Sex change**
  Sex change is fairly common in South African sparid fishes, for example in Roman, dageraad and slinger. In these fishes each individual starts life and reproduces as a female and then changes sex at some later stage and becomes a male. We call this protogynous hermaphroditism. The reverse, protandrous hermaphroditism, may also occur, eg Natal stumpnose. The implication of this is shown in Figure 1.

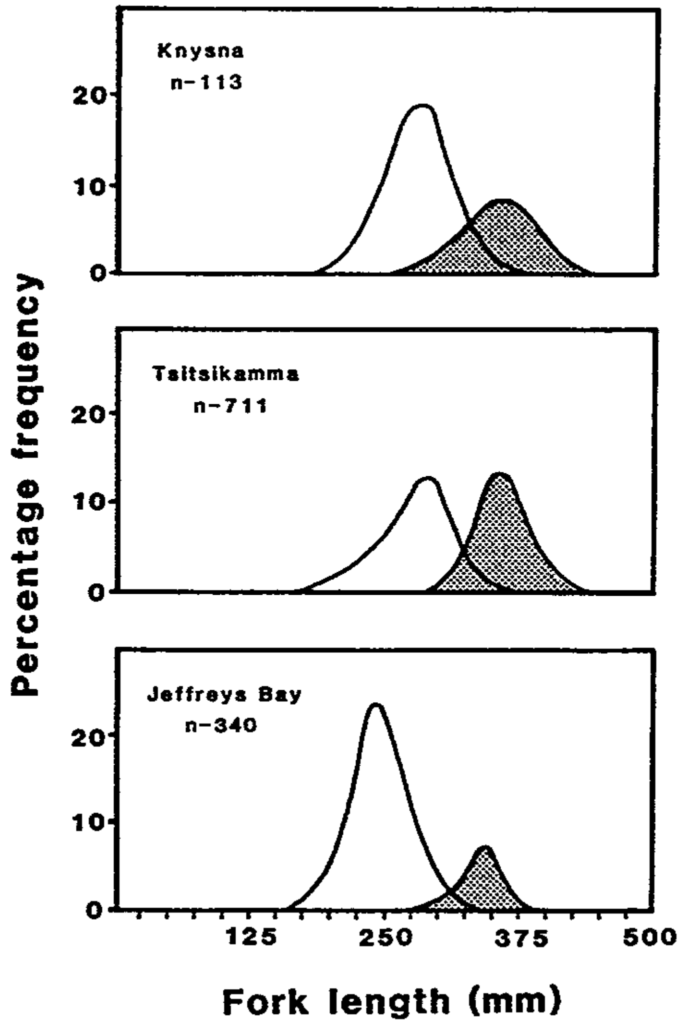

FIG 1: DISTRIBUTION OF FEMALES (OPEN) AND MALES (SHADED) IN CATCHES OF ROMAN *CHRYSOBLEPHUS LATICEPS* TAKEN BETWEEN KNYSNA AND JEFFREYS BAY

One can readily appreciate why this poses a problem for management, particularly with respect to minimum sizes. Setting a minimum size for females would not cater for the protection of males and setting it above the size at sex change would effectively prevent the catch of most of the population. The effect of fishing on the population structure can also be seen in the diagram. The ratio of males to females is very different in the three areas because most of the larger fish have been removed by fishing in the Knysna and Jeffreys Bay areas. We believe that this imbalance between the sexes could seriously affect the reproductive capacity of the population.

- **Longevity**
  Studies have shown that most of the local reef fishes live to a ripe old age and that growth is slow (Fig 2). Slow growing fishes are more vulnerable to exploitation because they have a low yield per unit stock. In other words, if we remove a certain mass of fish it takes a long time for this to recover because of a slow growth rate. Usually it is the older (larger) fish that we first remove from the population and it is these fish that are the most valuable in terms of the number of offspring they produce.

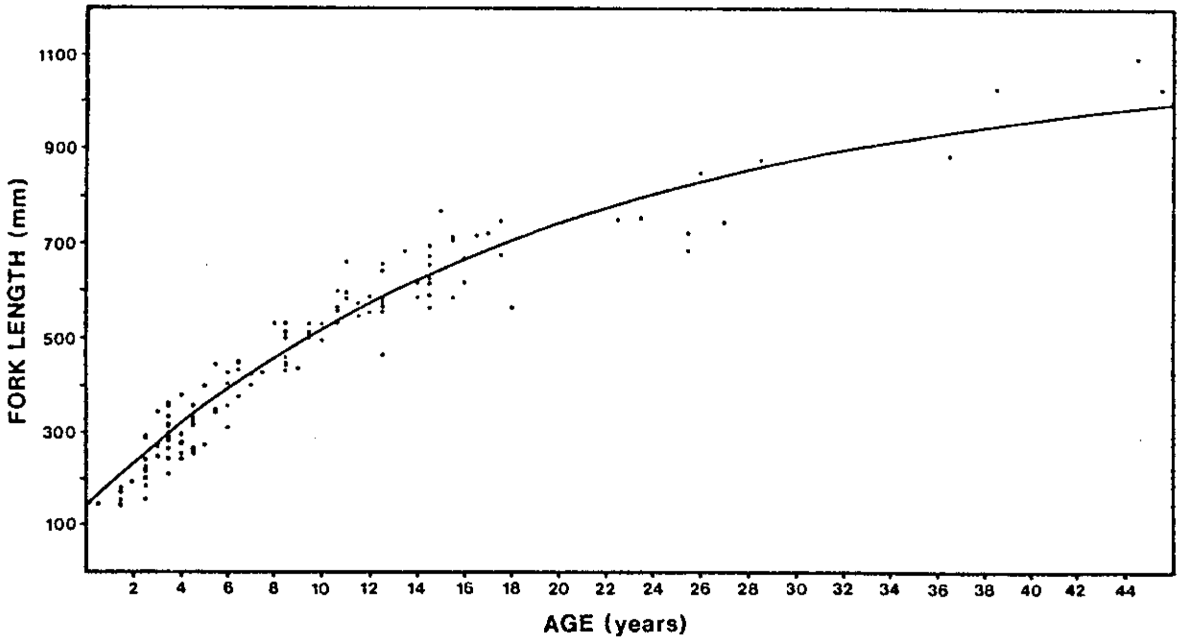

FIG 2: THE RELATIONSHIP BETWEEN LENGTH AND AGE OF POENSKOP *CYMATOCEPS NASUTUS*, SAMPLED ON THE EASTERN CAPE COAST

- **Residency**

  Ongoing tagging studies aimed at showing the movements of these fish have provided results that are quite remarkable. An example for Roman tagged in the Tsitsikamma Coastal Park is shown in Figure 3. Of the 12 recoveries so far, all have been very close to the area of tagging even after a long 590 days at liberty. None were reported from outside the Park. Sedentary fishes are also very vulnerable to localised over-exploitation. Most fishermen are aware of how the rockcods are the first to disappear from an area, a product of both residency and slow-growth.

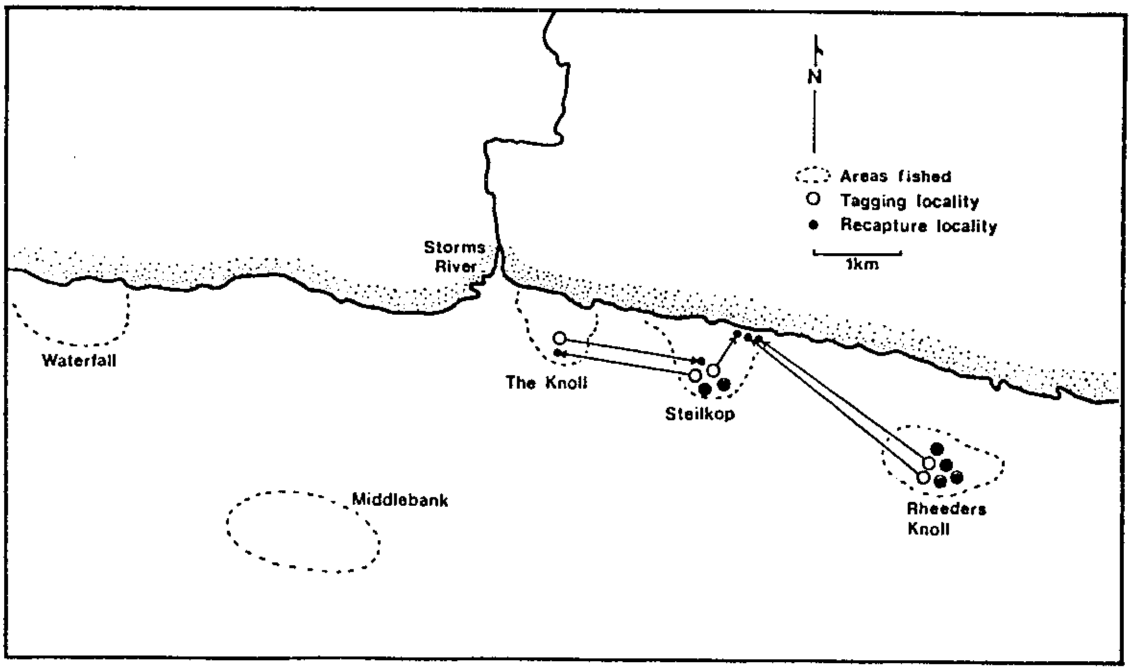

FIG 3: ROMAN TAGGING IN THE TSITSIKAMMA COASTAL PARK

- **Endemicity**
  An endemic species is one that is limited in its distribution, in other words, South African endemics are found nowhere else in the world. Of the sparids (seabreams) on our coast about 60% are endemics. Because of their limited distribution, recruitment from distant areas is not possible once these species are fished out. This is not only a management problem but also raises the ethical question of our international responsibility to look after animals unique to our area.

- **Barotrauma**
  Because of their demersal habitat (bottom dwellers) most reef fish suffer the effects of over-pressurisation when brought to the surface. This is an over-inflation of the swimbladder which forces the stomach out of the mouth. While it is possible to return these fish to the sea by carefully deflating the swimbladder with a hypodermic needle, we have no idea of the survival rate of those fishes once returned to the sea. This problem has very real consequences for management with respect to the returning of undersized fish and those caught in excess of the bag limit.

- **Multi-species fishery**
  The last consideration is the multi-species nature of the reef fishery. This makes it difficult to direct effort towards or away from particular species, for example, if the quota for one species was filled. Barotrauma further aggravates the problem.

The information presented here shows that current conservation options afford inadequate protection to species that change sex, are long-lived and that suffer from barotrauma. Also important are the multi-species nature of the fishery and the fact that the measures are species specific and do not address the wider aspect of ecosystem conservation. These problems are all avoided by the marine reserve option, which is recommended as an addition, rather than an alternative to current techniques. The function of reserves is seen as protection of spawner stocks capable of seeding adjacent areas. Bag limits will then serve to spread the catch equitably amongst users and minimum sizes will ensure catch of desirable size. Marine reserves will also contribute to the maintenance of essential ecological processes, life support systems and genetic diversity (see section on Marine Reserves further on in this document).

It is particularly important to recognise that management of reef fishes (and linefishes in general) must be approached in two ways; limiting catch and limiting effort. In the commercial sector limiting effort is relatively easy by the control of the number of participants. Despite claims to the contrary the number of commercial licenses has been frozen since the implementation of the new linefish legislation in 1985 (A J Penny, Sea Fisheries Research Institute, pers. comm.). Recreational fishermen have to recognise that in a common property resource such as the linefishery it is not possible to restrict the number of participants. For this reason we must control the catch through a combination of bag limits, minimum sizes and protected areas. It must be the common goal of all users and scientists alike to ensure a sustainable resource, both for ourselves and our children.

RED STEENBRAS AND SEVENTYFOUR: ASPECTS OF THEIR BIOLOGY AND ROLE AS PREDATORS

DR M J SMALE, PORT ELIZABETH MUSEUM (PEM)

INTRODUCTION

Two of the largest and most valued South African linefish are the red steenbras *Petrus rupestris* and the seventyfour *Polysteganus undulosus*. Both are piscivorous, endemic sparid reef fishes confined to the south-eastern coast of Africa. Their role in the SE Cape marine ecosystem is discussed - and while they have some features in common, many others are fundamentally different.

The biology of red steenbras and seventyfour are described and then compared with each other.

Red Steenbras

The red steenbras is the largest member of the family Sparidae in southern Africa, attaining at least 54 kg and 1400 mm total length. Their size makes them prized targets of both recreational anglers and commercial fishermen.

The life history of red steenbras is complex with adults usually found offshore and juveniles and adolescents on inshore reefs, particularly off the Cape. It will be seen from Figure 1 that the lengths of fish caught at different localities vary considerably (Fig 1a after Smale 1988). The greatest abundance of adults appears to be off the East London and Transkei coasts, although large catches of adult fishes have also been taken off the Agulhas Bank sporadically. Spawning of red steenbras occurs during the winter months. To date, however, catches from the Agulhas Bank have been made predominantly in summer, in the Transkei they are taken throughout the year, (including the breeding season) while in Natal they are taken primarily during the breeding season which peaks between August and October (Smale 1988).

As is the case with other members of this family, reproduction is interesting in that the juvenile gonad comprises tissue which is apparently female. With growth, a zone of male tissue develops. Some undescribed signal triggers the development of either male or female tissue so that either a functional male or female arises. There is no sex reversal in this species (Smale 1988). This process is illustrated in Figure 2 (after Smale 1988).

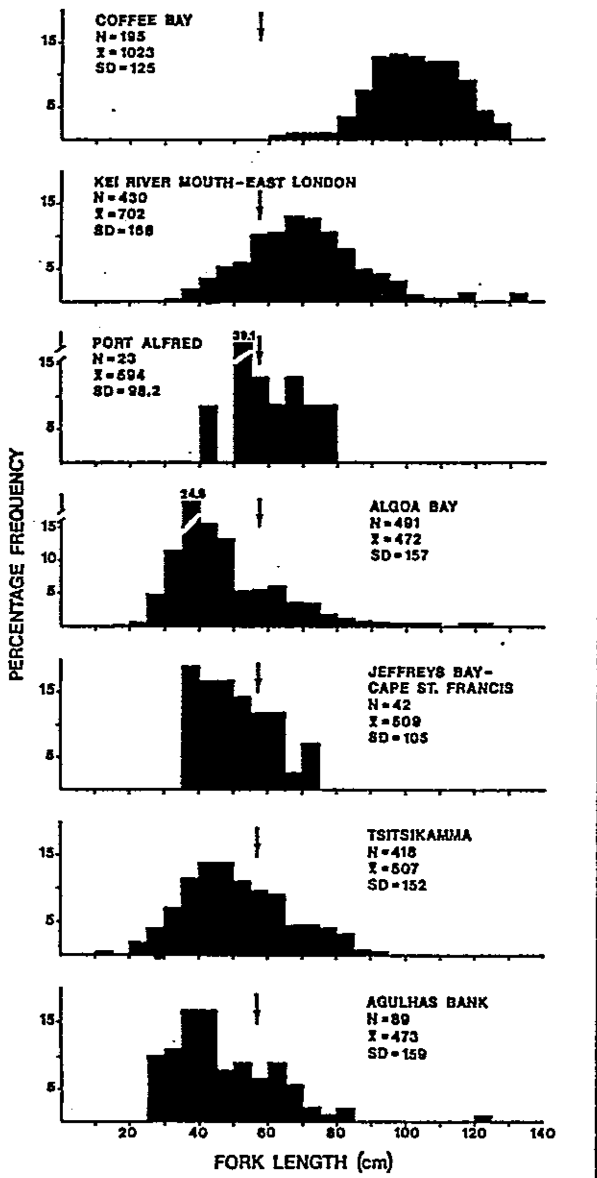

Figure 1a. Length frequencies of <u>Petrus rupestris</u> collected at various localities along the South African coast.

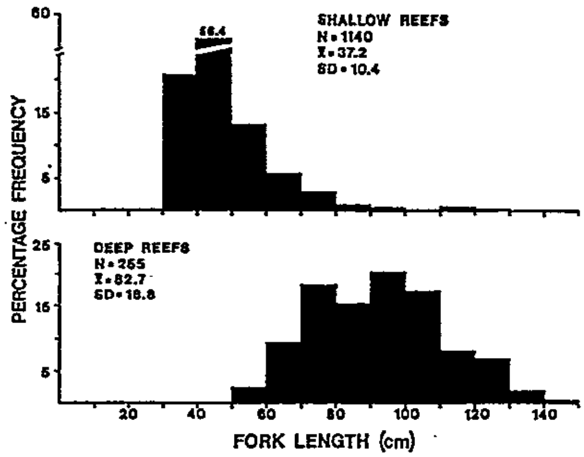

Figure 1b. Length frequencies of <u>Petrus rupestris</u> taken from lineboats operating on reefs of 20-50m depth between Struis Bay and False Bay, or on the deep reefs (>50m depth) of the 45 and 72 Mile Banks off Struis Bay. Data from A. Penney (SFRI).

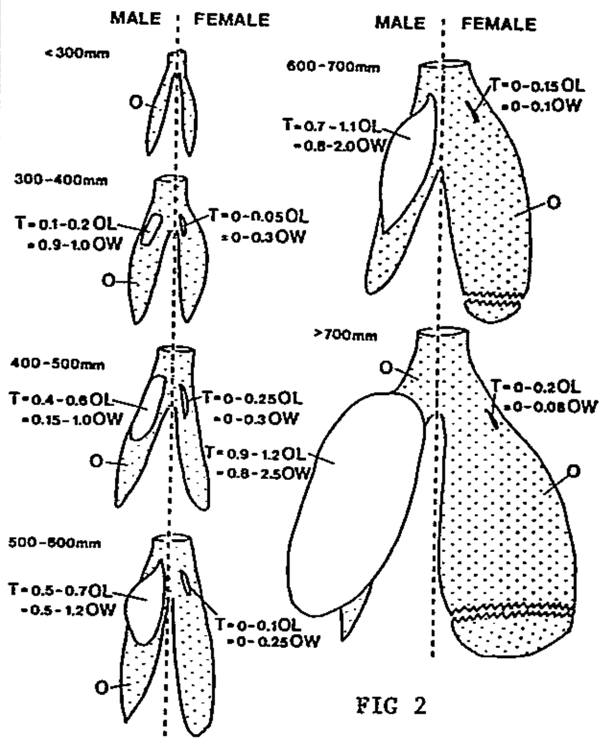

FIG 2

FIG 2: SCHEMATIC DIAGRAM OF MACROSCOPIC APPEARANCE OF SEXUAL DEVELOPMENT OF *P. RUPESTRIS*. THE LEFT SIDE ILLUSTRATES DEVELOPMENT OF A MALE AND THE RIGHT SIDE A FEMALE FISH. THE PROCESSES OCCUR IN DIFFERENT INDIVIDUALS, BUT ARE ILLUSTRATED TOGETHER FOR CONVENIENCE. T IS TESTIS, O IS OVARY. OL IS OVARY LENGTH, OW IS OVARY WIDTH. THE RELATIVE PROPORTIONS OF THE TESTIS TO THE OVARY WIDTH AND LENGTH ARE SHOWN FOR DIFFERENT SIZED FISH FROM MEASUREMENTS MADE OF FRESH MATERIAL. VALUES OF ZERO INDICATE THAT THE TESTIS MAY NOT BE VISIBLE MACROSCOPICALLY.

Growth is slow with 50% of the population in the spawning area mature at about 575 mm fork length (about 4 kg) or five to seven years old and 100% mature at ± 700 mm or 7 kg. Maturity seems to be delayed in those individuals not in the spawning areas. This means that the majority of red steenbras are caught several years before they have had a chance to mature and spawn. This excluded the offshore areas of Transkei and to some extent East London. In the Transkei all the fish show evidence of breeding when caught in the spawning season, and all are very large fish. Available evidence shows that red steenbras probably live to at least 30 years if they avoid capture.

These fish are piscivorous, evident by the massive canine teeth and powerful jaws used to grab and kill the prey prior to being swallowed. The bulk of their diet is made up of fishes, and to a lesser extent octopus and squid associated with reefs (Smale 1986).

The diet changes as they grow with fish less than 100 mm preying on small crustaceans. They feed on fishes by the time they attain 150 mm and these include clinids, gobies and fingerfins. Later they take larger fish especially such as barbel, other sparids (e.g Jan Bruin) and other reef-associated demersal fishes.

Seventyfour

Information on the seventyfour was derived largely from work done at ORI by Rosmary Ahrens (1964), although data are still being collected at various centres.

Seventyfour can attain about 15 kg or 1000 mm. These rather elongate and streamlined sparids are concentrated off East London and Transkei, but move into Natal during the spawning season. It is noteworthy that fishermen in Natal expressed concern about this fish more than two decades ago and called for the research and protection of this species well before its dramatic collapse.

Although not as well studied as some of the other sparids, this species is thought to not undergo sex reversal and its sexual development is probably similar to that found in red steenbras.

Sexual maturity is attained by the time they reach about 340 mm, when they are believed to be about 3-4 years old. It is also thought that they grow to at least 12 years (Ahrens 1964). In view of its perilous status and fishing pressure on this species, more work is needed to investigate its biology and stock.

Seventyfour prey mainly on fish and squid, although their diet changes with growth. Their elongate bodies, forked tails and small mouths adapt them to feeding on pelagic prey in the water column. Included in their diet are sardines, anchovy and squid. (Ahrens 1964, and personal observations). As is generally the case in fishes with this body form, seventyfour shoal and are able to overcome the defences of shoaling prey with this attack strategy. It is interesting to note that their migration to Natal coincides with the annual sardine run, a phenomenon found with several other winter migrants (Van der Elst, 1988).

PREDATOR/PREY RELATIONSHIPS

Predators and prey have amongst the most complicated relationships in wild populations. This is particularly the case of multi-species associations in the open sea, where major gaps exist in our knowledge of even the most important species. Changes in prey selection with growth and the varying availability of prey both on the short and long term all complicate matters. Furthermore, the cause and effect of differences in prey choice are extremely difficult to study, particularly in offshore predators.

Figure 3 illustrates the complexity of only a few trophic pathways of reef predators in the eastern Cape (Smale 1983). In every species studied, the prey changes radically as the fish grows from larval through to adult stages, well demonstrated by the red steenbras.

Prey choice is governed by abundance of suitable prey, and predators are well known for changing prey according to availability. Prey for their part have evolved a number of defence strategies. An analogy between the evolving predator attack strategies and the defences of prey has been likened to the human arms race. The predators and prey are in dynamic interaction, each trying to out-wit the other in the complex game of feeding and avoiding being eaten.

The ecosystem is sometimes said to be "balanced". It is important to realise that this state is dynamic and not stable. Good and bad years of recruitment for different species are acknowledged to occur and these changes are in some ways analagous to years of good and bad rainfall on land, with the consequent effect on the members of the community.

Red steenbras and seventyfour have evolved to take different prey and are thus able to live together on offshore reefs, each species following a lifestyle which has probably changed little over thousands of years.

But what now? What is the effect of the massive mortalities caused by fishing - a factor which is new in the evolutionary sense? In brief, we do not know and our models developed in the simple, one species level probably do not work at all well in the complex environment we are trying to harvest and manage. We suspect that the influences of exploitation are great but at this stage we are a long way from being able to construct predictive models.

For example, one effect may be that the prey species experience relief from predation and increase in numbers which in turn may result in more individuals of smaller species on the reefs than would otherwise have been the case.

Public perception that this is not a serious ecological problem changes dramatically if these are animals are seen to feed on fish larvae and eggs of species desirable to fishermen.

Experience in Natal with the small shark "problem", which has manifested itself by increased catches of these predators by local fishermen (v d Elst 1979), shows that man's interactions with the environment can have unexpected effects. Most are not yet understood, but nevertheless certain to have increasing negative impact on the marine environment.

It is most important to study and manage these influences and develop a mature and responsible attitude among all resource users. It will not help to point the finger in the other direction and say "It's them" (indicating the longliners, trawlers, commercials, amateurs, pollution, etc.) The point is that we all have an impact on the resource. We need to understand what this is and recognise that we are dealing with a complex system which needs to be studied further. Many of the apparently unimportant species may be just as important to study as the highly desirable species in understanding and managing the resource.

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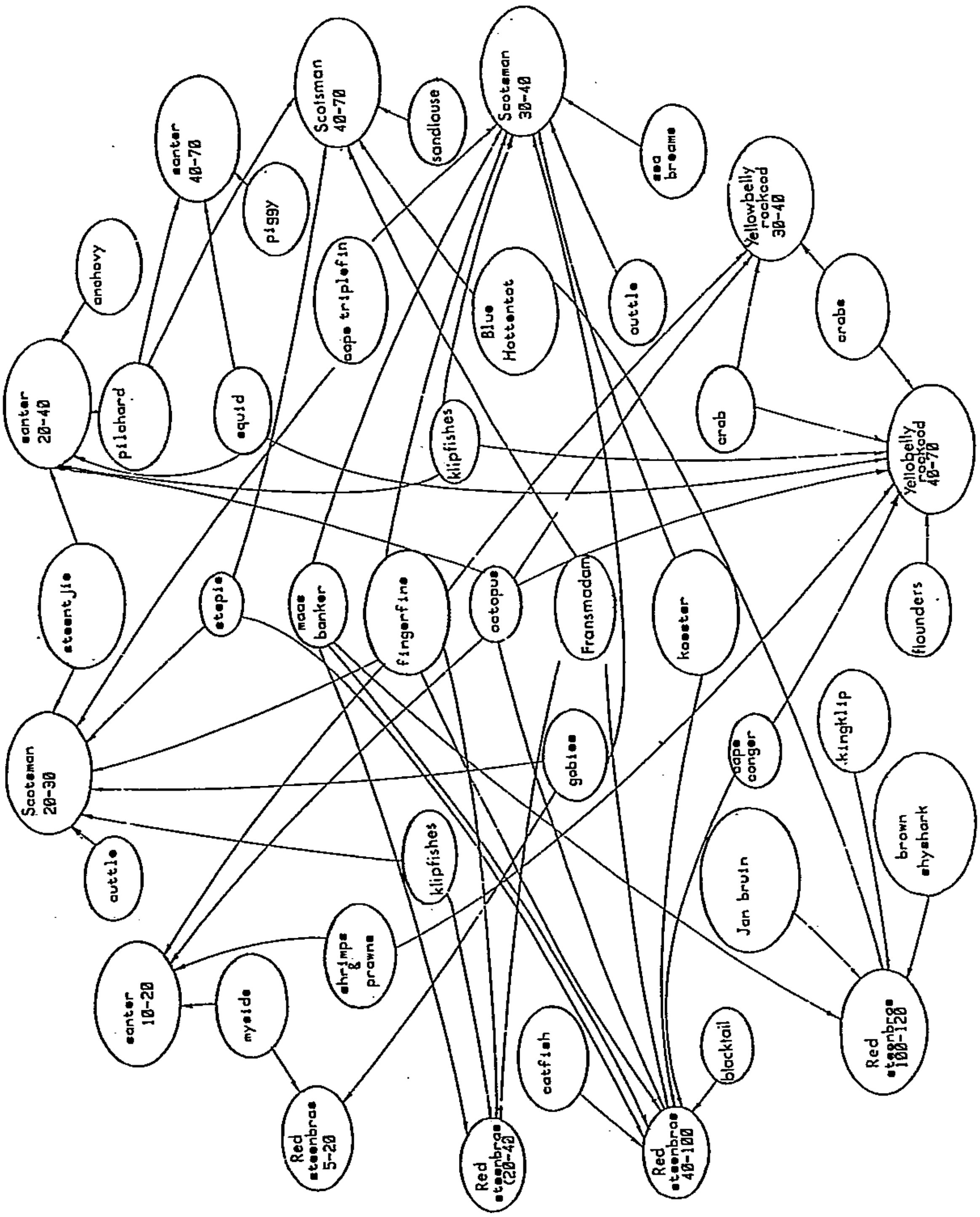

FIG 3: THE FOOD WEB OF COASTAL REEF FISHES IN THE EASTERN CAPE. PREY MAKING UP MORE THAN 4% BY MASS OF THE PREDATORS STOMACH CONTENTS ARE SHOWN

PELAGIC GAMEFISH, ILLUSTRATED BY BILLFISH AND LARGER MACKERELS

MR R P VAN DER ELST, OCEANOGRAPHIC RESEARCH INSTITUTE

Perhaps the single most important group of fishes that represent a future for marine recreational angling are the highly migratory gamefishes belonging to the families Scombridae and Istiophoridae. These nomads of the ocean are a prized target for deep-sea sport fishermen and constitute a large and highly productive resource. Besides the tunas, examples of such fishes are the billfish *Istiophoridae*, wahoo, *Acanthocybium solandri*, king mackerel (couta) *Scomberomorus commerson* and the queen mackerel (Natal snoek) *S. plurilineatus* which well demonstrate the biology and behaviour of pelagic gamefishes in general.

