Australian Society for Fish Biology
Workshop Proceedings

Recreational fishing: what's the catch?

Canberra • 30–31 August 1994

D.A. Hancock (editor)

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Australian Government Publishing Service
Canberra

ISBN 0 644 35992 7

Published by:
Australian Society for Fish Biology
c/o CSIRO Division of Fisheries
PO Box 1538
HOBART TAS 7001

Preferred way to cite this publication:
Hancock, D.A. (ed.) 1995, *Recreational fishing: what's the catch?* Australian Society for Fish Biology Workshop Proceedings, Canberra 30–31 August 1994. Australian Society for Fish Biology, Canberra.

Cover illustration reproduced from an illustration by Robynne Dunn and published by David Ell in *Angling in Australia—its History & Writings*.

Printed for AGPS by National Capital Printing, Fyshwick, ACT.

Foreword

D.C. Smith

President
Australian Society for Fish Biology

This Workshop entitled 'Recreational fishing: what's the catch?' continues the series, commenced in 1985 by the Australian Society for Fish Biology. The major objective of the Workshops has been to promote the opportunity, during the Society's Annual Conference, for the national fish and fisheries expertise to focus on an issue or issues of regional or national significance. The Workshop proceedings are now widely regarded as the benchmark document of current knowledge in the Workshop subject area.

The 1995 Workshop was extremely timely. Recreational fishing is a multi-million dollar industry, with over 4.5 million Australians estimated to participate each year. A number of recent State inquiries into recreational fishing and the draft National Policy for Recreational Fishing all highlight the dearth of information on major recreational fisheries. At the same time there has been an increased and more rigorous research effort.

This was the first extensive national Workshop held in Australia focussing on aspects of assessing recreational fisheries and some of the crucial issues concerning the management of these fisheries. It dealt with methods of estimating the catch, to the thornier issues of estimating value and resource allocation.

The Workshop commenced informally with a stimulating and provocative speech by well known fishing identity Rex Hunt. Dr Bob Kearney, Director of the New South Wales Fisheries Research Institute, set the scene for the two-day meeting by courageously attempting to estimate the total Australian recreational catch for his keynote address. His summing-up was also of the highest quality. The Society would also like to acknowledge the contribution of international guest speakers, Laurel Teirney (MAFFisheries NZ), Rudy van der Elst (Oceanographic Research Institute, Durban, South Africa), and Stephen Malvestuto (US).

These proceedings follow the format of recent years with papers delivered by panel members and followed by rapporteurs' reports of the ensuing discussions. Not surprisingly, for issues concerning recreational fishing, the latter were lively and thought provoking.

The Workshop was a great success as evidenced by the Society releasing its first ever Media Release on key outcomes of the meeting. As always many people contributed to its smooth running. Martine

Kinloch and Julian Pepperell had the difficult job of actually putting the whole thing together, as convenors of the Workshop. John Glaister was responsible for successful applications to funding bodies. Gina Newton chaired the local organising committee and Phil Stewart was the Workshop Facilitator.

The Society gratefully acknowledges the support of the Fisheries Research and Development Corporation who provided funds for this Workshop and have generously supported Workshops since 1988. The Bureau of Resource Sciences, the Murray Darling Basin Commission, Australian Fishing Tackle Association, Ansett Australia and Blackwell Scientific Publications were also significant contributors.

Finally, these proceedings could not have been produced without the efforts of the editor Don Hancock, and Gregg Berry and Jenny Martin of the Bureau of Resource Sciences.

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Summary of points raised during session discussions

D.A. Hancock
ASFB Workshops Coordinator

Keynote address

- The Keynote Speaker's estimate of a catch of some 50 000 tonnes p.a. by the Australian recreational fishery received a measure of support, noting the absence of any statistical confidence.
- Commercial catch data, although more readily available than recreational data, are, with the exception of the very highly priced species, themselves unlikely to be totally accurate.
- Catch estimates need to take account of the total 'kill' by commercial and recreational fishing.
- Estimates of the recreational catch have been shown to be at least as large as those of the commercial catch for some species and situations.
- The Workshop had addressed the question of 'What is the catch?', rather than the numerous and variable factors affecting that catch.

Session 1: International overview

- The Chair stressed the short history of quantifying recreational catches of only 40 or so years in Australia.
- Information on total recreational fishing effort and catch, characteristics and numbers of fishers involved, frequency of fishing, present and projected expenditure, and their opinions and political intentions, are needed by researchers, managers, sociologists, politicians, economists, town planners and business people.
- Approaches to obtaining such information have varied from country to country.
- South Africa undertakes surveys of launching ramps, beach surveys, and daily fishing returns and favours full usage of existing facilities, such as fishing tournaments and affiliated unions and clubs. (Note the caution expressed in other sessions about the use of club data). 60% of boats fishing in Natal waters provide daily fishing returns; 95% of recreational boats are affiliated with clubs. Beach survey staff receive full training.
- The cost of monitoring the recreational and commercial line fisheries in Natal is about 4-5% of production value, but there are additional hidden costs.
- Many United States fisheries are overexploited, and anglers support beneficial

management measures, including 'slot' regulations to restrict the take of both the larger and smaller fish.

- Well-designed creel surveys are being used effectively in the US to determine the optimum sustainable yield, and to measure the interactions between biological, socio-cultural, economic and fish consumption responses to site-specific management plans.
- New Zealand diary system results agree quite closely with boat ramp survey results in terms of species mix and catch per person, but diaries tend to underestimate the number of 'no fishing' trips.
- While NZ recreational fishers disclose illegal catches in written returns, the tendency in boat ramp surveys is to hide fish. In the paua (abalone) fishery, catches exceeded the bag limit in 14% of trips, verified by phone checking.
- Feedback of results and information, education and personal zeal are ingredients for public support, as well as involving fishers in research programmes.
- Conflict between recreational and commercial fishers in NZ has been reduced by feedback of survey results.
- A substantial body of quantitative information on recreational fishing exists in Australia, most of which has been collected over the past twenty years. Funding has been a critical limiting factor.
- The importance of long term data is emphasised, and there is a clear need for recreational fishing studies to be incorporated into a longer term framework. To date most surveys have been 'once off'. There are therefore few data in published reports to validate the claim that recreational fishing effort is increasing.

Session 2: Measuring catch and effort—the theory

- The unregulated nature of recreational fishing causes difficulties in obtaining catch and effort information compared with commercial fisheries.
- In the US, estimation of angler harvest rates has proved difficult from creel surveys alone, due to sampling biases associated with various types of creel survey.
- US designed 'bus-route' sampling has been used in South Australia and is suited to large recreational fisheries covering a wide geographic area with many access sites.
- Recreational fishing surveys are difficult to organise due to modest funding, the mobility of fish and anglers, the difficulty of angler recall information, and retrospective funding.
- Key design components should include:
  1. prioritised output specifications to enable cost-benefit analysis of research options,
  2. desk research including literature searches and secondary data sets,
  3. a broad approach with open options and not technique-driven, and
  4. initial testing and fine tuning to validate against output specifications.
- Careful tailoring of study design will lead to cost-effectiveness and improved data quality and utility.
- Collection and validation of data is a function of enforcement officers which

provides an important complement to research observations.

- In the United States, traditional sources of funding for recreational fishing research have included licence sales revenue and sales tax on fishing gear. Tax revenue on speciality items, like soft drink, has in some instances been diverted to recreational fishing.
- Precision estimates for fishing rate, fishing effort and harvest require proper attention.

Session 3: Measuring catch and effort—the practice

- The agenda for recreational targets has shifted from purely biological stock assessments to finding a compromise between what is biologically necessary, socially acceptable and politically expedient.
- Methods used to collect data on recreational fishing are determined by the type of information required, the temporal and spatial scale of the study area, the characteristics of the fishery and the resources available (personnel, funds and equipment).
- Large scale surveys (Statewide, National) generally use 'omnibus' or general population techniques, involving interviews of a random sample of the target population, and extrapolation to the total population.
- Roving and access site creel surveys have been used extensively, particularly in estuarine and marine inshore waters.
- Other methods include questionnaires, telephone surveys and personal interviews, diaries or logbooks, aerial surveys and analysis of historical data sets.
- Recall bias has been a major problem, e.g. in the Northern Territory barramundi fishery, but not in the Tasmanian trout fishery where anglers were able to remember catch data accurately. In the US, phone surveys are used in tandem with personal interviews.
- Regional social and ethnic groups have differing target species.
- In the US, changes in fishing quality/ angler enjoyment are assessed from anglers' ratings of fishing success, which, in fish caught for food, are strongly correlated with harvest rates: in catch and release fisheries they are not.
- Studies on angler motivation and satisfaction could involve anthropologists and socio-cultural information to advantage.
- In South Africa, setting management targets is proving to be a big challenge because of social and ethnic differences in enjoyment and motivation.
- A good angling experience in New South Wales is helped by improving access to impoundments, and involving anglers in education and stocking programmes, as well as data collection, analysis and dissemination.
- In Tasmania, the provision of a diversity of angling experiences close to major population centres has contributed to angler satisfaction.
- Recreational fishers were reported to have been disinterested in management, with poor attendance at meetings, and low response rates to requests for expressions of interest.
- In NZ, 'wilderness' rivers were valued highly for their scenic beauty and size of fish caught, whereas in 'recreational'

rivers the emphasis was on the amount of fish. An attitudinal survey led to a process of selection of nationally important rivers for protection, in which all anglers were involved.

- In Queensland, an inquiry into recreational fishing showed that anglers would value a 'conflict-free' fishery. Commercial-free areas are under consideration, but noting the existence of recreational-only fisheries where anglers are dissatisfied.
- A paper supporting a National Recreational Fishing Database was presented to this Session. The Society does not as a matter of policy endorse individual proposals, but the concept was discussed here and at other times during the Workshop. Standardisation of survey data would be the hardest to achieve, but club records, tagging databases, charter vessel programmes and compliance reports etc. should be more compatible.
- It is essential to establish a long term database such as for commercial fisheries. This should be more cost-effective on a national scale.
- A national survey has been strongly recommended, but agreement has not been reached about funding.

Session 4: Socio-economics of recreational fishing

- A management framework is an essential feature of any valuation for reallocation purposes.
- Compensation should accompany loss of resources but will be subject to legal arguments about perpetuity of rights. Loss of a licence in perpetuity should qualify for compensation.
- Decisions on allocation values require information, which of itself attracts a market value.
- Market approaches have the added advantage that they stimulate research and development.
- Education is a particularly important component of any allocation issue.
- It has been difficult for biologists, economists and sociologists to communicate, mainly because of differing terminologies.
- Resource allocation and reallocation is a dynamic process which needs the appropriate management structure to accommodate regular revision.
- There is a need to value the number of fish caught by the recreational sector using the same measure as for the commercial sector, i.e. the market value.
- Contingent value, if not carefully planned, can produce alarming findings, especially when immediate payment is not involved.
- The 'lifestyle' value of the commercial fishery needs to be taken into account when reallocating a resource. A measure of this can be obtained from survey-based approaches.
- In the US, recreational fisheries managers are trying to deal with this basic issue of the economic value of resource changes in response to both biological events and management strategies.
- The challenge for economists is to interact with fishery managers to determine such key economic response values. A contingent valuation survey is being incorporated into creel surveys

of Western Australian salmon and herring fisheries.

General discussion—day one

- In the US there is no national recreational fishing licensing but there are inland licences in all states and various marine licences in coastal states. The Australian national recreational fishing policy is being modelled on that of the US.
- In Victoria there are proposals for the establishment of a peak body for recreational fishing.—such a body would recommend whether there will be general recreational fishing licensing in Victoria.
- In Queensland, attitudes have radically changed towards supporting a general State licence, with a proposal that all private pleasure vessels should be licensed, with some of the fees going towards funding recreational fishing.
- Proper explanation of the reasons for and benefits from recreational licensing has helped towards support for them in Victoria, particularly by organised clubs, and in Western Australia, following advice that funds will be directed towards management and research.
- Any funds raised through national licensing should be paid into a dedicated fund and not consolidated revenue.
- In NSW there is strong support for a freshwater licence, but not by saltwater anglers.
- The best data collection systems are those with good feedback of information. Licence fees might better be known as research levies.
- The lack of a common purpose and inability to speak as one voice were cited as major problems facing both commercial and recreational sectors.
- The recreational community needs to come up with agreed priorities that are of mutual benefit to them and the stocks, and in accord with the philosophies of fisheries management agencies.

Session 5: Resource allocation—a forum

- Resource allocation issues have been clearly identified in recent fisheries policy development and strategic planning processes in Australia.
- Resource allocation issues include three types: strategic (planning), between user groups and within user groups.
- Adequate funding is needed not only for research monitoring and management, but also to support proper representation by recreational and other community interests.
- In WA, revenue raised by the licensing of high value recreational fisheries has been directed towards a specific fund for recreational fishing research and management, but raising revenue from licences is not always popular politically. Persistence is required.
- Schemes for buy-out of access entitlements require realistic assessment of relative economic values. In Canada, estimates of total recreational fishing expenditure on salmon fishing trips were about 25 times the market value of the commercial catch.
- The barramundi reallocation process in the Northern Territory involved a commercial licence buy-back scheme. As

elsewhere, decisions reflected political rather than data analysis considerations.

- The apparent emphasis on economic values as a basis for management decisions was cautioned where it tended to overshadow stock conservation problems.
- Specification of management goals and user group aspirations need to be part of the process of resolving resources allocation issues, and the focus should not be just on economic, but also artisanal and subsistence, considerations.
- Exclusive allocation of fish resources to recreational fishing has been applied to barramundi in the Northern Territory, but more data are required to use this type of resource allocation more extensively.
- Every interested group, including fish consumers, needs to be properly represented in any resource allocation process involving community input, such as the expert advisory body proposed for WA, and not rely only on the advice of recreational interests.
- Rights and entitlements in commercial fisheries are considered to be fairly secure, both in law and in terms of commercial values, and there are huge investments tied up in actual and goodwill values. There is therefore the expectation of compensation for resources lost through reallocation.
- Not all user groups may be sufficiently aware of the impact of different resource allocation outcomes to be able to effectively protect their interests.
- The exclusion of commercial interests from one fish stock has been known to result in increased exploitation, and consequent disadvantage to other users, in another.
- An industry view is that, if fisheries management continues to be dominated by the notion that the commercial fishery should be wound back purely because of the increasing numbers of recreational fishers, then the arguments and conflicts over resource allocation are unlikely to be resolved.
- In South Africa, some fisheries have been identified as primarily recreational or primarily commercial, while others were subjected to bartering or trade-offs, eventually leading to a list of species that are genuinely de-commercialised and on which recreational fisheries can plan effectively. In others recreational access has been limited.
- In New Zealand, a wide range of fisheries resource allocation mechanisms have been tried but not formalised but the most effective has been getting competing interests to sit down around a table to discuss their differences, often to find fewer differences than supposed, and sharing a common concern for the fish stocks. The key to success is the identification of real fishery management issues.
- It was agreed that State-wide trends towards discussion and negotiation between recreational, commercial and other interests is the only way towards resolving resource allocation issues.

Session 6: Management of recreational fishing

- Recreational Fisheries Management in Australia has, except for long-established

freshwater fisheries, begun to show progress only over the past 3 to 5 years, notably with the National Policy for Recreational Fishing soon to be finalised.

- Management of recreational fisheries includes a number of ingredients such as: data collection, biological research, the process of consultation enhancement, funding, rules controlling fishing, education, resource sharing issues, access requirements etc.
- Problems encountered include: insufficient funding to meet the National Policy for Recreational Fishing, situations where management seems to have failed, a background of declining catch rates, lack of databases.
- Recreational licences are seen as an aid to communications between management and fisheries. Recreational fishers need to know what their licence fees are being used for.
- The general view that there is significant opposition to licensing of recreational fishing and consequent high rate of non-compliance, was not the experience in the traditional freshwater fisheries of Tasmania, or recreational fisheries in Western Australia.
- The needed emphasis on extension and education is being hampered by declining budgets and staff cuts.
- With expenditure in Western Australia on fisheries education, research, operation costs etc. of around $2 million, the existing resources are being augmented by Volunteer Fisheries Liaison Officers.
- South Australia has various education programmes leading towards a community 'Fishcare' programme.
- There is a need for heavier penalties for infringements of fisheries regulations.
- The question was asked 'Do recreational bag limits really limit total catches or do they just shift the balance towards the commercial sector?'.

General discussion

- Recreational and commercial fishing sectors have far more in common than they have differences, which should provide the basis for trust and conflict resolution. The acceptance of the need for specific and detailed fisheries management plans, which explicitly state resource conservation, resource allocation and economic objectives, is helping to further cooperation between user groups and fisheries management agencies.
- Proper recognition is due to the size, diversity and general disorganisation of the recreational fishing sector in Australia, and help is needed to get it organised, just as the commercial sector has become organised.
- Broad community participation in decision making on resource allocation is fundamental to effective management. Without clearly defined and understood mechanisms for deciding and implementing resource allocation decisions they will remain a political consideration.
- Decision-making should not be subject to simple economic values. Community values need to be referred to the full range of economic benefits that flow, not only from commercial and recreational exploitation, but from the whole range of non-consumptive uses

of the resources, which rely on differing methodologies.

- While agreement has not been forthcoming on the concept of a national recreational licence, a national recreational survey is generally seen as an important step towards the measurement of catches and values of recreational fishing.
- A key issue is how to get the recreational fishing community empowered to take charge of its destiny. The issue of ownership of the resource will continue to be a matter for legal debate.
- Resource allocation is about who gets what share of the resource—determining the size of that resource is more to do with resource conservation and habitat protection.
- Collection of long term data is vital but can be very costly. While there is a need to concentrate on and utilise systems that are already in place, restriction to a few species may lead to an inability to monitor some of the catches over the long term.
- Fishery—independent surveys will be important where catch and effort data collection is not successful.
- Bag limits have not been welcomed by recreational fishers in Australia, compared with the US where they have become part of the culture. Education and communication are vital to greater acceptance.
- Angling club records are seen to be a valuable source of data, but need to be subject to the most careful scrutiny of the sources for bias. Recreational fishers' diaries have value in starting a data base which can be supplemented by detailed studies later on.
- Stocking of freshwater impoundments is being undertaken and will create new opportunities and benefits.
- Encouragement from the New Zealand experience is that user group management was a feasible proposition after only two years of information gathering, and nine months from user consultation to a management plan and changed regulations.
- 'Most who have attended the Workshop will leave accepting that more funding is essential.' (Keynote Speaker: Summing Up)

Welcome and opening

R.E. Reichelt

as Director, Fisheries Resources Branch
Bureau of Resource Sciences
(now Director, Australian Institute of Marine Science)

Welcome to all of you. This year's Workshop is being held right on the border of the ACT and NSW, which means we are close to the political action of Canberra. Recreational Fishing, our topic for the meeting, also has a strong political aspect, given the very large number of Australians who like to go fishing for pleasure.

I am frequently asked 'What does the Bureau of Resource Sciences do in regard to recreational fishing problems?' and I have to admit that my answer tends to vary slightly depending on the political direction from which I am being tackled. The role of the Commonwealth government in recreational fishing issues is controversial because the responsibility for regulation of such fishing rests with the States rather than the Commonwealth.

Notwithstanding the dominant role for the States and Territories, the BRS role to date has been to advise the federal Minister responsible for fisheries on issues such as the lack of information presently available on recreational fishing effort and catch, our poor knowledge of the state of fish stocks taken by recreational fishers, the need for data standards in recreational fishing statistics and so on.

Discussions about such issues can become political very quickly when one agency (or government) thinks that another is treading on its turf. We will be putting that aside for the next two days and hope that this Workshop focuses more on the difficult scientific problems that surround the study of recreational fisheries and their management.

Apart from welcoming you all, my task now is to introduce Dr Bob Kearney, our Keynote Speaker. Bob Kearney is the Director of the New South Wales Fisheries Research Institute, an internationally recognised fisheries scientist, and a keen recreational angler. He caught his first fish when he was three years old and has been studying the science and art of fishing ever since. To launch the Workshop I call on Dr Bob Kearney.

Keynote address
Recreational fishing: what's the catch?

R.E. Kearney

Fisheries Research Institute
NSW Fisheries
PO Box 21
Cronulla NSW 2230

Recreational fishing: what's the catch?

It seems a straightforward question!

It begs a simple answer!

But part of the reason for the question was obviously because there is no agreed answer to even its most obvious interpretation.

Surely somebody should try to answer the question. I'm game!

54 302 tonnes/year.

The organisers of this conference are to be complimented for introducing a very complex issue in the form of a short but provocative, and double-meaning question. From my discussions with them it was obvious that a broad approach to the question was expected. One single numerical answer is not what is required; even if you believed the answer anybody gave you. Nonetheless it may be the first time some of you, maybe even most of you, have seen a number put to Australia's annual recreational fish catch. At least it's the first you have seen today. Its validity, accuracy and precision are indeed other formidable questions.

A common response to difficult questions is more questions:

Why do you want to know? Is there a correct answer, and if not, why not? What are you going to do with the answer if I give it to you?

I'm sure most of you responded with similar questions when you considered—what is the catch?

Even before researching possible answers to the most obvious interpretation of the question of what is the catch, I was aware that there were remarkably few, if any, published estimates of the Australian recreational catch. There are a few, but very few, estimates of catch rates for localised fisheries but the lack of total catch estimates is telling. Yet when I looked for comparable statistics on commercial fisheries I had no problem whatsoever. Authoritative documents such as FAO 'Yearbook of Fishery Statistics' (FAO 1993) provide Australia's data and compare them with those of most major fishing nations. Another document, entitled 'Australian Fisheries Statistics', produced annually by the Australian Bureau of Agriculture and Resource Economics (ABARE), provides figures to the nearest tonne by major species category, by State or Territory by market destination; the Bureau of Resource Sciences' (BRS's) Australian Fisheries Resources, 'the Atlas', (Kailola *et al.* 1993) provides similar summaries. Most of the States have their own data publication series,

often providing estimates of the commercial catch by species to the nearest kilogram.

It is worth noting what reference is made to recreational fisheries in those documents that report on Australian fisheries production. The FAO Yearbooks 'present the annual statistics...on nominal catches of fish...taken for all purposes (commercial, industrial and subsistence) *except recreational*, by all types...of fishing units' etc. ABARE's 'Australian Fisheries Statistics' 'provides a *comprehensive* set of data for Australian fisheries production and trade'; but recreational catches aren't included in their definition of 'comprehensive'. BRS's Resource Atlas clearly indicates that its catch data cover only commercial fisheries. It correctly acknowledges that recreational fishing effort is significant by referencing a well known report by PA Management Consultants (1984) to quote 'that nearly one third of Australians over 10 years of age go fishing each year,...and about A$2000 million was spent in 1983–84 on fishing and related equipment' (PA Management Consultants 1984). The Atlas cites another report as estimating that 'between 80 000 and 100 000 jobs could be related to recreational fishing in Australia' (Lindner and McLeod 1991)—but provides no estimate whatsoever of catch. One could be forgiven for assuming that the recreational catch has no national significance. Or at best pales into insignificance when compared to the commercial catch.