There is clear evidence of a growing worldwide demand for highly migratory gamefish. Several reasons exist for this. Increased acceptance of these fish as food, growth in commercial longline fleets, lack of control in international waters and depleted local fisheries being some. During 1970 only three nations reported the capture of billfish around South Africa, but by 1987 this had increased to 11 nations. This trend is not confined to commercial fleets and sport fishermen have also increased their harvest, as seen in the annual landings of billfish in Natal (Fig 1).

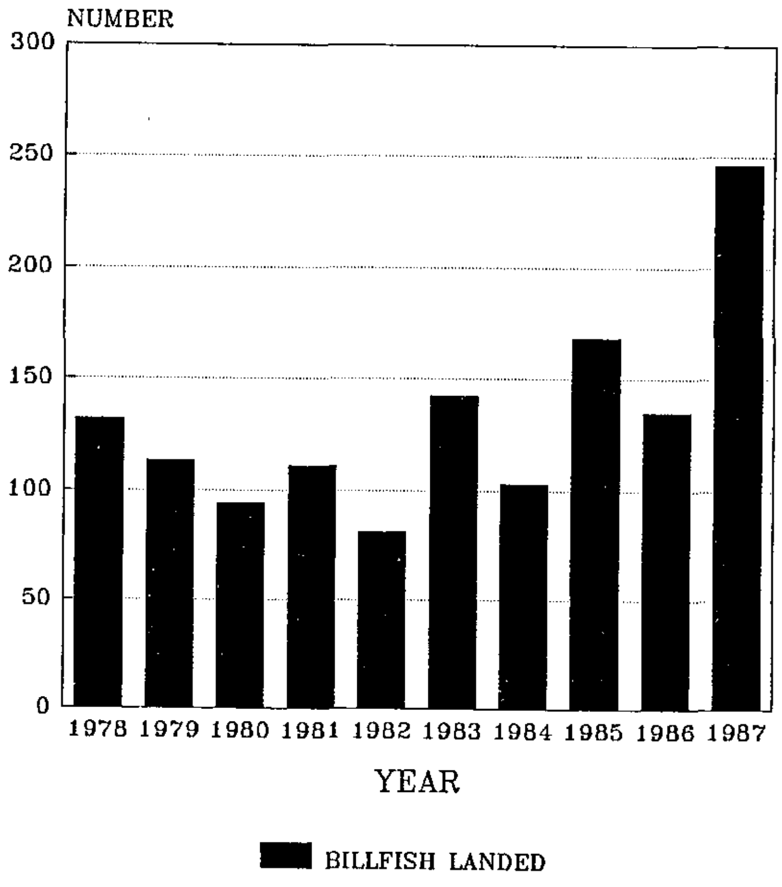

FIG 1: ANNUAL TOTAL LANDINGS OF BILLFISH MADE BY SPORTFISHERMEN OFF NATAL

South African waters probably sustain the highest diversity of billfish anywhere with ten out of the twelve known species having been recorded. Although there remains uncertainty about the taxonomic distinction between Atlantic and Indo-Pacific billfishes, the following species can be encountered (Nakamura, 1985):

Indo-Pacific sailfish *Istiophorus platypterus* Atlantic sailfish *Istiophorus albicans* Indo-Pacific blue marlin *Makarai mazara* Atlantic blue marlin *Makaira nigricans*, black marlin *Makaira indica*, striped marlin *Tetrapturus audax*, white marlin *Tetrapturus albidus*, short-billed spearfish *Tetrapturus angustirostris*, long-billed spearfish *Tetrapturus pfluegeri*, broadbill swordfish *Xiphias gladius*.

The greatest abundance of billfish in South Africa is attained along the East Coast, where migrant fish from Indo-Pacific origin occur each summer. Curiously the species composition of billfish varies significantly between different localities in the South West Indian Ocean as seen in Figure 2. Reasons for this are related to habitat preferences of the different species. In South African waters sailfish and black marlin predominate. Both are species that select coastal habitats, in strong contrast to the more oceanic blue marlin that are common at Mauritius. Of significance is the predominant presence of black marlin in South African waters. This species has a rather limited global distribution and as a consequence has not been well researched.

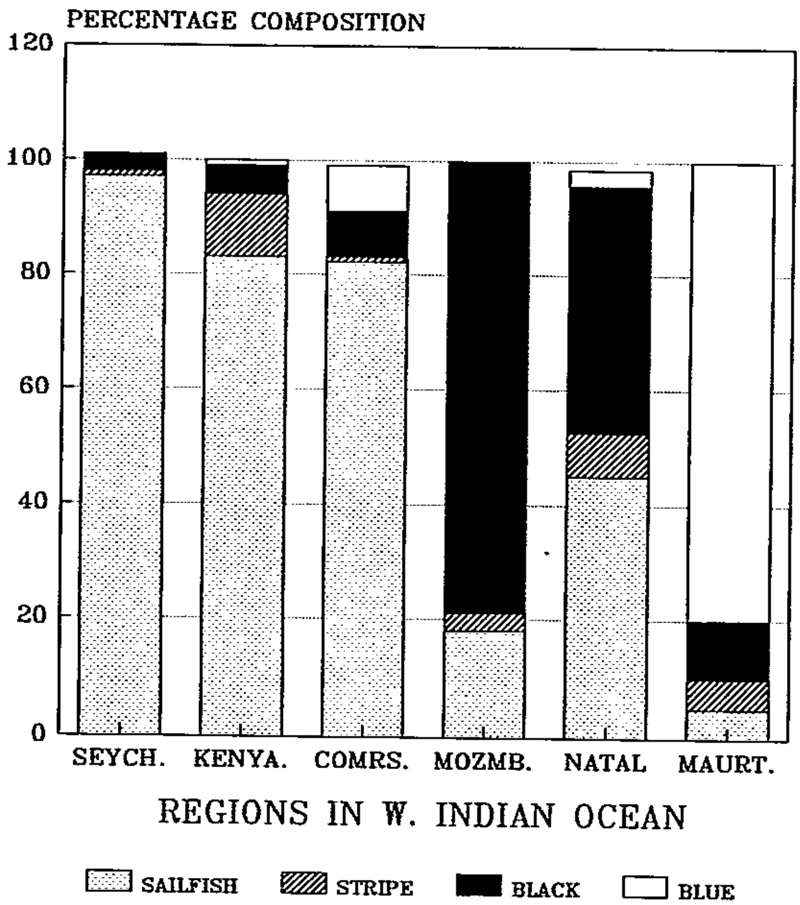

FIG 2: REGIONAL DIFFERENCES IN SPECIES COMPOSITION OF RECREATIONAL BILLFISH LANDINGS

The larger mackerels are also highly migratory and in most cases widely dispersed throughout the Indo-Pacific, especially the king mackerel and wahoo. One exception to this is the queen mackerel which is known to be confined to the coastal waters of South East Africa.

The life history of billfish and larger mackerels have many similarities. All are summer migrants to South Africa, primarily attracted by baitfish such as sardines, anchovies and scad. At least 50% of those caught are immature, while the adults in the catch are invariably in a non-reproductive state (v d Elst and Collette 1985, v d Elst 1988a, 1988b). In the case of billfish it is well known that females grow much larger than males, hence it follows that males should predominate in the smaller size classes such as occur off Natal. Curiously however, females significantly outnumber males in the catch, strikingly different to the sex ratio in most other regions. This would suggest that shoals are sexually segregated, a fact that may influence their management.

While these seasonal migrants to our waters are and should be optimally exploited by local linefishermen, it is important to recognise that elsewhere in their range they are also harvested by fishermen of other nations. For example South African sport anglers land only 10% of the South West Indian Ocean recreational billfish catch and less than 0.5% of the 45 000 tonne catch of king mackerel made in that region (FAO 1988). Management problems occur however with fish harvested in waters that fall outside the 200 mile economic zone of coastal nations. It is here that the activities of international fisheries agencies play an important role in protecting stocks and ensuring a fair allocation of the resource.

It is clear therefore, that in order to maximise our harvest of these migratory species we have an international responsibility toward their research and management. In particular this should involve the understanding of migration patterns and stock identity, largely attainably through tagging programmes. Identification of spawning grounds and juvenile nursery areas should be undertaken with emphasis on the dispersal of eggs, larvae and fry.

Of particular importance will be the study of the black marlin in South African waters, especially their age and growth rates. Urgent attention should also be given to documenting the catch per unit effort (CPUE) of billfish. This has to date been impossible to determine because the angling effort has been unknown. It is here that SADSAA members can make a particularly valuable contribution by submitting regular catch and effort statistics.

In addition to these pressing research requirements there remains the need for international cooperation. Good progress is being made here especially following the International Billfish Symposium held in Hawaii during 1988.

The future of marine recreational angling in South Africa is inevitably linked to these highly migratory species. We cannot manage them alone and should now urgently meet our research and management responsibilities to the international community.

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SOFT SUBSTRATUM FISHES, ILLUSTRATED BY KOB

MR R L TILNEY, DEPARTMENT OF ICHTHYOLOGY AND FISHERIES SCIENCE, RHODES UNIVERSITY

DEFINITION OF SOFT SUBSTRATUM FISHES

There are probably few, if any, linefish which are restricted entirely to soft substratum environments. Most species associated with soft sediments are also frequently caught over low profile reefs, and even pinnacles. The kob *Argyrosomus hololepidotus* is a good example of this. For the purpose of this paper, soft substratum fishes will include those benthic feeding fish which may forage over both soft and hard substrata, but which are known to move extensively over sandy areas. The results under discussion have been drawn from the research being conducted on the Port Alfred ski-boat fishery, on the south east coast of South Africa.

Characteristics of the recreational ski-boat fishery in the Port Alfred area are:

- bottom fishing makes up approximately 95% of all fishing trips,
- the fishing area is restricted to a range of 6-7 nm from the Kowie River mouth and to a maximum depth of approximately 56 m,
- the catches consist primarily of species associated with soft substrata and low profile reefs (see Table 1).

Table 1: Reproductive styles and fecundities of soft substratum and low profile reef fishes in the Port Alfred linefishery

Species	Reproductive style	Fecundity
Kob *Argyrosomus hololepidotus*	Gonochorist	High
Panga *Pterogymnus laniarius*	Prot herm	High
Silver *Argyrozona argyrozona*	Gonochorist	High
Hake *Merluccius capensis*	Gonochorist	High
Maasbanker *Trachurus trachurus*	Gonochorist	High
Barbel *Galeichthys feliceps*	Gonochorist	40-60
Spiny dogfish *Squalus megalops*	Gonochorist	2-4
Dusky shark *Carcharhinus obscurus*	Gonochorist	6-14
Copper shark *C brachyurus*	Gonochorist	13-20

The species listed above are subjectively categorised into two groups, desirables and undesirables.

DESIRABLES

Kob

Research being conducted in the Port Alfred area has indicated that kob is by far the most significant species in the recreational fishery and contributes over 50% of the total catch (see Fig 1). However, the average size caught is small, being between 55-60cm in length (see Fig 2). The average size of kob caught in the commercial fishery is even marginally smaller, at 50 cm. Sexual maturity occurs before recruitment into the fishery. In the region of 110 tonnes and 32 metric tonnes are landed annually by the commercial and recreational sectors respectively.

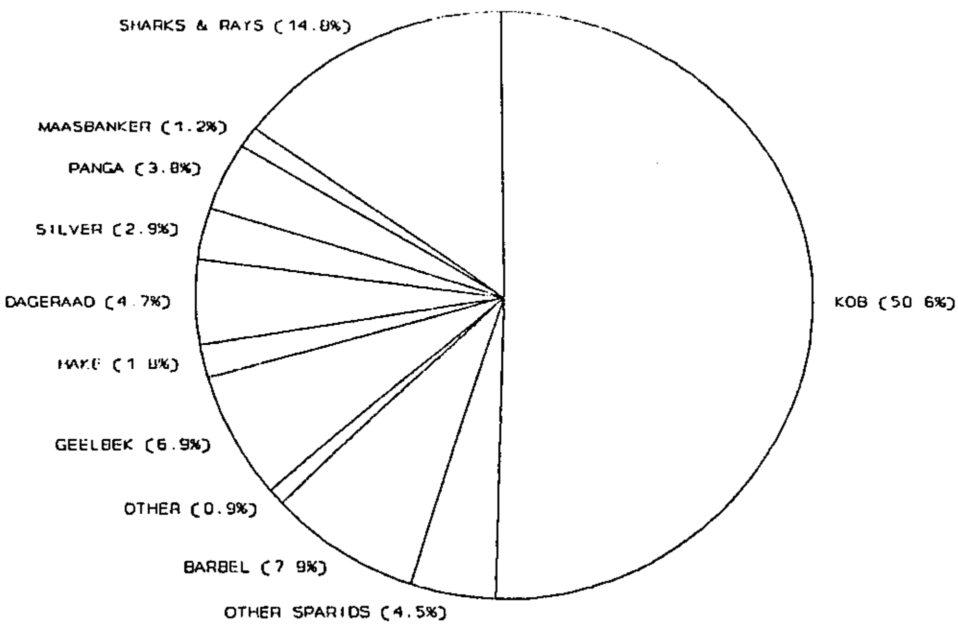

FIG 1: PORT ALFRED RECREATIONAL SKI-BOAT FISHERY: CATCH COMPOSITION

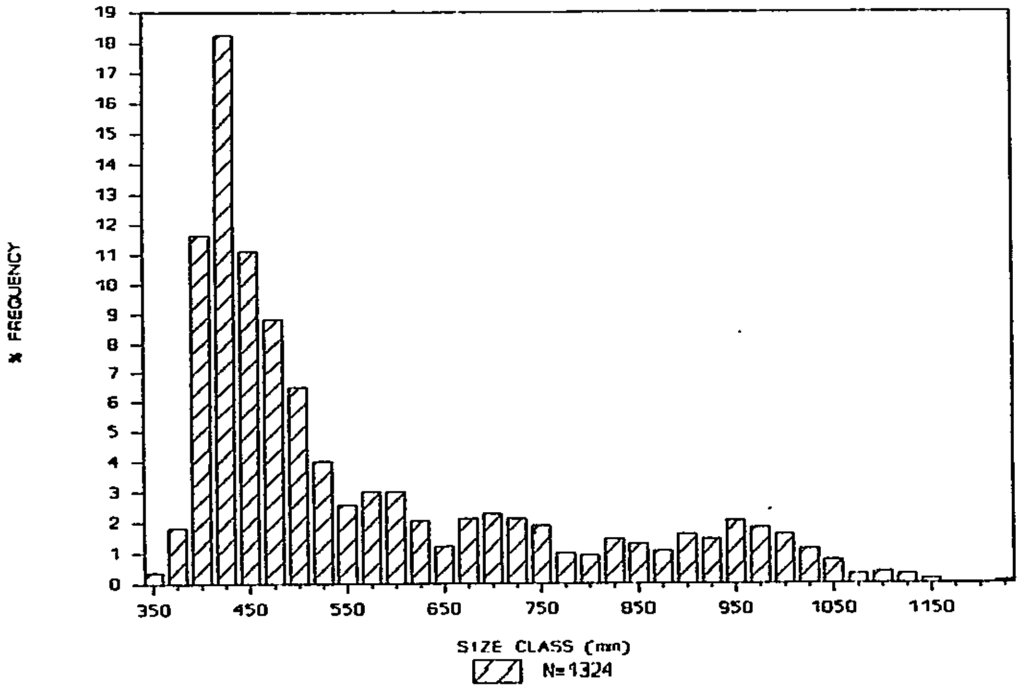

FIG 2: SIZE FREQUENCY OF KOB IN THE PORT ALFRED RECREATIONAL FISHERY

Panga

In 1987, approximately 75 tonnes of panga were landed by the commercial ski-boat fishery, but indications are that this species has increased in abundance in the past year and is now probably the most important species in this fishery in terms of landed weight. However, not much panga is landed in the recreational fishery because of its preference for deeper water and the fact that they are generally small in size, averaging 32 cm (FL) in the catches. There is evidence that panga undergo sex reversal from female to male *protogynous hermaphroditism,* but that this phenomenon occurs in only a certain percentage of the females (Hecht, 1976). The sex ratio of males to females in the fishery is 1:1, although the optimum sex ratio for the species is not known. Sexual maturity occurs at approximately 28 cm in both sexes, at an age of about five years. This species is recruited into the fishery below the size at sexual maturity, which is cause for concern.

Silver

As in the case of the panga, the silver is not a popular catch in the recreational fishery because of its small size and its preference for deep water. Approximately 135 tonnes were landed in the commercial ski-boat fishery in 1987, and it has been the mainstay in this fishery for the past 2-3 years. Evidence suggests that this stock is being fished beyond the maximum sustainable yield (Hecht & Tilney, in press). However, sexual maturity occurs at an age of approximately 3-4 years and a fork length of about 22.85 cm (Nepgen, 1977), which approximates the size at recruitment into the fishery.

Hake and maasbanker

Species such as hake and maasbanker are generally caught at depths greater than 60 m, which effectively also puts them out of range of recreational ski-boaters. These two species make up a very small percentage of the catches (see Fig 1).

UNDESIRABLES

Barbel

The barbel, *Galeichthys feliceps*, occurs in great abundance over soft sediments in the Port Alfred area. However, their small size and venomous spines make them an unpopular catch in the recreational fishery. In the commercial fishery, barbel are a by-catch and make up approximately 10% of the total annual catch. They are palatable and could be targeted for in the future. They have low fecundity and exhibit slow growth, making them fairly vulnerable to over exploitation.

Spiny dogfish

The spiny dogfish, *Squalus megalops*, is a common catch in the Port Alfred area, but generally discarded at sea by both commercial and recreational fishermen. Their abundance is remarkable in the light of their slow growth and low fecundity. Sexual maturity occurs at 12 years (Harris, 1984), while between two and four young are produced every second year (Smith and Heemstra, 1986).

Large sharks

Sharks such as the bronzie *Carcharhinus brachyurus* and the dusky *C obscurus* occur inshore and provide fair angling because of their size. The sport angler can derive a great deal of satisfaction from fighting large sharks, but to the angler fishing for the pot they are generally a disappointment.

RESILLIENCE OF SOFT-SUBSTRATUM FISHES

Noteworthy about the linefish species under discussion is that while their average size has undoubtedly decreased over the years, they still occur in relative abundance. This is especially significant considering they are exploited by both line and trawl fisheries. Their resilience may be attributed partially to two important phenomena, the large habitat they enjoy and the nature of their reproductive styles.

Extent of soft substratum on the continental shelf.

By far the greatest area of the continental shelf is covered by sandy and muddy sediments. In addition, on the East Coast, as much as 133 million cubic meters of top soil is deposited on the shelf each year (Dingle, *et al*, 1987). While a large proportion of this sediment is eventually moved off the edge of the shelf by the action of the Agulhas Current, it is probable that vast areas of low profile reef are being progressively smothered, constantly increasing the shelf area dominated by soft sediments.

Nature of their reproductive styles

Populations in which individuals have a predetermined sex at birth, and which are protected from the fishery until they have spawned at least once, are less likely to be fished out.

However, the term `fished out' is a loose one, and a matter for speculation. The size of kob most frequently caught in the Port Alfred fishery is only 45 cm, with few of the large size classes remaining (see Fig 2). The management strategy being implemented at present, namely a minimum size limit of 40 cm, should theoretically ensure the long-term survival of the stock. However, the real implications of fishing a stock until only the smallest spawners remain, are unknown. Larger fish tend to be proportionately more fecund than smaller individuals of the same species. Their contribution to the annual stock recruitment may be critical to the fishery. If they are all removed, it is conceivable that the stock may not cope under present levels of fishing effort.

MIGRATION

Little is known about the degree of residency, or alternatively, migration of any of the above-mentioned species. There is evidence of large populations of panga, maasbanker and squid on the Agulhas Bank, probably an important spawning and nursery area for these and many other linefish species. While little is known about the stock integrity of the Agulhas Bank populations, it is thought that there may be considerable `seeding' of the inshore shelf areas from this source. If there is movement of fish between the Agulhas Bank and the inshore shelf, it is important that we should incorporate biological data from this region into our management models. Foreign trawl catches of panga on the South and South West African coasts in 1987 amounted to 1332 tonnes, while local trawlers landed only 173 tonnes in 1988 (Stuttaford, 1989). Biological data relating to these catches is lacking, and their impact on the panga stocks can therefore not be gauged.

Kob are generally not found deeper than 60-70 m, and are restricted to the inner continental shelf. This makes them highly accessible to both trawling and linefishing, and there can be few places left where they are not heavily exploited. The degree of movement of this species is not known at present. Although a certain amount of seasonality in catches is evident, tag returns received by the Oceanographic Research Institute (ORI) in Durban have indicated that on the whole they do not move very extensively. Data from 112 returns, indicated that the average distance moved by individual fish was 29 km, at a rate of less than 1 km/day. The maximum distance moved by an individual was 926 km at a rate of 5.2 km/day. Most fish, 64%, had not moved at all, and of those that did move, roughly half migrated up the coast and the other half down the coast (Van der Elst and Bullen, 1989).

CONCLUSION

Recreational fishermen who enjoy bottom fishing need not fear for their sport in the long-term, but they should reconcile themselves to the fact that trophy fish will continue to become more and more difficult to find as time goes by. It is an irreversible consequence of the ever increasing fishing effort being directed on the stocks.

In spite of the considerable progress that has been made on the management front, the requirement for ongoing research into species biology, ecology, population dynamics and stock integrity is clearly evident in the light of the complexity of our multispecies linefishery.

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COASTAL MIGRANTS, ILLUSTRATED BY GEELBEK

MR M H GRIFFITHS, DEPARTMENT OF ICHTHYOLOGY AND FISHERIES SCIENCE, RHODES UNIVERSITY

A study on the biology of the geelbek, *Atractoscion aequidens*, was initiated in 1985 in response to reports by both authors and fishermen of radically declining geelbek catches. Table 1, which comprises an analysis and comparison of annual catch statistics recorded by Gilchrist and the Sea Fisheries Research Institute (SFRI), confirms this trend. It is important to note that the decline in present day catches has occurred in spite of technological advancements such as nylon lines, marine motors, electronic navigation aids and fish finders.

TABLE 1: The mean annual catches and catch per unit effort (CPUE) of *Atractoscion aequidens* in the South West Cape during the periods 1897-1906 and 1985-1986.

Period	1897-1906	1985-1986
Mean annual catch (tonnes)	998.12 ± 25.26	109.73 ± 7.54
CPUE (kg/man/year)	1383	30

At the outset it was suspected that the geelbek was a migratory species. To test this hypothesis fish were biologically sampled over a 30 month period from various geographical localities along the South African eastern seaboard. For this purpose the coast was divided into the six regions which are illustrated in Fig 1.

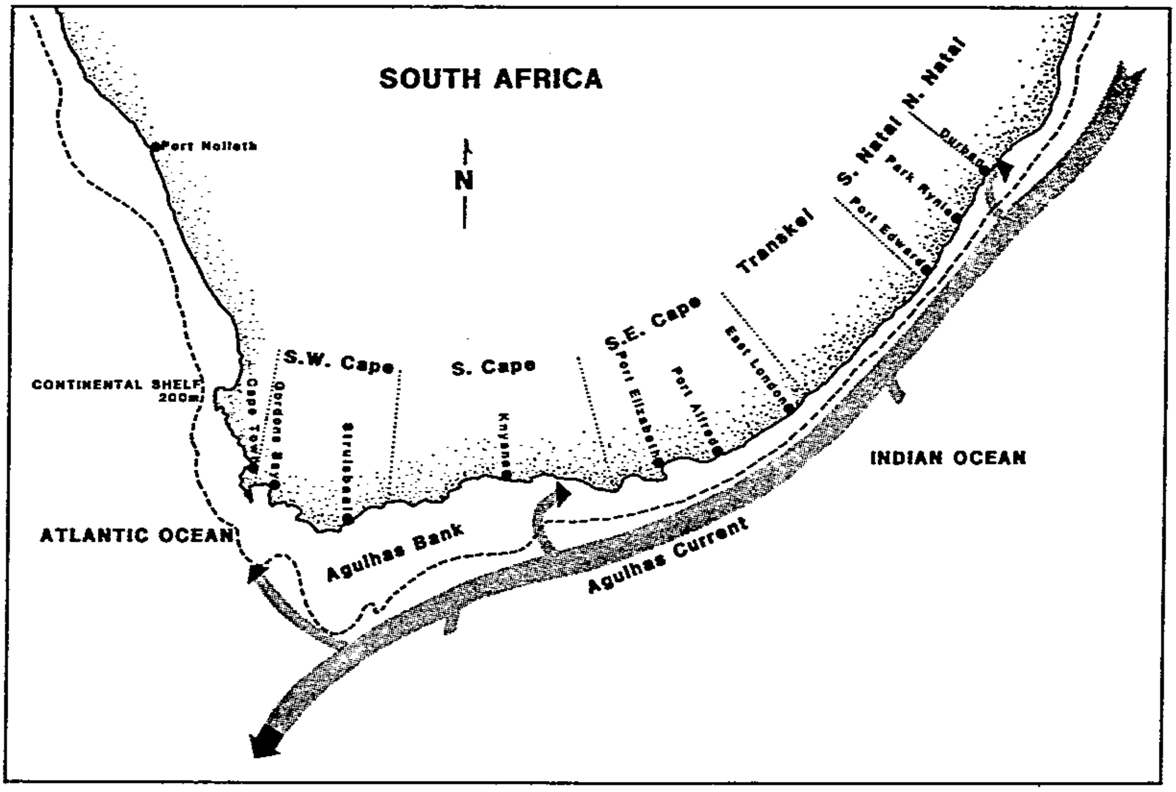

FIG 1: MAP OF SOUTH AFRICA SHOWING THE CONTINENTAL SHELF, THE AGULHAS CURRENT, THE DIVISION OF THE EASTERN SEABOARD INTO SIX COASTAL REGIONS, AND VARIOUS SAMPLING SITES

It was revealed that the South African geelbek population existed as three separate age groups. Those in the South West Cape consisted mainly of fish from 1-4 years; those in the South East Cape consisted of two age groups - 0-1 and 4/5-10+ years, respectively - and those in Natal of fish from the older age group.