I did find one reference to the magnitude of the recreational catch in a report on national fisheries issues. ABARE's report on 'Competition between recreational and commercial fishers' (Lal *et al.* 1992) states, to the apparent surprise of the authors, that 'In fact, in some fisheries, recreational catches may be larger than those of the commercial sector'. Unfortunately no catch figures are given to support this statement. Merely a reference to a statement that I had actually made myself, that in one river, the Richmond, the recreational catch of one species, tailor (*Pomatomus saltatrix*), exceeded the commercial catch (Kearney 1991).

So with no published national statistics and apparently not a lot of interest, where does my figure of 54 302 tonnes come from?

Statistical texts tell us that getting a total is merely a matter of adding up the parts. But if it can't be done by simple addition, which it obviously can't in this case, an estimate of the number of parts multiplied by the estimate of the average size can be used to give an approximation.

That is, total recreational catch in weight equals the number of people who fished in a unit of time multiplied by their average catch in that time

$W = NC$...equation 1

A minor modification of this gives

$W_y = N_y C_y$ ...equation 2

where W_y = the total weight of fish caught in one year

N_y = the number of fishing trips in that year

C_y = the average catch per trip in that year.

Now we start to run into statistical problems.

In Australia we have 9 million square kilometres of fishing zone, 36 thousand kilometres of coastline and thousands of rivers and lakes. There are many different types

of recreational fisheries for many species, in many different types of location. So we have to start combining components and making averages. To do this, let us suppose

A = the number of major subdivisions, e.g. States or Territories

H = the number of major habitat types that describe fisheries—e.g. lake, river, estuarine, beach, reef, offshore, etc.

S = the number of species.

Then we very quickly get to

$$W_y = \sum_{n=1}^{A} \sum_{n=1}^{H} \sum_{n=1}^{S} W_{ahs} \quad \text{...equation 3}$$

which when we add in all the other variables, such as the variation in the number of times people fish in any year, seasonal variability, variation due to weather, moon phase, time of day, tide, weekend, school holiday, etc., variation in the average size of the fish of each species, whether the angler used a boat, what bait was used, was the angler experienced, etc., etc., the equation quickly gets to look something like this:

$$W_y = \sum_{a=1}^{A} \sum_{r=1}^{R_a} N_{ary} P_{ray} \sum_{h=1}^{ha} \sum_{i=1}^{4} T_{hairy} D_{hairy} C_{rash} W_{rash} \quad \text{...equation 4}$$

And this type of equation is a gross oversimplification, which doesn't take account of the problems of estimating fish size, or length to weight conversions, or the differences between catch, landings and kill, etc. Perhaps even more importantly, it does not take into account the immense problem of determining the accuracy of the estimate.

The many components of the estimate of the total catch are themselves estimates and in most cases very imprecise ones. When components must be multiplied, for example the number of days by the average catch per day or the number of fish by the average weight, then the numerous variance estimates must also be multiplied. Confidence intervals around the estimate of the total quickly expand, and are themselves very difficult to determine. It is extremely difficult to determine what reliability, if any, should be attached to the end result. Looking at the agenda I assume there will be considerable debate on this issue.

From equation 4 you can see that estimating Australia's total recreational catch by this method is a statistical nightmare, even if we had data for all the component parts, and the correct confidence intervals for each. Which of course we don't. Maybe it's statistically not possible with the limited data currently available to answer 'what is the catch?'.

But while on the subject of statistical nightmares let me recall an incident that occurred about three years ago. I was attending a reception at the Sydney Fish Markets where representatives of many varied sectors of the fishing industry were present. I was enjoying a discussion on preparing and cooking fish with Bernard King, noted chef, entertainer and restaurateur, when we were somewhat rudely interrupted by a gentleman who proceeded to explain his exception to a statement I had recently made concerning the assessment of southern bluefin tuna (*Thunnus maccoyii*) stocks. The intruder repeatedly insisted, in spite of my defence, that the statistical processes I had used in my analyses were incorrect. Bernard was initially not amused by the interruption and he became progressively bemused with our colleague's repeated reference to statis-

tics and the problems with statistical analyses. Finally it became too much for Bernard who interrupted our friend with 'Excuse me! Can you die of statistics?'

I don't want to die of statistics, nor do I want you to, but how did I get 54 302?

Some of the multiple meanings of the question what is the catch, are contained in the dictionary definitions of the word catch. One of these is 'to ensnare, to deceive or to trick'. The catch here is that I didn't use equation 4 at all. I'm not a statistician, I didn't even derive it, Geoff Gordon did—thanks, Geoff. The one I used was the much simpler equation 2

$$W_y = N_y C_y.$$

N_y (the number of fishing trips in the year) I took straight from the PA Consultants report to which I have already referred (PA Management Consultants 1984), in which a figure of 48 million trips was given. C_y (average catch per trip in that year) I calculated from New South Wales (NSW) Fisheries research data, averaged on the basis of 25% of fishing trips being in freshwater, 40% in estuaries and 35% in the ocean. Estuarine data were weighted for boat and shore-based anglers and marine data were weighted for beach and rock and offshore-boat anglers. The average was 1.1313 kg per trip. 48 000 000 times 1.1313 gives 54 302 400 kg or 54 302 tonnes.

I am well aware of the horrendous assumptions that I have made, for example that the PA report was even approximately close, that NSW catch rates are representative of all of Australia, and that 1984 data would still be applicable.

But I had no alternative estimate and no data to employ a more sophisticated equation, such as equation 4.

But how far out is 54 302?

Even if we assume 25% of the 1994 population of Australia fishes at least once a year (PA said almost 33%), and that people who fish do so 10 times a year on average (PA estimated 15.2), and the average catch is 1 kg per trip (my best estimate for NSW was 1.13) we still get 45 million trips for 45 000 tonnes. Let's halve the difference between 54 302 and 45 000, and forget the accuracy and precision (as if the statisticians haven't had enough for one day) and we have a round figure of 50 000 tonnes.

I'm sure we all have grave concerns about using a figure like this at all, let alone the worries about its accuracy, but it's the best I have at the moment. Let's pretend we are economists and assume it is of the right order of magnitude. Now let's try and put it into the perspective of Australia's total fish catch.

As already stated it is easy to get commercial catch figures. ABARE's Australian Fisheries Statistics (ABARE 1993) list the nation's commercial fisheries production by year, by State or Territory by species. The last four years for which data are available are 89/90 to 92/93 during which time total production ranged between approximately 129 000 and 157 000 tonnes per annum (Table 1).

Therefore the total recreational fish catch of 50 000 tonnes per annum would be a little more than a third of the total commercial catch. But does this represent the true picture?

It is interesting to look at the species composition of the two sets of catches. Much of the commercial catch is taken of species which have little recreational relevance—for example orange roughy (*Hoplostethus atlanticus*), oreos (*Oreosomatidae*), blue grenadier (*Macruronus novaezelandiae*) and even sea mullet (*Mugil cephalus*). In Table 2 these and other non-recreational species have been discounted from the approximate commercial catches for the four years.

If we go back to the period of the original PA report in 1983/84, commercial catches of recreationally important species were closer to 40 000 tonnes per annum; the total commercial catch was only 71 000 tonnes in 1983/84, but proportionally more recreational species were taken.

Believe it or not but the average of my best estimates from 1983 to 1993 is 50 100 tonnes. Embarrassingly close to my 'guesstimate' of 50 000 tonnes for the recreational catch. There are a few recreational-only species, such as trout (*Oncorhynchus mykiss*), Australian bass (*Macquaria novemaculeata*) and marlin (*Makaira* spp. and *Tetrapturus* spp.), and the catches of these need to be deducted from the 50 000 tonnes recreational catch. Unfortunately I wasn't game to even guess what these might have been, but a deduction of at least a few thousand tonnes would seem appropriate.

The two figures remain very similar.

Not only do these 'guesstimates' of the total catches suggest that the recreational catch is indeed significant, but it must also be noted that as better data on recreational fisheries come to hand it is becoming obvious that recreational catches of some species, in some areas, particularly in our estuaries, significantly exceed commercial catches. For example, bream (*Acanthopagrus* spp.) in the Richmond River and Sydney Harbour where West and Gordon's (in press) studies and Gary Henry's (1984) work has shown that the recreational catch was 15 times and 30 times the commercial catch respectively. NSW statewide recreational bream and dusky flathead (*Platycephalus fuscus*) catches probably exceed commercial landings, as the averages for the Richmond and Clarence Rivers, Sydney Harbour and Botany Bay (Table 3) would suggest.

Even in near-shore oceanic waters recreational catches of many species are of at least the same order as commercial catches (Table 4).

In freshwater, trout, an introduced species, are taken exclusively by recreational fishers and the very limited data available suggest that recreational catches of our native species significantly exceed the total commercial catches of these species of approximately 200 tonnes/year.

Even if my guesses of the total recreational catch are wrong, that is they are seriously inaccurate, there is now an overwhelming amount of evidence to show that recreational fishing in Australia is a major sport. Nobody questions that. There are millions of participants and at least in some areas catches are significant. Why don't we know what the catch is?

The answer even to this question is not straightforward. I believe I have already demonstrated that answering the question accurately is difficult and requires a lot of data we currently do not have. These data would have been expensive to get. If we were to obtain accurate information on every major fishery in every area the cost

would run into many millions of dollars. Cost is obviously one reason. But why haven't even the most important recreational fisheries been extensively studied? Again there is no agreed answer, but I believe the following have contributed:

1. Until about the 1980s many Australian fisheries managers still believed in the myth that the resilience of our oceans was limitless. Even if there were limits to resources, economic forces of supply and demand would prevent at least serious overfishing. Therefore there was no real need to monitor total catches.

2. There was the perception that recreational fishing, or line fishing in total, could not overexploit a resource.

3. Again the perception, that if there *was* a problem it must be due to nets, which were assumed to be infinitely more efficient than line fishing.

4. There was a lack of quality research to quantify recreational fishing. There are very few papers in the hard scientific literature on estimates of Australian recreational catches (Caputi 1976; Battaglene 1985, but not many others) and even less on the impact of recreational fishing on the resource. The lack of quality research meant there were few real data, which to many meant there was no real problem. How many Ministerial enquiries on why fishing was deteriorating have been answered 'the available data do not suggest there is a problem'. There were no data so how could they suggest there was a problem?

5. In the absence of concerns for action there was no pool of funds dedicated to the assessment of the impacts of recreational fishing. One could argue the chicken and the egg scenario!

6. Monitoring of commercial catches through compulsory log-book or catch declaration programmes was a cheaper way of keeping an eye on the status of the resource, or at least pretending to keep an eye on the resource.

7. Anglers, and angling bodies, didn't really want to know what the total catch was, probably because of a combination of the perception that 'we couldn't possibly be the problem' and perhaps a hidden fear that if the truth came out catches might be restricted.

The good news is that in recent years at least some of these influences are changing; this Workshop is testimony to the increased interest in determining what is the catch. But there is no doubt that in many sectors of the recreational fishing community there is still considerable uncertainty and uneasiness (if not quite fear) about what will happen when we do know what the catch is. As a director of research I am constantly reminded of this apprehension. It was most obvious earlier this year when we were canvassing support for our attempts to obtain funding for Aldo Steffe's work on estimating angler catches in near-shore coastal waters. Support from representatives of recreational groups was shaky and much less than unanimous. On the other hand commercial fishing bodies were extremely supportive of this work.

As I have already suggested, the questions, what are you going to do when you do know the answer, and who is going to be affected by any action, can be anticipated to follow the original question of, what is the catch. Let me deal with the second of these questions first—who is going to be affected by any action?

It is generally accepted that there are two fundamental groups who use our fisheries resources, commercial and recreational fishers. One of the real problems of this overly simplistic division is that the title 'recreational fisher' is almost universally taken to include anybody with an active interest in the resource, except commercial fishers. Even commercial fishers can, and should, be included in the recreational community when they are angling, but not for profit. In a number of earlier talks I have drawn attention to the diversity of categories of people who get branded with the recreational fisher label:

1. unlicensed professionals (shamateurs)
2. accumulators, of fish as food or for barter
3. competitors, including those to whom the capture of more fish than others is primary
4. hunters, motivated by the chase and the kill
5. sportspersons, to whom the challenge, the skill, the odds, the adrenalin rush and the satisfaction of a job well done are important, but so is a feed of fish
6. recreational enthusiasts, to whom the outing is most important but for whom a feed of fish is still a prize
7. social fishers, to whom the camaraderie and fellowship are most important
8. adventurers, who like the hunter savour the chase,but not the kill, and who release their catch
9. lovers of open space, who if they do have a line in the water, do so purely to justify being outdoors.

Then there are:

10. observers, particularly underwater enthusiasts
11. preservationists, whose aim is to prevent change.

Obviously these categories are merely suggested subdivisions, and not by any means rigorous classifications of an extremely large and diverse group of people; equally obviously there will be overlap and one individual may fit a number of categories. You would also not have to be Einstein to conclude that the catches taken by the various groups would be considerably different, and that a gradation in catches from top to bottom could be anticipated, at least in catch per unit effort.

The good news is that there is a strong trend away from the very top of the table to more conservation-oriented enjoyment of 'recreational fishing'. It is only twenty years ago that accumulation of the biggest pile of fish would bring admiration and trophies. Competitions were almost all based on rewarding those who could kill the most. In recent years approaches by clubs and non-affiliated anglers have changed dramatically. Total release tournaments are not only a reality, but common, and increasing. Shamateurs are no longer heroes, even if not yet regarded by all as thieves. Exceeding the bag limit is progressively being regarded as anti-social.

So the attitude of the angling public has changed from the goal of catching huge quantities towards more moderate, conservative use of the resource. The Western Australians were rightly applauded for picking up on this trend in their 1990 definition of a goal for recreational fishing as 'To aim to catch a feed for oneself and

family and, for a variety of personal reasons, to enjoy the experience along the way' (Recreational Fishing Advisory Committee, Western Australia 1990). I suggest that this is rapidly changing more towards 'to enjoy the experience and perhaps take a feed for oneself and one's family'.

Strange as it may sound to some anglers, a similar transformation is happening in the ranks of commercial fishers. In many ports the 'best fisher' is no longer the accumulator of the greatest mass of fish, but the one who gets the highest prices. Quality control and maximising dollar returns on a sustainable basis are being increasingly championed by the commercial industry. This is particularly so for quota-managed fisheries. Of course there are still 'cowboys' out there, as there are in the recreational ranks, but the philosophy all round is changing for the better.

Most agencies with the responsibility for managing recreational fisheries have embraced this move towards resource sharing within the recreational sector. They are moving towards policies which facilitate enjoyment by the maximum number of people, often at the expense of maximum catches by a minority. Bag limits are here to stay. As more detailed catch data become available the need for conservative catches in most fisheries, and for further changes in community attitudes, will become more obvious. Maximum participation in the sport is dependent upon the realistic expectation of the average angler of catching a sizeable fish, not of a minority catching a boatload.

Of course some people will be reluctant to change. Some will never change their attitude. While I certainly don't encourage this I can understand it, and maybe even argue why it is so. I mentioned before that I am not a statistician but that didn't stop me dabbling in statistics. Neither am I a sociologist or an anthropologist!

Before civilisation, hunting and killing were the way to go—rape and pillage was the catch-cry—a shamateur's delight. There was active selection for the best provider or hunter. Not surprisingly hunting and killing became instinctive in those who prospered.

As civilisation rolled on, the killing was progressively controlled, or suppressed, but not eliminated. Hunting definitely stayed on. The accumulation of large catches of fish was a definite positive as the accumulator became either a short-term hero, or he/she would have become a long-term guru, as dried or salted stores were put away for the winter, or off-season as the case may have been. Most fish were abundant enough for excessive catches to be taken only seasonally, human populations were low, and fishing gear was so inefficient that long-term depletion of resources was not an issue.

It is really only with very modern gear and the ability to hunt species throughout the year and throughout their life-cycle that change has become necessary. A few generations at most have been exposed to the effects of seriously overexploited fish populations. Nowhere near enough to reverse the instincts acquired over thousands of years. And without education programmes to convince people that there is benefit in an alternative approach, why should they have changed? Particularly if nobody cared enough to even find out what was being caught, let alone to determine what impact it was having on the resource.

Now that I've dealt with statistics, economics and anthropology, what's next? I was a bit worried about straying into these areas as this is a workshop of the Australian Society of Fish Biology but when I looked at the programme and saw not a single session devoted to biology, I felt almost obliged to stray.

Let me hasten to add that I believe that the agenda is indeed most appropriate and covers the key issues. The international perspective of Australia's knowledge of recreational fishing, the theory and practice of measuring catch and effort, the socio-economic implications of fishing and the management of fishing, including resource allocation, are obviously the key issues. It's good to broaden the agenda and it certainly didn't stop the biologists turning up.

Back to the subject of the implications of knowing what the catch is and increased use of this information for sharing of the resource.

Even though there is inadequate information on recreational catches and catch rates many anglers contend that recreational catch rates are declining and that commercial fisheries are primarily responsible for this decline. What *is* the relationship between commercial catches and recreational fishing, even if you don't believe the catches of the two groups are about the same?

Australia's total commercial fisheries production has levelled off in recent years and is expected to fall with the decline in a few of our major fisheries, most notably orange roughy. Particularly for the more heavily populated States, such as NSW and Victoria, our total fish resources are mostly maximally exploited, if not overexploited. Some of the smaller pelagic species, such as pilchards (*Sardinops neopilchardus*) and anchovies (*Engraulis australis*), may support increased harvests but even then possible negative impacts from exploiting baitfish species may restrict expansion of catches. NSW fishers in particular, both commercial and recreational, need to approach the future accepting limited total catches and increased competition for what is taken. Increased use of quota management for commercial operators will help cap the tremendous increase in effective fishing effort which has occurred in recent years resulting largely from improvements in gear technology, most notably the Global Positioning System (GPS) and more efficient fish finders. But improvements in the effectiveness of recreational anglers through the same electronic gadgetry plus tackle, bait and boat improvements and increased leisure time will continue to lead to increases in the effective fishing effort of the recreational community.

Let me use some NSW fisheries as examples.

For several of the species for which there is commercial and recreational competition, commercial catches have been relatively stable for a number of years, e.g. dusky flathead (Figure 1) and sand whiting (Figure 2), while for others they have declined, e.g. snapper (Figure 3). There is little doubt, even in the absence of total catch figures, that recreational catches of all of these species have gone up in the last twenty years. Certainly total recreational fishing effort has increased and so has efficiency. The rapidly improving statistics show that for several of these species recreational catches now dominate in many areas. Therefore even with stable total catches and frozen levels of commercial catch, as appears likely with quota-man-

aged fisheries, further increases in recreational participation must result in declines in recreational catch rates.

As I have already mentioned, many anglers are already complaining about declining catch rates, with commercial fishing normally perceived as the cause. In those fisheries in which total commercial catches and catch rates have not changed in the last twenty years it is probable that the decline in angler catch rates is directly attributable to the increase in total angling effort. In several cases where commercial catches have declined, for example bream in the Richmond River (Figure 4), this decline is almost certainly due, at least in part, to increased total recreational catch which now accounts for more than 90% of the total catch from that river. Of course there are cases where excessive commercial fishing has led to serious declines in recreational catches, none more obvious than southern bluefin tuna off NSW. Careful management of all fisheries is obviously essential.

The current reality is that we must acknowledge that all fishing has some impact on the resource and that management will be necessary to maintain total catch levels of most species, regardless of whether the catch is taken by commercial or recreational users. An accurate description of the catch by all significant resource users is a primary tool for determining the impact of total use and for establishing future levels of use which will provide maximum benefit to all Australians. The task of sharing resources equitably between the major groups will be impossible without at least a reasonable description of the total catch of each group. The equitable sharing of resources within each group will require data collected to much greater precision.

More positive steps towards resource conservation and sharing within the recreational fishing community, such as voluntary constraint on individual catches, closer observation of size and bag limits, and more releasing of fish, will further protect the quality of angling. In the longer term, habitat restoration and improvement, enhancement of wild fish populations and establishment of optimum fish population sizes through research and management successes will all play their part.

In the shorter term, improved knowledge of what is the catch, and passing this information on to the angling community, together with accurate assessment and realistic interpretation of the impact of recreational fishing on the total resource, are prerequisites for protecting and improving the quality of angling. As is, of course, appropriate management of commercial fisheries with which there is competition.

In the process of improving the management of all fisheries, be they commercial or recreational, some of the old perceptions need to change. Most of us have heard the same cliches, for example, 'there are millions of us, we spend billions of dollars, we want more say in management, but we don't catch anything. Well maybe we do catch a little but it is insignificant compared to those blokes with the nets. After all how could a few anglers possibly have an impact on the limitless resources of the ocean?, particularly when most of them couldn't catch a fish if it jumped in their boat.'

It is not hard to understand where these perceptions come from, particularly as nobody has even bothered to measure the total catch. As my colleague Gary Henry often says, 'managing the perception is a big part of managing recreational fisheries'. Surely

knowing the catch must be a big part of improving the perception? And if the catch is as great as some of us suspect, then surely increased involvement of recreational fishers in the management process is appropriate.

In concluding, let me leave you with the words of Lennie Lower, a famous or notorious Australian of the 1930s and 40s; a comedian, story-teller and drinker of considerable note, therefore not out of place with many anglers, and some biologists. Lower enjoyed questioning people's perceptions and he loved provocative questions such as, 'what is the catch?' Lower wrote (Pearl 1963) 'Fred has a bad two-shilling piece which he passes on to a blind fruit-seller who gives him only eleven apples. Was he robbed?'.

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Table 1. Australia's fish production 1989/90 to 1992/93 (from ABARE 1993).

Year	1989/90	1990/91	1991/92	1992/93
Total Tonnes	129 137	157 102	139 289	130 226

Table 2. Data from Table 1 after discounting non-recreational species.

Year	1989/90	1990/91	1991/92	1992/93
Catch	41 000	74 000	75 000	71 000

Table 3. Recreational and commercial catches of selected species in the Richmond River, Clarence River, Sydney Harbour and Botany Bay as % of total catch.

	Yellowfin bream ***(Acanthopagrus butcheri)***	**Dusky flathead** ***(Platycephalus fuscus)***	**Sand whiting** ***(Sillago ciliata)***
Recreational	65	62	37
Commercial	35	38	63

Table 4. Recreational and commercial catches of snapper (*Pagrus auratus*) at Evans Head and eastern blue-spot flathead (*Platycephalus caeruleopunctatus*) at Ulladulla as % of total catch.

	Snapper	**Eastern blue-spot flathead**
Recreational	36	85
Commercial	64	15

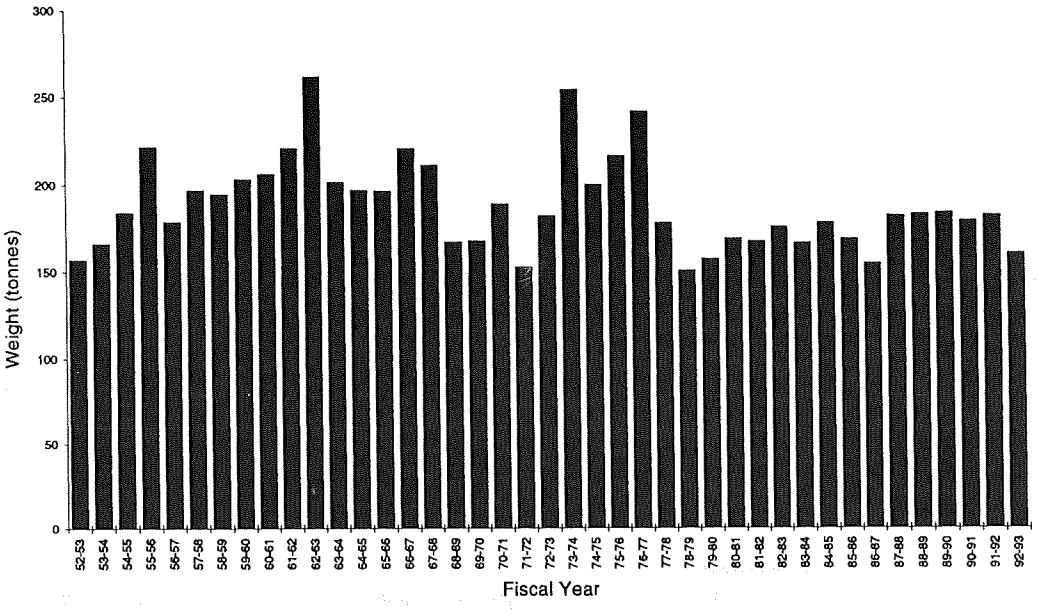

Figure 1. Total commercial production of dusky flathead, *Platycephalus fuscus* Cuvier, in New South Wales.

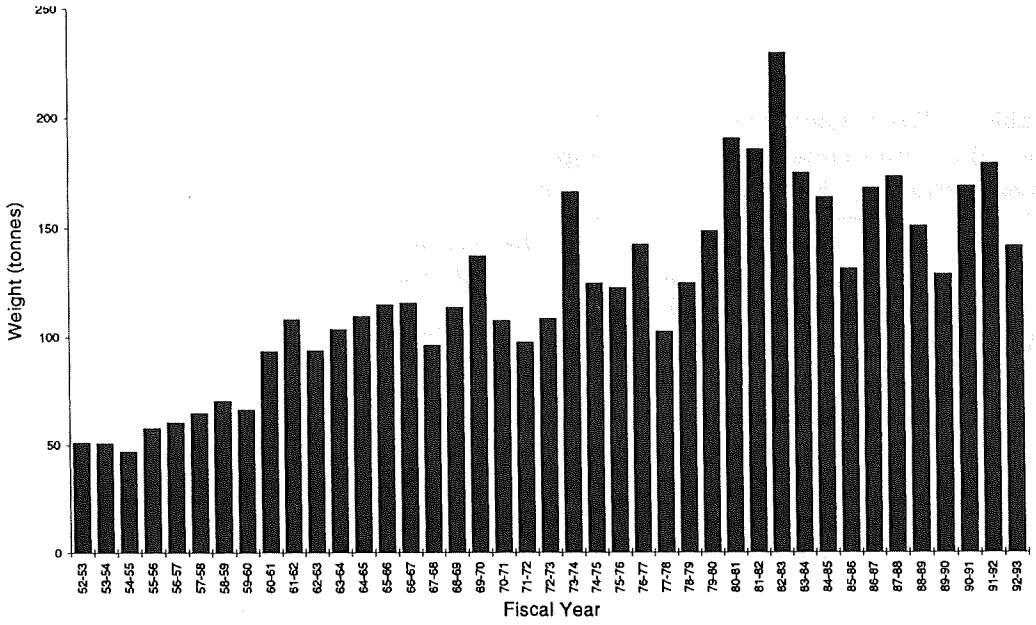

Figure 2. Total commercial production of sand whiting, *Sillago ciliata* Cuvier, in New South Wales.

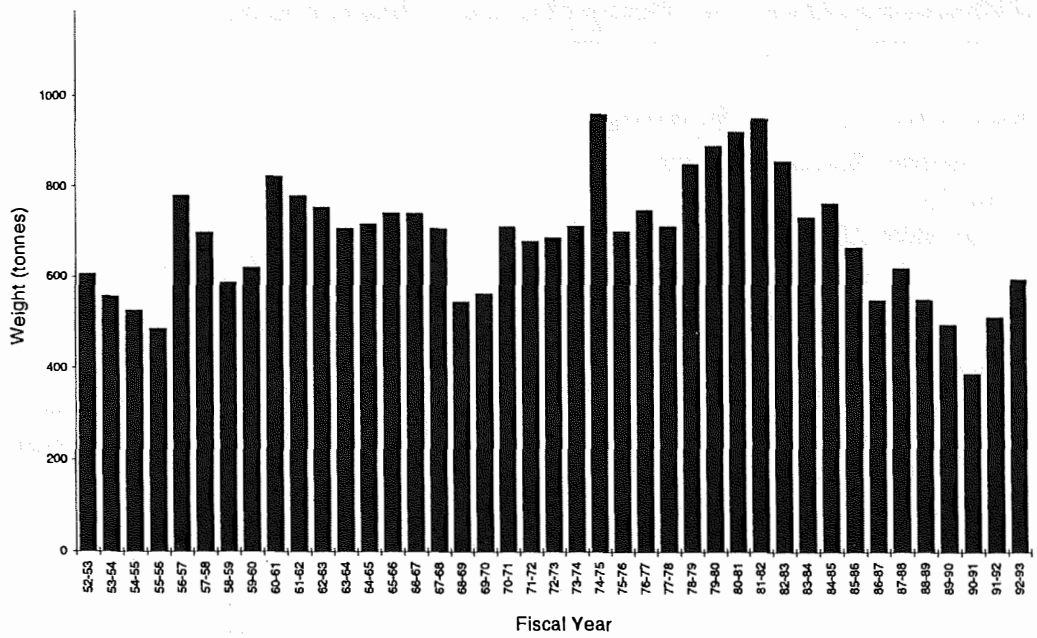

Figure 3. Total commercial production of snapper, *Pagrus auratus*, Forster (in Bloch and Schneider), in New South Wales.

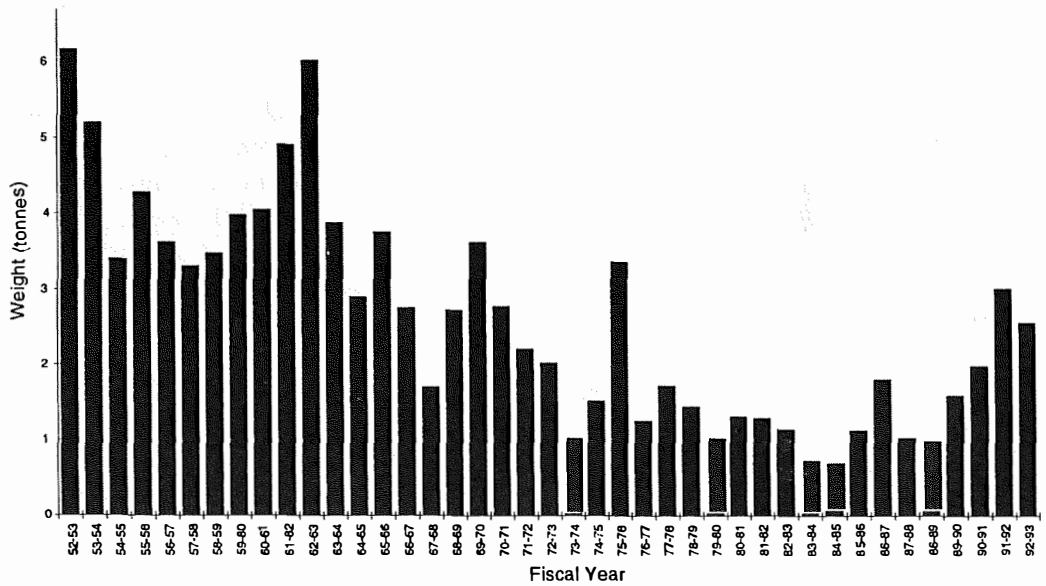

Figure 4. Total commercial production of black bream, *Acanthopagrus butcheri* Munro, and yellowfin bream, *Acanthopagrus australis* Munro, in the Richmond River.

Discussion of Keynote Address

Recorded by K.R. Rowling
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Peter Rogers commented on some similar calculations undertaken in Western Australia. Allowing for the fact that the WA population was about one-tenth of the Australian population, their calculations resulted in the same sorts of numbers. As another approach he suggested the use of a fish consumption survey which he believed would probably arrive at a very similar result. He imagined the estimate of fifty thousand tonnes wasn't very far from the mark.

In response, Bob Kearney confessed that he would not have used the figures if he didn't have at least some anecdotal pieces of evidence to support them. The data for New South Wales were improving greatly, and it was looking of that order or perhaps slightly greater. The real issue was that the figures for some areas and fisheries were heavily skewed. There were very few fisheries, with the exception of some deepwater fisheries, where the effects of recreational fishing didn't come into play, and he cited as an example a recent NSW recreational fishing tournament which was won by an angler catching hapuku, which was previously considered to be strictly a commercial species.

Albert Caton commented that Bob Kearney throughout his address had talked about the 'catch' and wondered if he was referring to the landings or to the actual 'kill' by recreational anglers.

Bob Kearney explained that he had mentioned the distinction between landings and catch in his address, and that he had started to do some calculations of the 'kill' by looking at a couple of examples, but had found it difficult to get figures he was happy with. He cited the commercial catch of juvenile snapper by prawn trawl in the Sydney area, estimated to be several hundred thousand, and compared it with estimates of the recreational catch of juvenile snapper from creel survey data, which amazingly came up with estimates of recreational 'kill' of about the same numbers (around three hundred thousand). He cautioned that he wouldn't put too much weight on these figures, but felt it was significant that estimates of the recreational and commercial catches were similar in magnitude. He had also tried to get accurate estimates of the 'kill' in the by-catch of beach haulers and anglers in the Richmond and Clarence Rivers, and although some figures were available, it was very difficult to estimate because of the degree of variability in how different groups treat the by-catch before returning it to the water. The rules in NSW about how beach haulers are

to return undersized fish are quite stringent, and unless they have particularly big catches it appears that the 'kill' is not that high. However, the kill of fish, particularly in non-discriminant recreational fisheries where people are fishing with a worm on a small hook, is indeed great, and the available data suggest that the levels of retained and discarded catch are about similar—he suggested this was a problem someone else may usefully take up at a later stage.

Colin Buxton observed that mention was made of the errors and variances in the estimates of the recreational catch, and wanted to know the level of confidence in the commercial reporting.

Bob Kearney responded that he had no doubt that the commercial catch was recorded more precisely, but commercial catch records are not accurate and should not be confused as such. Commercial catch data in NSW that can be validated are not out by 100% and with the exception of the very high priced species (e.g. abalone and lobsters) the landings data seem to line up fairly well in relation to known catches. He believed the commercial catch data were probably a better indicator of trends than descriptions of total catch. One also needs to keep in mind the effect that changing management policies may have on commercial data bases, and gave as an example the introduction of quota management policies. Even so, he believed they probably provide good 'ball-park' estimates of the commercial catch, and he would feel somewhat more comfortable with them than with the estimate of fifty thousand tonnes for the recreational catch.

Murray MacDonald commented on Victorian data for inshore catches and, for those species where they did have data, estimates of the recreational catch were at least as large as those for the commercial component. Given the complexity of the estimation of both recreational and commercial catches, he wondered if the potential impact of habitat change on the main species should be considered as an additional area of complexity that needs to be taken into account?

Bob Kearney replied that he had mentioned the effects of habitat change on two occasions, but he had concentrated on addressing the problem of 'what *is* the catch, and how do you estimate it', not what has affected the catch. He added that he believed it is a major issue, that should rightly be addressed in another forum.

Patrick Coutin asked Bob Kearney if he had any feeling for the breakdown of the recreational catch amongst the various gear types used, as recreational netting is significant in some States.

In reply Bob Kearney stated that there was no legal recreational netting for fish in NSW (and the figures he presented specifically excluded crustaceans and molluscs) and he considered such catches to be unlicensed commercial catches, as there was nothing sporting about them, and the average angler (or commercial fisher for that matter) would not wish to be associated with them. Such catches are almost impossible to measure and he had not attempted to estimate them for the purposes of the paper.

Just before Bob Kearney was thanked for his address, Ted Loveday commented that we had seen how to estimate what the recreational catch was, but what he was very interested in was the formula for how to allocate the resource between competing users!

Session I

International overview

Session Chairperson:	J.G. Pepperell
Sesson Panellists:	R.P. van der Elst S.P. Malvestuto L. Teirney D. McGlennon
Rapporteur:	K.R. Rowling

Chairperson's Introduction

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The history of recreational fishing is long. Bone fish hooks have been found in Europe which are at least 6 000 years old, and it is highly likely that wooden gorges were used for thousands of years before that. Of course, it can be argued that these methods of fishing were primarily for subsistence, but in those halcyon days of plenty, I would imagine that fishing was good and that recreation was an important component of a fishing trip.

In contrast, the history of quantifying the catch and other parameters of recreational fishing is very short; in fact, only of the order of forty years or so. Recreational fishing is a universal pursuit, and in most western countries, is widely regarded as a right rather than a privilege. In the face of increasing competition for resources, the need to quantify and monitor all aspects of recreational fishing has never been greater. The question is, how?

Fisheries managers would wish to know the answer to the question: What is the total recreational fishing effort and catch in a given fishery? Sociologists, politicians, economists, town planners and business people would also want to know: How many people fish recreationally? How often do they fish? How much do they spend on fishing? How much would they be willing to spend? Who are they (what are their demographics)? What are their dynamics? What do they want? What do they perceive about recreational fishing? What are the projections for all of these variables? and finally, How will they vote?

Attempts to answer many, if not all of these questions are quite recent, and approaches to answering them have varied from country to country. We are fortunate at this Workshop to have the opportunity to hear about these approaches on a broad scale in the four countries which have, I believe, gone farthest down the track towards those goals.

In this Session, we will attempt to discern similarities and differences in approaches to these problems in South Africa, the United States, New Zealand and Australia. Rudy van der Elst outlines his country's unique and ongoing 'Marine Linefish System' by which recreational catch and effort are routinely monitored on a broad scale. Stephen Malvestuto emphasises the utility of creel surveys in not only measuring catch and effort, but also in providing biological and human data on recreational fisheries. Laurel Teirney gives a review of a major national survey on recreational fishing in New

Zealand and importantly, shows how these data have already been applied to management problems; and finally, David McGlennon provides a comprehensive review of surveys and studies of recreational catch and effort in Australia. Interestingly, David's review does not support the oft-heard claim that recreational fishing effort has been and is increasing dramatically and inexorably.

We don't all have the same problems and solutions to recreational issues, but we can certainly gain by listening to the advice of those who are at the coalface in different countries.

Strategies for data collection in marine recreational and commercial linefisheries of South Africa

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1. Historical aspects

Despite the fact that in South Africa recreational angling commenced in the mid 1800s, a mere twenty years ago the Minister of Fisheries still considered marine recreational angling to be a mildly irritating activity undertaken by a bunch of lead swinging tourists. When motivating for support to investigate marine recreational angling in South Africa, we were told that it was a *sport* and that instead we should approach the Ministry of Sport and Recreation, which we duly did. Now, in a land where rugby rules supreme, you will understand that we had a tough time competing with those who play such manly games. However, we were successful and received some funding to make the first assessment of marine recreational angling in South Africa, supplemented by support from the World Wildlife Fund (WWF). But rugby won the day and funds were cut. Undaunted, we re-approached the Minister of Fisheries. We were told to remove the word 'sport and recreation' from the proposal and have it changed to 'linefishing', as practised by recreational anglers and commercial hook and linefishers. A modest grant was made available and so the South African marine linefish research programme came to be.

But where to start? The funding was modest and in a fishery that has 3/4 million participants distributed along 3000 km of coastline it was no small task to come to grips with the statistics of this fishery. A number of stocks had allegedly collapsed but there were no data to substantiate or investigate this. Stocks straddled different regions of the country. The thrust of research to date had been primarily biological with little attention to stock assessment. Many species were endemic with very slow growth rates. Hence, short-term investigations on species that attain 30 years would be of little use without longer-term investigation of data trends. The high incidence of endemics in the fishery meant that the international literature was often not adequate.

A variety of other factors had a direct bearing on developments at that time:

- The urgent need to document catch and effort statistics in the linefishery.

- Marine recreational angling was highly organised in South Africa and some groups had maintained exceedingly accurate records since the turn of the century.
- There was a desire amongst many anglers to assist in gathering data, seeing results and being part of research.
- In some regions, especially Kwa-Zulu Natal, there was a well organized nature conservation agency that was willing to play a key role in data collection.

As there were no more than six researchers engaged in the study of the linefishery at that time, it made sense to incorporate the goodwill and practical support of the thousands of volunteer anglers and nature conservation officers to gather the data for scientific analysis and fishery assessment. And so the National Marine Linefish System (NMLS) was conceived.

2. What is the NMLS?

The NMLS is a fisheries data base (one of the largest in South Africa) that maintains long-term catch and effort records of all important sectors of the linefishery. It facilitates and actively promotes access by researchers, students and fishers while providing the single most important source of fishery information for management decision support. It is unique in many respects in that:

- It has a highly flexible design that allows capture of fishery and biological information from a wide range of different sources.
- It is a national data base, hence pooling data from the various regions and to some extent from neighbouring countries.
- It is a collaborative undertaking with data collected, processed and used by government agencies, provincial conservation bodies, National Government Organisations (NGOs) and fishers.
- It treats the linefishery as a single, national resource, hence the recreational, commercial, subsistence and artisanal components are all documented in a single data base.

3. NMLS objectives

The objectives of the NMLS have changed over the years. Initially they were to design, develop and implement a system that would provide long-term catch and effort statistics of the linefishery. As the system developed so its objectives became more focussed so that the following six underlying objectives now drive the NMLS:

- To collect adequate long-term catch and effort data series from all important sectors of the linefishery to enable the state of stocks of important target linefish species to be assessed.
- To ensure that collected data are adequately representative of all linefishery sectors and linefish target species in major fishing areas.
- To supplement collected cpue data with representative length frequency data for major species at major landing sites and with necessary morphometric and growth data to facilitate quantitative stock assessments.
- To develop and administer a computerised database system capable of capturing all linefish data sources and providing analyses required for feedback, management and scientific study.

- To facilitate access to this system by all research and management agencies for the purpose of contributing data or obtaining analyses required for linefish research and management.
- To maintain data capture and processing standards for all the above objectives, to ensure long-term validity and compatibility of data collected.

4. How does the NMLS operate?

The NMLS is a cooperative programme involving state fishery agencies, (Sea Fisheries Research Institute SFRI; Natal Parks Board NPB; Kwa-Zulu Department of Nature Conservation KZDNC; etc.) and NGOs (Oceanographic Research Institute ORI), commercial fishers, recreational anglers and subsistence fishers. The NMLS concentrates on obtaining data from fishery-related activities already in place, some compulsory, others voluntarily. This includes mandatory catch returns submitted by commercial fishers, fishery harbour authorities and dealers, daily beach patrols undertaken by nature conservation officials (NPB), fishing registers at resorts and angling tournament records. Statistics are recorded in monthly log books, daily beach patrol registers, daily resort catch cards and annual angling registers. A system of codes and standardised procedures ensures data compatibility and extensive validation of data are built into the data capture process. This occurs at two centres in South Africa facilitating up-to-date analyses and feedback.

A major task of the NMLS involves the generation of feedback analyses to all its participants. This includes personalised analyses for the several thousand boat fishers, numerous angling clubs and regional conservation authorities. Regular data reports for scientific and management use are produced, including an overall assessment of total landings and trends in the linefisheries. The NMLS is managed by a small working group that reports to a larger linefish research committee and ultimately the chief director of fisheries in South Africa.

(A) Data sources

One of the ongoing design criteria of the NMLS is to ensure maximum flexibility in the capture of catch and effort statistics from diverse sources. Essentially, as long as a date, a fish species or group name and an index of catch in weight or number are available, the data can be captured. In addition to the fishery information there are also the system codes needed to code and validate the data.

System codes

These are used to code and validate all of the data, captured on the NMLS, but constitute a database of their own to some extent. Detailed coding systems were developed prior to development of the data capture facilities to ensure that long-term compatibility problems were avoided. Historic databases have been characterized by incompatible, short-term, *ad hoc* coding decisions that greatly complicate long-term analysis or comparison of data. NMLS codes are maintained for:

Locality. Considering the wide range of data sources, mostly provided by individual members of the fishing public, grid-based coding systems are not feasible. A system of distance codes along the Southern African coastline associated with real names for all known fishing areas, is used. Attached to these coastal codes is a system of offshore

indicators, allowing the depth/distance offshore to be captured for offshore operations. In addition to the system files, conversion lists are maintained for all common locality names encountered on returns from specific areas, to allow the correct system codes to be selected, e.g. where the same name is used for different sites along the coast.

Species. A system of four-letter mnemonic codes is used for both individual species and species groups, where fish are reported by fishers in categories rather than species. Attached to these mnemonics are the corresponding common names, the accepted scientific name, and the Family name, allowing for display of any of these name options on analyses. Also attached to each species code are the known weight and distribution ranges (in localities) of the species, allowing for validation of entered data, for example, where an incorrect common name results in a species being captured against an invalid distribution range. In addition to the system codes, conversion lists are maintained for all known common names used for various species in various areas, to facilitate the selection of the correct accepted common names.

Clubs and data sources. These codes are specifically created for each recreational angling club or data source (such as a specific resort) providing data, to ensure that data are captured against a valid club and that data are not accidentally duplicated. This also facilitates analysis of the data where results for a specific club, resort or other site are needed.

Morphometric data

Related to the system codes, these data are primarily used to convert data into formats required for specific summaries. For each species for which such formulae are available, whole:gutted weight, length:weight and von Bertalanffy growth parameters are maintained. These are used, for example, to raise gutted weights to whole weights for estimation of actual catches, to generate or validate sample weights for length frequency samples and to convert catch weights into catch-per-length-class and catch-per-age-class for stock assessment purposes.

Commercial monthly catch returns

Compulsory commercial catch returns comprise the largest section of data captured onto the NMLS. Forms are submitted on a monthly basis, either directly to the research institute or via fisheries control officers, by the ±3000 registered linefish vessels. Reports include daily crew, hours fished, fishing area and total catch per species. Weights on these returns are estimated by fishers and there have, not unexpectedly, been allegations of falsification of data by some.

Fisheries harbour returns

Monthly returns submitted by harbourmasters at fisheries harbours are one of the oldest commercial linefish data sources available, having been instituted prior to 1970 to monitor landings and activity in fisheries harbours. These have been maintained and upgraded to include estimates of effort (number of boats operational) and catches per species, and are received from all fisheries harbours. These harbour returns provide a good source of information for validation of catches in a number of areas, depending on the effort put into their completion by the staff concerned. While accuracy is poor in some harbours, at some places the harbour returns are highly accurate, and document almost 100% of the landings made by commercial vessels.

Linefish dealer returns

As with the other commercial data sources, these have been in use since prior to 1985, having been introduced in areas where other data sources were limited, but fish purchases were controlled by a single large company. Historic data, in the form of original purchase records from cooperative companies, extend back to the late 1950s. These purchase records are used to obtain independent estimates of total catch in certain areas used to validate individual boat returns.

Recreational skiboat catch cards

These daily returns are analogous to the monthly commercial returns, providing similar data. They were developed to provide information on daily, non-competition fishing, specifically by angling club members. They are therefore generally issued, controlled and returned via angling clubs, necessitating public relation efforts to both introduce and maintain data flow. These cards are somewhat more flexible than the commercial returns, allowing for reporting of catches in number, individual weight or total weight per species. Provision is also made for capture of club codes and user-specified boat codes, allowing for feedback of data to participating clubs and boats, and maintenance of anonymity for participating boats.