An analysis of SFRI catch statistics showed that the largest age group made a seasonal appearance in the South East Cape and Natal and that there was a progressive movement of these fish up the coast every year - generally first arriving in the South East Cape in April, in southern Natal in June and in northern Natal in July.

Reproductive studies revealed that only those fish belonging to the larger age class were sexually mature, and that fish in breeding condition were only sampled in Natal. This implied that the seasonal migration of geelbek to Natal was for reproductive purposes.

However, although the adult geelbek first arrive in Natal in June, the bulk of their breeding activity only takes place in September/October. This is apparently the result of a close association of adult geelbek and their primary food, the pilchard *Sardinops ocellatus*, which also undergoes a seasonal migration from the South Western Cape to Natal. Of course one might argue that the geelbek are merely responding to similar environmental stimuli, eg the narrow band of cool water which extends up the South African eastern seaboard with the onset of winter. However the predominance of pilchards in the diet of the geelbek coupled with the advantages of a constant energy supply for an energetically expensive reproductive strategy, tend to support the former idea. Therefore even though geelbek migrate to Natal to breed, the dynamics of the migration seem to be strongly influenced by the movements of their prey.

Once in Natal they apparently spawn offshore in spring. The eggs and larvae then drift southwards with the peripheral waters of the Agulhas Current. By the time they reach the South East Cape they have developed into juvenile fish and move inshore where they utilise this region as a nursery area. As they approach their first birthday they gradually move down the coast to the South West Cape. Here they remain for a further four years until they attain sexual maturity. During this time these sub-adults are believed to follow their main food source, the anchovy *Engraulis capensis*, moving inshore in summer and offshore and slightly eastward in winter. There is also some evidence to suggest that some of the older and larger sub-adults undergo a partial migration and gonad development with the adult fish.

After spawning the adults are thought to `ride' the Agulhas Current down to the South West Cape. During summer the pilchards on the eastern seaboard are most abundant on the Agulhas Bank. It is therefore possible that the adult geelbek spend summer on the Bank replenishing energy reserves that would have been depleted during gonad development and an extensive spawning migration. It is relevant to mention that during this period the adults virtually disappear from the South African linefishery as a whole.

In conclusion one finds that each of the three age related sub-populations of the South African geelbek stock display a separate migratory pattern. Firstly there is the active spawning migration of adults (5-10+ years) to Natal followed by a more passive return to the

South West Cape. Secondly there is the gradual filtration of juveniles (0-1 years) to the South West Cape, and finally there is the onshore offshore movements of the sub-adults in the South West Cape in response to the movements of their prey.

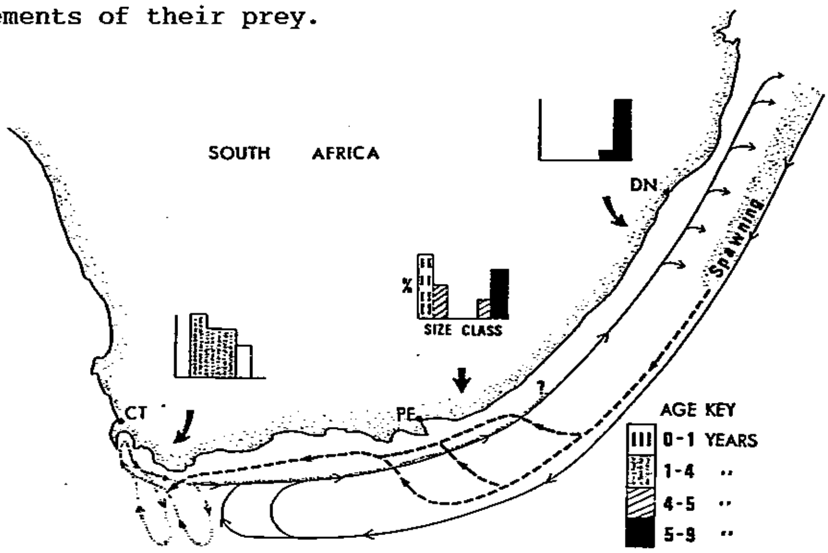

FIG 2: THE THEORETICAL LIFE HISTORY CYCLE AND MIGRATORY PATTERNS OF THE VARIOUS AGE-RELATED SUB-POPULATIONS OF GEELBEK ALONG THE SA EASTERN SEABOARD. FOR THE SAKE OF CLARITY, THE LATERAL DYNAMICS OF THE MIGRATORY PATTERNS ARE NOT DRAWN TO SCALE

YELLOWTAIL MIGRATION PATTERNS AND THEIR MANAGEMENT IMPLICATIONS

MR A J PENNEY, SEA FISHERIES RESEARCH INSTITUTE (SFRI)

A number of the larger predatory linefish species occurring off the southern Cape, including kob, geelbek and yellowtail, undertake extensive annual migrations along the Agulhas Bank. Adult fish of these species often migrate eastwards in late summer, possibly following pelagic fish shoals to spawn in warmer water from which their eggs and larvae can be returned by the Agulhas current. Fishermen have been aware of these migrations for many years and eagerly await the annual "runs" of these fish, often relying on them for much of their annual catch. It is therefore not surprising that distribution and migration patterns can markedly influence catch trends, or that management attempts without a detailed understanding of the species' life history can sometimes have confusing results.

YELLOWTAIL DISTRIBUTION AND MIGRATION

The yellowtail stock is centred on the Agulhas Bank south east of Cape Agulhas, where shoals gather in the summer months to feed prior to spawning (Fig 1). From October to March, shoals move rapidly between the various reef pinnacles on the bank, supporting both the commercial and recreational fisheries in the area. Towards the end of summer, a variable migration commences along the eastern coast, fish sometimes reaching as far as southern Natal. This migration appears to be related to current and pelagic fish movement, but is not as consistent as eastern Cape fishermen would perhaps like.

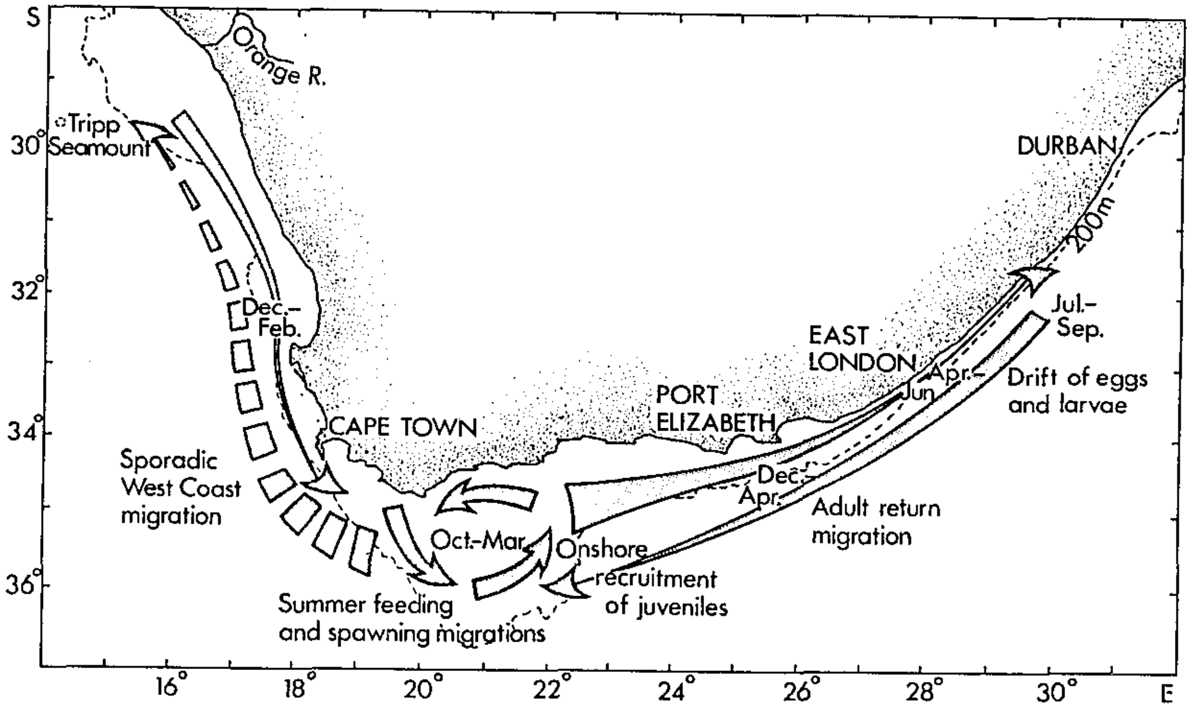

FIG 1: COASTAL DISTRIBUTION AND MIGRATION PATTERNS FOR THE YELLOWTAIL STOCK, SHOWING THE MONTHS IN WHICH FISH OCCUR IN VARIOUS AREAS

Yellowtail spawn from November to February with most spawning occuring offshore on the central Agulhas Bank, some as far as Natal. The adult fish return along the bank with the Agulhas current, as must the eggs and larva spawned along the East Coast, and both juveniles and adults again make an appearance on the Agulhas pinnacles in early October. The one and two year old juveniles appear inshore first, supporting the fishery in the early summer months, and the adult fish join the inshore migration later, appearing in catches from December or January onwards.

Migrations also occur up the West Coast, but this is poorly understood. Yellowtail can tolerate a wide temperature range and certainly move around Cape Point, probably in Agulhas Current eddies or filaments, as far as Dassen Island. They also occur consistently on Tripp and Vema seamounts but whether these fish migrate from the Agulhas area annually, or have become partially separated from the Agulhas stock, or have moved down from a northern stock is unclear.

THE YELLOWTAIL FISHERY - 1971 TO 1988

Prior to 1971, yellowtail were only caught by line fishermen, mostly off Struis Bay, and by beach-seine nets in False Bay. However, during 1971 a record 1100 tonne line catch of yellowtail off Agulhas attracted the interest of a few small purse-seine boats conducting experimental purse-seine netting for tuna. They found that yellowtail could effectively be caught using the same equipment and a directed yellowtail purse-seine fishery commenced. The initial 1971 catch was a modest 8 tonnes, but purse-seine catches steadily increased until, by 1976, they equalled the line catch (Fig 2). This combined catch of almost 1200 tonnes apparently exceeded the sustainable yield of the stock and catches by both sectors declined steadily thereafter. The mean size of the fish being caught also declined rapidly until, by 1981, there were very few mature fish in catches. It appeared that the adult stock had been severely depressed, resulting in poor annual recruitment and continued catch declines. As a result of these indications, coupled with continued representations by handline fishermen from the Agulhas area, purse-seine fishing for yellowtail was eventually prohibited in 1982.

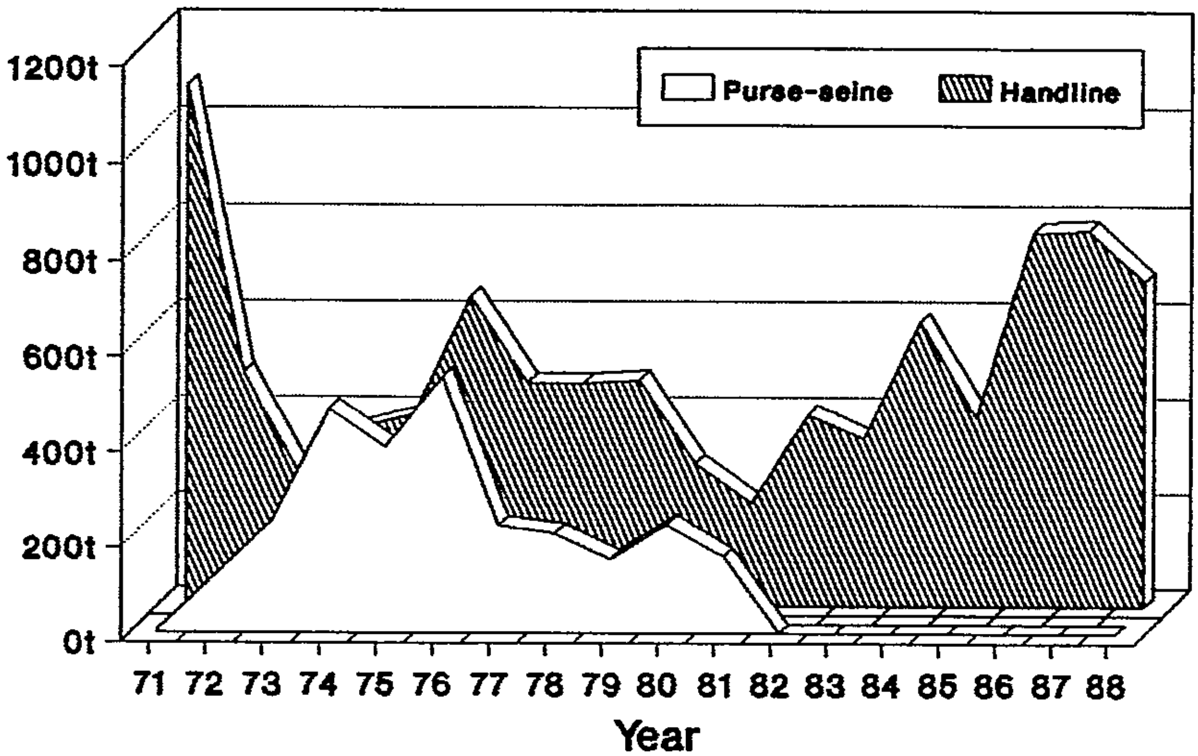

FIG 2: TOTAL ANNUAL YELLOWTAIL CATCHES REPORTED BY COMMERCIAL HANDLINE AND PURSE-SEINE FISHERMEN FISHING IN IN THE CAPE AGULHAS AREA FROM 1971 TO 1988

Catches of yellowtail increased rapidly after the purse-seining prohibition, to the stage where present catches approximately equal the best recorded in the past. In quick overview, this appears to be the direct result of the halving of catch that resulted from cessation of purse-seining, but this is an excessively simple view of the situation. The marked drop in catches from 1971 to 1973 and the subsequent rapid increase shows that the yellowtail stock can fluctuate markedly. The reason for this is that most of the catch has always consisted of immature one and two year old fish. Good catches therefore only result from good recruitment during the past two years. Catch sampling showed that an extremely strong cohort of fish was indeed spawned in 1982 and this has been largely responsible for catch increases since then. However, this raises the most important question concerning the recovery. If, in 1982, there were practically no adult fish left in the yellowtail stock, how was this exceptional cohort of fish spawned?

YELLOWTAIL OFFSHORE STOCK STRUCTURE

The answer to this apparent contradiction can be found by carefully examining the length-frequency distributions of fish caught on the Agulhas Bank during the 1984/85 season. Catches off Struis Bay were, as always, dominated by the one and two year old (45 cm - 55 cm) fish, but with good catches of three year olds (60 cm - 65 cm) from the 1982 cohort (Fig 3). There were still very few mature fish caught by inshore fishermen. However, during this season, a few larger boats made good yellowtail catches on the deeper Alphard, 40-Mile and 72-Mile Banks near the edge of the Agulhas Bank while looking for red steenbras. Length-frequency analysis of these offshore catches also shows the dominance of one, two and three year old fish, but with a marked contribution by very large, mature, 6 - 10 year old fish that do not appear in the inshore area (Fig 4). It is clear that these fish remained protected from the inshore fishing effort throughout the "decline" of the yellowtail stock, and that suitable water conditions allowed them to spawn a very strong cohort in 1982.

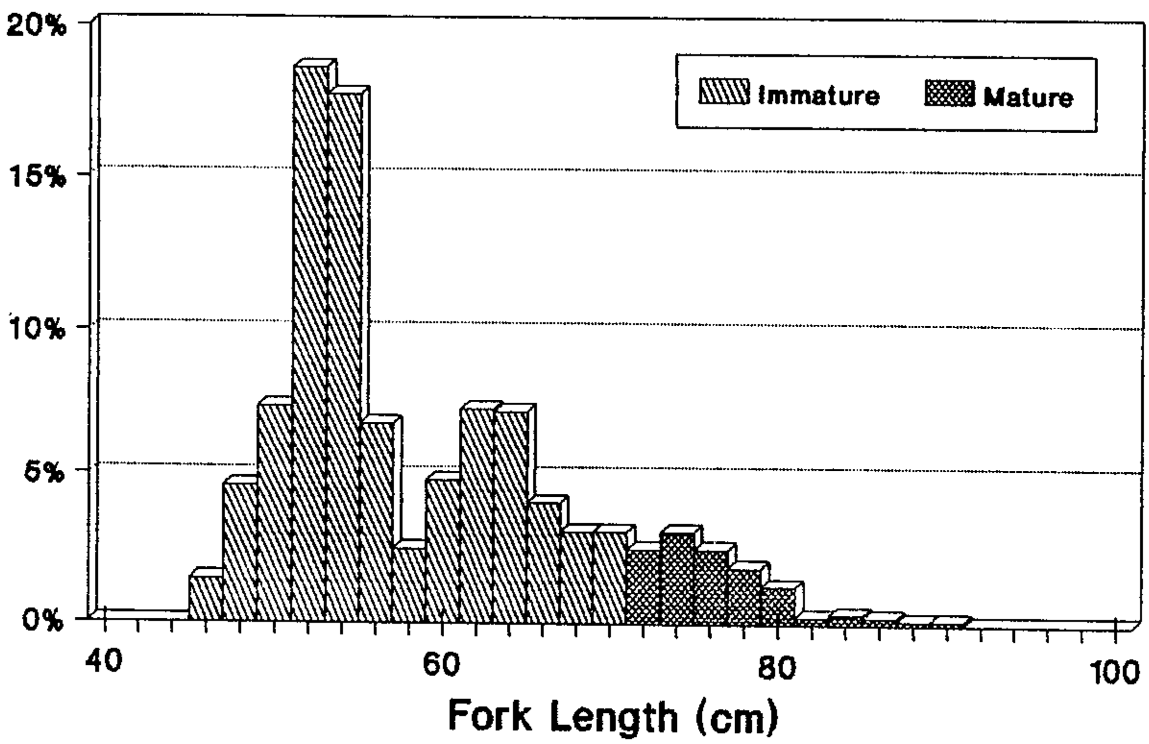

FIG 3: LENGTH-FREQUENCY DISTRIBUTION OF YELLOWTAIL CAUGHT BY COMMERCIAL LINEFISHERMEN FISHING INSHORE IN THE CAPE AGULHAS AREA DURING 1984/85

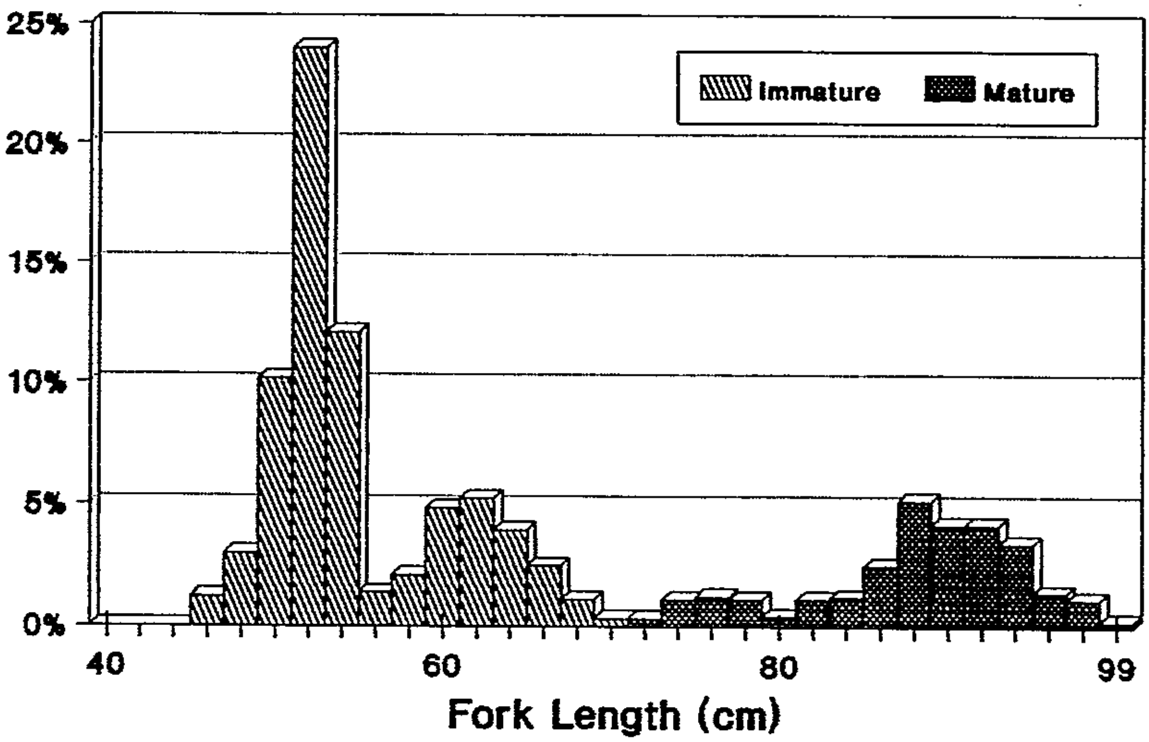

FIG 4: LENGTH-FREQUENCY DISTRIBUTION OF YELLOWTAIL CAUGHT BY COMMERCIAL LINEFISHERMEN FISHING OFFSHORE ON THE DEEP AGULHAS BANK REEFS

MANAGEMENT IMPLICATIONS

There are a number of management lessons to be learned from the above fishery history. The first and most obvious is that a thorough understanding of the biology, life-cycle, distribution and migration patterns of coastal migrant fish species is essential if effective management decisions are to be taken. The second is that stocks of the faster-growing species such as yellowtail can fluctuate markedly from year to year, and this must be taken into account when interpreting short-term catch trends. One must obviously be cautious in exploiting any fish stock, but it is often possible to increase catches for a few years after good recruitment without necessarily collapsing the stock, and decrease them again when the stocks decline to more usual levels.

However, the most important lesson to be learned is to ensure that management decisions are designed to address the real problems in a fishery. If not, they may create the impression that suitable conservation measures have been taken, when they are actually ineffective. In retrospect, although the prohibition of purse-seining decreased yellowtail catches and probably allowed a more rapid recovery, it is clear that the stock was actually protected by the offshore distribution behaviour of the adult fish. It appears that the future of the yellowtail stock may depend more on protection of the adult fish on the deep, offshore reefs on the central Agulhas Bank than on extreme restrictions on the inshore fishing sectors.

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HAS ROCK AND SURF FISHING IN THE SOUTHWESTERN CAPE DETERIORATED?

MR B A BENNETT, DEPARTMENT OF ZOOLOGY, UNIVERSITY OF CAPE TOWN

Allegations of serious declines in rock and surf angling catches in the southwestern Cape have been voiced almost since the inception of the fishery. The evidence for these declines has, however, mostly been anecdotal. This report aims to analyse these claims in the light of some available documented evidence.

A number of angling clubs in the southwestern Cape have held competitions at regular intervals over the years. Some have maintained detailed records of the number of man-hours fished and the number and weight of each species caught. In some cases records dating back several decades are still in existence and used in this presentation. These are available for several clubs since about 1970, while one of these clubs, the Liesbeek Park Angling Club, was able to provide a time series dating back to 1938, with only a short break during the latter part of World War II.

RESULTS

Results are presented as catch per unit effort, expressed in terms of numbers or weight of fish caught per man hour fished. Separate analyses were carried out for each of the nine species most abundantly caught by rock and surf anglers in the South West Cape. Individual species records appear to fall into three groups as listed below.

The first group comprises four species, white stumpnose *Rhabdosargus globiceps,* red stumpnose *Chrysoblephus gibbiceps,* Roman *Chrysoblephus laticeps* and yellowtail *Seriola lalandi* that were important in the catches prior to 1960 but were very poorly represented or absent thereafter (Fig 1). A second group, comprising white steenbras *Lithognathus lithognathus,* kob *Argyrosomus hololepidotus* and belman *Umbrina capensis* were almost absent from the catches prior to 1960. They show a progressive increase in CPUE until the early 1970's, but data for the latter part of the time series indicate declining catches (Fig 2). The third group, dassie *Diplodus sargus* and galjoen *Coracinus capensis,* fluctuate in availability throughout the time series (Fig 3).

The average catch in weight per unit effort of all species combined (including those not considered above) varied widely from year to year (Fig 4). There is, however, clear evidence that catches have declined steadily since World War II.

DISCUSSION

Initial examination of these results would suggest that fish in group 1 have been overfished and those in group 3 have increased in abundance over time. More detailed examination of club records, however, indicates that catch trends may also reflect the habits of the fishermen, in particular the locations at which competitions were fished (Fig 5).

Prior to 1950 competitions were held either on the West Coast of the Peninsula or between Simonstown and Partridge Point on the East Coast. These locations yielded catches comprised mainly of white stumpnose and galjoen, together with some red stumpnose and Roman so that catch rates for these species were elevated over this period. From 1950 to 1960 competitions were sited mainly at Rooikrans or Rooiels, where deep water is accessible from the shore. Such areas are unsuitable for galjoen and white stumpnose, leading to a decline in these catches, but favour species such as yellowtail and Roman, which thus comprised an increasing proportion of the catch and show a pronounced peak in availability over this period. After 1960 there was a trend towards holding more competitions along the northern coast of False Bay although, after this time, competitors were offered the option to fish almost anywhere between Melkbosstrand and Kleinmond. This resulted in an increase of fishing effort in beach or mixed rock and sand habitats, favoured by species such as kob, white steenbras and belman. These species thus show an increased CPUE towards the latter part of the time series, as shown in Figure 2. Transfer of effort away from deep water sites simultaneously resulted in a decline in catches of red stumpnose, yellowtail and Roman, all of which are poorly reflected in catches late in the series.

The question that remains to be answered is: why were there changes in the areas in which the competitions were held? Changes in venue may have occurred as private vehicles and improved roads allowed different areas to become more accessible. It is also likely that improvements in fishing methods, such as the widespread introduction of nylon fishing line and fibreglass rods improved the efficiency of anglers in some areas. The most likely reason, however, and one that is supported by the data, is that the fishermen changed areas when forced to do so by declining catch rates suggesting that catches have indeed deteriorated since the 1930's.