These cards are currently the largest individual recreational data source captured by ORI and this data source can also be used to capture information from personal logbooks. Data submission does fluctuate, depending on the spirit of cooperation from clubs. Card returns have declined sharply at times in response to promulgation of unpopular management measures.

Light-tackle boat catch cards

These are essentially the same as the skiboat cards, but are specifically used for monitoring recreational boat angling by the light-tackle sector, usually in estuarine environments. As a result of the importance of systems such as St Lucia in Kwa-Zulu Natal, this the second most important recreational data source, providing approximately half as much data as skiboat cards. Although the species differ to some extent from those caught in the marine environment, these data are important for monitoring the estuarine catch of marine species whose juveniles are dependent on estuaries. The issue and return of these cards is controlled through angling clubs and resort management authorities.

Shore angling catch cards

These are similar to other daily cards, but are not specifically submitted by clubs. The most important data sources are controlled areas, such as coastal reserves with controlled access entrances, where anglers are required to complete a card before exiting the area. Shore cards are also issued to certain individual anglers who have expressed an interest in providing data. These cards were introduced by ORI before the other card systems, specifically to monitor fishing in popular shore angling areas, and as an adjunct to the NPB shore patrols. Providing a similar quantity of data to the light-tackle cards, the importance of the data sources varies. In some cases a complete picture of landings is achieved whereas returns from some other areas are poor.

Spearfishing catch cards

These were the most recently introduced system of catch cards. While returns from the various Cape provinces have been

poor, they have become very important in Kwa-Zulu Natal. These cards are practically identical to the skiboat daily cards, and are issued both to clubs and to interested individual spearfishers. Returns are also submitted in conjunction with a spearfisher licence system in Kwa-Zulu Natal, providing additional data.

Tournament fishing returns

Tournament angling returns are the oldest regular source of recreational data on the NMLS. Initially, data were derived from a variety of tournaments, some dating back to 1955. In recent years efforts have been made to develop standardized competition recording forms, and to encourage their wider use. As a result of the variable design of existing competition record systems, this data source is the most flexible of all, and data can be captured in just about any format. However, this also means that data are less comparable, and that certain important data fields may not be provided on some of the competition returns. More seriously, the use of competition data for linefish stock assessment poses problems related to different targeting during tournaments, and shifts in targeting (e.g. to cartilaginous species) during competitions over the years.

Despite the limitations, competition returns have provided data for sectors or areas not monitored in any other way, such as shore angling in the Cape. For much of these data, it has also not been necessary to introduce or motivate its collection, as this has been an existing club requirement. Some of the competition return sources therefore provide fairly long time series of data, dating back to the mid 1950s.

Shore patrol records

Shore patrols on foot or by vehicle are part of the daily routine of the NPB staff to ensure compliance with legislation. However, to generate more value from such patrols and to interact more positively with the public, recording of catches during such patrols was introduced as a cooperative activity between ORI and the NPB. Despite the relatively strong club affiliation in Kwa-Zulu Natal, the majority of anglers are not club members. It was particularly the dramatic decline in elf ('tailor') catches in Kwa-Zulu Natal that prompted the introduction of regular shore patrol records and this system has increased steadily in data quantity and quality to the stage where it now provides an excellent, and fairly complete coverage of Kwa-Zulu Natal shore angling effort. As a result of regular data feedback and the use of these data in support of many shore angling management decisions in Kwa-Zulu Natal, the NPB have also come to rely on the analyses of their patrol efforts for monitoring the performance of their staff and for planning patrol strategies to ensure coverage of important fishing areas and seasons.

This data source differs markedly from other recreational sources, in that it is obtained, on a planned and cooperative basis, by trained and involved management staff, under close scientific supervision. The data collected are therefore of a relatively high quality, as well as being comparable over time. Such 'observer' data collection systems provide an attractive alternative to conventional submitted data for providing indices of catch and effort for fisheries amenable to such observation.

Boat inspection cards

As a result of the success of the NPB shore patrol records, and in response to the good working relationship between the ORI and the NPB, the collection of observer data has recently been extended to coverage of boat fishing operations. In independent initiatives, the SFRI and ORI have respectively designed and introduced boat inspections cards for use by patrol officers in reporting, respectively, commercial and recreational boat catches of linefish. These systems were introduced to provide a means for validating existing returns by fishers, and to provide independent indices of catch and effort.

In Kwa-Zulu Natal, the system has already resulted in improvement in data as a result of follow-up of discrepancies between inspection cards and monthly catch returns. More importantly, the cards have shown that over 90% of the monthly returns submitted in Kwa-Zulu Natal are substantially correct.

Collection of recreational boat inspection data by the NPB has grown rapidly since introduction of this system in 1986. Inspections were initially limited to controlled launch areas, such as Cape Vidal and Sodwana, where submission of voluntary cards is relatively poor. However, the system has now been extended to the whole Kwa-Zulu Natal coast. The recreational boat inspections have been used more as an independent data source than as a means of validation, and are steadily becoming a viable alternative to voluntary cards, particularly where cooperation by fishers has declined in response to implementation of management measures.

Length-frequency data

All length-frequency data collected by linefish researchers can be captured on the NMLS, together with information on catch method, catch area, date and sample weight. These data can be summarised directly to provide size composition summaries, and are also used to convert catch weight data into catch-per-size-class summaries.

Biological data

The NMLS also provides a facility for capture of standard biological sample data (lengths, weights, sex, maturity and gonad stage), but this facility has been designed mainly as a data capture facility for use by SFRI scientists. No summary facilities are provided, and research staff must extract the required data for subsequent analysis using software of their choice.

(B) Current holdings

To date there has been a total of 4 million fisher-day outings documented in the NMLS, 41200 shore patrols (about 1 million kilometres or 15% of the coastline on an averaged daily basis), 3800 boat inspections and 1/2 million fish measured. Annually this represents about 25 megabyte of data. Each year about 125 000 data forms are encoded and processed (35 000 of which are recreational) which requires approximately five full-time staff.

(C) Summary facilities

As a result of the wide variety of data sources as well as the involvement of so many members of the fishing public, one of the main characteristics of the NMLS is the diversity of summaries provided. These essentially fall into three types: system,

feedback and scientific summaries. System summaries are used for control and maintenance of the NMLS itself, particularly aspects of data capture, validation and management. Feedback summaries are specifically designed to provide for return of summarised information to all participating fishers, harbours, dealers and other data collection agencies. Scientific summaries are designed to provide information necessary for research projects and input to management agencies.

System summaries. These summaries are central to the system itself in that they provide for management in a number of areas. Examples include: time logs and form logs, daily transaction files, data listings to assist with validation, data inventories to manage the flow and distribution of data, commercial boat listings to determine the coverage of compulsory returns, etc.

Feedback summaries. These are a key element of the NMLS and a significant factor contributing to its success. Recreational anglers as well as commercial fishers are given an annual analysis of their results and performance when related to the rest of the coast. Most of this information is automatically generated by the computer although specific brochures and analyses are produced as well.

Feedback summaries are available for all data sources, including all catch cards and competitions, commercial boats, harbour and dealer returns. They provide basic catch and effort for each species caught with limited selection of areas possible. Selection of individual species is not provided in this system. This feedback system is a service to fishers and in many instances provides an excellent catalyst to stimulate data collection.

Scientific summaries. A suite of reports is automatically produced to provide for a scientific overview of the data and assessment of broad trends. The distribution and adequacy of the data can be determined in this way and these summaries also provide a useful source of information for producing status reports, decision support documents etc. A variety of reports are included such as all details pertaining to beach patrols, length frequencies, as well as commercial and recreational summaries that allow for interpretation of broad trends in landings.

New developments include an on-line extraction facility that will facilitate more flexible scientific data extraction and manipulation.

(D) Validation of records

As in any large fisheries database, there is the question of data validity. The NMLS is no exception. Some have argued that it overestimates landings, others believe it provides too conservative a picture. Most criticism comes at a time when unpopular management actions are envisaged or it is generated by those who are not using the system. In truth, the system is extensively cross referenced and tested. The following are some of the systems in place.

- Data capture is undertaken by trained staff who double check all entered data. The capture programs are designed to trap anomalies by comparing data against a static information code. This includes outsize specimens, species found outside their normal range, excessively large or unseasonal catches etc.

- Wherever possible, overlapping data collecting systems are introduced. Thus the shore patrols by trained conserva-

tion staff can be used to cross reference the voluntary submission of catch cards from a particular resort.

- A number of observer programmes have been introduced that further cross reference the data. Boat inspections, creel surveys and regular attendance by staff at angling tournaments provide ongoing validation.
- Numerous research projects by individual scientists have generated comparable data which, in virtually all cases, have correlated remarkably well with the NMLS database.

The NMLS is designed to be of benefit to all users, including anglers who are encouraged to use the data in their own interest. Regular production of feedback and good public relations greatly assist in keeping the data clean. In promoting the system we often suggest anglers should:

> 'themselves contribute to a sound scientific data base for good management instead of leaving management decisions to a politician who may well suck his thumb to determine the future of their fishery!'

5. Products and services

The NMLS is designed to provide a broad spectrum of services and products which range from specialized scientific reports to individual data listings, and are provided to people ranging from individual fishers to the Minister of Environmental Affairs and Tourism. The major products are:

- *Feedback reports and summaries*

  These are provided on a personal basis to participating fishers, clubs, agencies, resorts etc. Some 5000 of these are produced each year. A variety of pamphlets summarizing the fishing trends are produced for different facets of fishing and different regions. Close on 30 000 of these are printed each year, providing an excellent product to enlist further voluntary support. A complete series reflecting a decade of fishing trends is now available for some regions.

- *Individual fisher's requests*

  For a variety of reasons a fisher may desire a detailed breakdown of his landings for the year. This ranges from the selection for national honours in angling to resolving disputes and measuring performance.

- *Annual reports*

  These are produced as an obligation to the funding and participating agencies. Included are statistics submitted to international agencies such as ICCATT, FAO etc.

- *Scientific summaries*

  Numerous scientific projects draw raw or processed data from the NMLS. These are usually provided in the form of a data report and in time will become an on-line facility. This task is especially onerous when a national fisheries or oceanographic conference is to be held when many researchers discover the real value of the NMLS.

- *Management reports*

  A large variety of reports, discussion documents and green papers are based on NMLS-generated information. This ranges from motivations for improved fisheries management and resolving of user conflict, to the impact of specific

development projects. In particular the implications of various management alternatives can be determined or simulated. Once management measures are taken, the NMLS offers an opportunity to monitor any possible change in the fishery and subsequent management can be adjusted accordingly.

- *Publications*

  The NMLS has provided a catalyst for the production of papers, ranging from popular articles and data reports to papers in the primary literature. More than 269 publications have been based on data from the NMLS and, judging by the range of publications, the NMLS clearly occupies an important niche in networking between science, management and fishers.

6. Some results and their application

Numerous examples of results generated by the NMLS exist. Most focus on trends in the fishery, especially long-term changes in species composition. Most significant was the development of a new national Linefish Management Plan in 1992 which relied extensively on the NMLS. Changes in landings of slow growing endemic species prompted stricter legislation for these selected fish. Issues of user conflict were resolved by clear identification of recreational species which have subsequently been completely decommercialised.

More scientific application has come from the use of total catch estimates (in king mackerel) for stock reduction analyses. The NMLS interfaces with mark and recapture programmes to provide annual estimates of effort and hence changes in fishing mortality F for specific periods. Length frequency analyses assist in size-based estimates while trends in cpue have generated mortality estimates. Many more examples can be detected from the publication list.

7. Future plans

We have painted a rosy picture of success. But we are also aware of some of the problems that remain. An appropriate balance between distribution and quantity of data, needs to be refined. We undertook an elaborate statistical investigation into the data to refine our procedures and minimise our collecting effort without forfeiting accuracy or variance. For example we randomly halved certain data sets and compared their results with the complete set. To an extent this was useful and certain improvements were made.

In particular we need to extend the recreational data collecting to other regions such as the provinces of Cape. There is no doubt that intense and continued contact (and interest) shown by scientists to anglers pays dividends in data generation. A link with the NMLS is currently being developed with Mozambique as this neighbouring country shares many linefish stocks with South Africa. Eventually a complete linefish database for the region should be set up. This will not only provide much needed data on linefish stocks of the region but also promote and facilitate multi-institutional and inter-regional fisheries collaboration.

8. Acknowledgements

Many agencies and individuals have contributed to the success of the NMLS. Funding has been provided by the SFRI, SAAMBR, NPB and WWF. Staff directly involved are C. Wilke, M. de Wet, L. Smith, H. Nelmapius and R. Govender. Special thanks are due to the coastal staff of the Natal Parks Board for their outstanding beach patrol records.

Measuring the response of recreational fisheries to management strategies in the United States: the role of creel surveys

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Abstract

A fishery can be defined as a complex of interactions among environment, fish stocks, and man. Appropriate fisheries management demands understanding the interactions among these components. The creel survey is the sampling method by which information on the interaction of anglers with fish stocks is collected. Traditionally, creel surveys are the only way to obtain estimates of fishing pressure, catch and catch per unit effort (cpue); cpue is used as an index of stock density and as a measure of angling success. For development of optimum yield management strategies, creel surveys focus not only on measurement of biological responses of fish stocks to fishing pressure, but additionally on the sociocultural, economic and fish consumption responses of people using the stocks. Creel surveys can be used routinely to provide the biological and human dimension data necessary for development of appropriate site-specific management plans.

Introduction

This paper provides a perspective on recreational fishery management in the United States, with special reference to the role of creel surveys. A recreational fishery might be defined as a complex of interactions among environment, fish stocks, and man that provides recreation and food acquisition opportunities. Management is a planned manipulation of a fishery as per defined objectives to increase benefits to people. When fisheries are managed, they respond in certain ways. To measure response, variables must be identified and a pertinent question becomes 'Which variables should be measured to evaluate attainment of management objectives?' To properly evaluate management response, it is necessary to measure the specified variables both before, and after, the management action.

A management scenario

I will address the subject of measuring fishery response by stepping through a management scenario. Assume that we have sampled a freshwater reservoir fishery and this is our current assessment: (1) We are working on an oligotrophic to mesotrophic lake, i.e., not a highly productive system; (2) there is a major predator that is

the primary target species of anglers—this would be the largemouth bass in the south-eastern United States; (3) there are only one or two main prey species, also sought by anglers; (4) the limited productivity restricts the surplus production of larger individuals, so there is a limit to how many larger largemouth bass (greater than 30 cm) the system can support; (5) the stock density of the major predator is high for fish less than 30 cm because of a 30 cm minimum length limit—even limited spawning success is enough to 'stockpile' individuals just below the minimum length limit; (6) large individuals of the main prey species are rare because of high mortality of young prey inflicted by smaller predators—a few prey fishes escape being eaten and grow up to be large, desirable sport fish; and (7) fishing success is poor for both the major predator and the main prey species and anglers are dissatisfied.

Specification of management objectives

Based on the assessment itemized above, the general management goal would be to improve fishing success for both the predator and the prey species, which means increasing the stock densities of the larger individuals. The specific management objectives would be to: (1) encourage the harvest of the smaller predators (20 to 30 cm) to thin high stock density—this will increase the growth rate of these fish so that they reach harvestable sizes, and also will reduce predatory pressure on the prey species; (2) protect the larger predators over some length range in order to build the stock density—in this case we might want to promote catch and release fishing over this protected range; and (3) allow harvest of memorable-sized predators to satisfy anglers.

Choice of management strategy

These management objectives might be satisfied by implementation of a slot length limit. A slot length limit protects individuals within the length slot, but both smaller and larger individuals can be harvested. For example, a 30 to 35 cm slot length limit would protect predators between 30 and 35 cm, but individuals below 30 cm (high density portion of the stock) could be removed, and larger individuals greater than 35 cm (memorable-sized fish) also could be taken home. The slot length limit is an example of the resurgence in the United States of customized length limits to control angling pressure on certain size classes of exploited stocks and to try to manipulate the populations to function in a more productive way.

Expected fishery response to management

If the 30-35 cm slot length limit were implemented, what changes would we expect to see? Over the short term, we would expect an increased harvest of smaller predators between 20 and 30 cm—we would be encouraging people to take home these smaller fish, thus inflicting higher mortality on the high density portion of the predator stock. We would expect no harvest of predators between 30 and 35 cm—this is evidence that people are adhering to the restriction. This situation provides an opportunity to promote catch-and-release fishing to maintain angler satisfaction even though fish of protected lengths cannot be taken home.

Over the long term, we expect to see stabilization of the harvest of the smaller predators, and continued catch and release of protected individuals. We expect decreased abundance and increased growth rates of predators between 20 and 30 cm, and increased harvest of memorable-sized predators greater than 35 cm. Ultimately, we would like to see shifts in the length structures of both predator and prey stocks toward larger proportions of larger individuals—we desire to create new size structures for the predator and prey populations that will allow more productive stock dynamics leading to increased harvests by man.

Definition of response variables

Given our expectations concerning changes due to the management plan, what variables should be measured to determine if our objectives have been met? Fishery independent surveys can provide measures of stock density, length structure, and growth for key species. Based on the proposed slot length limit, we are particularly concerned with abundance and growth within three length groups of the predator population, i.e. fish between 20 and 30 cm, fish between 30 and 35 cm, and fish greater than 35 cm. The creel survey will provide estimates of catch-and-release rates, harvest rates, and total harvests for target stocks within the three length groups.

If we refer back to our definition of management, a logical question is, 'Which response variables really measure the benefits derived by the anglers?' We might answer that the number and sizes of fish harvested are measures of benefits to people; however, these variables relate more directly to the biological status of the stocks and the fishing pressure on the stocks, rather than to the response of anglers to fishing. Numbers and sizes of fish are traditional maximum sustained yield (MSY) management end points and provide a very limited assessment of the human, or societal, response to management.

To adequately measure human response to fishery management requires definition of response variables that measure benefits to people. In a larger context, it would be desirable to have a standardized information framework for evaluating multiple yields from management strategies. In a conceptual sense, we need an empirical structure for moving from MSY to OSY, or optimum sustainable yield.

An information framework for application of OSY

To move toward the concept of OSY, I have established four social accounts that, in essence, categorize the kinds of information that should be collected to adequately assess fishery response to management (Malvestuto 1989). These four accounts are ecosystem value, human health value, economic value and socio-cultural value (Figure 1). The ecosystem value account concerns the health or integrity of the ecosystem. The human health value account measures the dietary and medicinal benefits associated with the harvest and consumption of fish or other aquatic organisms. The economic value account determines users' willingness to pay for recreational fishing, and the socio-cultural value account identifies benefits derived through resource use that cannot be valued conveniently using money. The idea is that concurrent consideration of all four accounts will provide an information framework for application of OSY.

Figure 2 depicts relationships that describe the interplay between the value of the ecosystem account and the values of the other three accounts. The x-axis represents use, with zero use at the origin. Increasing levels of use can be viewed as increasing levels of man-induced stress—the more use, the more stress, or pressure, the ecosystem must sustain. The vertical axes represent the yields from the ecosystem. As indicated, there are several yields. The straight line relation with the negative slope represents yield measured as the intrinsic value of the ecosystem. The ecosystem has value in, and of, itself, based on its health or integrity. The maximum intrinsic ecosystem value occurs when the ecosystem is in a pristine state, before it has been subjected to use by man. For the fish community, this would represent the equilibrium state in the absence of fishing pressure. As the negatively sloping line indicates, intrinsic value begins to decrease as the ecosystem begins to be used—man changes the ecosystem relative to its no-use equilibrium, and the ecosystem begins to degrade. The more pressure man applies, the more the ecosystem degrades, and the more the value of the ecosystem account declines.

On the other hand, when man begins to use the ecosystem, the health, economic and socio-cultural benefits to people begin to increase. It is visualized that these extrinsic values would peak as people continued to use the ecosystem—the maximum point on the parabolic curve in Figure 2 is represented by MEY (maximum extrinsic yield). Beyond this point of use, however, extrinsic values would fall as stress on the ecosystem continued to increase. As the intrinsic value of the ecosystem falls because of excessive use, the capacity of the resource to support extrinsic benefits to people also declines. The circled intersection of the two curves represents the point of maximum extrinsic value at minimum devaluation of the ecosystem. Conceptually, this point might represent OSY.

To determine the status of the four accounts, it is necessary to measure each one in some manner. These response variables would provide a measure of the yields from these accounts. The intrinsic yield from the ecosystem account is more a measure of the health or integrity of the ecosystem, rather than a measure of something that people are taking away, or deriving from, the ecosystem. Thus, standard indicators of environmental health, such as biodiversity, water quantity and quality, habitat critical for reproduction and feeding, etc. are relevant here. Our traditional fish population assessment techniques fall into this account and most of the statistics that we traditionally measure from creel surveys, e.g. length frequency distributions, catch rates, species composition in the harvest, really describe how the fish populations are functioning, more than how people are benefiting from the resource. Fishing effort, measured through a creel survey, becomes a component of use measured on the x-axis of Figure 2—an ecosystem approach ultimately would require that the x-axis incorporate all types of commercial, residential and recreational use.

The human health account measures benefits from consumption of organisms harvested from the ecosystem, most notably fish. In a less direct manner, this account concerns human health benefits related to the provision of medicinal products from the ecosystem; however, this probably becomes a basic issue of protection of biodiversity for maximization of the potential to

derive useful medicines in the future. The more immediate purpose of this account is to measure benefits attributable to consumption of fish by anglers. At a very crude level, this might only entail determining if anglers perceive harvested fish to be important to family meals or family health (an importance ranking). At a more formal level, estimation of *per capita* consumption rates would be warranted, and at an even more sophisticated level, the dietary contribution of fish might be quantitatively assessed (e.g. in situations where other forms of high quality food are limited so that fish consumption is critical for good health).

The economic account measures benefits in monetary terms (dollars). In a general sense, we want to determine people's willingness to pay to use the ecosystem. Minimally, this would include willingness to pay for the opportunity to fish at a particular site, trip expenditures, and investments in durable equipment. For subsistence anglers, economic benefits might also include dollars saved on food bills because of consistent use of the resource.

The socio-cultural account includes characterization of angler groups, employment opportunities offered by the fishery, family benefits, community benefits, personal satisfactions, and attitudes and opinions of anglers. Angler groups can be characterized in terms of basic demographic descriptors (place of residence, sex, age, race, income), as well as by angling behaviour (facilities used, fishing location, fishing technique, reasons for fishing, and species sought). Personal satisfaction can be ranked in several areas, e.g. condition of the ecosystem, adequacy of facilities, fishing success.

It is possible to collect information representing all four accounts using a well designed creel survey. Only through interaction with users can measures of human health, economic values and socio-cultural values be derived. Only through purposeful and integrated measurement of all four accounts can we move toward more optimum assessment and management of recreational fisheries.

Reference

Malvestuto, S.P. (1989). Sociological perspectives on large river management: a framework for the application of optimum yield, pp. 589–599. In D.P. Dodge, editor. Proceedings of the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

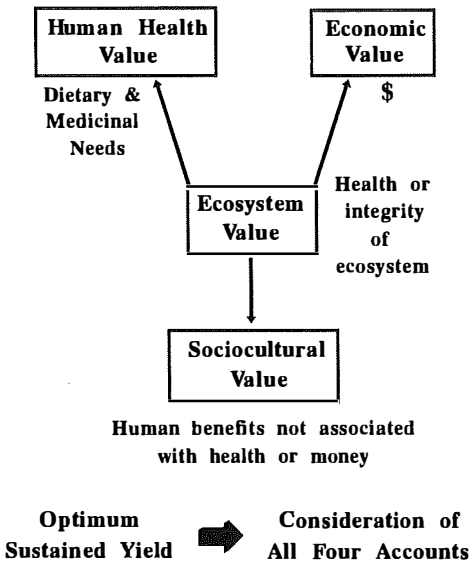

Figure 1. Definition of four social accounts for information acquisition. Integrated consideration of all four accounts is the basis for specification of optimum sustained yield for any given recreational fishery.

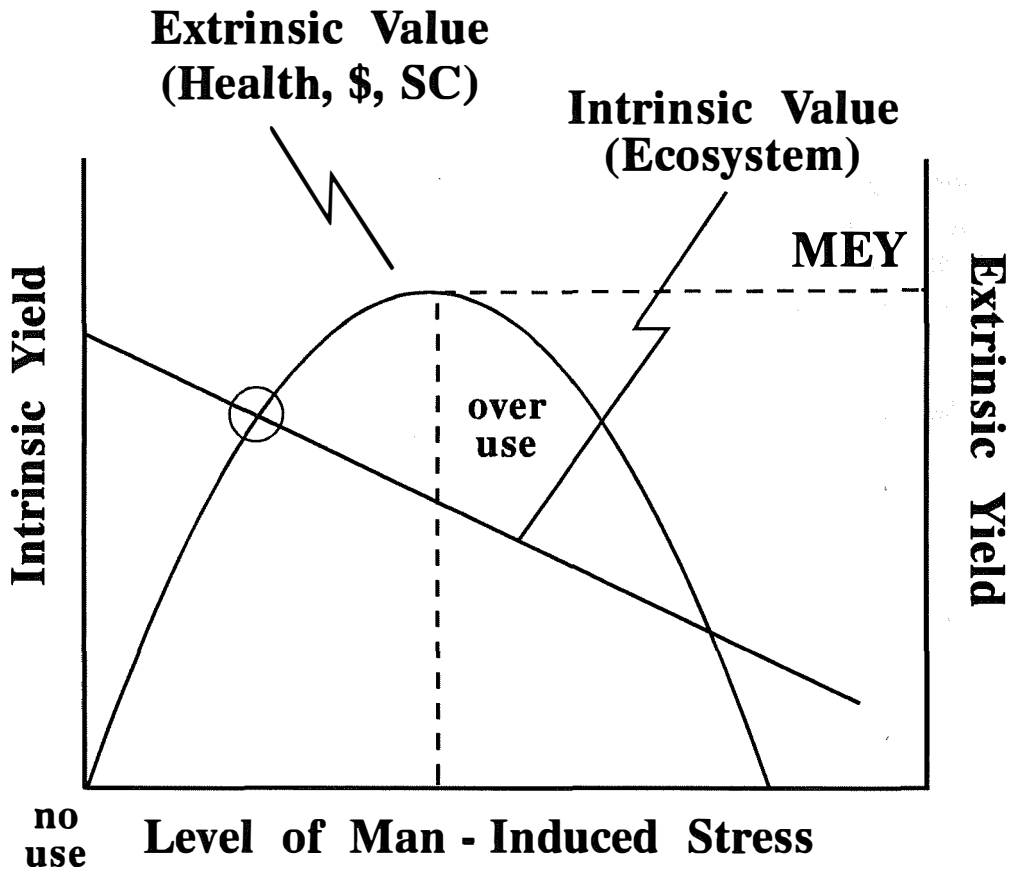

Figure 2. Conceptual relationships between human use of an ecosystem and social yields. Social yields are classified as either intrinsic (ecosystem value) or extrinsic (human health, economic and sociocultural values). Circled intersection represents logical OSY point where extrinsic yield is maximised relative to loss in intrinsic yield.

Determining the recreational share of New Zealand's marine harvest

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Introduction

New Zealand is endowed with a diverse marine fishery resource, a coastline of 15 000 km, reputedly equivalent in length to that of the USA, and a population of only 3.5 million. Nevertheless, competition for access to the resource has become one of the major issues facing recreational, commercial and Maori participants in the fishery.

Approximately 0.5 million or 15% of all New Zealanders spend time marine recreational fishing, something which is regarded by many as an unalienable right and an integral part of our way of life. About 40 inshore species are of prime interest to the recreational fishing sector. Species mentioned in this paper are listed in Table 1.

New Zealand's Exclusive Economic Zone (EEZ) is the fourth largest in the world. Last year, this area yielded a harvest of 600 000 tonnes to the commercial fishing sector and export earnings of $1.2 billion, moving fishing into fourth place as an export earner. It is the stated intention of the fishing industry to increase this figure to $2 billion by the year 2000.

Maori claims to the fishery were recently addressed by the passing of the Treaty of Waitangi Settlement Act which has seen Maori become the largest quota owner in New Zealand. Nearly 40% of all quota is now owned by Maori. The Settlement Act also supplemented existing customary fishing rights with provisions for local tribes to assume responsibility for managing fisheries within coastal areas of traditional significance.

Overall responsibility for the research, management and enforcement of marine fisheries is currently vested with the Ministry of Agriculture and Fisheries (MAF) and funded by the Crown. Deepwater fisheries are managed centrally from Wellington whereas inshore fisheries are more the focus of the three regional centres of Auckland, Nelson and Dunedin (Figure 1). However, the current review of the Fisheries legislation, the introduction of user charges for the fishing industry in October 1994 and the restructuring of MAF including the transfer of all research functions to a Crown Research Institute, will see a considerable change to current arrangements.

Through what are exceptionally dynamic times for all those involved in marine fisheries in New Zealand, it is clear that both commercial and Maori rights to the fishery are being strengthened and defined more clearly. In contrast, I believe that the recre-

ational fishing sector is in an increasingly vulnerable position compared with the other user groups. To date, there is little evidence that recreational fishers are prepared to contribute the necessary funding to get organised, and without such funding, representative groups cannot effectively advocate for their rights to the fishery.

As far as research is concerned, the Government currently allocates approximately $17 million to MAF for what is termed stock assessment research. This represents about 2% of the landed value of our fish. In comparison, the USA invests 6.6% of the landed value of its fish in equivalent research. It is only over the past six or seven years that funds have been allocated specifically to recreational fisheries research and then the allocation has amounted to about 2–3% of available research funds, which has placed considerable constraints on what can be carried out. To make the most effective use of available funds, the Recreational Fisheries Research Working Group was established in 1990 comprising researchers and representatives from all user groups including the recreational and commercial fishing sectors, tangata whenua (Maori) and environmental interest groups. Each year the group considers research directions and priorities, and reviews progress, an approach which is suited to a small country with limited resources, and one which has seen considerable progress recently.

Research priorities for New Zealand's marine recreational fishers

Top priority goes to *quantifying the recreational harvest by species and area.*

Firstly, this information is fundamental to determining *sustainable harvesting levels.* Commercial overfishing of inshore fish stocks saw the introduction of the Quota Management System (QMS) in 1986 and the replacement of many input controls with controls on the amounts of fish that could be harvested. To determine the Total Allowable Catch (TAC) and set Total Allowable Commercial Catches (TACCs) for almost thirty species which are currently in the QMS, data on both the commercial and recreational catches are required for stock assessments. Clearly, if the recreational harvest is a significant or increasing component of the catch, and this is not taken into account, the harvest may not be sustained.

Quantifying the recreational harvest is also required to enable meaningful negotiations between the recreational and commercial sectors, and Government over *allocation of the resource.* Each year the Minister of Fisheries has to take into account the recreational harvest before setting commercial catches. Furthermore, if the combined harvest has to be reduced an equitable way to apportion the cuts must be found which is acceptable to the various user groups.

A third major issue for which recreational harvest data are required is that of *allocating the harvest fairly among the many thousands of recreational fishers.* The main management mechanism in recreational fisheries is the daily bag limit. To determine bag limits which are an effective management tool, the relationship between the total recreational harvest of each species and individual daily catches needs to be established.

Research strategy

Very few studies of marine recreational fishing were conducted prior to 1990 and those that were did not address the question of recreational catch estimates. What was needed was an approach to quantify the recreational harvest that could be implemented nationwide within the constraints of available resources.

Our approach combines a telephone survey component to identify a random sample of marine recreational fishers (there is no licensing system for marine recreational fishers in New Zealand), and a diary scheme whereby the sample of fishers identified are invited to keep detailed records of their fishing activities for one year. Diarists return their records every three months and those who fail to do so are followed up by telephone. To encourage a high response rate, all returns, including no fishing returns, are entered into a draw for prizes of fishing equipment. A newsletter summarising results is also sent to all diarists.

This approach was successfully implemented in the South region during 1991/92 and has since been extended into the Central and North regions in 1992/93 and 1993/94 respectively.

To provide a check on certain critical aspects of the diary scheme, the results of boat fishing diarists have been compared with those from an intercept survey of selected boat ramps in the Central region. In the North region, a check on harvest estimates for boat fishing in the Hauraki Gulf is currently being derived from a combined aerial survey and boat ramp interview approach. Results from these complementary studies will enable us to refine our approach and improve the accuracy of the harvest estimates, a high priority given the stake the commercial sector has in the fishery and their keen interest in the results.

Implementing the survey in the three regions over the past three years has involved randomly selecting and telephoning over 35 000 households, or 3% of all households in New Zealand. Of these, 16% contained marine recreational fishers, 4 579 of whom qualified according to certain criteria and agreed to keep diaries, representing 1.2% of the estimated 389 000 fishers 15 years of age and over who go marine recreational fishing around the New Zealand coastline.

Results from South region survey

In the South region, where results are now available, 860 fishers agreed to keep diaries and a response rate of 90% or better was achieved in each of the four quarters between September 1991 and 1992. Over 30% of respondents did not go fishing and 50% made fewer than 10 trips during the year (Figure 2). Fishing opportunities in the South region are constrained by the exposed nature of the coastline which is subject to regular cold southerly fronts straight from the Antarctic.

The geographic distribution of fishing trips generally reflects the distribution of the population, especially around the centres of Christchurch, Dunedin and Invercargill (Figure 3). However, the small coastal fishing town of Kaikoura attracted many fishers from Christchurch, and Stewart Island, which offers an exceptional fishing experience, attracted fishers from throughout the region.

Different fishing methods are used to target fish species which are typical of distinctly

different coastal habitats. For instance, shore fishers target salmon, kahawai and red cod (Table 1) from sweeping gravel beaches and river mouths, while boat fishers harvest blue cod, which are widely distributed in reef habitat both inshore and farther off the coast. Whereas divers focus on reef habitat to collect rock lobster, paua, and reef fish, set nets are also used to catch reef species. Both set nets and drag nets are used to harvest flatfish from the heads of harbours and bays and hand gathering of shellfish species is popular on sandy beaches and reefs.

The success of recreational fishers in harvesting their targeted species was highly variable (Figure 4). Blue cod was by far the most sought after fish, accounting for 22% of the 4 461 trips recorded by diarists and making up the largest proportion of the catch. On the other hand, although the salmon/red cod/kahawai combination was much sought after, fishers were considerably less successful at catching these species. Of note are the species such as Jock Stewart (sea perch), spiky dogfish and the wrasses, which were not sought but caught in considerable numbers. In total, almost 18 000 finfish and more than 5000 rock lobster and paua were recorded by the diarists.

To calculate harvest estimates, the number of each species caught was multiplied by the average weight of a fish to give the weight of fish harvested by the sample of fishers. To derive a total harvest estimate, the sample harvest was adjusted by a factor to account for the various response categories and then a further scaling factor was used to convert the sample harvest to the total population of recreational fishers.

At 440 tonnes, the blue cod harvest was four times that of paua, rock lobster and red cod, the next most harvested species (Figure 5). Spiky dogfish, with an estimated harvest of 122 t, is a species which recreational fishers do not appreciate and yet one which makes a significant contribution to the recreational harvest.

Application of results to management

Sustainable harvesting levels

In 1993, the recreational harvest estimates were incorporated into stock assessment determinations and published in the relevant documents, thus meeting our first major objective of contributing data to the process of ensuring stock sustainability.

Allocation between the commercial and recreational sectors

Before an appropriate allocation between the commercial and recreational sectors can be determined the combined harvest must be calculated and the recreational harvest expressed as a percentage of that. Percentages of the harvest attributable to recreational fishers ranged from a high of 65% for blue cod to less than 1% for red cod. The significance of the recreational contribution is obviously related to the size of the commercial harvest. For instance, although recreational fishers harvested an estimated 100 t of red cod, this was an insignificant amount when compared with a TACC of 12 300 tonnes.

Blue cod and paua provide useful examples to illustrate the way in which the recreational contribution to the total harvest, and the geographic distribution of the recreational catch can be used to help resolve allocation issues (Figures 6, 7 and 8).

For instance, an estimated blue cod harvest of 250 t in QMA 3 (BCO 3), puts the recreational blue cod harvest at 65% of the total harvest (Figure 6). Given the importance of this species to recreational fishers in the South region, a suggestion that the TACC be increased, currently being promoted by the commercial sector, is unlikely to occur unless adequate consultation takes place and agreement is reached with the recreational sector.

Farther south in BCO 5, the situation is quite different. Both recreational and commercial sectors are concerned about local depletion of blue cod stocks in Foveaux Straits which separate the South Island from Stewart Island. Although the recreational harvest made up only 18% of the total harvest in 1991/92, the major part of the estimated 190 t recreational harvest came from the Foveaux Straits area (Figure 7a). However, examining the distribution of the commercial harvest revealed that the bulk of the almost 900 t commercial catch also came from the Foveaux Straits area. Together, these pieces of information indicate that management attention needs to be focussed initially on the commercial fishery and fishing practices to address the issue.

A similar situation exists for paua in QMA 5 (PAU 5), where the commercial and recreational sectors, and Maori, began expressing serious concerns about a depletion of the paua resource in the early 1990s. A Paua 5 Management Working Group, was formed to address the issue and is comprised of representatives of all user and interest groups and facilitated by MAF Fisheries. On the basis that the estimated recreational paua harvest represented only 12% of the total 1991/92 harvest, the Working Group decided to focus on improving the management of the commercial paua fishery rather than suggesting daily bag limit reductions. Attention turned to the problem of managing a sedentary, clumped species over a very extensive QMA.

Data on the distribution of the recreational and commercial harvests showed that some parts of PAU 5 were harvested almost exclusively by the commercial sector whereas other areas supported both commercial and recreational paua harvesters (Figure 7b). On the basis of this and other information, the Working Group decided that the PAU 5 should be sub-divided so that management could be tailored to the requirements of smaller areas with distinct stock characteristics and fishing patterns. To achieve this, provisions enabling subdivision have been drafted into the new fisheries legislation.

Both the paua and blue cod examples show the value of recreational harvest estimates and catch distribution data for clearly identifying fisheries issues and selecting the most appropriate approach to resolving these. Such information is fundamental to the equitable allocation of access to the fisheries resource and the success of a growing user group involvement to fisheries management in New Zealand.

Allocating within the recreational sector

Turning now to the third major objective of the survey, allocating the resource within the recreational sector, the survey data have been used to revise daily bag limits. A series of bag limits were adopted on the basis of daily catches, the size of fish, state of the stocks and the nature of the

commercial fishery. Bag limits of 30, 15, 5, 2 and 1 now characterise our finfish stocks.

We aimed to place the bag limit at the point where current catches would not be unduly constrained but where lowering the bag limit would reduce the total harvest. Blue cod and flatfish daily catches show the classic distribution for finfish species where most trips result in a few fish and a few trips result in the bag limit (Figure 8a and b). Raising the bag limit is unlikely to increase the catch significantly but lowering the bag limit will certainly reduce the catch. A similar distribution characterises butterfish, kahawai and blue moki but daily catches are lower and a lower bag limit was therefore warranted (Figure 8c, d and e).

In contrast, more accessible, sedentary species such as rock lobster and paua are more easily targeted and produce a catch distribution which is constrained by the bag limit (Figure 9a and b). Raising the bag limit would definitely increase the catch and lowering the bag limit would reduce the catch.

To determine the potential impact of lowering bag limits on the recreational harvest, blue cod can be used as an example. It should be noted that two years ago, there was a serious proposal to lower bag limits to 20 nationwide, and this exercise provides some insight into the impact this could have had on our blue cod fishers in the South region.

Distribution of the blue cod harvest shows 350 trips during which fishers caught from one to five fish, accounting for a total of 900 fish. At the other extreme, only 35 trips during which fishers caught 26 to 30 fish, accounted for an equivalent harvest. Converting fish numbers to weights shows that approximately 30% of the harvest was accounted for by those catching between 20–30 blue cod per trip (Figure 10). It is this portion of the harvest which would have been impacted by reducing the bag limit to 20. All the trips resulting in 21–30 fish would instead catch 20, translating into a saving of 450 fish. Converting this to a tonnage for all recreational fishers in the South region equates to a reduction of 25 t or 21 700 blue cod (Figure 11). Note that the shifting of 95 tonnes to the 16–20 per day category (i.e. catches of fishers who previously caught 21 to 30 fish), converts the characteristic finfish catch distribution into one which is now constrained by the bag limit. So for blue cod our position that the bag limit should not be lowered was supported by the survey data. Given that blue cod stocks in the South region appear to be generally healthy, the views of the recreational fishers who argued that a cut to the bag limit for no real reason would adversely affect a substantial number of blue cod fishers were vindicated.

Similar exercises have been conducted for other key recreational fish species such as paua and rock lobster in response to suggestions that bag limits should be lowered where there are concerns about the state of the stocks. Such an approach allows the effectiveness of various bag limit reductions to be evaluated, and associated issues such as non-compliance to be identified.

Conclusion

The approach we have adopted has shed light on three major objectives; stock sustainability, ensuring recreational fishing access to the resource and allocating that share fairly among recreational fishers. The survey information is proving invaluable,

and the results are being applied to many more fisheries issues than have been covered here.

It is accepted that every approach to investigating recreational fisheries has limitations and that the key to a successful application is to recognise these and attempt to minimise or compensate for them. Throughout the development of our approach, considerable effort has been, and continues to be, made to validate critical aspects of the survey method we have adopted.

Currently, the Recreational Fisheries Research Working Group is considering proposing that the survey be conducted nationally in 1995/96 so that the variability in the recreational harvest from year to year can begin to be monitored. Specific recreational fisheries issues in particular areas will continue to be addressed using intercept methods.

Finally, I believe that our approach to recreational fisheries research in New Zealand is beginning to allow recreational fishing rights to be defined. Given the power of the other stakeholders in the resource and the implications of the current institutional reform, this is indeed timely.

Table 1. Fish species referred to in the text which are caught by recreational fishers.

Common Name	Specific name
Barracouta	*Thyrsites atun*
Blue cod	*Parapercis colias*
Blue moki	*Latridopsis ciliaris*
Butterfish	*Odax pullus*
Flatfish	*Rhombosolea plebeia*
	Rhombosolea leporina
	Rhombosolea retiaria
	Rhombosolea tapirina
	Peltorhamphus novaezeelandiae
	Colistium guntheri
	Colistium nudipinnis
	Pelotretis flavilatus
Groper	*Polyprion oxygeneios*
Kahawai	*Arripis trutta*
Common paua	*Haliotis iris*
Red cod	*Pseudophycis bachus*
Rig	*Mustelus lenticulatus*
Spiny rock lobster	*Jasus edwardsii*
Chinook salmon	*Onchorynchus tchawaschta*
School shark	*Galeorhinus galeus*
Sea perch	*Helicolenus papillosus*
Spiky dogfish	*Squalus acanthias*
Wrasses	*Pseudolabrus* spp.

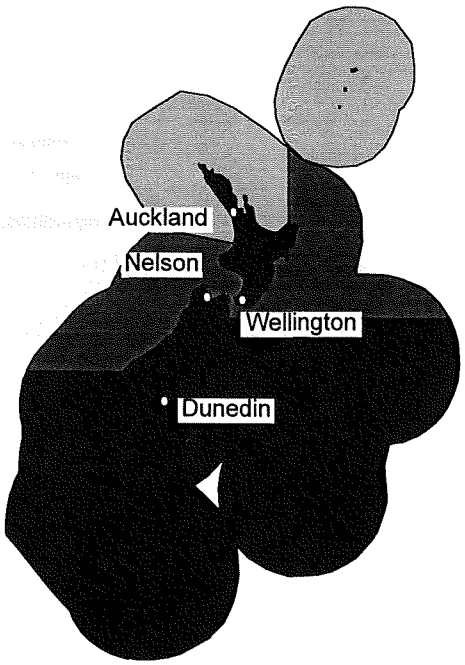

Figure 1. New Zealand EEZ showing MAF Fisheries regions.

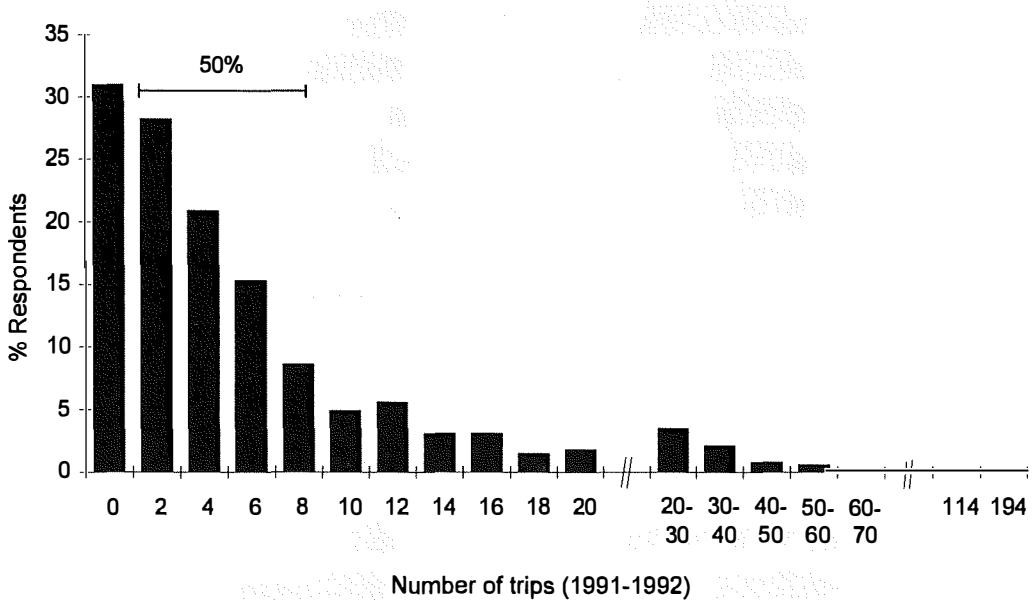

Figure 2. Distribution of fishing effort among respondents.