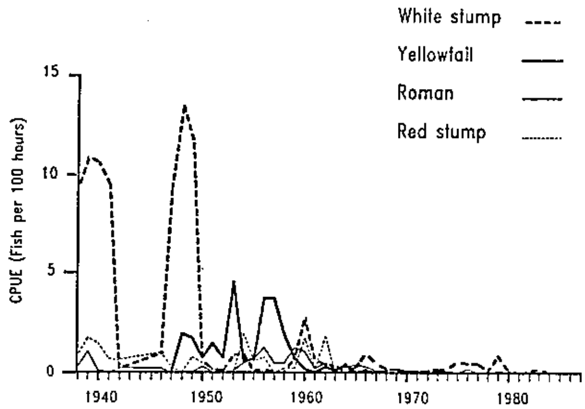

FIG 1: CATCH PER UNIT EFFORT FOR:

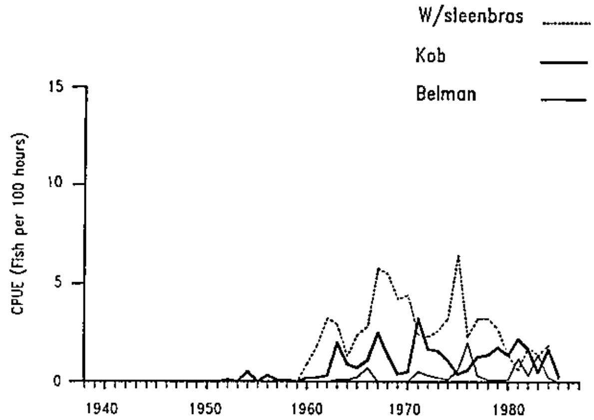

FIG 2: CATCH PER UNIT EFFORT FOR:

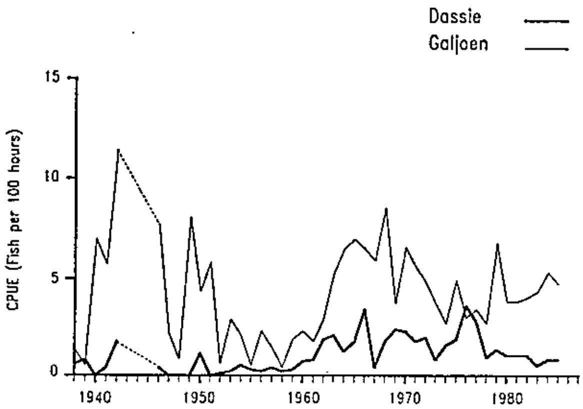

FIG 3: CATCH PER UNIT EFFORT FOR:

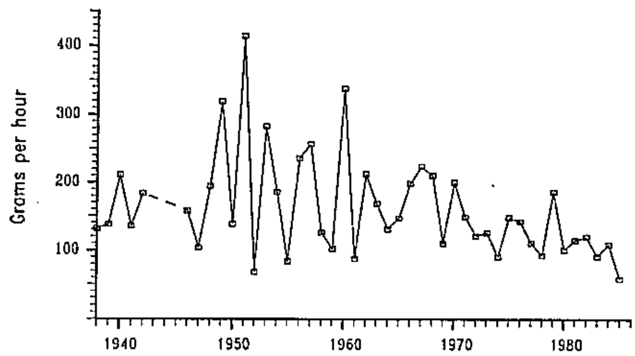

FIG 4: WEIGHT OF FISH CAUGHT PER ANGLER PER HOUR SINCE 1938

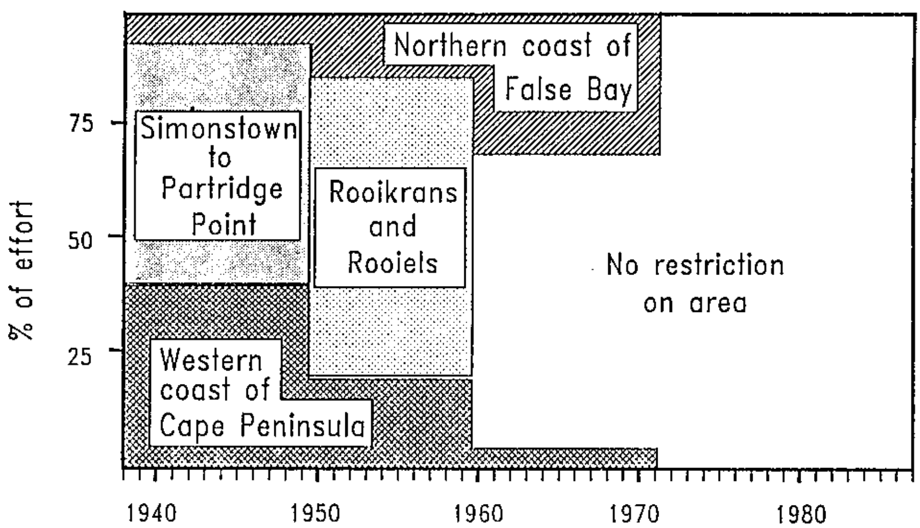

FIG 5: DISTRIBUTION OF FISHING EFFORT

SHARKS AND RAYS, ILLUSTRATED BY THE BLUE STINGRAY

MR P D COWLEY, DEPARTMENT OF ICHTHYOLOGY & FISHERIES SCIENCE, RHODES UNIVERSITY

Marine recreational fishing for cartilaginous fishes (both sharks and rays) has increased greatly in recent years. Because of their large size and abundance inshore, certain species are targetted for by competition anglers going for maximum points. Besides these club anglers, more and more 'non affiliated' recreational fishermen are also pursuing sharks for their fighting ability.

In the past, sharks and rays were considered vermin and often left on the beaches to decay or killed and dumped at sea. Fortunately, this trend has changed and an increasing number of recreational fishermen now return their catches live. It is felt that this change has been augmented by the ORI/SFW tag and release programme and a growing conservation awareness because of the often used phrase "depleting fish stocks".

The state of research on the natural history of cartilaginous fishes in this country is at its infancy. Hence, before emphasis is placed on studying a particular species the need arises to identify those species most important to the fishery. Table 1 lists the sharks and rays which are of consequence to the recreational fishery.

If we consider the overall pressure exerted by recreational anglers on cartilaginous fishes, it is considered negligible compared to the threat posed by commercial exploitation. Several commercial chondrichthyian fisheries exist; the first and probably the most alarming being the indirect fishery where sharks and skates comprise a large percentage of the bycatch in the demersal hake trawl industry. It has been calculated that approximately 10 000 to 20 000 tonnes are caught annually, most of these fish are either trawl damaged or dead before being dumped. Other fisheries include the soupfin and St Joseph shark fisheries in the South West Cape, and the inshore anti-shark netting programme along the Natal coast.

Shark fisheries worldwide have all had the same sequence of events, one of "boom and bust". The reason for this is due to the natural history of elasmobranchs, which can be characterised by slow growth, late maturing and low rate of reproduction.

Research results of the blue stingray *Dasyatis marmorata* provide an excellent example. It has been revealed that sexual maturity is reached at about 500 mm disc width which coincides with an age of approximately seven years. An average fecundity from adult females carrying either uterine eggs or young has been calculated at 2.9. Assuming that a female reaches a mean maximum age of 20 years, it implies that each female produces on average 38 young in a lifetime. Such figures are quite alarming when one considers the number of eggs spawned by most bony fishes.

In conclusion then it is clear that a high fishing mortality on cartilaginous fishes can have a drastic effect in a very short time. The management of such fisheries are different from most and require a thorough knowledge on the biology and habits of the exploited species. Therefore, to produce a sustainable yield over an indefinite time period justifies the need for further research on elasmobranch fishes.

Table 1: The most important sharks and rays caught in the recreational fishery, with an index of abundance in the catches of the different angling facets for different regions along the coast

Species	Region	Angling facet	Abundance
Notorynchus cepedianus	Namibia, SW Cape	LT Boat, Rock & surf	***
Squalus megalops	SW Cape to Transkei	Ski-boat	***
Carcharias taurus	S Cape to Natal	Rock & surf	*
Alopias vulpinus	SW Cape	LT Boat	*
Isurus oxyrinchus	S Cape to Natal	Ski-boat	*
Poroderma africanum	S Cape, E Cape	Rock & surf, Skiboat	**
Poroderma pantherinum	S Cape, E Cape	Rock & surf, Ski-boat	**
Haploblepharus fuscus	S Cape, E Cape	Rock & surf	***
Galeorhinus galeus	SW Cape	Rock & surf, LT Boat, Ski-boat	***
Mustelus mustelus	Namibia to E Cape	Rock & surf, LT Boat	***
Triakis megalopterus	Namibia to E Cape	Rock & surf	**
Carcharhinus brachyurus	Namibia to E Cape	Rock & surf	***
Carcharhinus obscurus	Natal	Rock & surf, ski-boat	***
Carcharhinus brevipinna	Natal	Ski-boat	*
Carcharhinus limbatus	Natal	Ski-boat, rock & surf	**
Rhizoprionodon acutus	Natal	Rock & surf, LT Boat	***
Sphyrna zygaena	Transkei, Natal	Rock & surf, Skiboat	**
Rhynchobatus djiddensis	Natal	Rock & surf	**
Rhinobatus annulatus	SW Cape to E Cape	Rock & surf, LT Boat	***
Raja alba	SW Cape	Rock & surf, Ski-boat	*
Raja straeleni	Namibia to E Cape	Rock & surf, LT Boat	*
Dasyatis marmorata	SW Cape to Natal	Rock & surf, LT Boat	***
Himantura gerrardi	Natal	Rock & surf	*
Himantura uarnak	Natal	Rock & surf	*
Gymnura natalensis	SW Cape to Natal	Rock & surf, LT Boat	**
Myliobatus aquila	SW Cape to Natal	Rock & surf, LT Boat	**

* Occasionally caught

** Commonly caught

*** Very commonly caught

ESTUARINE FISHES, ILLUSTRATED BY THE SPOTTED GRUNTER

DR A K WHITFIELD, JLB SMITH INSTITUTE OF ICHTHYOLOGY

Estuaries are regions where marine and freshwaters meet, where environmental stress is pronounced and where exceptionally high levels of primary and secondary productivity are often recorded. These factors have a major influence on the numbers and variety of fishes that can live in estuaries. In particular, the often abrupt changes in salinity, temperature, oxygen concentration and turbidity place considerable physiological demands on fishes which reside in estuaries. However, those species which are broadly tolerant of the above variations are at an advantage over those fishes which cannot survive such fluctuations, since the former group are able to utilise a food-rich environment from which many potential competitors are excluded.

The dominant category of fishes in South African estuaries comprises marine species which spawn at sea, the larvae drift in ocean currents until the postlarval stage is reached and an onshore migration occurs. The postlarvae, which are approximately 1 cm in length, locate an open estuary and enter the system using flood tidal transport, at which stage they move to either the side or bottom so as to avoid being washed out of the system on the ebb tide. It is these shoals of small fish in the shallows which are seen and assumed by most people to have been spawned in the estuary, yet in reality many of the fry have already travelled in excess of 50 km before entering the estuary. In the case of species such as the strepie *Sarpa salpa* and garrick *Lichia amia*, spawning appears to take place off the Natal coast, the eggs and larvae are washed southwards in the Agulhas Current, with the juveniles entering eastern and southern Cape estuaries after a journey exceeding 1 000 km.

The spawning of most marine species utilising Natal estuaries occurs during late winter and spring, often in close proximity to the coast so that the distance between spawning and nursery grounds is reduced. The postlarvae enter permanently open estuaries almost immediately and blind (closed) estuaries when they open following spring and early summer rains. In the Cape, recruitment into many estuaries reached a peak during summer and extends into the autumn for some species. Once again the period of maximum recruitment coincides with the time when many temporarily closed estuaries are open.

Most marine species which utilise South African estuaries as nursery areas spend between one and three years in these systems, before returning to the sea. Some estuaries may remain closed for longer than two years, in which case the trapped fish will continue growing and even become sexually mature. They are however unable to breed in these systems and will resorb their gonads if unable to reach the sea during a particular spawning season.

Examples of angling species which make extensive use of South African estuaries include the leervis, kob, white steenbras, spotted grunter, ten-pounder, Cape and Natal stumpnose. I will now briefly examine the life cycle of the spotted grunter *Pomadasys commersonnii* (Fig 1), to illustrate how this marine fish species utilises estuaries and why it is important that these habitats are conserved for the future.

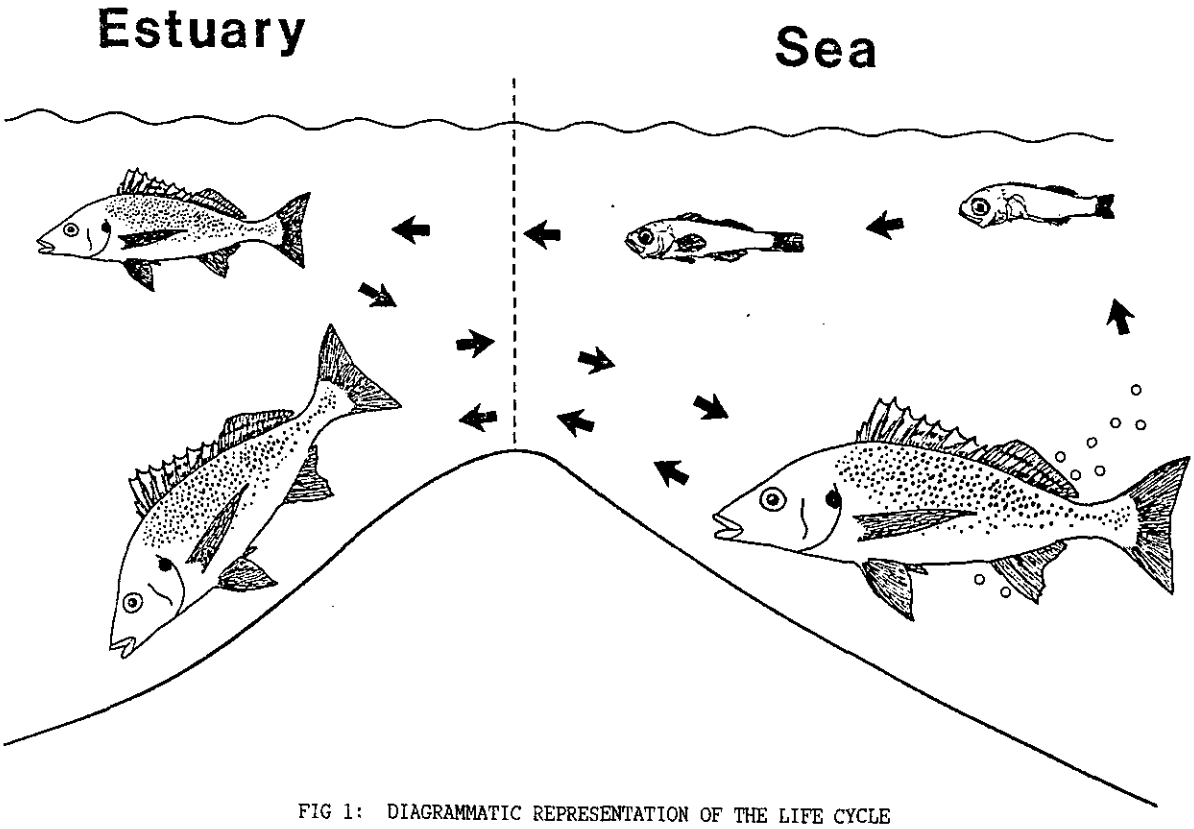

FIG 1: DIAGRAMMATIC REPRESENTATION OF THE LIFE CYCLE OF THE SPOTTED GRUNTER IN SOUTH AFRICA

The spotted grunter inhabits shallow coastal regions, including estuaries, along the warmer stretches of the Natal and Cape coasts. Spawning occurs in the open sea during late winter and the fry (2 - 5 cm in length) enter Natal and eastern Cape estuaries between July and December. Adult fish often return to the estuarine environment after spawning, with the spring 'grunter run' in the St Lucia system being a good example of this. The juvenile grunter grow rapidly (1.2 to 1.5 cm per month) in the food rich estuarine environment for approximately a year, at which stage they return to the sea where maturity occurs at about three years of age (length ± 39 cm; weight ± 0.8 kg). Following sexual maturity, weight increments range from 0.6 to 0.7 kg per annum, with a ten year old fish measuring 77 cm and weighing approximately 5.2 kg. The South African angling record for this species is 9.5 kg and such a specimen would be more than 15 years of age.

Spotted grunters forage on the bottom and more than 75% of their diet in eastern Cape estuaries comprises the mud prawn *Upogebia africana,* sand prawn *Callianassa kraussi* and pencil bait *Solen cylindraceus.* The prawns are extracted from their burrows by using a gill chamber pump action, similar to that of bellows. A jet of water is forced into the burrow system and the prey is blown out, at which stage it is captured and consumed. Destruction of prawn or pencil bait beds due to over exploitation or environmental degradation will result in a decline in the numbers of this valued angling fish species. An example of the above scenario was recently recorded in the Seekoei estuarine lagoon, where salinities more than twice that of seawater killed not only the resident grunter population, but also the mud prawns and pencil bait on which this fish feeds. It will take many years for this system to recover, even if the supply of freshwater is restored and salinities decline to normal levels.

In conclusion, there are many reasons for conserving estuaries, not least of which is their recreational value for both marine and estuarine anglers. The support of fishermen in maintaining these important nursery areas in as natural a condition as possible, will go a long way towards providing healthy fish stocks for the future. If our estuaries continue to be abused, the number of fish associated with these habitats will decline, regardless of restrictions placed on bag limits etc. The key to avoiding the above situation is to practise wise estuarine and river catchment management before it is too late.

FUNDAMENTALS OF MARINE LINEFISH RESEARCH IN SOUTHERN AFRICA

PROF T HECHT, DEPARTMENT OF ICHTHYOLOGY & FISHERIES SCIENCE, RHODES UNIVERSITY

INTRODUCTION

Marine linefishing is a particularly widespread and popular activity in South Africa, with some half million regular participants, growing at about 6% per annum (v d Elst, 1988). Activities include recreational and commercial deep-sea fishing as well as recreational and subsistence rock and surf angling. The economic asset of South Africa's commercial linefish landings alone is considerable, exceeding ca. R40-R50 million annually, ranking third in value behind the offshore trawl and seine fisheries and exceeding the value of the inshore trawl and rocklobster fisheries. The linefishery also sustains a large and growing support industry comprising tackle manufacturers, boat builders and tourist facilities (Smale & Buxton 1985, Hecht & Tilney in press). Numerous coastal developments, both private and state, are intimately linked to the linefish resource. In addition to this economic asset, marine linefishing plays a most important role in the recreational activities of the community. A continued dedicated research effort to provide the basis for the rational management of the resource is therefore essential.

The resource is presently revealing increasingly negative trends (see contributions by Garratt & v d Elst, Penney and Hecht). The objectives of our research endeavours are, therefore, to investigate the biology of and fishery for linefish with a view to providing the scientific basis for their optimal management and to develop modern technologies that will enhance the sustained use of South African linefish. However, because of the multi-species and multi-user nature of the fishery this task is not an easy one. Multi-species fisheries are notoriously difficult to manage in relation to single species fisheries. The underlying reason for this is that the selective removal of one species from a predation based community ultimately affects the structure of this community. In other words the catching of a particular species from a multi-species community could have a ripple effect throughout that community. The problems are further exacerbated by the complicated life history traits of many of the species, particularly the sparids, eg longevity, complicated reproductive styles such as sex reversal, endemicity and migrations.

Over the last decade the focus of research has changed progressively from being largely of an inventorial and biologically descriptive nature to quantitative and predictive assessments. Our research on the biology of many species has also reached a point where we can now ask fundamental questions about the driving forces of predation based multi-species communities or more applied questions such as "What determines the resiliency or non-resiliency of species to fishing pressure in the light of their life histories and habitat preferences?"

The emphasis of our research endeavours is largely geared towards

- understanding the natural history and life styles of fishes and their relationship to quantitative fisheries biology and management;

- the evaluation of management options, particularly marine reserves, minimum sizes, bag limits, restricted access, closed seasons, etc;

- the development and evaluation of predictive management models based on biological and environmental parameters;

- larval and juvenile dispersal mechanisms;

- the understanding of the dynamics of boundary current migrations and

- the development and evaluation of regional fisheries management strategies.

I will deal briefly with a number of these, and comment on the various techniques that are used, in order to achieve our objectives.

The relationship of natural history and life styles to quantitative fisheries biology and management

A great deal of information on key life-history parameters is now available for many of our important linefish species, such as growth rates, longevity, age and size at first and 50% maturity, age-specific mortality rates, spawning seasonality, the temporal extent of spawning seasons, fecundity and reproductive styles and strategies. Research now needs to be undertaken on assessing the exploitation related changes in the age distribution and size composition of catches, changes in sex ratios, changes in size at maturity and sex reversal as well as catch composition. Recent work by Buxton (1987), for example, has shown that the application of standard yield per recruit models to fishes which change sex give misleading predictions. Continued research on the reproductive styles and behaviour of target species, particularly the sparids which exhibit various forms of hermaphroditism (Buxton & Garratt 1989), is therefore of vital importance. Moreover, we also need to investigate in detail the gonadal development within each reproductive style and to relate this to population structures and spawning behaviour.

In order to relate the results to various levels of fishing mortality the work is undertaken on a comparative basis in exploited and unexploited regions. The fact that the research can be undertaken on this basis underscores the importance of our major marine reserves, such as the Tsitsikamma Coastal National Park, the De Hoop Reserve and the St Lucia Reserve.

We also need to understand the ontogeny of our linefish species. In order to achieve this, wild parent stock are currently maintained in captivity and induced to spawn by means of hormonal injections, whereupon the larvae and subsequently the juveniles are reared. These procedures allow us to investigate the early life history of fish and also offers the opportunity to investigate in detail the development of their gonads.

Ultimately the accumulated information requires synthesis and integration to develop and construct predictive models. These models will theoretically provide the basis from which to determine the vulnerability to exploitation of linefish with different life-history styles and hence, to ultimately facilitate the understanding and development of overall management strategies for multi-species fisheries. Data of this nature will also allow for the interpretation of these findings in relation to the fundamentals of modern life-history theory (Adams 1980, Stearns & Koella 1986).

At this stage the research has concentrated mainly on the key species in the fishery. Basic ecological theory, however, requires that the research on these aspects also be undertaken on as many species as possible in order for us to ultimately understand the dynamics of the community in its entirety.

Marine reserves and linefish research and management

Marine reserves in South Africa embrace some 625 km of coast (c. 21% of the total South African coastline) and represent an unknown, but certainly important factor in the future of the linefish resource. Marine reserves, particularly the three major reserves (Tsitsikamma, De Hoop and St Lucia) offer the opportunities to develop and test linefish research and management strategies that would certainly not be possible if the research were restricted to exploited areas. Besides the role played by reserves as 'open-air controlled laboratories', the role of marine reserves in terms of species, community as well as systems conservation and management, requires detailed study. This includes investigations leading to the optimal siting and size of reserves, the conservation efficacy of reserves for fish with different life styles (see above) and the development of cencusing techniques to be used for such investigations and subsequent monitoring.

Other studies which are currently underway in several of the larger and smaller marine reserves include movements and migrations of key species within, into and out of these areas. These studies are important for the understanding of the extent to which reserves are protecting resident and semi-resident species and the extent to which they seed adjacent areas through the migration of juveniles and adults. The actual work in the reserves, apart from the biological work, includes visual SCUBA assessment of relative fish abundance and distribution, behavioural observations (shoaling and reproductive), trends in catch statistics within and areas adjoining the reserves, mark and recapture experiments to quality migration to and from reserves and to obtain estimates of population size, visual size frequency estimations in order to calculate levels of mortality for comparison with mortality estimates in exploited areas.

Larval and juvenile dispersal mechanisms

The study of larval and juvenile fishes in South African waters has hitherto been seriously neglected, mainly due to a lack of available research funds. However, we now anticipate that a project of this nature will come off the ground in 1990. The primary objective of the project would be specifically to undertake investigations into the distribution and abundance of the larvae and juveniles of key linefish species. The major focus will be on the Agulhas Current system (inclusive of eddy currents and seasonal counter currents), thought to be a major factor responsible for the passive southward dispersal of larvae and juveniles. The results of this study will elucidate the dispersal processes and provide essential knowledge on stock integrity and juvenile recruitment, fundamental to effective resource management.

This project requires monthly sampling cruises from an appropriate vessel capable of simultaneously recording comprehensive oceanographic data over a two year period. Samples will be collected by means of obliquely hauled Bongo and surface neuston nets on a grid of stations across the East Coast Shelf region.

Species composition, distribution patterns and larval abundance, related to temporal and spatial oceanographic conditions, will be examined. In addition, specific key family groups will be identified for descriptive ontogeny, taxonomy and, wherever appropriate, the construction of identification keys.

Boundary current migrations

Dominant amongst the features that characterise the South African ichthyofauna are the pronounced seasonal migrations undertaken by several linefish species (v d Elst 1976, Griffiths 1988, Garratt 1988). The present understanding of the nature and driving forces behind these migrations is limited to a few species, viz elf *Pomatomus saltatrix* and geelbek *Atractoscion aequidens*. However, catch data and tagging results confirm that many more species are involved in longshore migrations. Often such migrations represent a major part of the fish's life history and, accordingly, could directly influence resource management strategies for these species.

The aim of the project is to acquire an understanding of the selective advantage of migrations in relation to the dynamics of the Agulhas Current, its eddies, meanders and counter- currents. It will further be established if such migrations are alimental, gametic or both. From a management perspective an understanding of spawner stock migrations are fundamental as they are, during this time, extremely vulnerable to fishing mortality.

Work is currently focused on the kob *Argyrosomus hololepidotus*, leervis/garrick *Lichia amia*, marlin species, slinger *Chrysoblephus puniceus*, king mackerel *Scomberomorus commerson* and the panga *Pterogymus laniarius*, as well as on some of the principal prey species, eg *Sardinops ocellatus* and *Engraulis capensis*. An understanding of the dynamics of these migrations will have direct management implications for many of the most important linefish species. Furthermore this project will interface with the juvenile dispersal study in establishing the nature of the temporal and spatial drift of eggs, larvae and juveniles. This project will be greatly dependent on the data generated by the supportive SFW/ORI Tagging Programme as well as on the National Linefish Catch Statistics Programme. The work involved includes analysis of temporal and spatial length frequencies, stock integrity, determining reproductive seasonality, following fish migrations to analyse gonadal recrudescence and predator/prey interrelationships, age and growth, age and size at recruitment, sexual maturity, inter-age class mortalities and spawner biomass/recruitment analysis.