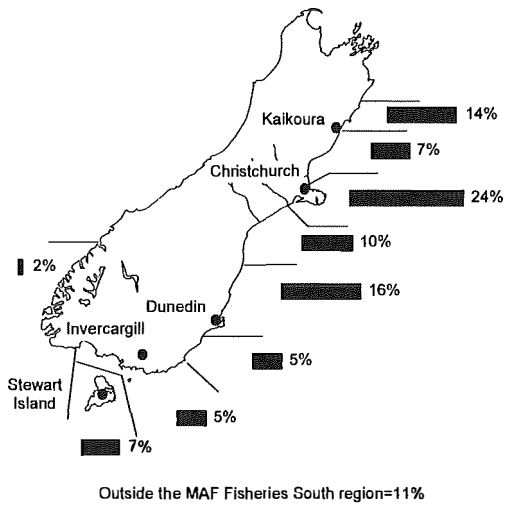

Figure 3. Geographic distribution of fishing trips.

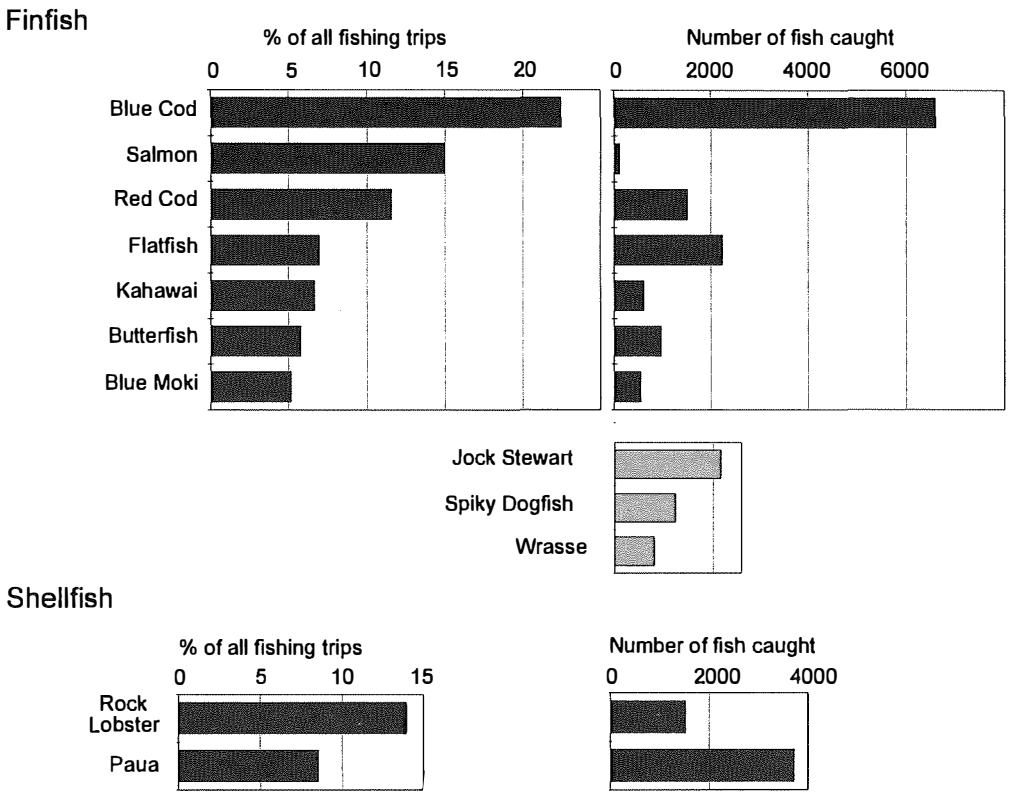

Figure 4. Species sought and species caught.

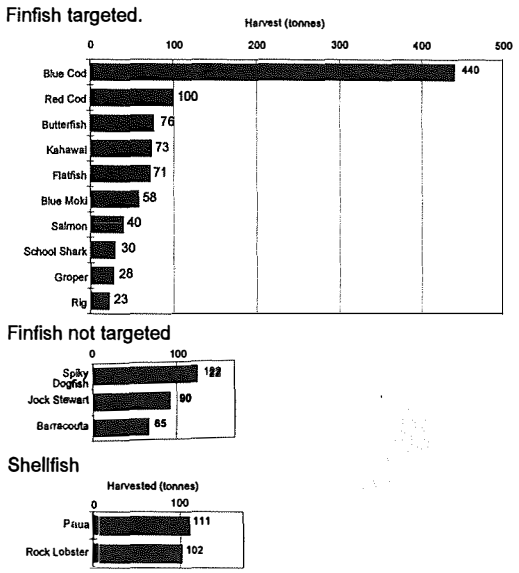

Figure 5. Recreational harvest estimates for MAF Fisheries South region fishers.

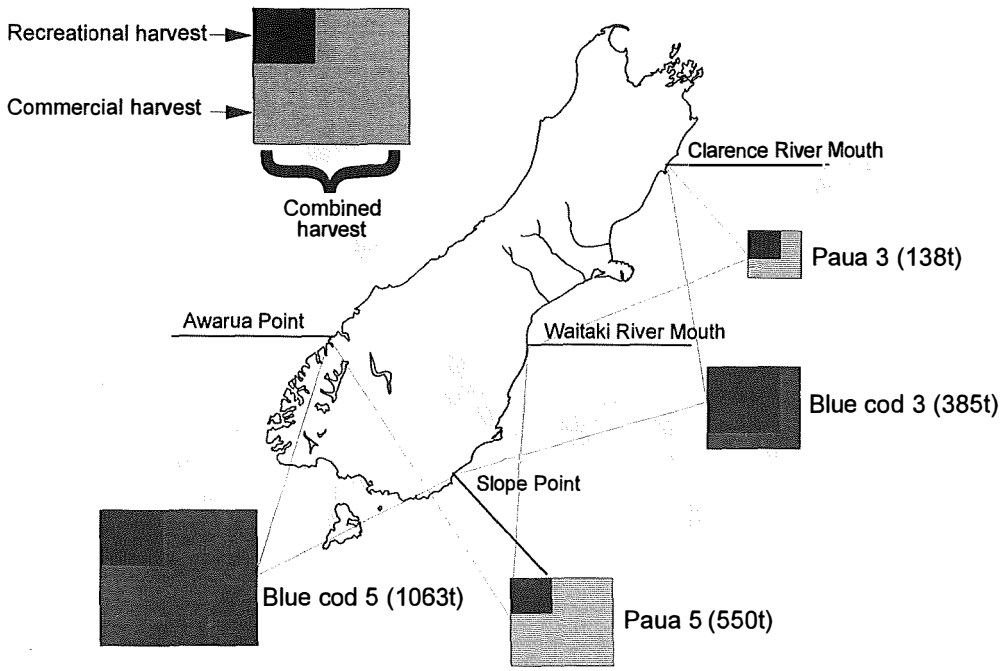

Figure 6. Relative contribution of recreational and commercial catches to combined catches for blue cod and paua.

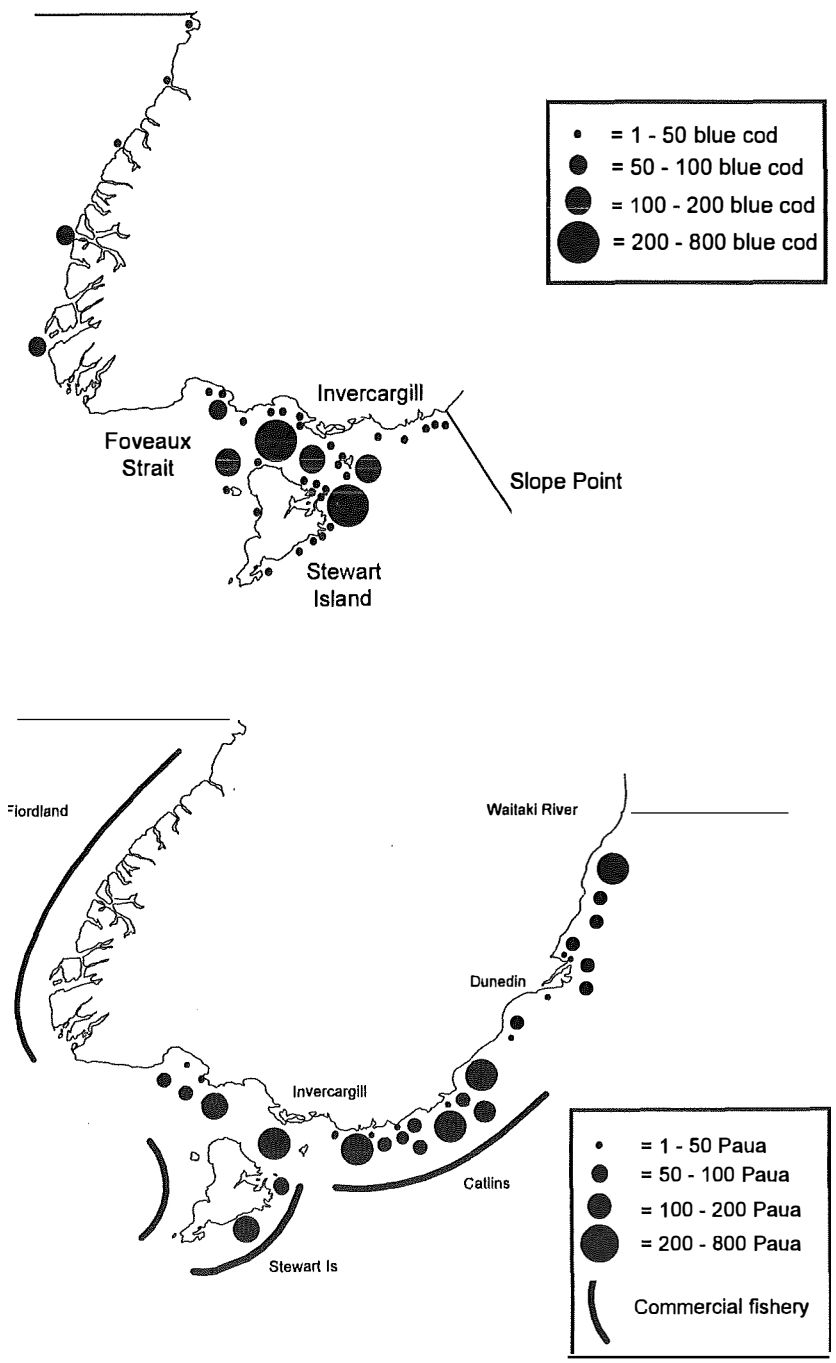

Figure 7. Distribution of the recreational harvest of (a) blue cod in BCO 5 and (b) paua in PAU 5.

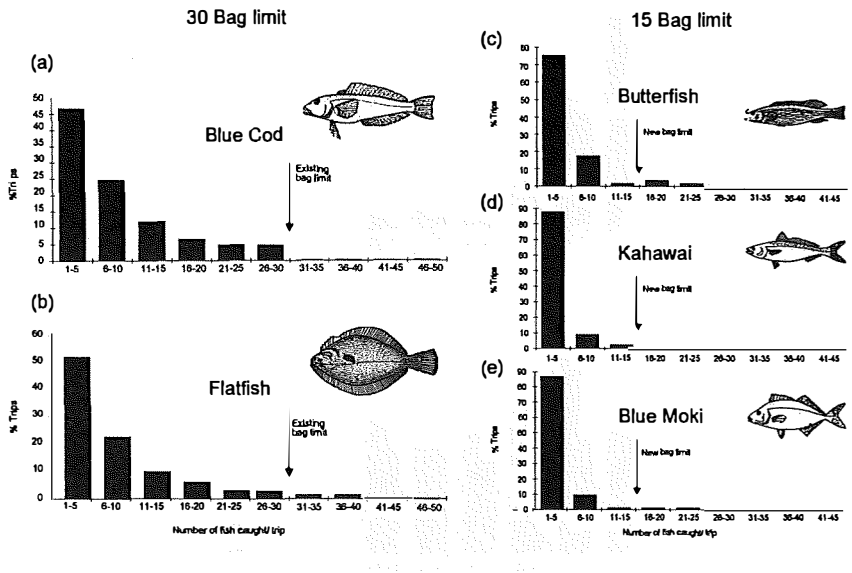

Figure 8. Relationships between daily bag limits for selected finfish species and the distribution of daily catches: (a) blue cod, (b) flatfish, (c) butterfish, (d) kahawai and (e) blue moki.

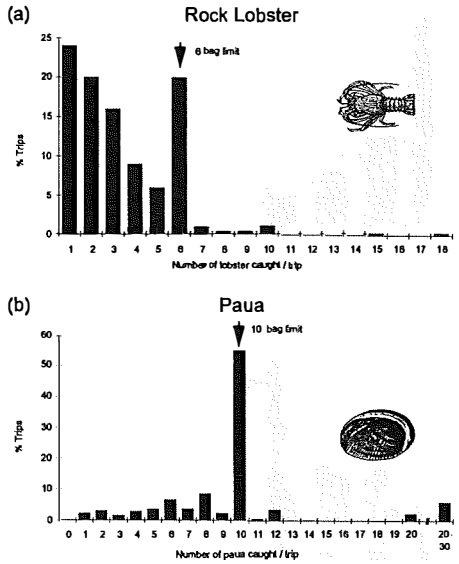

Figure 9. Relationships between daily bag limits and the distribution of daily catches for (a) rock lobster and (b) paua.

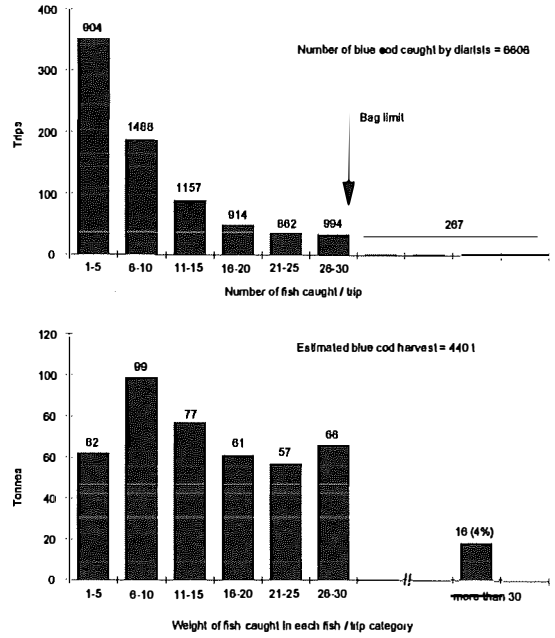

Figure 10. Relationship between daily catches and the weight of blue cod harvested.

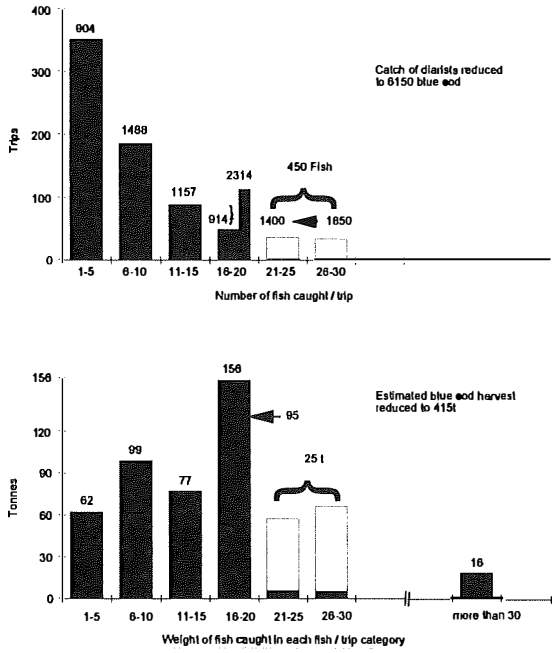

Figure 11. Potential impact of reducing the blue cod bag limit on the harvest.

A review of recreational fishing surveys in Australia

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Introduction

The presentations in this opening Session have provided an international perspective on current and past recreational fishing research. To conclude the first Session, I will provide a perspective of past Australian research, by describing the history and geography of past studies, summarising the type of data that have been collected and commenting on the general utility of these data.

Approximately 110 reports have been located on recreational fishing and it is these that provide the basis of this presentation. The reports have been located through computer and reference searches, bibliographic papers and assistance from workers in all States and the Northern Territory. The data presented for marine and general population surveys are considered to be quantitative, while data for studies concentrating exclusively on freshwater fisheries are qualitative only.

Studies which have not been formally reported (e.g. unpublished data, studies in progress, etc.) have not been included.

1. History of studies

a) General population surveys (omnibus)

General population or omnibus surveys elicit broad characteristics and patterns from a sample of the entire target population (e.g. the population of Australia). They are particularly useful for determining demographic patterns and/or where no prior information is available.

To date, only one national general population study has been conducted: the PA Management Consultants' survey of 1984 (PA Management Consultants 1984). This study gave the first and only comprehensive picture of the demographic structure and economic behaviour of Australian anglers as a whole, and its data are still regularly cited.

In addition to the national study, Statewide studies have now been conducted in all States and Territories at least once. The first such study was completed in NSW in 1978 (McNair, Anderson and Associates 1978, cited in Anon 1992), but all other studies have been reported since 1985. In addition to these broad scale surveys, regional surveys have been conducted in

areas such as the Moreton region of SE Queensland and Port Phillip Bay, Victoria.

Historically, therefore, demographic and socio-economic data from general population surveys are relatively recent (i.e. generally post-1984).

b) Marine

Studies of marine fishing also cover a relatively short period. The first reported survey was undertaken in 1972/73 in Serpentine Creek, Queensland, as part of an environmental impact study (Dredge 1974). Following this, a substantial increase in research activity occurred during the 1970s and early 1980s (Figure 1).

While output appears to have declined in the 1990s (Figure 1), the data refer only to published reports. The inclusion of work known to be currently underway, or recently completed, increases the current total to at least 19 studies for 1990–94 (Figure 1).

c) Freshwater

Freshwater recreational fishing studies span a substantially longer time period than other work. The first reported fieldwork that I have located occurred in 1948 on trout lakes in NSW and Tasmania (Lake 1957; Nicholls 1958 a;b). Creel surveys were also conducted in some Victorian lakes in the early 1960s (Hume 1991), while Western Australia carried out research into the recreational trout fishery in 1967/68 (Morrissy 1972).

Despite being commenced well before marine studies, it appears that the number of freshwater studies has not been as high. In addition to those already mentioned, 26 study reports were located from literature searches. Of these, the majority have been conducted in the eastern States. Victoria and New South Wales conducted several studies in the 1970s and 1980s, while Queensland has been particularly active in the last five years.

Of the other States, Tasmania and Western Australia have conducted longer-term surveys. Tasmania has conducted mail surveys of recreational licence holders over the last ten years (Peter Davies pers. comm.), while Western Australia has used a long-running logbook programme of licensed fishers for monitoring the recreational marron fishery (Morrissy and Fellows 1990).

2. Location of studies

Given this historical overview, it is now worth considering the spatial distribution of research activity.

In terms of output of reports of general population and marine surveys, New South Wales has been the most productive State, followed by Queensland and South Australia (Figure 2). When reports of freshwater studies are included, Queensland becomes the leading State and, with New South Wales, is far in advance of all other States.

The spatial distribution of these studies is shown in Figure 3. There is a clear concentration around areas of high population density along the eastern seaboard, and other metropolitan centres around Australia. Workers associated with the Great Barrier Reef Marine Park Authority (GBRMPA) have been particularly active, and nearly 50% of Queensland studies relate to areas within the Park.

The spatial distribution of freshwater studies is a little harder to map meaningfully as most studies have been undertaken in relatively small lakes.

In addition to geographic location, studies can also be categorised by the type of waterbody in which they were conducted (Table 1). By far the greatest majority (68%) of marine studies have been undertaken in inshore waters—coastal waters, estuaries and bays. This is not surprising as these areas generally support the greatest concentration of anglers. Further, it might be argued, they represent areas which are most amenable to traditional direct survey methods.

Perhaps for similar reasons, most freshwater studies have been undertaken in lakes. Only three studies that I have located were undertaken in natural rivers, all of which were in Victoria (Hume 1979; Koehn 1984; Myers 1988), although much of the marron data from WA would relate to river catches (Morrissy and Fellows 1990).

3. Summary of information collected

Having discussed the history and geography of recreational fishing studies in Australia, it is appropriate to consider what information has been collected. Recreational surveys compile substantial amounts of information; reports at times have exceeded 100 pages with up to 60 pages of tables and graphs.

The principal categories of information collected can be seen in Table 2. While this table refers to marine and general population studies, similar results could be expected from freshwater studies.

The most commonly reported parameters were those relating to the recreational catch—catch per unit of effort (cpue), fishing effort and harvest. Additionally, the biological components of the catch—species and size composition—were also reported, although less commonly.

Many studies also provided demographic information on the surveyed population, while least common were economic data. Of the 34 reports including economic data, the great majority were fishing-related expenditure. It is only recently that studies have been conducted on the economic value of fish to recreational fishing (e.g. Dragun 1991; Staniford and Siggins 1992).

In all categories, either New South Wales or Queensland has compiled the most information (Table 2). However, it should be noted that even in these States, only a dozen or so estimates are available for critical information such as fishing effort and harvest, and some of these are for limited areas only.

4. Utility of these studies for management

Having looked at where, when and what data have been collected, it is appropriate in this forum to comment on the general utility of the results. One important question that this Workshop will need to address is 'To what extent have past studies assisted proper management of Australian fisheries?'. If they have assisted, how and why; if not, why not?

There is no doubt that past results have clarified some of the common characteristics of recreational fisheries. For example, general population studies have shown that demographic parameters of the fishing population are relatively consistent around

the country—at least at the level of resolution of those studies (Table 3).

For example, apart from one WA study (Anon 1984), all results show that between 25 and 36% of the population participate in recreational fishing at least once a year. Similarly, all studies show that males outnumber females in active participation, usually by a ratio of between 2 and 3:1. Furthermore, the most active age group is generally teenagers through to those in their 30s.

Another common characteristic of the fishing population is the frequency with which they participate. Most studies show that nearly half of active fishers participate less than 5 times a year. Only 15% fish more than 20 times a year.

A related statistic is the contribution of a small number of trips to the total catch. Several studies have calculated the percentage of trips which catch 50% of the total catch. Results show a range from 25% down as low as 4.7% (Craik 1986; Henry and Virgona 1980; Anon. 1981) While the proportion of trips is therefore low, I am sure that the percentage of anglers making those trips is even lower. The situation may therefore exist where as low as 3 or 4% of anglers are contributing 50% of the catch.

In addition to identifying common characteristics such as these, past studies have no doubt been very useful in resolving local resource allocation disputes. Many studies cited controversy over resource allocation as a primary reason for instigating the research. The results of these studies no doubt assisted in the resolution of those disputes.

Additionally, the collective results of many studies have now highlighted the biological impact that recreational anglers can have on fish stocks. This, in addition to data on economic activity, has substantially raised the profile of recreational fishing in political and fisheries management arenas.

Past studies have therefore been very useful in establishing the importance of recreational fisheries, biologically and economically, and quantifying their features. However, in the context of promoting Workshop discussion, it is also important to discuss their limitations. These are, of necessity, generalisations and do not refer to individual studies. I will discuss the limitations in two categories—scale (temporal and spatial) and comparability.

One of the most enduring paradigms of fisheries management is that recreational fishing effort is increasing. And yet, in published reports, there are very few data to support that claim. The principal reason for this is that there are very few areas in Australia for which time series data are available.

Results relating to trends in cpue, harvest and resource allocation are similarly lacking. The best long-term datasets for cpue are those from angling clubs. These have been well used by Queensland workers to give trends in cpue over periods of up to 40 years. However, without comparative effort data, cpue trends can not elicit trends in harvest or resource allocation.