Regional fisheries
Several linefisheries along the South African east and west coasts fall into distinct geographical units. Three trial units have been identified, i.e. the Port Alfred/Kenton Linefishery, False Bay and St Lucia. Considerable progress has already been made in assessing and evaluating the Port Alfred fishery (Hecht & Tilney, in press). The research strategy for regional fisheries is a combination of understanding the needs and aspirations of, and the conflict between commercial and recreational deep-sea fishermen, understanding the socio-economic intricacies of the fishery, understanding the biology and ecology of the component species, an assessment of the specific stocks in the area as well as the status of the fishery as a whole. The ultimate aim is to develop regional fisheries management strategies (Branson 1887, Miller 1987, Fullerton 1987) as a possible alternative to the present management strategy.

Some of the current thoughts being discussed among scientists, commercial and recreational fishermen, representatives of the support industries, fish wholesalers and retailers include; restricted access, direct and indirect control of commercial as well as recreational fishing effort, licensing of all craft (commercial as well as recreational) and the institution of obligatory catch returns. The rationale for this approach is simply based on the fact that we are harvesting a common property resource. Therefore all participants need to be directly restricted in some or other way, and all catches need to be recorded in order to determine a reasonable level of fishing effort to sustain the fishery in that region to the satisfaction of the user communities as a whole.

CONCLUSION

Research on the linefish resource in South Africa has now been in progress for just over a decade (v d Elst and Wallace 1983). The research during the early years was largely of a biological nature. The results have contributed significantly towards our understanding of the natural history of many key linefish species and formed the basis of the present linefish management strategy.

Although our present research endeavours are still undertaken with the same aims and objectives there has in recent times been a subtle change in approach. In the last three to four years there has been a drift towards more sophisticated research on fish life-history strategies and tactics, as well as towards more systems orientated research. Considering the advancement of our knowledge of key species within the fishery this evolutionary change was to be expected. To be more specific, the current research effort is directed, a step at a time, towards understanding the complex environmental and biological driving forces of multi-species communities and the development of predictive multi-species models.

Presently our fisheries models are still largely dependent on, and restricted to, catch and effort data from the commercial fleet. We do not know the total extent of recreational ski-boating and very little about the landings, not only in terms of weight but also in terms of species composition, as well as size and sex composition. Considering that recreational fishing, in contrast to commercial linefishing, is geared more towards the larger fish, rather than bulk, it is of vital importance that size and catch composition data be available to the scientific community in an organised manner. These data are essential in order not to underestimate fishing mortality and thereby overestimating the status of any given stock. More sophisticated dynamic pool models, dependent on biological information such as growth parameters, mortality, sexual maturity etc., are now also being used to estimate acceptable levels of fishing mortality.

Bearing in mind that there are infinitely more recreational boats than commercial boats, albeit that their CPUE is not as high, their impact on the resource is nevertheless significant. We therefore cannot afford not to have detailed information from that sector if we really wish to conserve the resource. Perhaps the members of the recreational ski-boat fraternity would like to suggest how this can possibly be achieved with a minimum amount of outcry from the majority and unfortunately uninformed recreational ski-boat fishermen. Similarly we need to have information on the impact of inshore trawling on these resources.

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COMMERCIAL AND RECREATIONAL DATA ON THE NATIONAL MARINE LINEFISH SYSTEM

MR A J PENNEY, SEA FISHERIES RESEARCH INSTITUTE (SFRI)

Catch and effort data form the basis of many fish stock assessment techniques and are used to develop and support many fisheries management decisions. Changes in catch per unit effort (CPUE) often give the first detectable signs of changes in the stock or availability of linefish species and, in the absence of other more sophisticated assessment techniques such as acoustic surveys, must often be relied on to motivate limitation of catches or redirection of effort when stocks become over-fished. However, such data are not only used to limit catches. Their main use is to gather information concerning the distribution and movement of fish stocks and to monitor changes in their size and availability. They are also used to directly benefit fishermen by, for example, planning fishing facilities, scheduling harbour improvements or negotiating access rights for fishermen with past involvement in a fishery.

THE NATIONAL MARINE LINEFISH SYSTEM

Despite the obvious importance of catch and effort data, few historic data have been collected for the linefishery. Apart from occasional counts of boats and estimates of total catches, little was known about catch trends or effort increases until the recent development of recreational and commercial catch return systems. During the late 1970's and early 1980's the Sea Fisheries Research Institute (SFRI) began instituting compulsory harbour reports, dealer returns and commercial returns, while the Oceanographic Research Institute (ORI) in Natal developed voluntary competition returns and catch cards for recreational shore and boat anglers. Subsequent escalation of data collection made it clear that improved computer facilities would be required to administer these data sources and in 1983 the SFRI accepted the responsibility of developing and administering the National Marine Linefish System.

The National Marine Linefish System (NMLS) is a computerised data capture and analysis system, designed to store and summarise linefish catch and effort data from all sources. It incorporates both the compulsory commercial catch return systems introduced by the SFRI and the recreational competition returns and catch cards developed by the ORI. Analysis facilities cater for all needs, ranging from personalised feedback summaries for participating anglers to sophisticated scientific summaries for stock assessment purposes. Scientific summaries have already been used by various linefish researchers studying specific species and by resource managers involved in the development of the recent linefish management measures. Data on the system have also been used to motivate the development of a slipway at St Francis Bay, to plan harbour improvements at Struis Bay, to review options for alternate launching facilities at Yzerfontein, to assess commercial licence applications and to motivate a number of recreational shore, boat and spearfishing competitions.

Data Captured on the National Marine Linefish System

The NMLS was developed in early 1985 and capture of available data commence soon thereafter. Historic data are limited, however, consisting largely of competition returns from shore anglers and ski-boats in Natal, records of Natal Parks Board shore patrols, and fisheries harbour returns. To improve coverage of commercial catches, compulsory monthly returns were introduced for all registered boats in 1985 and these, together with the voluntary recreational catch cards developed in Natal, have become the main data input to the NMLS.

Combined recreational and commercial data returns reported over 66 000 fishing days in 1985 (shore-patrol data excluded), of which 45 000 were reported on commercial returns. The recreational data emanated almost entirely from the well-established catch-card systems in Natal and this has continued to be the case. The amount of recreational data received has only varied slightly, reporting approximately 25 000 days fished annually. In contrast, improved administration and enforcement of the monthly commercial return system has resulted in a steady increase in commercial data, with over 90 000 commercial fishing days being reported in 1987 (Fig 1).

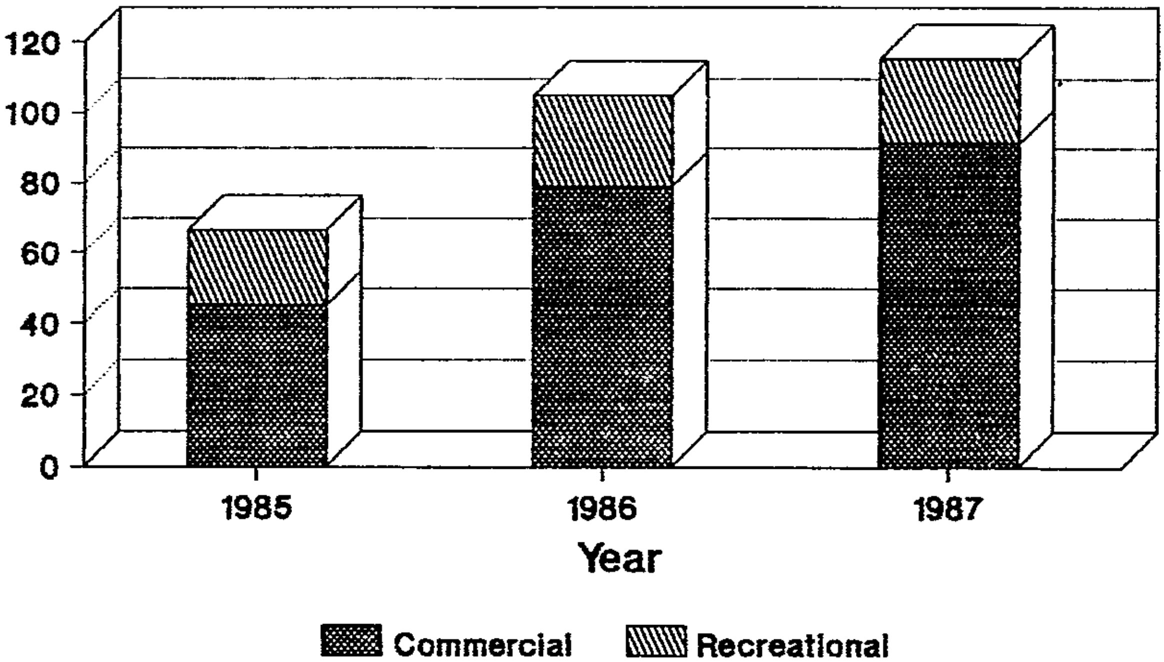

FIG 1: TOTAL NUMBER OF COMMERCIAL AND RECREATIONAL DATA RECORDS (THOUSANDS OF MAN DAYS FISHED) CAPTURED ON THE NATIONAL MARINE LINEFISH SYSTEM SINCE ITS INCEPTION IN 1985

Commercial and Recreational Data Types

Commercial data currently make up 75% of the NMLS database. The majority of these data are compulsory monthly returns from registered boats, but harbour returns are also received from fisheries harbours. These are an important data source, particularly on the West Coast where they occasionally provide better coverage than commercial returns. In certain South and East Coast areas, linefish dealers also provide information on purchases, particularly during runs of species such as yellowtail, kob or geelbek.

As a result of the number of different angling facets, recreational returns are more varied. Ski-boat cards are the most important recreational data source (see Fig 2), providing more data than light-tackle boat cards and shore-angling cards combined. Spearfishing is the smallest angling facet and spearfishing cards were only recently introduced, so few returns have yet been received from this facet.

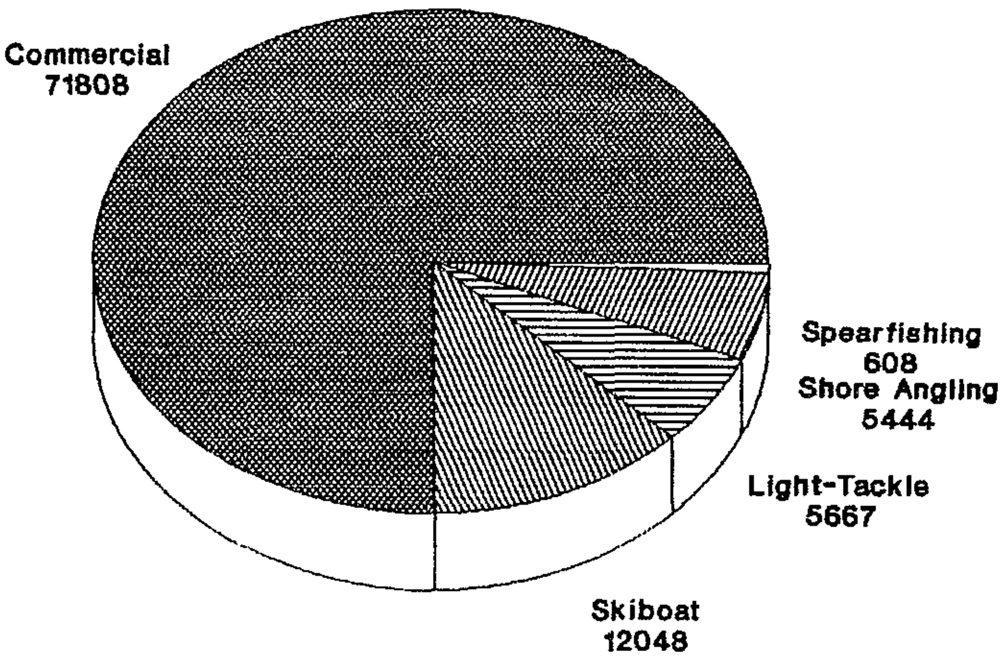

FIG 2: AVERAGE ANNUAL CONTRIBUTION OF DATA (DAYS FISHED) TO THE NATIONAL MARINE LINEFISH SYSTEM BY VARIOUS COMMERCIAL AND RECREATIONAL DATA SOURCES (SHORE PATROL DATA NOT SHOWN)

Coastal Coverage by Commercial and Recreational Data

Many of our linefish species are caught by both commercial and recreational anglers along much of our coast. A number of the more important species are also highly migratory and their distribution patterns and population dynamics can only be understood if representative catch data are available for their full ranges. Adequate data coverage is even more important to ensure that management decisions take account of catch patterns or requirements of recreational and commercial fishermen in different areas. Commercial data coverage is comparable for all coastal areas and is proportional to the amount of effort expended in each area (Fig 3). As expected, most data are received from the West and Southwest Cape where linefishery concentrates on the larger shoaling species such as snoek, yellowtail, kob and geelbek. However, registered boats in all areas provide similar data and commercial returns currently cover over 80% of commercial catches.

In comparison, there is a marked discrepancy between the amount of recreational data obtained from the various areas (Fig 4). 96% of all recreational catch cards and competition returns received emanate from Natal, with only a few competition returns being submitted from clubs in the Cape. Despite the fact that a higher proportion of part-time fishermen are registered in the Cape, there is no doubt that recreational fishing effort distribution reflects that of the commercial linefish fleet. There is therefore a high recreational fishing effort in the Cape for which no data are received, and which cannot be adequately catered for during the development of management measures.

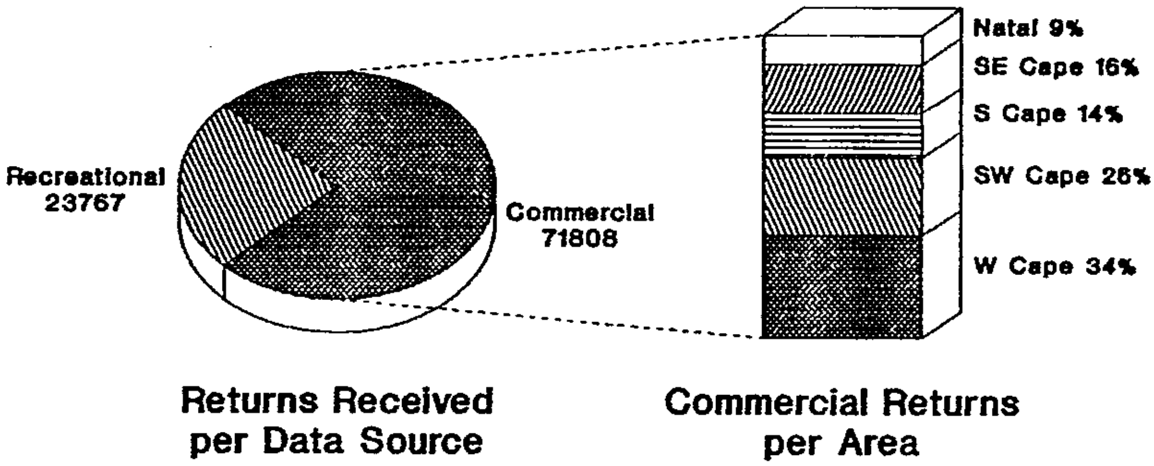

FIG 3: PERCENTAGE CONTRIBUTION OF COMPULSORY COMMERCIAL CATCH RETURNS (DAYS FISHED) FROM THE MAJOR COASTAL AREAS

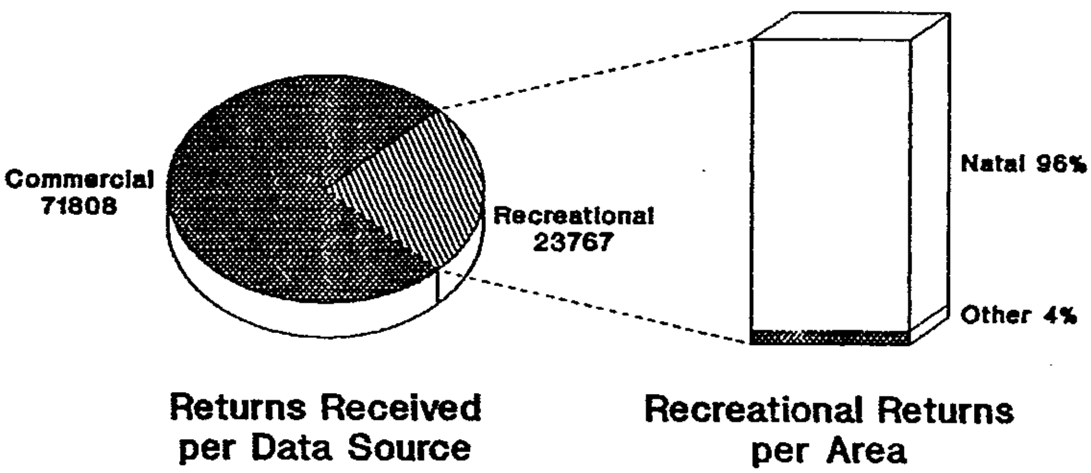

FIG 4: PERCENTAGE CONTRIBUTION OF VOLUNTARY RECREATIONAL CATCH RETURNS (DAYS FISHED) FROM THE MAJOR COASTAL AREAS

Future Data Requirements

Catches of many linefish species have declined and a number of species are in need of protection. Both the commercial and recreational fishing communities are also increasingly demanding better management of their specific interests in the linefishery. Effective long-term management measures are needed to resolve these problems but, if they are to be successful and acceptable to fishermen, they will have to be based on adequate data. These data will not only have to represent all the important linefish species and fishing areas, but also both the recreational and commercial sectors if management plans are to cater for their different aspirations.

Commercial linefish catches are currently well covered by compulsory monthly returns and a system of boat inspection cards is shortly to be introduced to the inspectorate to ensure that data quality continues to improve. Our most important future data requirement is therefore the improvement in collection of recreational catch returns, particularly from the Cape. Recreational catch cards were developed and introduced by the ORI in Natal, so it is to be expected that most of the recreational data emanates from that province. Although they both report the same sort of information, recreational returns also differ from commercial returns in being voluntary, so it is therefore perhaps to be expected that fewer recreational returns should be received. However, if recreational fisherman have a genuine interest in their future in the linefishery, then they have a responsibility to provide the catch and effort data so vitally necessary to understanding their role and requirements.

MARINE FISH TAGGING IN SOUTH AFRICA

MR R P v d ELST & MISS E BULLEN, OCEANOGRAPHIC RESEARCH INSTITUTE

INTRODUCTION

Despite the considerable advances made in fisheries science in recent years, it remains an imprecise science dependent primarily on indirect methods of estimating and predicting fish abundance. While these methods often involve the use of many parameters in complicated mathematical models, their accuracy should be validated by as many other techniques as possible. One such technique is the mark and recapture of fish, a research method that has proved valuable in numerous studies. There are at least four major parameters that can be investigated through the tagging of fish:

- The documentation of migration routes. There can be little more direct proof of migration than the recapture of a fish that was tagged at some distant locality.

- Stock identity can be determined from analysis of migration patterns and is fundamental to successful fisheries management.

- Confirmation of growth rates. While the age and growth of fishes is best determined by analysis of patterns in their bony structures, the recapture of tagged fish that have been free for a long time provides valuable confirmation of such results.

- The mortality rates of fish, both natural and man induced, can often be successfully determined through tagging studies. Clearly tagging holds great potential for fisheries research and management.

History of tagging in South Africa

South African researchers have long made use of tagging as a valued fisheries technique. The first documented large scale tagging took place in 1934 when Sea Fisheries Research Institute (SFRI) staff tagged and released 3755 snoek *Thyrsites atun* along the Cape West Coast. This project successfully demonstrated there to be a single stock of snoek in the Benguela system, a fact that considerably enhanced the management of that resource. Decades later, in 1957, SFRI again tagged fish intensively, this time 141 000 pilchards *Sardinops ocellatus*, the results of which illustrate this all important species' West Coast migration routes. Sharks were the main tagging target in 1966, when ORI staff successfully unravelled the migrations and shoaling behaviour of potentially dangerous species. Similarly the 1980 tagging of 6 000 elf *Pomatomus saltatrix* by ORI documented migrations, stock identity and mortality rates to assist with the management of this important sport fish.

Numerous other, smaller projects have also come underway, many with excellent results.

Research and development

Although many positive tagging results can be reported, progress has not been without its problems. Many of these remain to be resolved and are briefly discussed.

The shedding of tags by fish presents a major problem. While great improvements have been made it remains worrying that in the case of some species the shedding rate can be as much as 50% per annum. In many cases this was attributed to the inferior quality tag being imported and since using the new Australian Hall-Tag this problem has been virtually elliminated. Nevertheless, tags do fall out and continuous research is underway to minimise this problem.

The shape of tag used can have an important impact on its successful application hence considerable development in this field has occurred (Fig 1). For example, it was shown by Davies and Joubert (1966) that an oblong disc tag, as used on their sharks, caused undue movement and hence damage to a swimming fish. Consequently, they designed perfectly round tags that did not vibrate in the water.

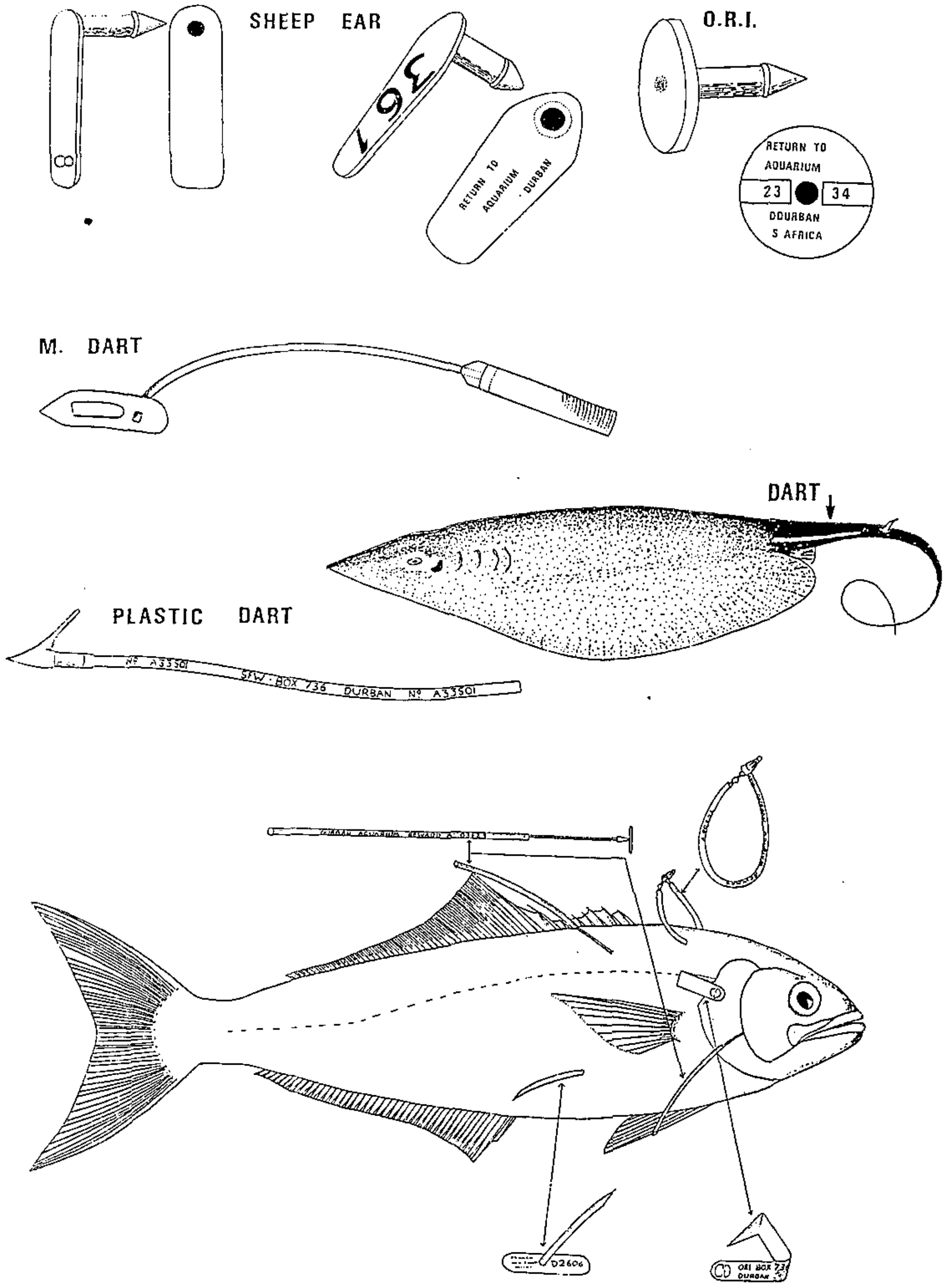

FIG 1: A SELECTION OF TAGS USED AND EVALUATED BY SOUTH AFRICAN FISH RESEARCHERS

A further problem that continues to beleaguer tagging programmes is the non-reporting of recaptured fish, a factor of importance if mortality estimates are to be made. Techniques have been developed to estimate this fraction, including the direct questioning of anglers at various venues from which it was deduced that as much as 20% of anglers fail to return their tags.

There have also more recently been successful attempts to develop new tagging techniques to meet specific local situations. In collaboration with the Natal Sharks Board an effective underwater tagging method has been developed which has already seen their divers tag some 150 large raggedtooth sharks *Eugomphodus taurus*, of which five have been recaptured. This technique is now also being applied to the tagging of whale sharks *Rhinchodon typus*, which appear off the Zululand coast each summer. Further development has seen the introduction of a suitable tagging technique for stingrays, which have hitherto seldom been tagged.

SFW-ORI Tagging project

While progress with fish tagging in South Africa is seen to have been reasonable, many factors have nevertheless limited its application, especially in the case of linefish. In 1985 it was decided that many of these could be overcome by instigating a cooperative and nationwide tagging programme that involved the fishermen themselves. This is indeed what occurred when the Stellenbosch Farmers' Wineries undertook to sponsor such a programme. By mid-1989 there were 2000 registered members who had tagged and released more than 30 000 fish. The success of this joint venture surpassed all expectations and the scientific information being generated has proved outstanding.

There are several reasons why angler involvement in tagging has proved so successful. If tagging results are to be relied on for scientific information it is necessary to tag a large number of fish of a particular species. In most cases there are simply not enough researchers to do the job, hence the assistance of thousands of anglers resolves the manpower shortage. It has also been shown that the involvement of anglers leads to a better understanding of the problems faced by both the angler and scientist. This in turn improves management of the resource for the ultimate benefit of fishermen. A further benefit that comes with tagging is the pure pleasure derived from participation, especially the recapture of fish tagged on distant shores. As recreational angling depends on more than simply maximising the catch it follows that tagging improves the angling experience and hence the quality of angling. Finally, the participation of anglers sees to the generation of much needed scientific information required to conserve the stocks. If this can be achieved it will be of obvious benefit to the future of angling.

Procedures laid down for the SFW-ORI tagging project ensure the widest participation possible. Once accepted as a *bona fide* member, the angler can select one or more of five different tagging systems, depending on his type of fishing. Thus there are tags available for various sizes of sharks, gamefish, marlin, small shore fish, stingrays and most other species. Computerised administration sees to it that members are informed of all their recaptures, while regular newsletters keep everyone up-to-date on latest progress. Members may request personal analyses of their own tagging efforts and for certain targets reached certificates and badges are issued to attest to the anglers' contribution. The most important procedure is the dissemination of scientific data. This is made possible by the compilation of scientific data reports which report on the results of specific species. Such reports are made available to the researchers on request and have already provided valuable input into many projects around the country. While most tagging is undertaken by recreational anglers, there are increasing numbers of commercial participants. Furthermore, records show that these fishermen play a most important role in returning tags.

Progress in the SFW-ORI project has been excellent as revealed in regular newsletters (v d Elst & Bullen, 1989) and scientific papers (v d Elst 1988). Application forms and newsletters are available on request.

Several facts of relevance to anglers arise. The first is that most tagging is done by anglers not affiliated to the SAAU and the second is the wide but uneven distribution of tagging effort along the coast (Table 1). Of further note is the overall poor contribution made by ski-boat anglers. With one or two notable exceptions most tagging still takes place from the shore, despite the fact that ski-boaters land considerably more fish. It seems appropriate therefore to appeal to organised angling to further promote tagging amongst their members. In particular the SADSAA is well poised to make a significant contribution.

Table 1: A breakdown of the tagging effort expressed as a percentage of the total for each of the SAAU coastal provinces

PROJECT OVERVIEW

	1984	1985	1986	1987	1988	Overall
New members	425	500	403	376	204	1908
Fish tagged	1413	4639	7087	8643	8685	30516
Species tagged	103	156	175	185	186	236
Fish recaptured	63	201	242	246	217	969
% recaptured	4.46	4.33	3.41	2.85	2.50	3.18
Max. time free (yrs)	4.09	3.55	2.89	1.75	0.99	4.09
Av. time free (days)	296	191	177	136	64	152
Max. km travelled	821	1110	2078	1478	1778	2078
Av. km travelled	147	46	94	61	57	71

REGIONAL TAGGING EFFORT

			Percentage of total			
	1984	1985	1986	1987	1988	Overall
Zululand	14	18	13	15	15	15
Natal	23	14	13	11	8	12
Transkei	2	8	15	18	7	12
Border	5	10	11	14	4	9
Eastern Cape	6	14	17	14	13	14
Southern Cape	5	6	4	2	2	3
Western Cape	36	16	14	13	39	22
SWA/Namibia	11	14	13	15	13	13

CONCLUSION

The need for a healthy marine recreational fishery has been identified on numerous occasions during this symposium. Indeed of equal or greater importance is the need to accommodate the aspirations of future generations of anglers. It has been shown, despite the many negative trends revealed, that there is also cause for optimism. Improved research and innovative new techniques hold promise for the future. However it is equally apparent that these are dependent on wider support than has hitherto been provided by a handful of linefish researchers. Few other methods make this more possible than the cooperative SFW-ORI tagging project which has the added bonus of enhancing the angling experience and involving anglers in assuring their own future.

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THE EFFECTS OF HOOK SIZE ON AGE-SPECIFIC SELECTIVITY AND ITS CONSEQUENCES FOR MANAGEMENT

MR B A BENNETT, DEPARTMENT OF ZOOLOGY & MR A E PUNT, DEPARTMENT OF APPLIED MATHEMATICS, UNIVERSITY OF CAPE TOWN

INTRODUCTION

It is common knowledge amongst fishermen that there is a relationship between the size of hooks used and the sizes and species composition of the resulting catches, i.e. small hooks catch small fish and *vice versa*. Knowledge of this relationship may be of practical importance for the management of linefish. For example, calculations of mortality and yield under different management regimes involve making an assumption that the size (=age) composition of samples of the resource reflect the natural population. If the hooks used to obtain the samples are selective in a manner not consistent with the sampling scheme underlying the algorithms used to obtain yields and mortalities, then these algorithms are invalid and predictions may be substantially biased. Another reason for investigating hook size selectively is that the minimum size of fish caught may be controlled by regulating the hook sizes used. The need to restrict catches of some species is widely accepted and bag limits and minimum size regulations have been implemented. Such restrictions, however, are not ideal in practice because of mortalities induced by barotrauma and the practice of discarding dead fish only after the bag limit has been filled. It would obviously be preferable if the minimum size could be increased and the bag decreased by a method whereby unwanted fish were not caught and killed. It is possible that minimum sizes of hooks may achieve this.

In order to examine hook selectivity effects, a large number of fish of 28 species were collected using six different sizes of hooks (#10 to 10/0). The findings presented in this paper concern only Hottentot *Pachymetopon blochii* from the Robben Island Reserve. This species was chosen because the large sample size obtained best illustrates the hook selectivity effects, and because modelling is not complicated by the effects of exploitation.

METHODS

Fishing

Four different sizes of Mustad 92247 hooks (#10, #4, 1/0 and 4/0) were used. They were fished on hand lines, two hooks of the same size per line on traces of approximately equal length, below fixed weights. The size range of hooks were fished simultaneously by eight or 12 fishermen, each using one line. Lines were rotated between fishermen at 1/2 hour intervals to reduce the effects of skill. The same bait was used on all hooks throughout the sampling period. Fish caught on each line were placed in separate marked containers for later counting and measurement of total length.

Modelling

The relationship between the hook size used and the resulting numbers and lengths of the catch was assumed to be the product of two independent effects:

- the relative abundance of the various age (=length) classes in the population and

- the selectivity of the hook used as a function of fish length.

The effects of fishing mortality and emigration are assumed to be insubstantial and, therefore, the relative abundance of the various age classes in the population is only affected by natural mortality (M) (Fig 1). The relative abundance (N) of fish of a particular age class (a) can therefore be represented by:

$$N(a) = e^{-Ma} \quad (1)$$

Of the three alternative models for the selectivity of a hook as a function of fish length that have been investigated, the model which provided the best fit is the one in which selectivity rises to a maximum and then decreases to zero (Fig 2). This is modelled by:

$$S_{(h,\ell)} = e^{-(\ell-\ell_h)^2/(2\sigma_h^2)} \quad (2)$$

where $S(h,\ell)$ is the selectivity of hook h for a fish of length ℓ,
ℓ_h is he length corresponding to the maximum selectivity of hook h, and
σ_h measures the "width" of the selectivity curve for hook h.

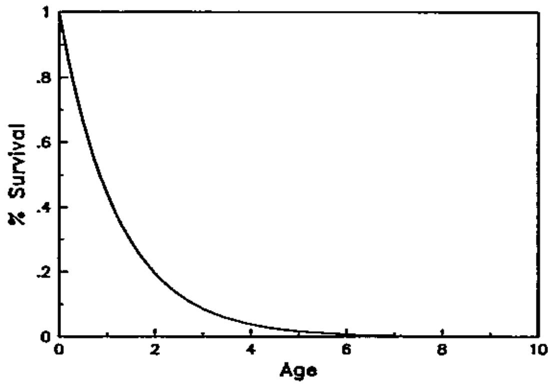

FIG 1: RELATIVE ABUNDANCE AS A FUNCTION OF AGE

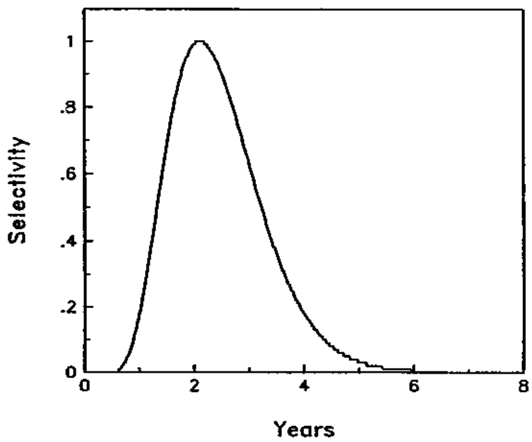

FIG 2: THE SELECTIVITY FUNCTION WHICH CORRESPONDS TO THE BEST FIT TO THE DATA

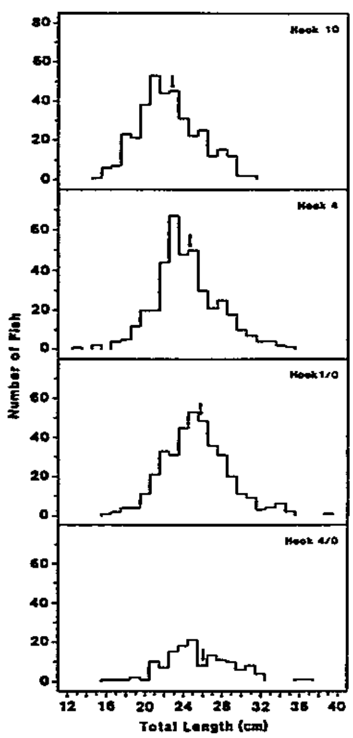

FIG 3: THE COMPOSITION OF HOTTENTOT CATCHES ON FOUR DIFFERENT SIZES OF HOOKS. ARROWS INDICATE MEANS

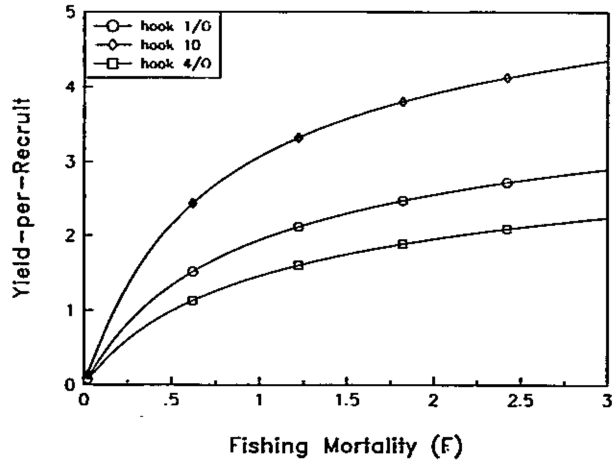

FIG 4: YIELD-PER-RECRUIT VERSUS FISHING MORTALITY CURVES FOR THREE TYPICAL HOOK SIZES

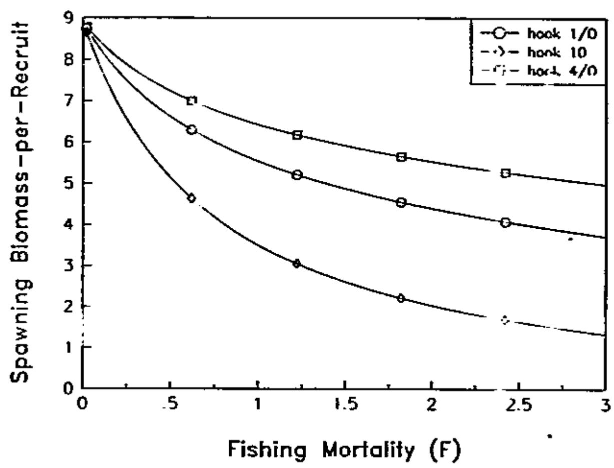

FIG 5: SPAWNING BIOMASS-PER-RECRUIT VERSUS FISHING MORTALITY CURVES FOR THREE TYPICAL HOOK SIZES

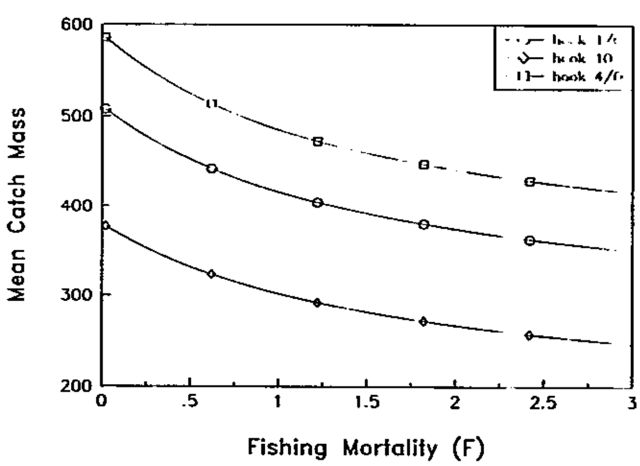

FIG 6: MEAN FISH MASS VERSUS FISHING MORTALITY CURVES FOR THREE TYPICAL HOOK SIZES

RESULTS AND DISCUSSION

A total of 1270 Hottentot were caught on the four hook sizes used in this study. The number and size composition of the fish caught on each hook are shown in Fig 3. It would seem from this Figure that the average size of fish caught increases with increasing hook size, and that the smallest and largest hooks caught fewer fish than the two intermediate sized (#4 and 1/0). These observations are confirmed by the modelling study, because the ℓh estimates differ significantly ($F=39.141$, $df=2.53$, $P < 0.01$) and because the predicted catch numbers are larger than the observed number for the smallest and largest hooks and vice versa for two intermediate hook sizes.

In order to compare the effects of the different hooks used in the fishery, the responses of yield-per-recruit, spawning biomass-per-recruit and mean mass to fishing mortality are shown in Figures 4 to 6. Yield-per-recruit is a measure of the total yield of the Hottentot stock, and spawning biomass-per-recruit a measure of the biomass of fish larger than the age at 50% maturity (five years for Hottentot). Consideration of Figures 4 and 5 show that the use of the larger hooks will result in similar yields which, although lower than those obtained on the smaller hook, will result in the maintenance of a much larger spawning biomasses which will help to guarantee future recruitment success. The use of larger hooks will also ensure that the average mass of the fish caught will be substantially larger (Fig 6).

The above analysis shows that, in a single species situation, it may be possible to select a minimum size of hook that will ensure the maintenance of a viable spawning biomass and a reasonable mean size without significantly reducing yields. There are, however, serious practical difficulties if hook size control is to be considered as a general management tool. The main reason for this is that the Hottentot linefishery is primarily a multispecies one and the implementation of almost any minimum hook size would result in the capture of unacceptable numbers of small fish of large species and, at the same time, markedly reduce yields of small species. A further, probably insurmountable, difficulty is that the ease with which illegal hooks could be concealed would render any law concerning minimum hook sizes almost unenforceable.

ARTIFICIAL REEFS AND FADS

MR P A GARRATT & MR R P v d ELST, OCEANOGRAPHIC RESEARCH INSTITUTE, (ORI)

INTRODUCTION

The linefish resource is now known to be severely limited and conventional management strategies may not be adequate to ensure that all future demands are satisfied. Consequently, new technology must be developed to derive the maximum possible benefits from the resource. Artificial reefs and fish aggregating devices (FADs) are two of such developments. Both have been shown to have beneficial effects for fishermen in that they make fish more accessible to the angler while probably also improving the habitat for certain fish species.

Artificial reefs are man-made or natural structures, intentionally placed in selected areas of marine or estuarine environments to provide or improve fish habitat (Stone, 1985). Their value in fisheries enhancement and improved fishing success is widely recognised - with more than artificial reefs now in place worldwide and many states and governments formally adopting a policy of artificial reef development - especially in California. (Lewis & McKee, 1989).

FADs on the other hand do not promote the establishment of communities but serve purely to attract pelagic fish to their general vicinity. They are thus a means of concentrating fish that would otherwise be widely distributed and hence inaccessible. Theoretically this could lead to over-exploitation of such fish and this has led to some concern amongst a number of anglers and scientists about their continued use. There is no doubt, however, that if they are deployed for a specific purpose such as attracting bait fish for marlin fishermen, they can provide easy access to such fish. This may be important in areas in which bait fish are scarce, especially if the FAD can be placed close to the launching site. Obviously their use should be carefully considered before they are deployed.

Artificial reefs

Sand covers the largest portion of the continental shelves of many countries and it has been estimated that no more than 10% of the ocean floor around the USA is covered by reefs. It is doubtful whether South Africa has any more than this. Reefs are inherently more productive than sandy substrata and they supply food, shelter, spawning sites and nursery habitats for most of our common linefish. However, as the extent of reef is limited, so too will be the associated ichthyofauna. It follows then that artificially expanding reefs, especially in regions naturally devoid of them, could enhance local fisheries. This fact is increasingly appreciated with worldwide attention being given to artificial reef construction as a means of improving catches. Properly constructed and sited they can provide easily accessible fishing grounds which benefit not only the anglers in particular areas, but also the economies of proximal shore communities (D'itri, 1986).

Their design should permit the establishment of entire ecologically balanced habitats around which whole communities can develop. Ideally such reefs should enhance the overall productivity in an area, especially where no other reefs exist. It may be possible to construct the reef in such a way as to benefit certain groups of fishes. For instance the creation of specific juvenile nursery habitats that may have been destroyed elsewhere has great potential of success.

The design and material composition of artificial reefs has many possibilities as seen in USA experiments. Initially anglers merely dumped various items to the ocean floor where they wanted to create reefs, but it was soon found that most materials were not suitable. These structures did not attract the numbers of fish expected and many soon broke up leaving no more than a pile of rubble. Obviously man-made reefs had to meet certain requirements before they could function properly. Marine scientists were called in to conduct surveys on various reef types and configurations and, after several years, they concluded that the siting (including configuration on the ocean floor), and profiles of such reefs were critical to the amount of benefit anglers could expect to gain from them. Well planned reefs improved fishing success dramatically.

Much research has already been conducted on artificial reefs worldwide and South African anglers are in the fortunate position of being able to draw on experiences elsewhere. An important consideration is cost. Projects such as these are expensive and a great deal of heavy machinery may be required to install suitable structures hence costs must be weighed up against the possible benefits that may accrue.

Fish aggregating devices (FADs)

Fishermen throughout the world have for many years been aware of the association of fish with floating objects and, in the coastal waters of the Philippines and Japan, the use of FADs began before World War 2. Initially bamboo rafts were moored in sheltered waters, but activities were later expanded into open waters. This required better construction and mooring and today there are probably as many designs as there are rafts in the Pacific and Indian oceans. Presently there are about 1 000 FADs deployed in these oceans. In South Africa the ORI has had several years of first hand experience in mooring various objects along our high energy coastline. Not only have we developed a suitable system for our waters (Fig 1), we have also determined it's life expectancy. Three FADs have been deployed off Sodwana Bay in recent years and anglers are adamant that the third (which was positioned in the most suitable area) worked very well indeed, concentrating much needed baitfish. As this cut down the time spent searching for these fish considerably, it was welcomed by all who made use of it.

Today FADs are known as a proven technique for attracting and holding migratory fish and hence increasing their harvests (Samples, 1986). In many instances fishing success in their vicinity has been dramatic. In South Carolina it has been shown that catch per unit effort (CPUE) is 80% higher around FADs than in open ocean areas, and scientists are claiming that FADs have contributed more to increasing pelagic catches in tropical seas than any other technological advance in the last ten years. It has been calculated that within three - five weeks of deployment the biomass of predators in the vicinity of a FAD may range up to 100 tonnes!

Through tagging it has also been shown that predators rapidly remove prey from around FADs and then move away, sometimes up to 25km, only to return at regular intervals. Apparently this behaviour indicates use of the FAD as a reference point in the otherwise featureless open ocean they inhabit.

CONCLUSIONS

There is no doubt that artificial reefs and FADs that have been well planned and deployed, can enhance fishing success and possibly improve fisheries productivity. Sufficient research has been conducted to indicate best designs though much local testing will be necessary before implementation in South Africa. The technology and the knowhow is available. It is up to the South African fishermen to decide whether or not they want to make use of such systems and hence offer their support.

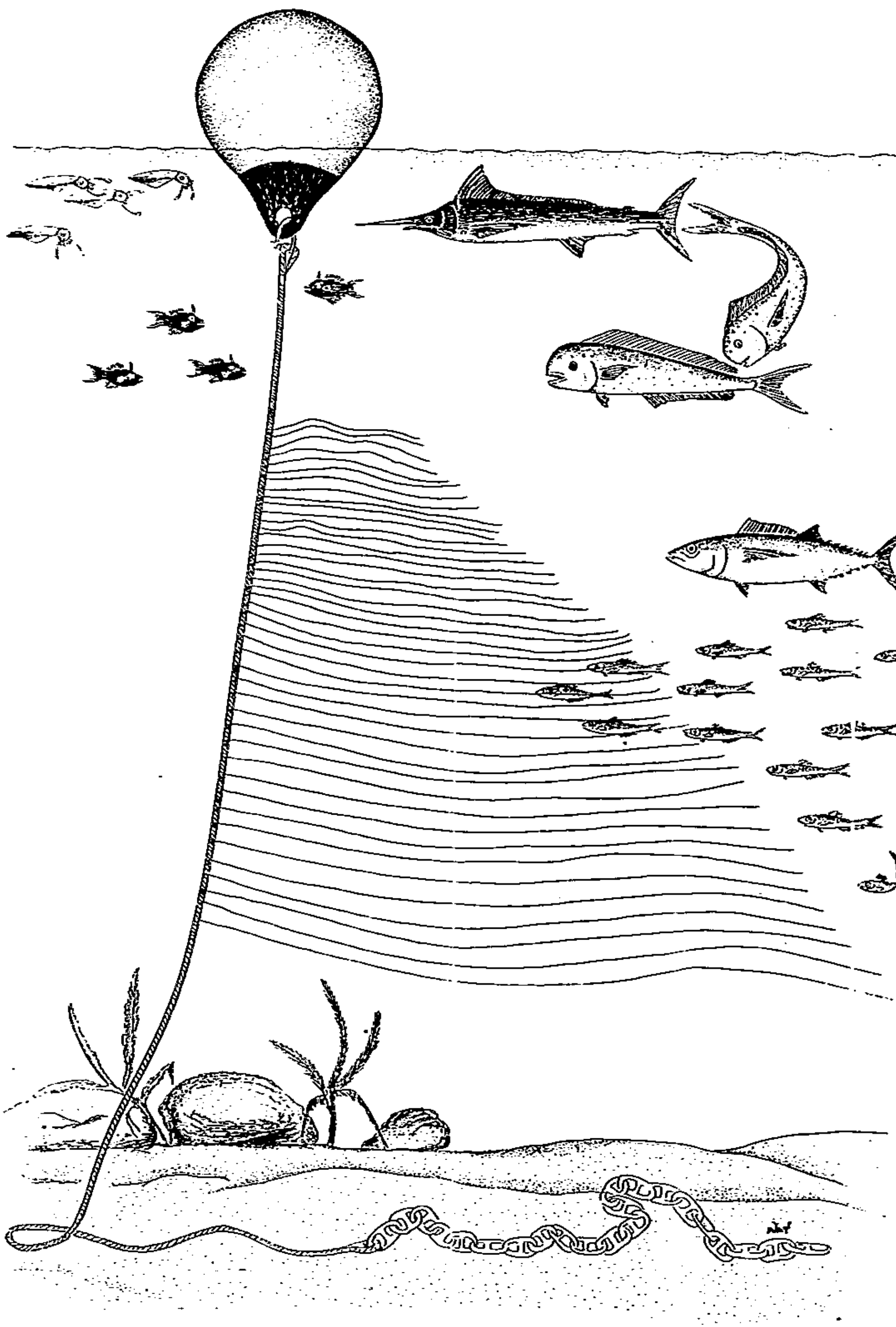

FIG 1: DESIGN OF FAD SUCCESSFULLY DEPLOYED OFF SODWANA BAY. STREAMERS ARE UP TO 10 M LONG AND CONSIST OF BLACK PLASTIC BINDING MATERIAL

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IS RESEEDING A VIABLE LINEFISH MANAGEMENT OPTION?

PROF T HECHT, DEPARTMENT OF ICHTHYOLOGY AND FISHERIES SCIENCE, RHODES UNIVERSITY

INTRODUCTION

Several papers have been presented at this Symposium sketching the present status of various linefish stocks, or fisheries as a whole. Common to all regions discussed (Natal & Transkei, eastern Cape and the southern & western Cape) was a declining trend in catch per unit of effort associated with a change in the species composition over time.

This obviously raises the question whether these negative trends can be reversed, perhaps through the option of the reseeding of selected species in the light of modern advances in aquaculture methods.

In the freshwater sport fishery, locally and abroad, the reseeding of rivers and/or lakes has been successful and contribute significantly towards satisfying the needs of anglers. In general terms such fisheries are known as "put and take" fisheries. In South Africa such fisheries are, in the higher altitude regions of the country concerned with the stocking of suitable streams and lakes with rainbow trout and in the warmer regions with carp, black bass and tilapia.

In terms of reseeding the marine environment with selected angling species, special thought needs to be given to the life histories of the fish involved, predator-prey interrelationships on reefs and the factors controlling reef fish population densities. For example, consider some of the important angling sparids. Recent studies by Buxton (1987, 1989) and Buxton & Clarke (1989) have shown that these fishes are extremely long lived with a slow rate of growth and often complicated reproductive styles. For example a black steenbras *Cymatoceps nasutus* of ca. 28 kg is in the region of 38 years old (Buxton & Clarke 1989). The dageraad *Chrysoblephus cristiceps* reaches a maximum age of 22 years with females reaching sexual maturity at ca. 365 mm FL, (seven years) and sex reversal to males taking place at ca. 400 mm FL (ten years) (Buxton 1989).

Consideration must also be given to those factors that control reef fish populations. Shulman & Ogden (1987) point out that juvenile mortality is likely to have a stronger influence on adult population sizes than the proportionately equivalent changes in the rate of recruitment.

In view of the relatively high capital and production costs of growing reef fish under culture conditions to an appropriate size for reseeding, as well as the numbers required, in conjunction with the factors mentioned above it would seem unrealistic to consider the culture of sparid species for such purposes. I would predict that the ultimate recruitment rate of such fish to the recreational or commercial line-fishery would simply be too low for reseeding to be a viable proposition.

This scenario can however be viewed from a different perspective. Given the high price of sparid linefish on the South African fish markets (between R9 and R12 per kilo) it would be quite feasible to culture sparids to satisfy a portion of the market demand, thereby indirectly alleviating some of the pressure on natural stocks. Presently fish such as gilthead bream *Sparus aurata*, red seabream *Sparus major*, and Natal stumpnose *Rhabdosargus sarba* are cultured successfully and profitably in Israel, Japan and France. Of interest is the fact that these species were, at one stage, all highly prized linefish. However, when their levels of abundance became too low for viable fishing operations, attention turned towards their culture.

Table 1 is a list of those marine species which are currently cultured successfully. There are several close relatives of these species which occur in South African waters and there is no reason why they could not also be produced for the markets under intensive culture conditions. Some of these include *Acanthopagrus berda*, *Rhabdosargus sarba*, *Diplodus sargus*, *Lithognatus lithognatus*, *Epinephelus quaza*, *Argyrosomus hololepidotus*, and *Lethrinus nebulosus*.

The technology for the successful culture of several sparid species exists. To a large extent a South African interest in sparid farming would only require the transfer of technology and the subsequent modification and adaptation of this technology for our local species and environmental conditions.

The only marine species currently receiving attention from a culture point of view is the galjoen *Coracinus capensis*, (V d Lingen 1986) and the leervis or garrick *Lichia amia*.