This demonstrates one of the fundamental differences between commercial and recreational fisheries management. Substantial funds are allocated every year to maintaining commercial catch and effort databases, with a view to monitoring trends over time. No commercial fishery would consider management based on once-off surveys. And yet the data available for

recreational fisheries are mostly just that—once-off.

Some exceptions do exist. For example, the barramundi fishery of Northern Territory has information on some areas since 1978; the barramundi fishery of Charlotte Bay has data covering a 4–5 year period; and Mallacoota Inlet and the Gippsland Lakes were the subject of extended surveys in the early 1980s. Additionally, some Victorian and Tasmanian lakes and bays and estuaries in New South Wales and South Australia have been surveyed more than once.

The importance of long term data cannot be overstated, and there is a clear need for recreational fishing studies to be incorporated into a longer term framework.

It is noted in passing that, where data are available, the results either contradict the fishing effort paradigm or are equivocal (e.g. see Griffin this volume).

In addition to temporal scale, the majority of studies have been limited in spatial scale, with a high proportion of marine studies conducted in estuaries and bays. While this has no doubt resolved immediate and local concerns, and is satisfactory for stock assessments of localised and sedentary stocks, it is of limited value for stock assessment of migratory and widespread species. Where concerns for these types of stocks exist, recreational data over larger spatial scales (i.e. covering the distribution of the species) are needed.

The second area that needs attention is that of comparability between studies. This in turn can be split into two components. The first concerns the fairly arbitrary way in which survey responses have been categorised. For example, demographic data used to report participation rates have defined populations of 10+, 13+, 14+, 15+ and 17+. Similarly, the collation of ages of anglers have used widely varying categories of age groups. The categories used for frequency of fishing (i.e. days per year) vary significantly, often even with studies conducted by the same organisation. Results reporting expenditure on fishing-related items have grouped data into a wide range of categories.

While this may seem a minor criticism, these variations make it very difficult to compare the results of different studies. If improvements are to be made in the collection of time series data, it seems to me that standardisation in the way of reporting these results is necessary. Further, it would facilitate comparisons between recreational fisheries in different areas.

The second component which makes comparisons difficult is the lack of reporting of variation associated with many estimates. This applies particularly to estimates of cpue, effort and harvest. Again, comparisons over time will make reporting of error terms obligatory, and would greatly facilitate comparisons between fisheries.

I would like to note that current research appears to be addressing some of these issues. Longer temporal scales have been incorporated into projects in Queensland and NT, with a longitudinal component in current and planned surveys. Larger spatial scales are being addressed by surveys in NSW and SA.

There is no doubt that the question of scale has been recognised by past researchers. As always, funding has been a critical limiting factor. Changes in the criteria for Fisheries Research and Development Corporation (FRDC) funding have been largely

responsible for both the level and scale of several current projects, and this positive change in funding criteria should be formally acknowledged.

In conclusion, a substantial body of quantitative information exists on recreational fishing in Australia. The majority of this has been collected over the last twenty years, and covers a large proportion of the high effort fishing areas of the country. It represents a substantial series of baseline data upon which could be built a second generation of studies, providing on-going repeated measures to determine long-term trends in recreational fishing. It is hoped that input from such a wide variety of backgrounds as exists at this Workshop can provide the focus and impetus for this to occur.

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Table 1. Summary of survey area types for recreational fishing studies in Australia to 1993.

(a) Marine and general population studies (n = 84)

Type of waterbody	All waters	Inshore			Offshore	Intertidal
		Estuary	Bay	Coastal		
Number of studies	16	23	13	21	9	2
(%)	(19)	(28)	(15)	(25)	(11)	(2)

(b) Freshwater studies (n = 26)

Type of waterbody	All waters	Lakes	Rivers
Number of studies	4	19	3
(%)	(15)	(73)	(12)

Table 2. Categories of information collected during marine and general population studies (n = 84) of recreational fishing in Australia 1972–1993.

State	CPUE	Effort	Harvest	Species Comp^n	Size Comp^n	Demo-graphic	Eco-nomic
National	—	1	1	—	—	2	2
QLD	16	13	12	10	12	7	8
NSW	14	11	12	14	7	13	6
VIC	7	7	7	7	5	8	9
TAS	1	1	—	—	—	1	1
SA	13	8	7	10	6	6	3
WA	5	5	4	3	1	5	3
NT	4	4	4	—	3	4	2
Total	60	50	47	44	34	46	34

Table 3. Common demographic characteristics of the recreational fishing population of Australia.

	Participation rate (%)	Male: Female	Most active age
National	34	2:1	25–44
QLD	30	2.2:1	20–44
NSW/ACT	30	—	—
VIC	36	2:1	14–24
	28		
TAS	25	3:1	31–40
SA	26	3:1	10–19
WA	43		13–24
	27	2.2:1	25–34
NT	35	2:1	15–22

Sources: National—PA Management Consultants 1984; Qld—ABS 1985; NSW/ACT—McNair, Anderson and Associates 1978; Vic—Beinssen 1978; MacDonald and Hall 1987; Tas—Tasmanian Dept. Sport and Recreation 1986; SA—Philipson *et al.* 1986; WA—Anon 1984; ABS 1987.

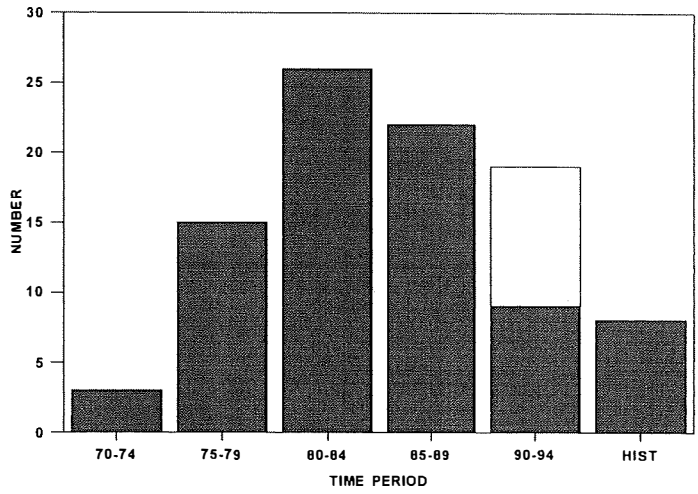

Figure 1. Summary of the number of Australian marine, estuarine and general population studies of recreational fishing undertaken from 1972–1994. Studies have been allocated to the periods during which field work was carried out but, where field work overlapped time periods, they were allocated to the period in which field work was initiated. The unhatched area in 1990–94 indicates the number of studies known to the author to be underway at the time of writing (Nov. 1994). HIST = studies which analysed historical data sets.

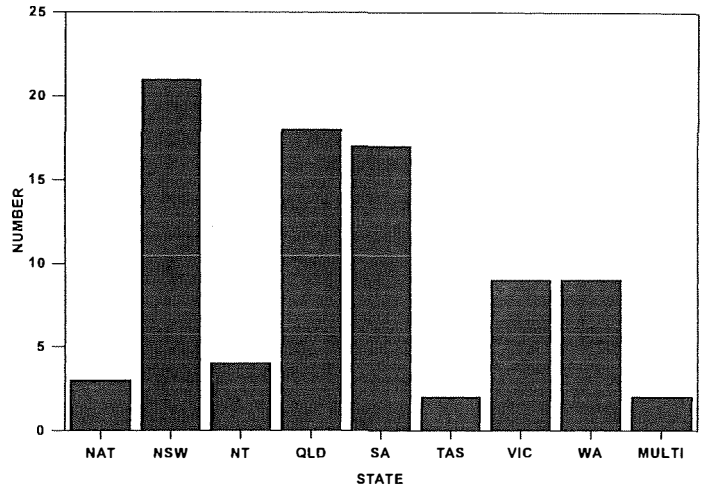

Figure 2. Summary of the number of completed marine and general population studies of recreational fishing in each State and the Northern Territory, as well as multi-State and national studies, from 1972–93.

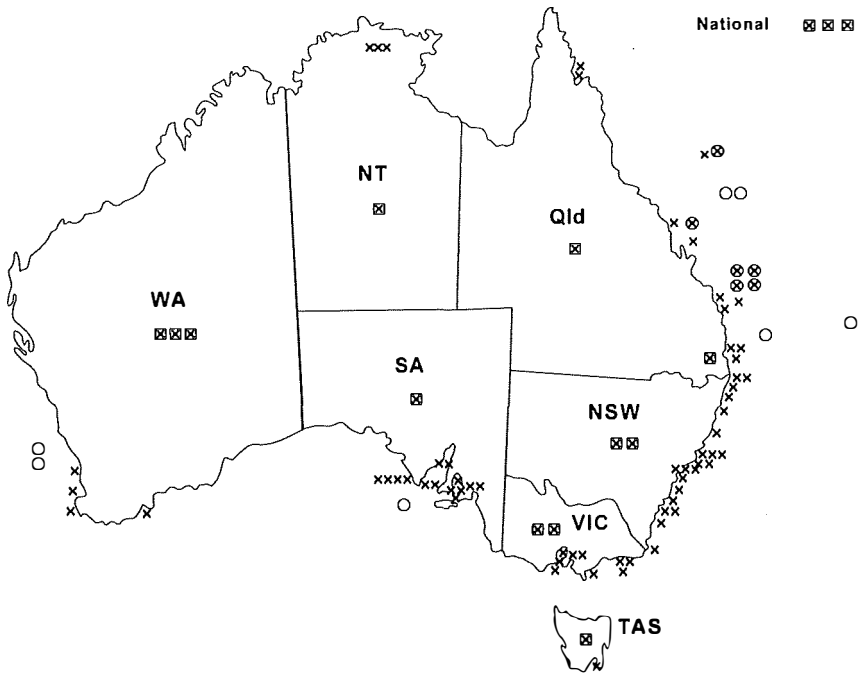

Figure 3. Spatial distribution of marine, estuarine and general population studies of recreational fishing in Australia from 1972–93. Symbols; × = inshore/estuarine; ⊗ = offshore; O = extended areas; ⊠ = general population surveys.

Discussion of Session 1

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Each panel presentation was followed by a time for questions, after which the Session was opened for more general discussion.

Following *Rudy van der Elst's* presentation, Rod Lenanton noted that the provision of commercial catch data was compulsory whereas recreational data were only provided on a voluntary basis. He asked if the recreational data could be considered representative of the total recreational catch.

Rudy van der Elst responded that the data presented reflected total recorded landings, but for Natal where there were good records of total effort, the data were able to be scaled up for each launching site to estimate the total catch. It was estimated that about 60% of boats fishing from each site provided daily fishing returns, so such scaling up is quite justified.

Nick Caputi was interested in the relative reliability and cost effectiveness of data from the different recreational sources.

Rudy van der Elst replied that in terms of cost effectiveness they had tried as far as possible to utilise existing facilities, such as fishing tournaments and affiliated unions and clubs. He considered data collected through such sources to be accurate, and noted that in Natal about 95% of recreational boats were affiliated with clubs. Staff who undertook beach surveys were extensively trained and procedural manuals were followed, and again the data resulting were considered to be accurate. In the case of data submitted voluntarily, obviously there was room for inaccuracies, and such data were cross checked by means of observer programmes.

Albert Caton commented to *Steve Malvestuto* on the difficulties in accurately measuring the length of live fish, noting that errors of plus or minus 2 cm had been observed in some studies. He wondered how recreational anglers had fared in measuring fish to comply with the 30–35 cm bandwidth.

Steve Malvestuto responded that many fisheries in the United States were overexploited and anglers were actively seeking beneficial management measures—there was therefore a great deal of support for such management measures and there had not really been much of a problem with adherence to such 'slot' measurements.

Rob Day wondered if the accumulation of fish below the minimum legal length was due to spatial differences within the systems where animals grew to different

sizes, or to some sort of selection in a closed lake system.

Steve Malvestuto did not feel it was a spatial effect, but it did tend to occur in systems where there was limited productivity but reasonably high exploitation rates.

Rob Day further asked if in such systems there had been no accumulations of larger fish even prior to exploitation.

Steve Malvestuto replied that this view was correct, and that in many systems there seems to have been very little surplus production. Many of the minimum legal lengths had been set in an effort to maintain some trophic dynamics in the systems concerned.

Murray MacDonald commented that the model seemed to be based on the assumption that they were dealing with a 'recreational only' fishery, and recruitment was either constant or determined by fishing pressure—he wondered how the model might work in a situation where there was competition for the resource or variable recruitment due to environmental factors.

Steve Malvestuto replied that variable recruitment almost certainly did exist, but as they were measuring the responses of anglers to management measures, he didn't feel that recruitment variation would have a major influence, although some variables may move up or down from year to year in response to such environmental variability. The intention in developing the model was to take into account the human factors, not to address some of the allocation issues, and so the model should be able to be used in commercial or mixed fishery situations as well.

Ted Loveday commented to *Laurel Teirney* that recreational fishers were unlikely to submit returns if they had taken over the bag limit, and asked if it was felt that information may have escaped inclusion in the study because of non-reporting.

Laurel Teirney replied that, amazingly, fishers seemed happy to disclose in a written response that they had exceeded the bag limit, whereas the tendency in boat ramp surveys was for people to hide their fish. In the paua fishery, for something like fourteen percent of the trips, reported catches were over the bag limit and this result was verified by phone checking.

David McGlennon's presentation was followed by 'forum' questions to all authors in the Session 1 panel.

Chris Hull commented that he had recently visited some freshwater fishing sites in South Africa and found them to be well regulated, with licences and creel surveys in place. He asked Rudy van der Elst if the Oceanographic Research Institute was involved in the monitoring of freshwater fisheries.

Rudy van der Elst replied that freshwater fisheries in South Africa were managed on a State or Provincial basis, and although this may change in the future, the Institute was not currently involved nationally with freshwater fisheries as it was in the marine fisheries.

Chris Hull then asked Laurel Teirney if she would like to comment on recent editorial remarks in the angling press in New Zealand which were adverse to the commercial fishery and seemed to be promoting conflict between recreational and commercial fishers.

Laurel Teirney said she was sad to say that this controversy was being fuelled in some areas, and that she could not support it, and did not think it represented the views of the majority of recreational anglers. In the southern areas where data from the recreational surveys had been available for some time, there was much less conflict than in the northern areas where data from the surveys were not yet available.

Derek Staples noted that the speakers agreed we certainly need good information on recreational catches, but asked how much it cost to collect such information (figures up to seven percent of the value of production had been suggested in some quarters) and who should pay for such collections.

Rudy van der Elst estimated that for the recreational and commercial line fishery in Natal the cost of monitoring was about four to five percent of production value, but it was difficult to estimate as some costs were hidden in existing infrastructure.

Frank Prokop commented that it was important in creel surveys to measure the catch by individual anglers, because management focus is generally on measures which apply to individuals such as bag limits, and figures like average catch per unit effort are not particularly valuable for determining such measures. He then noted that the successes reported by both Rudy van der Elst and Steve Malvestuto related directly to the level of support they had been able to gain from the recreational fishing community, and he wondered what factors they considered were of greatest significance in maintaining the ongoing support of recreational fishers.

Steve Malvestuto replied that in the United States success depends on provision of results and information back to the public—unfortunately in some states this process has lagged somewhat, but in many states there is a high level of public support, based on information and education.

Rudy van der Elst added that in South Africa a great deal of importance was placed on involving fishers in the research programme itself, and while it didn't always work (sometimes for political reasons), if it was pointed out that it was always better to provide good information for decision making rather than having decisions made in the absence of information, then cooperation generally resulted.

Colin Buxton commented that the successes in Natal were largely due to Rudy van der Elst's personal zeal for the programme, and that in his own area of eastern Cape there was much less research effort and the level of success was nowhere near the same.

Kim McClymont asked Laurel Teirney how organised illegal poaching was taken into account (compared with simply catching just over the bag limit) as he believed the levels of poaching may be significant in some instances.

Laurel Teirney replied that the wider issue of 'thieving' is a problem, and cited as an example the abalone fishery where losses due to this cause were estimated to be about 120 t per year. Efforts of compliance officers are targeted at this problem which involves amateurs, illegal professional divers and quota holders.

Alex Julius asked if any of the presenters had done any work on further evaluating the concept of sustainability, and in particular whether there was a need to

differentiate between commercial and recreational sustainability.

Rudy van der Elst commented that there were the usual problems with allocation of the resources between recreational and commercial users in South Africa, and although they didn't have all the answers about sustainability there were some species that were dedicated to recreational use only, and with that went responsibility towards ensuring the sustainable use of those resources.

Steve Malvestuto observed that there was not a lot of commercial fishing in his area in freshwater, but he felt that sustainability in freshwater fisheries was a somewhat abstract concept, and he agreed that the term had a much broader context in regard to recreational fishing and this needed to be addressed.

Gavin Begg asked Laurel Teirney how well the boat ramp survey had confirmed the diary records.

Laurel Teirney replied that in terms of species mix and catch per person the diary system results agreed quite closely with the boat ramp survey results. However it was found the diary system tended to underestimate the number of 'no fishing' trips. There were also some problems with the boat ramp surveys, for example 'group catches' where anglers couldn't remember who had caught which fish and also they often couldn't recall how long they had been fishing for.

Session 2

Measuring catch and effort—the theory

Session Chairperson:	N. Caputi
Sesson Panellists:	S.P. Malvestuto J.L. Woolcock and M.A. Kinloch L.D. West
Rapporteur:	S.G. Ayvazian

Chairperson's Introduction

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The task of measuring catch and effort for commercial fisheries is 'relatively' straightforward. It usually involves asking fishers and/or processors to complete compulsory returns. For nearly all commercial fisheries the vessels (or fishers) are licensed and their numbers are restricted. In many cases, the season and location of fishing and the number of effort units are also restricted. On the other hand, the estimation of catch and effort for recreational fisheries is an order of magnitude more difficult and hence more expensive. Few recreational fisheries are licensed and they usually involve a large number of fishers with a large variation in fishing ability. This means that researchers have to be more creative in the approach used to obtain total catch and effort, and catch rate data for these fisheries.

This Session will explore some of the options which are possible and their advantages and disadvantages. These approaches may vary depending on the main characteristics of the fishery, e.g. whether the recreational fishing activity is licensed (e.g. charter licence, recreational fishing licence, boat licence), the level of illegal activity occurring, the nature of the location (e.g. marine park, river, beach), the seasonality of the fishery, time of day of fishing.

Some approaches which have been used or are being attempted in assessing Western Australian recreational fisheries include:

- Australian Bureau of Statistics (ABS) population surveys
- creel surveys
- boat counts by aeroplane
- mail or phone surveys
- fisheries officer 'surveys' of legal and illegal catch
- abalone surveys by temporary inspectors
- fishing club competitions
- voluntary fisheries liaison officers (honorary)
- logbooks.

As creel surveys and some of the other techniques will receive more attention from the panellists, I would like to comment on two approaches, population surveys and fisheries officer 'surveys', which have proved useful in providing ongoing information on recreational fisheries.

The ABS survey on recreational fishing activities was part of the Market Labour Force survey of the general population conducted in July 1987 (Anon. 1989). This survey was undertaken by personally interviewing a responsible adult who was able

to answer questions on behalf of all household members. This approach enabled a large number of randomly selected households (4675) to be surveyed. The cost would have been prohibitive if it were undertaken as a separate survey. The survey was aimed at identifying the main species being targeted by recreational fishers, and their fishing methods, approximate days of fishing (e.g. 1–5, 6–10 days) and general fishing location (e.g. metropolitan area, south-west region). Interviewees were asked to recall the fishing activities in the past twelve months of household members. No information on catch was sought.

An alternative approach to the above survey would be to utilise the Population Survey Monitor, set up by the ABS to conduct surveys for a number of organisations quarterly, though the sample sizes are much smaller. However the sample sizes may be built up by repeating surveys over a number of quarters. Users pay on the basis of the number of questions they wish to ask in the survey.

The above two survey approaches may be utilised to obtain regular catch and effort information on recreational fisheries as undertaken by New Zealand (Teirney this volume). The random surveys would identify the households with recreational fishers and these could be asked to complete a diary of fishing activities for 3–12 months. This would provide an overall assessment of catch and effort for the main recreational fisheries. Creel surveys provide detailed catch and effort information for a region for a period, usually 1–2 years, and may be necessary when detailed assessments of fisheries are required or the management of the fisheries is being reviewed. However they are generally too expensive to provide ongoing monitoring of all recreational fisheries.

One common criticism of survey methods for obtaining catch information is that they do not take into account any illegal activities. One approach to obtain information on such activities would be to utilise information collected by Fisheries Officers. They are regularly in the field 'interviewing' recreational fishers and can provide useful information not only on illegal activities but also an ongoing monitoring of the number of fishers operating, their methods, catch rates, etc.

With greater emphasis being placed on performance indicators in all aspects of Government services, recording of information by Fisheries Officers would also enable an objective assessment of the success of the management methods being used. Information such as the proportion of fishers who are aware of the fishing rules, and the level of compliance, could be used as indicators of the success of management.

A criticism of this approach is that the Fisheries Officers are often targeting suspected illegal activities and hence a biased result is obtained. The methods used by Fisheries Officers, and indeed most policing officers, may be regarded as a two-stage sampling process. That is, some recreational fishers are approached in a 'random' or systematic manner as spot checks for illegal activities while others may be targeted because they are suspected of undertaking illegal activities. If this is so then Fisheries Officers would have to clearly identify the approach being adopted on any particular occasion. The former group could then be used to provide population estimates of recreational fishers' activity while the second group would provide some supplementary data on the nature of illegal activities.

Because of the difficulties in monitoring catch and effort information from recrea-

tional fishers, a number of approaches need to be explored as no one approach is going to provide all the information requirements for the proper management of recreational fisheries.

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Estimation of angler harvest rates for recreational fisheries using creel surveys: current limitations and options for improvement

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Abstract

The acquisition of reliable estimates of harvest rate, measured as number of fish harvested per hour of fishing (hpue), has proved elusive as a creel survey objective. There are several reasons for this. Harvest rate is, by definition, a ratio and there are many ways of combining the numerator (harvest) with the denominator (effort). Different ratio estimators can produce widely differing estimates of hpue at different levels of precision. Depending on the survey method, effort and harvest data can be based on different types of interviews. On-site roving surveys provide interviews from uncompleted trips, while access point surveys provide completed trip interviews. Hpue estimates generally are highly variable, more so for marine and riverine fisheries than for lake fisheries. Common design stratifications, e.g., months, day types, geographical areas, have little positive effect on variability, and sample sizes required to obtain reasonably precise estimates can be prohibitive. Recent research suggests: (1) avoid per party estimators—they give relatively inflated and variable values; (2) use data from on-site, completed trip interviews if possible; (3) sample at an intensity to cover at least 70% of the possible fishing days; (4) divide the survey period into temporal strata that are as small as possible, but still allow replicate samples to be drawn; and (5) allocate relatively more effort to collecting interviews within days to compensate for high levels of within-day variability typical of hpue estimates.

Introduction

Harvest rate, measured as the number of fish harvested per angler-hour, is a primary fishery statistic traditionally estimated using creel surveys. Estimates of harvest rate are taken as a measure of angling success and are used as an index of stock density. The current popularity of length limits as a management tool in the United States, with the increased importance of catch-and-release fishing as a conservation tool, has made it necessary to distinguish between harvest rates and catch rates. I will use hpue (number of fish harvested per hour of fishing) here to signify harvest rate, and cpue (catch per unit of effort) to signify catch rate. Catch rate is the number of fish caught per angler-hour, including those fish released. The estimation of catch rate, then, entails that anglers be questioned about those fish caught and released (not observa-

ble at the time of the interview), as well as those in-hand at the time of the interview. There is potential for catch rates to be influenced by various recall biases, e.g. prestige bias and traditional recall bias; however, most recall periods are relatively short (mean fishing trip length usually averages between 3 and 5 hours) which makes severe recall bias unlikely.