The culture of certain gamefish for reseeding coastal waters however has a greater potential than the former group of fishes. The reason for the greater potential is simply as a consequence of their faster growth rate. Several species could be considered here, although first and foremost would undoubtedly be the leervis. Other species which could be considered are the dorado *Coryphaena hippurus,* yellowtail *Seriola lalandi* and several of the pompano species. Dorado are successfully grown under controlled conditions in Hawaii and the Caribbean and reach two kg in six months. The yellowtail *Seriola quinqueradiata* on the other hand is the most important marine fish cultured in Japan. At present 95% of all fish produced under marine culture conditions in Japan are yellowtail. The average growth rate is not as high as for dorado but the fish nevertheless reach two to three kg per year.

Given the growth rate of these species it would be feasible to produce six month to one year old fish for restocking purposes with a lesser probability of their being preyed upon by piscivorous predators than sparids after one year. Although exact information on the spawner biomass of leervis, for example, is presently not available it can be speculated that the supplementation of the stock with yearling fish would or could contribute towards sustaining spawner biomass. This has to be seen particularly in the light of the well defined migration of the leervis spawner stock, during which time they are highly vulnerable to fishing pressure.

I would conclude that in theory the culture of several species for reseeding purposes is certainly possible although the financial constraints against such a venture might be prohibitive. The first and most important question to be answered would be: Who would carry the financial responsibility and risk for the establishment and running of such facilities. On the other hand if the fish were cultured with the express purpose of satisfying a proportion of the market demand I do not foresee a financial problem for the simple reason that such a facility would be profitable.

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Table 1: Marine species which are cultured either on a commercial or experimental basis.

Family or Order	Common name	Scientific name
SPARIDAE	Red Seabream	*Sparus major*
SPARIDAE	Gilthead Seabream	*Sparus aurata*
SPARIDAE	Sheepshead	*Archosargus probatocephalus*
SPARIDAE	Blactail	*Diplodus vulgaris*
SPARIDAE	Pinky	*Pagellus acarne*
SPARIDAE	Yellowfin Bream	*Acanthopagrus latus*
SPARIDAE	Riverbream	*Acanthopagrus berda*
SPARIDAE	Yellowfin Bream	*Acanthopagrus bifasciatus*
SPARIDAE	Yellowfin Bream	*Acanthopagrus schlegeli*
SPARIDAE	Natal Stumpnose	*Sparus (Rhabdosargus) sarba*
SPARIDAE	Hybrid	*Sparus sarba / A. schlegeli*
SERRANIDAE	Greasy rockcod	*Epinephelus tauvina*
SERRANIDAE	Malabar rockcod	*Epinephelus malabaricus*
SERRANIDAE	Seabass	*Dicentrarchus labrax*
CARANGIDAE	Yellowtail	*Seriola quinqueradiata*
CARANGIDAE	Pompano	*Trachinotus sp.*
CORYPHAENIDAE	Dorado	*Coryphaena hippurus*
GADIDAE	Cod	*Gadus morhua*
PLEURONECTIFORMES	Turbot	*Cophthalmus maximus*
	Flounder	*Paralichthys olivaceum*
	Halibut	*Hippoglossus hippoglossus*
LETHRINIDAE	Emperor	*Lethrinus nebulosus*
OPLEGNATHIDAE	Kukubass	*Oplegnathus fasciatus*
SIGANIDAE	Rabbitfish	*Siganus guttatus*
SIGANIDAE	Rabbitfish	*Siganus rivulatus*
SCIAENIDAE	Red Drum	*Sciaenops ocellatus*
CHANIDAE	Milkfish	*Chanos chanos*
TETRAODONTIDAE	Puffer	*Fugu rubripes*
SCOMBRIDAE	Yellowfin Tuna	*Thunnus albacares*
CORACINIDAE	Galjoen	*Coracinus capensis*
MUGILIDAE	Mullet	*Mugil cephalus*

MARINE RESERVES - PROSPECTS FOR THE FUTURE

DR C D BUXTON, DEPARTMENT OF ICHTHYOLOGY AND FISHERIES SCIENCE, RHODES UNIVERSITY

Proclamation of reserves in the marine environment has lagged considerably behind similar efforts in terrestrial ecosystems. Only recently has man entered the sea to appreciate not only its beauty but its limitations. There has long been the belief that the sea's resources were inexhaustible, making conservation unnecessary. This led to uncontrolled pollution and a rapid depletion of many fish stocks. But this situation has improved, in the ten years between 1974 and 1984 the number of marine reserves worldwide increased from a little under 200 to an estimated 1 200.

We may ask ourselves why this is so? Why the sudden interest in reserves? The answer lies in the interconnectedness of biological interactions and ecosystems on our planet. Early attempts at conservation were largely single species efforts of which there are a great many terrestrial and marine examples; whales, elephants, seals, rhinoceros to name a few. However, conservationists soon began to realise that species do not exist in isolation, they are cogs in a huge ecological machine. It is of little use protecting species if we do not look after their environment as well. For example, it is useless trying to conserve a forest bird if we remove the forest on which it depends.

Modern wildlife management therefore addresses the problem of preserving biological interaction instead of individual species because without these interactions a species cannot exist. The need to save as much biological diversity as possible has resulted in considerable effort to identify representative areas and to implement their preservation. In South Africa most conservation bodies, including the National Parks Board, have adopted the International Union of the Conservation of Nature and Natural Resources' definition of the term conservation as **"...the management of human use of the biosphere so that it may yield greatest sustained benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations."** The three primary objectives of this process as defined by the IUCN are:

- Maintenance of essential ecological processes and life-support systems (such as soil regeneration, recycling of nutrients), on which human survival and development depend.

- Maintenance of genetic diversity for the protection and improvement of cultivated plants and animals as well as scientific advance, technical innovation and the security of industry that relies on natural resources.

- Sustained utilisation of valuable species and ecosystems (notably fish, forests and grazing), which support millions of rural communities and major industries.

The third of the above objectives is of particular relevance to the use of marine reserves as an option for the maintenance of yield in a fishery. In this context the role of the reserve is to maintain a breeding stock sufficient to seed adjacent areas that have become incapable of doing so themselves as a result of the exploitation of adult fishes. Simultaneously, preservation of the entire community results in the maintenance of the interactive environment necessary for the preservation of the species.

Fundamental to the understanding of such processes is a thorough knowledge of the biology and ecology of individual species. This is necessary for us to be able to identify the critical habitats that our marine reserves are to encompass and parallels our research direction in the marine linefish community; first investigating the biology of individual species followed by hypotheses testing in which answers to specific questions are sought, for example, how big must reserves be? and do they seed adjacent areas?

THE TSITSIKAMMA COASTAL NATIONAL PARK AS AN EXAMPLE

For the past five years research on the life histories of Roman *Chrysoblephus laticeps* and dageraad *C. cristiceps* in the Tsitsikamma has been aimed as assessing the usefulness of the reserve in protecting these and other similar reef fish. The area has been closed to exploitation since 1965 so theoretically the populations found there were thought to be "normal". Results obtained from the park were compared with those obtained in exploited areas between Mossel Bay and East London.

This research has shown that these fishes change sex (from female to male), are long-lived (attaining ages in excess of 15-20 years with slow growth) and are sedentary (remain in the park for extended periods). I have elaborated on these characteristics elsewhere in this document (see section on reef fishes). Two other findings deserve special mention here.

Relative abundance

Visual underwater assessments of large reef fishes shows considerable differences between the fish in exploited and unexploited areas. A significant difference in the relative abundance of Roman and red steenbras was observed (Table 1).

Table 1: Comparison of overall mean density estimates of three sparid fishes in the Cape Recife (exploited) and Tsitsikamma (unexploited) areas

SPECIES	CAPE RECIFE ($fish.m^{-2}$)	cv	n	TSITSIKAMMA ($fish.m^{-2}$)	cv	n	U
C. laticeps	0.006 ± 0.007	1.09	38	0.025 ± 0.014	0.56	76	6.3 **
P. rupestris	0.001 ± 0.002	2.64	31	0.013 ± 0.013	1.02	63	6.4 *
C. cristiceps	0.003 ± 0.006	2.04	38	0.004 ± 0.006	1.66	54	0.4 ns

cv = coefficient of variation
** = P<0.01, * = P<0.05, ns = not significant

Although abundance of dageraad was similar in the two areas, we believe that this related more to their avoidance of divers than to their density. This was apparent in the line catches in each areas dageraad being very abundant in the catch even on days when few were seen underwater. In addition, both the range of sizes and mean size of the fish from the Park were larger than those in the exploitated area (Fig 1). Both effects were directly attributable to linefishing.

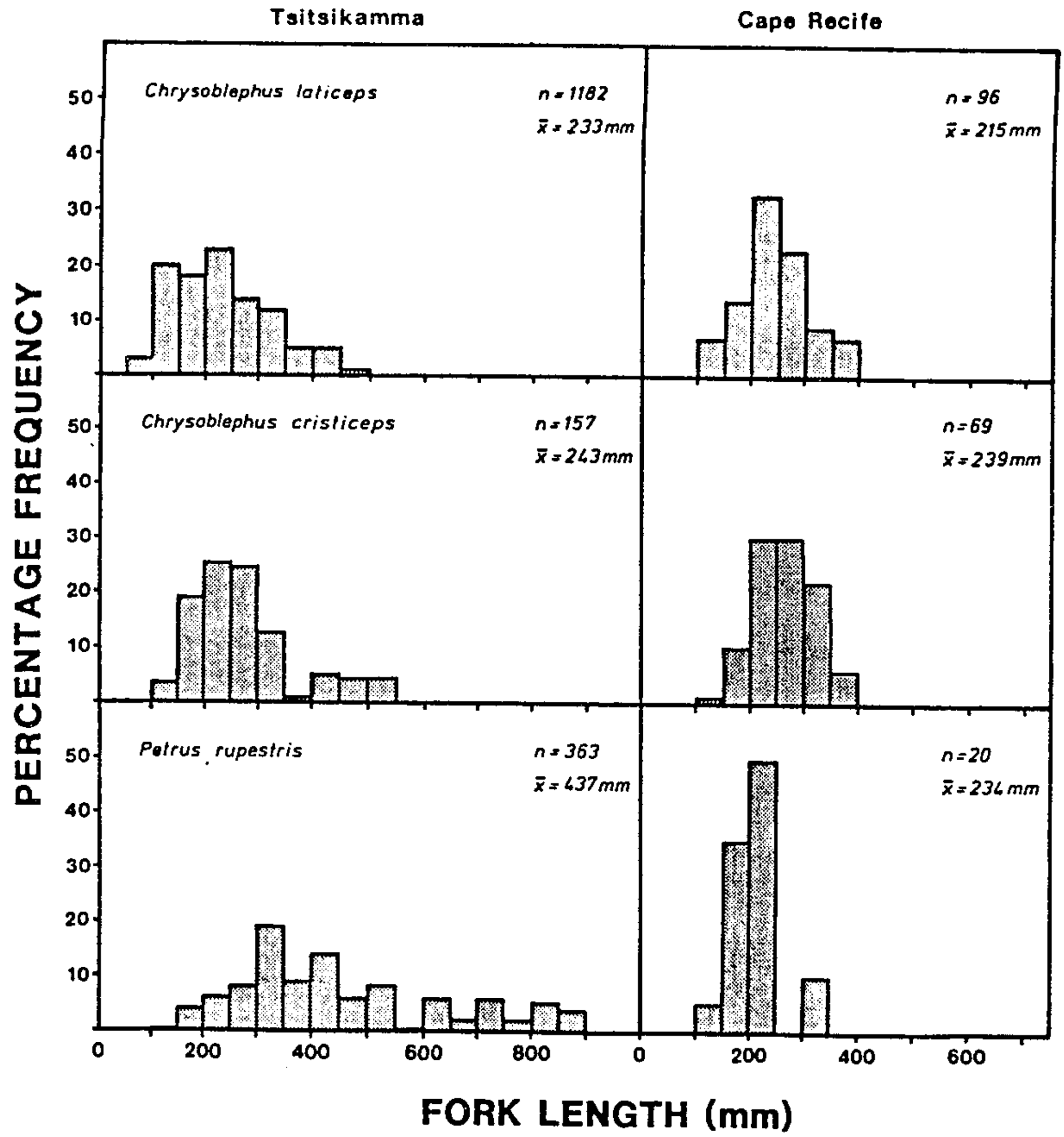

FIG 1: SIZE FREQUENCY DISTRIBUTIONS OF ROMAN *C. LATICEPS*, DAGERAAD *C. CRISTICEPS* AND RED STEENBRAS *PETRUS RUPESTRIS* VISUALLY ASSESSED IN THE TSITSIKAMMA (UNEXPLOITED) AND CAPE RECIFE (EXPLOITED) AREAS

Population structure

Comparison between a number of areas revealed a change in the mean size of fish caught, the size at maturity and the sex ratio, that correlated with the degree of exploitation of the fish (Table 2). In dageraad a similar investigation also showed a decrease in the size at sex reversal in the exploited areas. Reasons for these changes are beyond this discussion, suffice to say that such changes would be expected biological responses to increased mortality (in this case fishing mortality).

Table 2: Mean length and standard deviation of the catch composition and reproductive characteristics of Roman caught in exploited and unexploited areas on the southern Cape coast between 1980 and 1986. All lengths are fork length (mm)

	K&MB	JB	SB-StC	StC-WC	TSI
Total catch	277±48	280±51	305±47	322±46	317±44
Sampler number	340	113	933	453	997
Size at sex change	300-325	300-325	300-350	325-350	300-325
50% maturity	-	-	ca. 172		ca.180
Sex ratio (♂:⚥:♀)	1:-:2.78	1:0.75:3.9	1:0.16:2.01	1:0.07:1.04	1:0.36:0.83

K&MB - Mossel Bay to Knysna; JB - Jeffreys Bay; SB-StC - Sardinia Bay to St Croix Island; STC-WC - St Croix Island to Woody Cape; TSI - Tsitsikamma.

Together these differences between the exploited and unexploited populations show that fishing may have significant effects on the population and more importantly, that the park affords protection to the fish. In spite of these findings we are still in need of considerable research into the effect of reserves in the management of linefishes. Key questions still unanswered include; how big should the reserve be? and how well do the reserves seed adjacent areas through egg and larval transport and migrations?

Generally it is considered that a large reserve is better than a small one or many small ones, and that reserves should either be in close proximity to one another or connected by thin runways. These principles were developed using terrestrial examples and are designed to increase the genetic flow between small populations. However, issues such as close proximity and interconnectedness are perhaps irrelevant in the sea because the sea is a continuous habitat and communication between reserves will be assured. This also means that boundaries will be difficult to define in the sea and that influences such as pollution and sedimentation from rivers will be difficult to exclude from marine reserves.

In conclusion, research shows that for many of our reef fishes current legislation is unlikely to adequately protect the parent stock (large females and males) especially those that change sex, are long-lived and are sedentary. Two alternatives are possible:

- To increase the minimum size of the fish to a level at which protection is afforded both males and females (it is important to note that this would exclude most of the present catch).

- The alternative is to identify and proclaim as reserves areas large enough to protect the breeding populations of sedentary species. Minimum size levels can then be set suitable to particular needs, for example trophy size for recreational anglers and marketable size for commercial fishermen. This distinction is made because I believe that the time will come when it will be necessary to divide the resource into species that are able to sustain commercial levels of exploitation and those that will support the recreational fishery.

Once recruitment is assured through the protection of the parent stock, minimum sizes are only necessary to achieve a sustained yield of the desired size and bag limits will act as a quota system, spreading the catch equitably between the participants. Marine reserves have the added attraction that they embody the concepts of the IUCN, to preserve entire communities rather than individual species.

HISTORY AND BASIC PRINCIPLES OF LINEFISH MANAGEMENT IN SOUTH AFRICA AND ELSEWHERE

DR D E POLLOCK, SEA FISHERIES RESEARCH INSTITUTE (SFRI)

Any nation's marine resources are known as `common property', a term which implies that they belong to no single user group. The management of these resources has to be conducted in such a manner as to benefit the community as a whole.

These are lofty ideals indeed, but nowhere is it more clearly demonstrated in South Africa than in the linefishing industry, with its multi-disciplinary utilisation. In this fishery, to a far greater extent than in the other major fisheries (demersal trawling, pelagic and rock lobster), the need for consultation, compromise and consensus (the three C's) is essential amongst all user groups, which include shore and estuary anglers, recreational boaters, spearfishermen and commercial line- and netfishermen.

In this fishery, there has been and always will be, debate about the "proper" sharing of catches between commercials and recreationals, and as anyone who has served on multi-disciplinary linefish committees will know, consensus is not easily achieved. However, few would deny the need for conservation of natural resources, and the necessity to impose restrictions in the face of escalating fishing pressure, particularly from the increasingly affluent recreational sector (Kearney 1989). For restrictive measures to be effective (and not just good in theory), they have to be based on knowledge, as well as on common sense about the practicality of enforcement. Scientific research will provide knowledge, but a strong need also exists for experienced managers at State and Provincial level to ensure that recommended management measures are sound in practice, and enforceable.

The current legislation governing linefishing resulted from consultation with all user groups under the auspices of the recently disbanded

National Marine Linefishing Committee. Numerous meetings of this committee resulted in a series of compromises aimed at bringing about consensus on matters of vital importance to all sectors. The basic options available for management in this fishery (as well as in most other exploited resources) are as follows:

Restrictions on:

- Activities (e.g. zoning by area - includes concept of marine reserves).
- Number of participants (e.g. limited entry by licensing anglers or boats).
- Number of fish captures (e.g. bag limits or quotas).
- Type of equipment (e.g. no nets for recreationals, no dynamiting etc).
- Season of fishing (closed seasons).
- Size of fish (minimum size limits).

It is common knowledge that the current linefish legislation is not perfect, and parts will have to be refined and modified from time to time. It must be borne in mind, however, that whenever new legislation is formulated, a balance must be found between the costs of enforcement and the effectiveness of the new legislation. As far as the latter is concerned, the acronym "USE" summarises the most important considerations:

U	=	UNIFORMITY	(Fewer and more uniform laws cause less confusion).
S	=	SIMPLICITY	(who can remember complicated rules?).
E	=	ENFORCEABILITY	(if many infringements are known to be taking place, but few are convicted and fined, then something is wrong with the legislation or its enforcement).

A few words on the history of the linefishery are relevant here. About a hundred years ago, the Govenor of the Cape made provision for closed fishing seasons and fish size limits under the fish protection Act of 1893. At about that time, the first marine biologist appointed for the Cape, Dr John D. Gilchrist expressed his concern about the numbers of small, immature fish which were being caught, and soon thereafter a proclamation was issued which set a minimum size limit for silverfish at ten inches - very close to the 25 cm size limit applicable today! Snoek in Gilchrist's time also had a size limit of 24 inches - again not much different from the 60 cm size limit applied today.

During Gilchrist's term as marine biologist and Director of the Fisheries and Marine Biological Survey from 1896 until his death in 1926, he produced a series of reports which provide us with a unique and detailed insight into fisheries matters at the turn of the century. He saw to the employment of 15 fisheries officers located at major landing points along the Cape Coast, whose job it was to check on infringement of regulations, to collect catch statistics and to hear and report on problems of fisherfolk in various regions.

From reading the chronicled reports of these 15 early-day inspectors, it is interesting to see that one of their major complaints was that there was simply not enough supervision to ensure that fisheries regulations were complied with! Doesn't this ring a familiar bell today - a hundred years later?

It is informative to compare the historical development of linefisheries in South Africa with those from early days in Australia. The following quotation is from an article written by the Director of the New South Wales Fisheries Research Institute, Dr Robert Kearney (1989), entitled "Is Fisheries Management becoming harder?"

"Concern over declining fish resources in New South Wales had been expressed in the middle of the last century to the extent that a Fisheries Enquiry Commission concluded that the quantity of fish in certain bays and estuaries had fallen off enormously up to 1880. As a result of this concern over the state of our fisheries resources the Fisheries Act of 1881 and the subsequent Amendment in 1883 introduced restrictions on commercial fishing methods. The restrictions introduced at that time included minimum mesh size of nets, maximum length of net, minimum length of fish species, closed areas and closed seasons."

It is quite remarkable how similar were the problems developing at about the same time here as well as in Australia, and how similar the response was to these growing problems. To take the analogy further, let us examine some examples of current linefish legislation in Australia. In western Australia, these include a general bag limit for reef fish per angler of ten fish per day, additional bag limits on certain threatened species, and a list of minimum sizes not unlike our own in South Africa. Sizes range from 15 cm to 76 cm in western Australia compared with a list of minimum sizes ranging from 15 cm to 70 cm for linefish in South Africa.

The reason for the large degree of similarity in the legislation of South Africa and Australia is not because of duplicative behaviour, but is probably connected with the similarity of the *types* of fish involved, together with basic common sense on the part of scientists and fisheries advisers in both countries.

An interesting difference is evident in the way in which certain laws are applied in Australia. For example very heavy penalties are applied to prevent the sale of fish by recreationals. It appears that Australian commercial fishermen are very active in ensuring that the bread is not taken out of their mouths by sport fishermen, and they have a relatively strong lobby which makes itself heard at high level. In South Africa, a large body of so-called weekend-commercials (B licence-holders) exist, who are not *bona fide* commercial fishermen, but who are nonetheless entitled to sell their catches.

To sum up, it is difficult to escape the conclusion that, despite the well-meaning actions of authorities in the past, many linefish stocks have undoubtedly declined. Is it the type of legislation which has been inadequate, or the implementation thereof - or BOTH? The question remains: Can we stem the tide of consistent and gradual decline in linefish stocks as population and economic pressures continue to grow?

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THE ANGLERS' VIEW OF LINEFISH MANAGEMENT AND RESEARCH

MR G WINCH, S A DEEP SEA ANGLING ASSOCIATION (SADSAA)

PREAMBLE

The perceptions and opinions of linefish research and management vary across the four marine angling facets - deep sea, rock and surf, light tackle boat and underwater. However, there is a common thread that most anglers accept: "The fishing just isn't what it used to be." In apportioning the blame, they generally look outwards rather than inwards: "Who us? We could never fish them out!"

PARITY

The recreational angler's view of management measures is seriously jaundiced by the fact that he is the only resource user with a bag limit. He sees the main destroyers of the resource doing as they like while he "carries the can". Many see the resource as doomed by the activities of commercial fishing and some use this as an excuse to ignore the bag limits and grab their share while they can. This mistrust rubs off onto research and co-operation is grudgingly given provided no big effort is required. Nothing short of parity in bag limits, for commercials and recreationals, on the protected species will restore credibility to this management measure. Opinions were cavassed from all facets of the SAAU and presented here in summary.

PERCEIVED INEQUITIES

While bag limits on recreationals remain in force the following practices have been reported by SADSAA and other anglers from various regions:

Western Province:
- Beach seine netting of yellowtail, white steenbras, etc.
- Yellowtail purse netting (prohibited, but has it stopped?)
- Tuna : proliferation of poling boats; foreign longliners and foreign gillnetters.

Southern Cape:
- Chokka : proliferation of commercial licences;
- Chokka boats : impact on local fish when chokka fishing is poor;
- Closed season imposed on recreationals because of chokka closed season.
- Kob trawling.

Border and Transkei:
- Commercial linefishermen : impact on red steenbras and seventyfour;
- Continuing transfer and issue of commercial licences;
- Trawling of red steenbras : Kidds Beach, Christmasvale.

Natal:

- No bag limits on commercials;
- Commercials take undersize fish.

Inland Provinces:

- There is concern about the apparent exploitation within the St Lucia Marine Reserve at night while anglers are not permitted to fish for reef fish. It must be noted that recreational anglers are not against bag limits on vulnerable reef fish. However, there is a strong feeling that the main exploiters of this resource - the linefish commercials - must be subjected to equal limitations.

INADEQUATE POLICING :

There is frustration among the 80% of anglers who obey the management laws only to see the other 20% break the laws with impunity. There is just no one there to catch them! If we are going to manage the resource we will have to :

- increase the inspectorate
- increase the penalties

CLOSED SEASONS

- The total ban on reef fish in the southern Cape during November is most unpopular.
- Only exception - panga which is limited but is a trawl fish should be deregulated. (Curiously the panga is also limited, though it is extensively trawled and should therefore be de-regulated.)

SIZE LIMITS

- Regarded as being far too small.
- In the border area, the black steenbras *Cymatoceps nasutus* and the yellowbelly rockcod *Epinephelus guaza* are regarded as fish where the size limit could be doubled. Especially since they are usually caught in shallow water and do not suffer barotrauma, they can therefore easily be returned.
- Natal anglers have identified a need to increase the minimum size of Cuda *Scomberomorus commerson*.

MARINE RESERVES:

The general reaction to marine reserves amongst anglers is positive though several regions having specific grievances:

Border

- Peer pressure has made voluntary and proclaimed reserves sacrosanct
- Past problems with rubber ducks have been largely resolved.

Western Province
- Unhappiness over the opening of Millers Point Reserve to snoek fishing.
- Furore at Hermanus over the opening of Walker Bay to trawling.

Sodwana
- Transvaal's only access to reef fish being restricted.
- Incidental catches of bottom fish while `Cuda fishing is wasteful as dead fish are discarded.

SALE OF FISH

There is general consensus that the law against the sale of fish by amateurs can never be enforced and should therefore be scrapped. Consideration could perhaps be given to licence dealers.

TAG AND RELEASE

- While there is partial acceptance, some scepticism exists as to survival rate of tagged fish, especially among the Border rock and surf anglers.

- To extend the number of tag and release tournaments requires pressure from angling administrators.

EDUCATION

It is the author's view that education is the one important tool in resource management that has been under-utilised. We desperately need to get recreational anglers from all disciplines and commercials to understand what has happened to the fish and why, and how resource management can work. Some funds should be allocated to:

Posters
Posters covering - The biology of endangered and popular species
- Resource Management - how and why

(There are 52 clubhouses in SADSA alone, in addition they can be hung in libraries, schools, coastal hotel bars, private bars, etc.)

Presentations by Scientists
These could be done directly on TV shows such as 50/50 or by personal presentations to clubs backed by slides and video material.

Articles in the popular press
Most newspapers have an angling column and there are four angling magazines and other outdoor magazines.

Symposia
Symposia such as this one should be repeated to update and expand on the previous information.

PROBLEMS ASSOCIATED WITH THE IMPLEMENTATION OF LINEFISH MANAGEMENT MEASURES

MR M M BROKENSHA, INTERNATIONAL GAME FISH ASSOCIATION (IGFA) REPRESENTATIVE IN RSA

Historically, linefish management measures in the RSA can be traced to the 18th century and were first implemented in Natal in circa 1868.

In those days the regulations (which are really only the rules by which the game must be played) were based by the Governments of Natal and the Cape on empirical observation and it is interesting to see how many of the regulations in force in the Republic today are still the same as, or in line with, the original historic decisions.

At this stage it is not out of place to make the point that linefish management involves many aspects interdependent on each other - such as the food chain, ocean currents, seasons, pollution etc. One should therefore be cautious in considering linefish in isolation. For this reason the regulations in force in the Republic accommodate many of these aspects, although this adds to difficulties in implementation.

Until a few years ago different regulations were in force for the Cape, Natal and the off-shore sector, which is catered for by the Marine Branch of the Department of Environment Affairs. Managers recognised these difficulties and under the leadership of the then Minister of Fisheries, the late Mr John Wiley, who should go down in history as a man who contributed greatly to the management of the marine resources in the Republic, a start was made on tidying up these management measures.

A start was made to eliminate the confusion over size limits that had long existed, and with the guidance of researchers, a situation was reached where minimum sizes were standardised nationally. This in itself posed problems as Natal and researchers world-wide had long been using fork length while Cape legislation sought total length. Having resolved these problems, closed seasons were next considered so that one by one, all regulations were standardised as far as possible.

A complication existed (and still does) with the two independent states of Transkei and Ciskei that share linefish stocks with South Africa. Attempts were made to standardise regulations - but this met with only limited success, with the Ciskei adopting a number of management measures but Transkei having made no progress in this field at all. This has posed further problems with implementation. For example, it is well known that threatened red steenbras spawn off the Transkei coast and that strict conservation meansures are practised in the Republic. Despite great efforts and a number of meetings we have been unable to get the Transkei to cooperate - with obvious serious long-term implications.

Delays in promulgation of regulations always occur. This is a regrettable and serious situation because management <u>must</u> keep pace with changes to be effective. Speedy promulgation is therefore essential otherwise the impetus of the legislation is nullified. There is also too often a clash between commercial operators and sport fishermen - a world wide problem. In his editorial in the March, 1989, Saltwater Sportsman, Rip Cunningham observed "you see the commercial fishing industry doesn't believe that any fishery should have user access restricted to any individual group. Unless of course that group happens to be commercial fishermen".

Then of course we have the semi-commercials in this country who really believe that the sport should pay for itself - another major stumbling block with implementation. It is very difficult to catch people selling fish illegally, let alone prove it!

Shortages of research funds also present a problem for implementation of management measures. Research is an indespensible component of management decisions - it is no good closing the proverbial stable door when the horse has bolted.

Perhaps most important of all is the shortage of funds with which managers must contend! Already far too thin on the ground, relief for this beleaguered fraternity is not yet in sight. Whether it be in the Cape or Natal staff must be increased more than substantially, and they must have an infrastructure to support them. Men without vehicles and boats cannot implement management measures.

The ruling by the commission for Administration that ranging staff must have nature conservation diplomas also needs to be reviewed. Diplomas should be an incentive and not a big stick, and any organisation charged with implementation needs workers. Serious staff shortages have been caused by this requirement particularly because the diploma is overrated. Finally on the subject of staff, it is important to put trained and committed men into the field - there is no point in charging men with implementation if they know nothing about the marine resource, have no idea what they are talking about or lack interest in the matter.

A further problem of implementation concerns conflict between user groups which are becoming more and more apparent. A good example is Sodwana Bay where the growing conflict between scuba divers and anglers is obviously influencing management. Similarly the conflict between commercial and non commercials presents hurdles to effective management.

Difficulty in implementing the regulations on the sale of some pelagic species has recently prompted a proposal to reduce the bag limit on these species to two to curtail the sale of these fish.

Conservation authorities must remember that they have a mandate in respect of the conservation of the species and a failure to implement existing regulations cannot be rectified by introducing bag limits which are not based on conservation grounds, but on expediency. Removal of the right of people to utilise a renewable natural resource which is not in any danger of over exploitation is not acceptable. This type of action only results in total resentment on the part of people whose support is essential.

An example of this occurred some years ago when the Department of Health requested that the area between the South Pier in Durban and Isipingo be closed for the taking of crayfish, mussels and oysters as they were contaminated by pollutants. The Natal Parks Board refused the request on the grounds that their mandate was in respect of conservation. As this was no conservation issue it should have been dealt with by the State Health Department who were attempting to pass the buck - and escape the ensuing implementation problems!

Finally, but nevertheless most significantly, the penalties for breaking conservation laws in South Africa are hopelessly inadequate. In too many cases it simply pays people to contravene regulations.

REQUIREMENTS OF LINEFISH MANAGERS IN ORDER TO PLAN FUTURE STRATEGIES

MR E A FEARNHEAD, NATAL PARKS BOARD (NPB)

The histories of certain of South African line fisheries present a dismal picture. The prognoses for the future are equally dismal and are certain to be proved accurate unless the problems are timeously and correctly addressed.

The Natal Parks Board has a mandate which can be simply stated as being "the conservation of the biosphere". In other words the conservation of the environmental and recreational resources of the Natal coast to the benefit of all user groups, present and future.

Covered by this mandate is the management of the line fisheries of the Natal coast which includes the design and administration of management strategies. In order to meet this mandate the Natal Parks Board sees its main requirement as the clear identification and definition of those problems relating to the above resources on the Natal coast.

To attempt to do so the Board works in close collaboration with research bodies and with user groups. It has established formal and informal liaison committees in conjunction with the user groups concerned with the marine environment and with the Oceanographic Research Institute, CSIR, SFRI and several universities. At these meetings problems are identified and solutions sought. The complete cooperation of all parties at these meetings is an essential and integral part in the formulation of the management strategies for the Natal coast. Further it is essential that this cooperation extend beyond the meetings and into the field.

Certain problems can be solved relatively simply, but others require the investment of considerable time and effort in the form of research programmes. These programmes are designed for the collection of data and the role of the user groups has been invaluable and is to become increasingly important.

From the managers' point of view the prime requirement of these programmes is the determination of the status of the stocks of fishes, of bait organisms and of the vital nursery areas - the estuaries and sub-tidal zones. Further, the programmes are designed to provide information on growth rates, sizes at which maturity is reached and at which sex reversal takes place, data as to duration of residency, longevity, breeding seasons and migrations, catch per unit effort, etc. From the data the sustainable yield of the relevant resources can be established.

Simultaneous to obtaining the research input the manager needs to know the numbers and aspirations of the various users. The purpose of the data collection of the research advice and user requirements is to assist the managers in the selection and implementation of one or more of the following management options.

- Size restrictions. Such restrictions are related to the sizes of maturation, sexual reversal and optimal age at harvesting of the target species.

- Bag limits and/or restrictions on the number of licences issued.

- Closed seasons which are designed to provide protection to the target species at their most vulnerable period - for example, during breeding seasons or migration period.

- The design and proclamation of marine reserves in order to provide protection to spawning stock, protect new recruits and maintain a balanced ecosystem.

- Control of the activities and numbers of off-road vehicles in specific areas. Such control provides areas of isolation and creates informal reserves.

- Marketing control.

- Environmental manipulation by, for example, the installation of fish aggregating devices, artificial reefs and the rehabilitation of vital nursery areas.

Each of the above management options has its particular role to play in the formulation of management strategies. The selection and implementation of one or more of the above options is made against the background of continuing monitoring of existing legislation in the light of research advice received and the user pressures on the resource.

In addition to the formulation of a direct management strategy or strategies the responsibility of the manager goes further. The education of the general public and of the user groups as to the needs and reasons for the application and implementation of management strategies is essential if such strategies are to be successful.

FUNDING MARINE LINEFISH RESEARCH

MR R P V D ELST, OCEANOGRAPHIC RESEARCH INSTITUTE (ORI)

INTRODUCTION

Much has been said these past two days about the value of sustaining a healthy linefishery. Aside from the very considerable social and recreational advantages there are substantial economic implications. Largest of these is probably the most difficult to ascertain: the support industry including tourism and related enterprises. However, some measure of marine linefish's economic impact can be derived simply from putting a value on its landed catch. During 1982 this was calculated to be R36 million (Bross, pers comm.). At current FOB prices and considering a total landing of 15 000 tonnes, the 1988 South African linefish catch totals R75 million - sizeable by any standard - and fourth largest fishery in the country, ahead of rock lobster, inshore trawling and others.

History of Linefish Research

For many years linefish research was considered unimportant and received very little official support. Increasingly, however, the value of this resource and its socio-economic implications have been recognised. While this considerably delayed and impeded the development of linefish studies, the situation improved markedly during 1976 with the instigation of the SANCOR Marine Linefish Programme (SANCOR, 1979). Under its guidance and with its moderate but welcome funding, studies on marine linefish progressed from an average of two projects per year to more than twelve during 1988. All told the SANCOR programme will have seen to the execution of 30 different projects dealing with marine linefish. In addition there have been linefish studies outside the ambit of SANCOR, notably at the SFRI and several universities. The impact of linefish studies have been considerable. Initially research concentrated on the biology of individual species (Wallace and v d Elst, 1983). This markedly improved the state of knowledge of fish important to fishermen and allowed for the identification of vulnerable species with preliminary recommendations for their management. Increasingly, projects have focussed on the quantitative aspects of these target species. The results of this now allow for better assessment of stock and improved harvesting strategies. It is anticipated that future research will substantially improve our ability to sustain and enhance our linefish stocks. Clearly then, while the linefish programme is modest in scope, it has made significant progress in the past decade.

Funding and responsible agencies

While marine research is generally recognised as a relatively expensive arm of science, linefish studies have to date been very modest in their financial demands with the average price of projects lower than most other marine disciplines. Nevertheless, the problem of securing adequate funding is a constant dilemma that faces all linefish researchers, especially those that study recreational fisheries. Part of the problem lies in the fact that there is no direct market value of the recreational catch and hence research funding cannot be easily linked to a cost-benefit equation. Real benefits are more obscure (but not less important) and these have yet to be fully recognised and quantified. Traditional reluctance to support "sport fish" research merely aggravates the situation. It is important therefore to recognise that recreational marine fish research may be in need of special financial support if it is to remain viable.

It is all very well highlighting the need for funds, but who is actually responsible? There are four possible agencies that can be identified: Statutory, research, private enterprise and fishermen.

First and foremost the State carries a statutory commitment to ensure optimal and fair exploitation of our natural resources. This necessarily involves applied and fundamental research to ensure that this can be achieved. Present funding by central government through the SFRI is good, but regional and provincial contributions remain inadequate. In particular the commitment by local authorities and municipalities along the coast is seriously wanting. Similarly private enterprise has to date been singularly shortsighted in their support for linefish research. While there are some very notable exceptions (Table 1) it is here that many of the linefish benefits accrue. Fish dealers, tackle manufacturers, boat builders and tourist entrepeneurs are but some who benefit direcly but put little back into the resource.

Fishermen themselves have also not really come forward to assist financially with the research of the resource they depend on. While a number of individuals and clubs have contributed, most hold the opinion that it is not their responsibility. Perhaps the eventual introduction of an anglers' licence will resolve this.

Most funding has in fact come from research organisations. While this includes considerable State revenue, many also committed private funds to linefish research.

Table 1: Significant contributors to linefish research in South Africa 1976-1988 (Acronyms from page iv)

CATEGORIES OF SPONSOR

STATUTORY	RESEARCH	PRIVATE	ANGLING
SFRI	SANCOR	SFW	NCAU
NPB	ORI	BLENKINSOP	SGFC
CPA	DIFS		
BNR	JLBSII		
	UCT		
	PEM		
	UPE		
	SEFREF		
	SAASSPER		

While SANCOR funds are but a part of the overall money spent on linefish research - estimated to be ca 40% - an analysis of trends in these funds does provide useful insight into the growing importance attached to linefish (Fig 1). During 1979, the first year of the linefish programme it was allocated a mere 2% of the total budget. However, during 1989, this had grown to almost 10%. Competition for limited funds within the marine research community remains strong illustrated by the total budget allocation made in 1988 (SANCOR 1989; Fig 2).

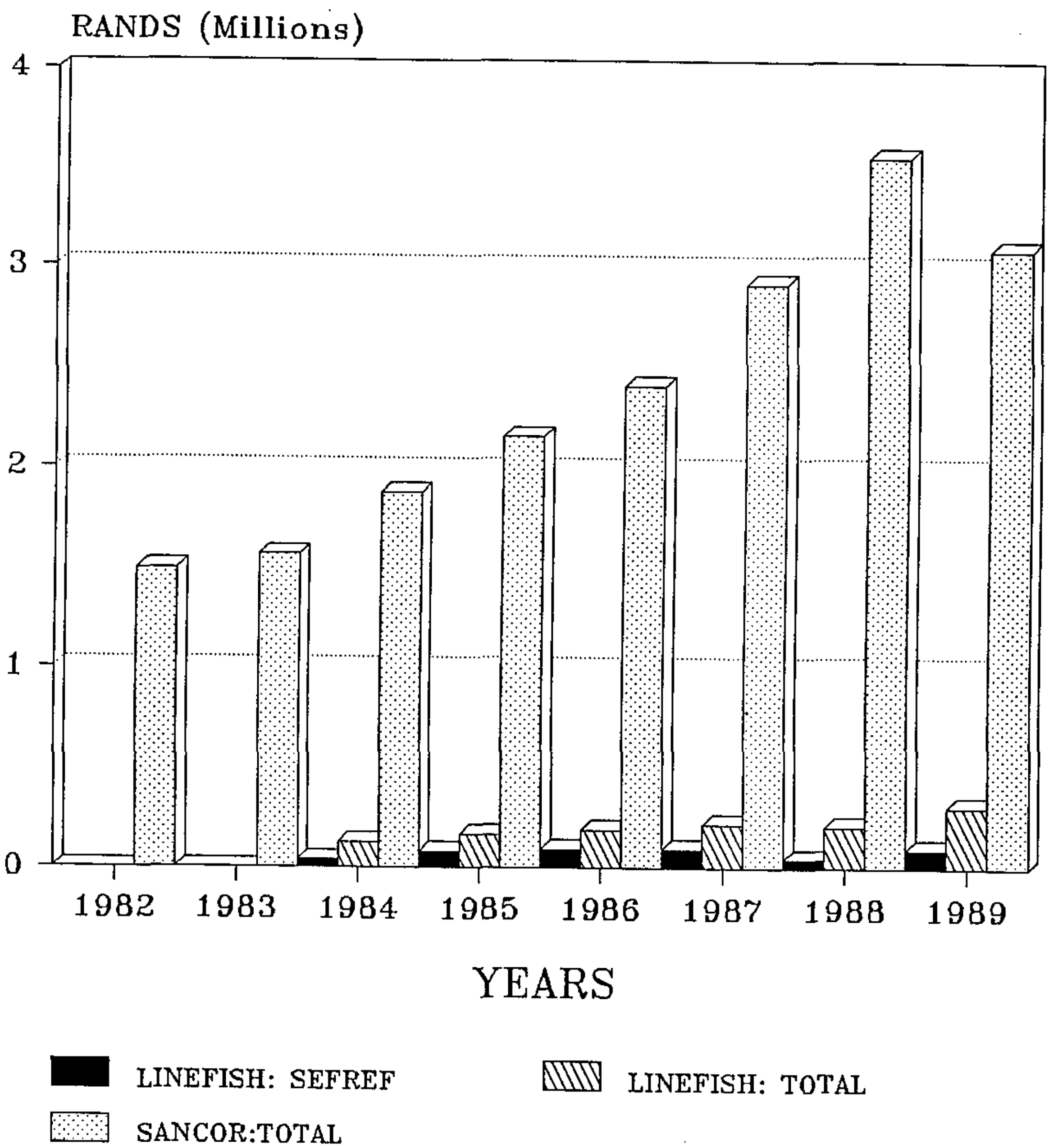

FIG 1: TREND IN TOTAL SANCOR BUDGET SINCE 1982 WITH RELATIVE LINEFISH ALLOCATION

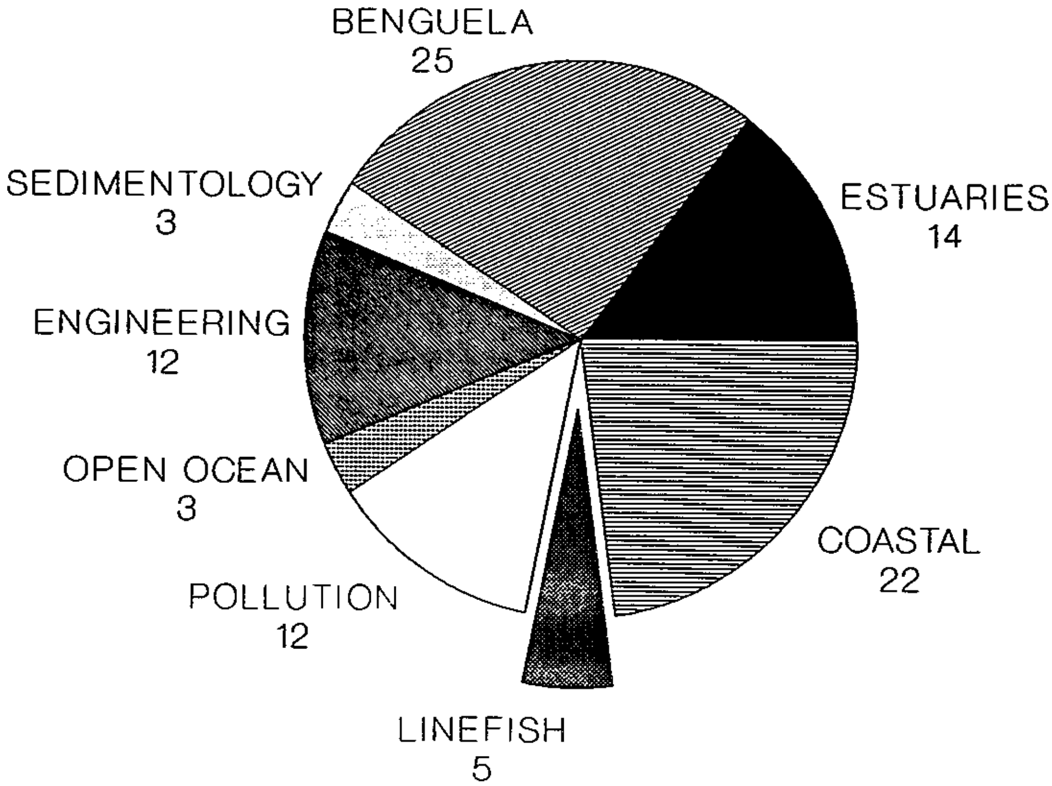

FIG 2: PIE CHART OF 1988 SANCOR ALLOCATIONS

CONCLUSION

The future well-being of South Africa's linefish stocks are inextricably linked to the extent and quality of research undertaken. Consequently there is a serious commitment on the scientists, not only to conduct the research but also to facilitate its funding. This commitment has been taken seriously, witnessed by the recent compilation of comprehensive proposals for future linefish research. This will serve not only as a Special Programme application to the FRD (CSIR), but also as a plan that should satisfy the needs of resource management and the aspirations of South African fishermen.

The time has come to plan cohesively for the future and this is only possible with assured funding. The uncertainty and temporary nature of employment that faces so many marine scientists must be remedied if we are not to lose them to other disciplines or continents. There is clear evidence that too few beneficiaries of linefish are committed to footing the bill. That must change. Support of research, both in finance and in spirit will ensure that they continue to prosper. The requirements are modest but the benefits immense.

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BRIEF SUMMARY OF THE GENERAL DISCUSSION ON THE EVALUATION OF STRENGTHS AND WEAKNESSES IN THE CURRENT RESEARCH AND MANAGEMENT PROGRAMME

The following recommendations were made:

- Regional liaison committees should be established with representation by management groups, local scientists and the angling community.

  The Chief Directorate Nature and Environmental Conservation of the Cape Provincial Administration undertook to liaise with the Sea Fisheries Research Institute to assess the feasibility of establishing regional liaison committees in the southern and western Cape similar to the successful Natal Coastal Liaison Committee.

- The National Marine Linefish Advisory Committee should be re-instated by the Minister of Environment Affairs. Commercial and recreational fishermen should be represented on this Committee or its sub-committees.

- A recreational marine linefish symposium should be held every second year at different venues. Wider participation of anglers should be sought while the commercial fisheries and other user groups should also be encouraged to participate.

- Intensive educational programmes should be introduced in order to create conservation awareness amongst anglers and the general public. Posters, popular publications and public meetings were considered suitable methods.

- A socio-economic study should be conducted to attempt to assess the direct and indirect value of the linefishery to the South African economy.

- The proceedings of the symposium should be published, preferably in the South African National Scientific Programmes Report series issued by the Foundation for Research Development of the Council for Scientific and Industrial Research. Articles on the symposium would also be published in the Ski-boat journal.

- There was consensus on the most important point that emanated from the symposium - namely the depletion of the marine linefish resource and the lack of funding for its research and management. This serious shortcoming should be conveyed to the Minister of Environment Affairs.

APPENDIX 1

PARTICIPANTS

Name	Affiliation
Alexander R L	JLB Smith Institute of Ichthyology
Bok A N	Directorate of Nature and Environmental Conservation, CPA
Baker K	SADF
Beckley L E	University of Cape Town
Bennett B A	University of Cape Town
Botha A	East London Ski-boat Club
Bouwer M C	Natal Parks Board
Bowmaker A P	Oceanographic Research Institute
Brokensha M M	IGFA, (RSA)
Bruton M N	JLB Smith Institute of Ichthyology
Bullen E	Oceanographic Research Institute
Bursik E	Natal Deep Sea Anglers Association
Bush R A	Eastern Province Deep Sea Anglers Association
Buxton C D	Rhodes University
Carrol B	S A Light Tackle Boat Association
Claverie Jr M N	IGFA, (USA)
Cliff G	Natal Sharks Board
Cook P A	SA Underwater Union
Cooper R S	Southern Cape Deep Sea Angling Association
Cowley P B	Rhodes University
Crous H	Western Province Deep Sea Angling Association
du Preez B	Christmasvale Ski-boat Club
du Preez S	Christmasvale Ski-boat Club
Fearnhead E A	Natal Parks Board
Garratt P A	Oceanographic Research Institute
Geldenhuys N D	National Parks Board
Govender A	Oceanographic Research Institute
Griffiths C L	University of Cape Town
Grobler J H	Natal Parks Board
Harris F P	East London Ski-boat Club
Hart B	Natal Deep Sea Angling Association
Hecht T	Rhodes University
Heemstra P	JLB Smith Institute of Ichthyology
Hindle R	Border Anglers Union
King P J	Kings Sports
Kirchmann R	SA Deep Sea Angling Association
Krohn R	Foundation for Research Development, CSIR
Krull P	Border Undersea Club
Mann B	Rhodes University
Maritz W	East London Aquarium
Neethling J H	Directorate of Nature and Environmental Conservation, CPA
Penney A J	Sea Fisheries Research Institute
Pollock D E	Sea Fisheries Research Institute
Punt A	University of Cape Town
Reynolds D E	Southern Cape Deep Sea Angling Association

PARTICIPANTS (Continued)

Name	Affiliation
Schnetler A	Foundation for Research Development, CSIR
Schultz M	SA Deep Sea Angling Association
Smith J C	Sea Fisheries Research Institute
Sparg A	Border Deep Sea Angling Association
Steyn P	SA Deep Sea Angling Association
Tilney R	Rhodes University
Titmus L	SA Rock and Surf Angling Association
Van Langelaar J	Directorate of Nature and Environmental Conservation, CPA
Van der Elst R P	Oceanographic Research Institute
Van der Westhuysen O A	Foundation for Research Development, CSIR
Van Rooyen C	Eastern Province Deep Sea Angling Association
Wanvig G	Eastern Province Deep Sea Angling Association
Whitfield A K	JLB Smith Institute of Ichthyology
Whittle T P	Christmasvale Ski-boat Club
Wilke C G	Sea Fisheries Research Institute
Wilmot K	Diaz Deep Sea Association
Winch G	SA Deep Sea Angling Association

APPENDIX 2

LISTING OF COMMON AND SCIENTIFIC NAMES OF FISH DISCUSSED DURING THE SYMPOSIUM

COMMON NAMES	GENERIC NAMES
Albacore	*Thunnus alalunga*
Anchovie	*Engraulis capensis*
Bank steenbras	*Chirodactylus grandis*
Barbel	*Galeichthys feliceps*
Belman	*Umbrina capensis*
Black steenbras	*Cymatoceps nasutus*
Blacktail	*Diplodus sargus*
Blue stingray	*Dasyatis marmorata*
Brindle bass	*Epinephelus lanceolatus*
Bronze bream	*Pachymetopon grande*
Butterfish	*Chirodactylus brachydatylus*
Carpenter	*Argyrozona argyzona*
Clinids	*Clinidae*
Couta	*Scomberomorus commerson*
Dageraad	*Chrysoblephus cristiceps*
Dassie	*Diplodus sargus*
Dorado	*Coryphaena hippurus*
Elf	*Pomatomus saltatrix*
Emperor	*Lethrinus spp.*
Fingerfish	*Chirodactylus grandis*
Flounder	*Paralichthys olivaceum*
Fransmadam	*Boopsoidea inornata*
Galjoen	*Coracinus capensis*
Garrick	*Lichia amia*
Geelbek	*Atractoscion aequidens*
Gilthead bream	*Sparus aurata*
Gobies	*Gobiidae*
Gurnards	*Triglidae*
Halibut	*Hippoglossus hippoglossus*
Hottentot	*Pachymetopon blochii*
Jacopever	*Helicolenus dactylopterus*
Jan Bruin	*Gymnocrotaphus curvidens*
John Brown	*Gymnocrotaphus curvidens*
King mackerel	*Scomberomorus commerson*
Kob	*Argyrosomus hololepidotus*
Kukubass	*Oplegnathus spp.*
Leervis	*Lichia amia*
Malabar rockcod	*Epinephelus malabaricus*
Milkfish	*Chanos chanos*
Mullet	*Mugilidae*
White musselcracker	*Sparodon durbanensis*
Natal stumpnose	*Rhabdosargus sarba*
Panga	*Pterogymnus laniarius*
Parrot fish	*Scaridae*
Potato bass	*Epinephelus tukula*
Pinky	*Pomadasys olivaceum*

Poenskop	*Cymatoceps nasutus*
Puffer	*Fugu rubripes*
Rabbitfish	*Siganus spp.*
Red drum	*Sciaenops ocellatus*
Red seabream	*Sparus major*
Red steenbras	*Petrus rupestris*
Red stumpnose	*Chrysoblephus gibbiceps*
Roman	*Chrysoblephus laticeps*
Santer	*Cheimerus nufar*
Seabass	*Dicentrachus labrax*
Seventyfour	*Polysteganus undulosus*
Sheepshead	*Archosargus probatocephalus*
Slinger	*Chrysoblephus puniceus*
Snoek	*Thyrsites atun*
Springer	*Elops machnata*
Spotted grunter	*Pomadasys commersonnii*
Steenjie	*Spodyliosoma emarginatum*
Strepie	*Sarpa salpa*
Ten pounder	*Elops machnata*
Turbot	*Cophthalmus maximus*
White steenbras	*Lithognathus lithognathus*
White stumpnose	*Rhabdosargus globiceps*
Wrasse	*Bodianus spp.*
Yellowbelly rockcod	*Epinephelus guaza*
Yellowfin bream	*Acanthopagrus latus*
Yellowfin tuna	*Thunnus albacares*
Yellowtail (foreign)	*Seriola quinqueradiata*
Yellowtail (local)	*Seriola lalandi*
Zebra	*Diplodus cervinus*

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