The focus here will be on the estimation of angler harvest rates (hpue) for recreational fisheries using creel surveys. Most of the data available pertain to harvest rates rather than to catch rates; however, the two variables should behave similarly. The results reviewed here are from on-site angler surveys where harvest can be observed and measured by trained field technicians so that non-response or recall bias is not an issue.

Traditionally, hpue and cpue are used as measures of fishing success, as indices of stock density, and as one of the two primary variables (the other is fishing effort) used to calculate total harvest and total catch, respectively. It is apparent that the same estimator of hpue might not be appropriate for all three objectives. In this paper, I want to consider three important questions relevant to measuring hpue: (1) Which ratio estimator is best to use for particular objectives? (2) Are uncompleted fishing trip interviews acceptable? and (3) How does the sampling design account for variability in hpue?

(1) Choice of estimator

Crone and Malvestuto (1991) evaluated 5 ratio estimators of hpue (Figure 1). The first estimator was the mean party estimator (MP)—hpue is calculated for each individual party and a mean is taken over the number of parties (m) interviewed. The second estimator was the mean daily estimator (MD)—a single estimate of hpue is calculated for each day sampled by summing all the harvest from the interviews that day in the numerator and dividing by the sum of the total effort measured that day in the denominator. A mean is then taken over the number of days in the sampling period (n) to provide a mean daily value.

The third estimator of hpue was the total ratio estimator (TR)—a single estimate of hpue is calculated where the numerator is the sum of all of the harvest over m interviews over n days, and the denominator is calculated by summing the measured fishing effort from all m interviews over n days in the survey period. In essence, all of the harvest over all interviews is divided by all of the effort over all interviews to provide a single ratio estimate of hpue.

The final two estimators were the party regression (PR) and the daily regression (DR) estimators. Using these estimators, hpue is estimated as the slope of the line which best fits the plot of harvest on fishing effort. Harvest (Y) is plotted on fishing effort (X) where the points are derived either from interviews (party regression) or from days (daily regression); daily values are the sum of harvest and effort over all interviews taken within each day. The slope measures the rate of change in harvest per unit of fishing effort, or hpue.

The authors evaluated the behaviour of these five ratio estimators on three reservoirs in Alabama. The reservoirs ranged from 5000 to 15 000 hectares. Estimates of hpue were calculated for two species of fish, largemouth bass (*Micropterus salmoides*) and crappie (*Pomoxis sp.*), based on interviews of anglers who were targeting these

species (Figure 2). Largemouth bass is the major predator in the southeastern United States and crappie (2 species) is one of the most sought-after pan fishes.

Figure 2 shows how estimates of hpue varied across the five methods for the two species fisheries for the three lake reservoirs in Alabama. The general within-lake trend was that the mean party estimator (MP) and mean daily (MD) gave high values of hpue and the daily regression estimator (DR) gave the lowest. This range was considerable in some cases. For example, the difference between MP and DR for Lake Demopolis was 0.2 fish/h for largemouth bass anglers and over 1 fish/h for crappie anglers. For the crappie fisheries, in particular, the party regression estimator (PR) also gave relatively low values of hpue. The total ratio (TR) estimator gave values that were intermediate to the others. To some degree, patterns were lake-specific, e.g. values of hpue were relatively consistent across estimators for Lake Weiss for both species.

Figure 3 shows similar graphs, except that the response variable is the coefficient of variation (CV) of hpue. This figure, then, shows trends in the precision of the estimators being compared. These trends were very similar across lakes and species fisheries. The highest CVs were associated with the party estimators, both MP and PR. Variability dropped sharply within lakes, usually by more than half, when estimates were based on the daily formulations (DR, MD and TR).

Given that the estimators evaluated can give different values with different levels of precision when applied to a set of data, it is logical to ask which estimator behaves the best given certain objectives. For example, if cpue from a creel survey is being used as an index of stock density, then seemingly it should correlate well over time with cpue values derived from traditional fishery-independent methods of tracking stock density, such as electrofishing.

Figure 4 shows trends in electrofishing estimates of cpue relative to estimates of cpue from the five methods outlined above, over a 4-year period on West Point Lake for largemouth bass. The electrofishing was conducted during the fall of each year and the creel surveys were conducted during the following years in the spring. The objective of the study was to determine if catch rates from fall electrofishing could be used to predict catch rates for recreational fishing the following fishing season. The correlation coefficients (r) between the electrofishing values of cpue and each of the creel survey estimators of cpue are shown at the top of the figure.

The regression estimators (PR and DR) of cpue through the creel survey were highly correlated with the electrofishing values ($r = 0.94$ and 0.98, respectively). The mean daily (MD) and total ratio (TR) estimators were moderately correlated with the electrofishing values ($r = 0.75$ and 0.79, respectively), and the mean party estimator (MP) was weakly correlated ($r = 0.37$). Based on this empirical analysis, the regression estimators provided the most accurate trends in stock density of largemouth bass over time.

(2) The acceptability of uncompleted trip data

Traditional on-site creel survey methods require that data on cpue and hpue be gathered either at access points or by rov-

ing through the survey area. In the first case, anglers are intercepted at the end of their fishing trips, so that the interview data are based on completed trips. In the second case, anglers are intercepted in the act of fishing, so that the interview data are based on uncompleted trips.

The critical issue is that hpue and cpue estimated from uncompleted trip interviews are unbiased only if the rate at which fish are caught is largely independent of the time spent fishing. The evidence to date suggests that the validity of this assumption, i.e. that catch rate is independent of fishing time, is fishery specific. The assumption may not hold for strongly diurnal species or species that are very active only during certain parts of the day, or for fisheries where successful anglers, on-the-average, spend less time fishing than unsuccessful anglers. For example, a low creel limit might allow experienced anglers to limit out early and stop fishing, thus leaving the less experienced anglers on the water longer for the creel clerk to interact with. If there are strong doubts about the acceptability of uncompleted trip interviews, then it may be necessary to incorporate access point sampling into the survey.

(3) Appropriateness of the sampling design

It is frequent that estimates of cpue and hpue are highly variable and that commonly used sampling designs account for only a small portion of the sampling variance. Table 1 lists five fisheries in Alabama. These fisheries were surveyed using sampling designs that stratified the year into months and also into day types. The first two lakes on the list, Yates and Thurlow, are small, less than 2000 hectares; Lake West Point is larger, about 12 000 hectares. The Thurlow tailwater is the immediate stilling basin in the river below the dam at Lake Thurlow, and the data collected from the Tombigbee River represent a 350 km stretch. So, the fisheries surveyed represent an array of different environmental conditions and associated fish species. The larger systems, i.e. West Point Lake and the Tombigbee River, were divided into sampling sections which were chosen at random using non-uniform probabilities. Thus, the designs were relatively sophisticated, taking advantage of temporal stratification and non-uniform probability sampling (Meredith and Malvestuto 1991).

The numbers in Table 1 are residual variances expressed as percentages of the total variances, for fishing effort and hpue. For any given fishery, the residual was what remained after the design extracted as much variability as possible (using ANOVA) based on the defined stratification. The percentages thus measure the amount of variability *not accounted for* by the design. It is apparent that the designs are more efficient for the estimation of fishing effort than for the estimation of hpue. On average, the designs could not account for 61% of the variability in fishing effort and 92% of the variability in hpue. At best, the design on West Point Lake explained 20% of the variability in hpue.

In general, traditional survey designs are not doing a very good job accounting for variability in hpue. What do we need to do? First, we need to have large enough sample sizes. The most recent evidence suggests that we should sample at least 50 to 70% of the available days within the survey period (Bayley *et al.* 1991). This would be fifteen to twenty days a month mini-

mally. Even at these levels, sampling can be problematic during seasons of high daily variability. The winter season in the southeastern United States provides very poor fishing days interspersed with a few very good fishing days. This leads to high levels of day-to-day variability, such that it is not really feasible to sample enough during this season to obtain good estimates of hpue, particularly considering that winter generally accounts for only a small portion (10%) of annual effort and harvest.

Large sample sizes may not be adequate for species specific estimates of hpue. Typically, when data are partitioned into species specific sets, sampling days are lost when no one is targeting a particular fish. When too many days are lost, mean daily estimators become inefficient because the sample size is reduced too much. The total ratio estimator based on fishing parties is more generally applicable for computation of hpue for species fisheries, but using parties as measurement units leads to higher levels of variability, as discussed above.

The inability of monthly and day type stratification to explain meaningful portions of variability in hpue (Table 1) suggests that other stratifications might be more effective.

Day-type stratification, that is stratification into weekdays and weekends, generally is of little advantage for estimation of hpue unless there is a systematic difference between hpue across these two strata, which we have not found to be the case for the fisheries tested to date. A stratification designed to account for variability in hpue should focus more on within-day variability, so that morning, afternoon, and evening strata, for example, might be more effective. Recent studies (Lester *et al.* 1991; Malvestuto and Knight 1991) show that typically most of the variability in estimates of hpue resides within days, rather than between days, so that within-day stratification, as well as increased sampling within days, will increase the precision of estimates of hpue.

Summary

(1) Mean daily or total ratio estimators of hpue probably are the best choices—they were relatively stable and behaved consistently across the reservoirs;

(2) Perhaps regression estimators are best for indexing stock density—these estimators were very highly correlated with annual changes in the stock density of largemouth measured with electrofishing;

(3) To avoid potentially biased estimates of hpue, use completed trip interviews from access points, if possible;

(4) To reduce variance in estimates of hpue, sample at an intensity to cover at least 50 to 70% of the possible fishing days; and

(5) Allocate adequate effort to within-day sampling.

These considerations will provide best estimates of hpue possible, but more experimentation and research is warranted if agencies are to increase information return for dollars spent.

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Table 1. Residual variances from ANOVA expressed as percentages of the total variances for fishing effort and hpue for five fisheries in Alabama, USA. The tabled values represent the percentage of variability not accounted for by the survey designs (see text for details).

Fishery	Effort (%)	hpue (%)
Lake Yates	53	97
Lake Thurlow	61	99
Lake West Point	68	80
Thurlow Tailwater	48	94
Tombigbee River	74	89
Mean	**61**	**92**

(1) $$MP = (1/m) \sum_{i=1}^{m} (H_i / E_i)$$

(2) $$MD = (1/n) \sum_{j=1}^{n} \left(\sum_{i=1}^{m} H_i \Big/ \sum_{i=1}^{m} E_i \right)$$

(3) $$TR = \frac{\left(\sum_{j=1}^{n} \sum_{i=1}^{m} H_i \right)}{\left(\sum_{j=1}^{n} \sum_{i=1}^{m} E_i \right)}$$

(4) PR & DR

$Y = a + bx$

Harvest = a + HPUE (Effort)

Figure 1. Mathematical definition of five estimators of hpue from creel surveys (from Crone and Malvestuto 1991). MP = mean party estimator; MD = mean daily estimator; TR = total ratio estimator; PR = party regression estimator; and DR = daily regression estimator.

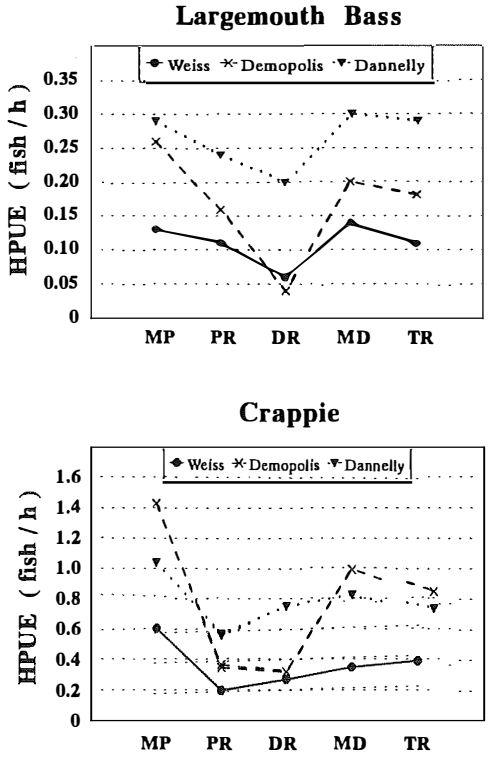

Figure 2. Trends in estimates of hpue (fish/h) over five estimators for three lakes in Alabama, USA, for largemouth bass and crappie fisheries (based on data from Crone and Malvestuto 1991). Estimators are designated as MP = mean party, PR = party regression, DR = daily regression, MD = mean daily and TR = total ratio.

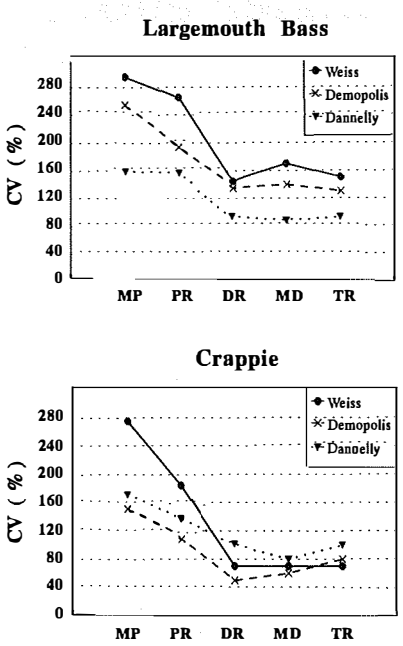

Figure 3. Trends in estimates of the precision (CV) of five estimators of hpue (fish/h) for three lakes in Alabama, USA, for largemouth bass and crappie fisheries (based on data from Crone and Malvestuto 1991). Estimators are designated as MP = mean party, PR = party regression, DR = daily regression, MD = mean daily and TR = total ratio.

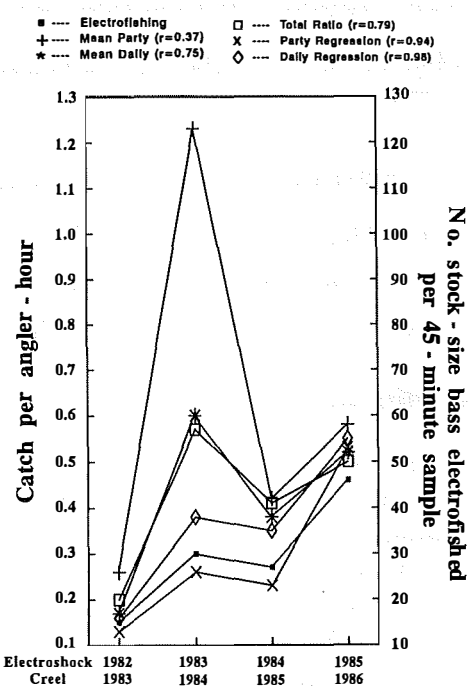

Figure 4. Relationships between cpue measured by electrofishing in the fall, and cpue of anglers measured by a creel survey the following spring, on West Point Lake for five estimators of angling cpue. The correlation coefficient (r) between electrofishing cpue and each estimator of angling cpue is given at the top of the Figure.

An assessment of the 'bus-route' method for estimating angler effort

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Introduction

In 1989, Robson and Jones published a paper describing a new survey method designed to estimate recreational fishing effort on large bodies of water having a high number of access sites. They called their survey design the 'bus-route' method and its advantages are its logistic ease and relatively low cost, since only limited personnel and equipment are required for its implementation.

The basic idea of the bus-route method is for a survey agent to travel by car around the body of water in a cyclic manner, stopping at all fishing access sites along the way. The agent remains at each access site for a predetermined amount of time and, while there, records the length of time that each boat trailer (i.e fishing trip) is present (Figure 1). If a fishing party returns during the waiting time, an interview with the returning fishers is conducted to estimate such things as species composition and catch rate. The amounts of time that trailers are observed are then used to obtain an estimate of total fishing effort on that day.

The purpose of this paper is firstly to provide a simple example to show how this estimator for total fishing effort is derived, and then to look at one way in which the bus-route method is being applied in a South Australian fishery. For a more detailed explanation of the bus-route survey method see Robson and Jones (1989).

Simplest case

Here we just observe if a trailer is present or not when our observation point is chosen at random in [0,T] (Figure 2). We define Y_i to be a random variable such that

$$Y_i = \begin{cases} 1 & \textit{observe boat trailer} \\ 0 & \textit{otherwise} \end{cases}$$

and thus arrive at the following probability distribution:

Y_i	1	0
$Pr(Y_i)$	$\frac{D_i}{T}$	$\frac{T - D_i}{T}$

From the above probability distribution, the survey agent's expectation of observing an angler's trailer will be:

$$E(Y_i) = 1 * \frac{D_i}{T} + 0 * \frac{T + D_i}{T}$$
$$= \frac{D_i}{T}$$

Hence, the length of a given fisher's trip, D_i, can be arrived at through the expected value of observing this trip multiplied by the length of the fishing day:

$$E[TY_i] = D_i$$

We have now arrived at a probability of observing a boat trailer which relates to the length of the fishing trip, D_i.

Waiting times

This theory may now be extended to include the survey agent not only observing whether or not a boat trailer is present, but remaining at the access site for a certain length of time and recording the period of observation of each boat trailer (Figure 3).

Let X_i = length of time that angler's trailer is observed

and w = waiting time for survey agent at ramp.

Suppose that the survey agent arrives at a random time $t \in [0,T]$, then X_i will vary according to the time that the survey agent arrives at the access site:

$$\begin{aligned}
t = 1 \quad & E[X_i | 0 < t < a_i - w] = 0 \\
2 \quad & E[X_i | a_i - w < t < a_i] = \frac{w}{2} \\
3 \quad & E[X_i | a_i < t < d_i - w] = w \\
4 \quad & E[X_i | d_i - w < t - d_i] = \frac{w}{2} \\
5 \quad & E[X_i | d_i < t < T] = 0
\end{aligned}$$

Associated with each of these expected values of the length of observed time, is a probability that the agent will be at that access site at time t:

$$\begin{aligned}
t = 1 \quad & Pr(0 < t < a_i - w) = \frac{a_i - w}{T} \\
2 \quad & Pr(a_i - w < t < a_i) = \frac{w}{T} \\
3 \quad & Pr(a_i < t < d_i - w) = \frac{D_i - w}{T} \\
4 \quad & Pr(d_i - w < t < d_i) = \frac{w}{T} \\
5 \quad & Pr(d_i < t < T) = \frac{T - d_i}{T}
\end{aligned}$$

Combining these probabilities and expected values, we arrive at the expected length of observation of a trailer, $E[X_i]$, given a fisher's trip of duration D_i:

$E[X_i]$ = Pr (agent at site) * $E[X_i |$ angler at site$]$

$$= \left(0 \star \frac{a_i - w}{T}\right) + \left(\frac{w}{2} \star \frac{w}{T}\right) + \left(w \star \frac{D_i - w}{T}\right) + \left(\frac{w}{2} \star \frac{w}{T}\right) + \left(0 \star \frac{T - d_i - w}{T}\right)$$

$$= \frac{w}{T}\left(\frac{w}{2} + D_i - w + \frac{w}{2}\right)$$

$$= \frac{w}{T} D_i$$

Hence:

$$E\left(\frac{T}{w}X_i\right) = D_i$$

The D_i and its associated X_i relates to a particular fishing party utilising a particular access site. To arrive at the total angler effort for the sampling day, it is necessary to sum up all lengths of time that trailers are observed at all access sites within the survey area. If waiting times (w) at all access sites are the same, then total angler effort is given by:

$$TE = \frac{T}{w}\sum X_w$$

A practical example

The bus-route method is currently being applied in South Australia to undertake a roving creel survey of the recreational boat fishery in Gulf St Vincent and the adjacent waters of Investigator Strait and Backstairs Passage (Figure 4).

This represents a body of water of approximately 7000 square kilometres accessed by about 20 major and 35 minor boat ramps. The total perimeter of the fishery, and thus distance to be covered by survey agents, is roughly 500km.

It was therefore necessary to subdivide this area into more manageable units by grouping the boat ramps into a number of individual bus-routes such that a circuit of each route could be covered in a working day. The particular geography and distribution of ramps around Gulf St Vincent allowed the delineation of four routes containing five to seven ramps each. Each complete circuit is, on average, 200 km long (Figure 5).

Next, it was necessary to define Δ or the length of the fishing day. This will obviously vary depending on the time of year. In summer, when the days are finer and longer, people will stay out fishing later. The distribution of fishing effort throughout the day was known from a pilot study undertaken the previous year, so fishing day lengths were selected such that no more than 5% of effort was missed completely. This led to the selection of a 9 hour fishing day in winter (0900–1800) and a 12-hour fishing day in summer (0700–1900). This was divided into two shifts (δ) of six hours or eight hours respectively with an overlap period in the middle of the day. These shift times corresponded to the amount of time taken to accomplish a complete circuit of one 'bus-route', thus, for our purposes, $T = \delta$ (symbols from Robson and Jones 1989).

With these shift lengths fixed, the four routes were driven in order to ascertain precise travelling times between ramps. The remainder of the shift time was distributed as waiting times at ramps. As an example, for Route 2 in summer (T = 480 minutes), the total travelling time is 150 minutes and waiting times, which range from 30–80 minutes depending on the importance of the ramp, sum to 330 minutes (Figure 6).

The survey is to be carried out over a full year and this period has been divided into six temporal strata. Sampling frequencies within each stratum were calculated according to pilot data estimates of means and standard deviations for harvest such that coefficients of variance (CVs) were less than 10%. This resulted in 12 survey days per month in winter rising to a maximum of 26 days per month during autumn (April and May) for all four routes combined.

The accuracy of the method was tested using a set of census data of *known* fishing effort collected at a number of boat ramps which were kept under 24-hour surveillance. These data were used in 12 000 computer simulation trials which generated estimates of effort using the bus-route method of sampling under a variety of combinations of Δ, δ and T at different sampling frequencies.

Results showed that the method yielded estimates that were within 10% of the actual value using sampling frequencies as low as 10 days per stratum. The method was also shown to be precise and unbiased.

The cost of the survey is in the region of $12–14 000 per month. This covers salaries for four staff (1 research officer and 3 technical services officers), vehicle hire and travel expenses. In 1995 the survey will continue into Spencer Gulf which is approximately half as big again as Gulf St Vincent. Preliminary reconnaissance suggests that this area can be covered by six individual bus routes and that costs should be only slightly higher.

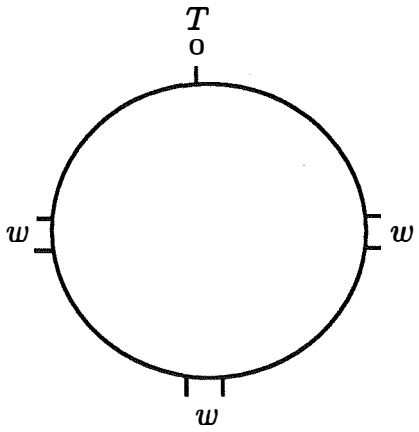

Figure 1. A pictorial representation of a circuit around a fishery which takes time T to travel and consists of three access sites with equal waiting time, w.

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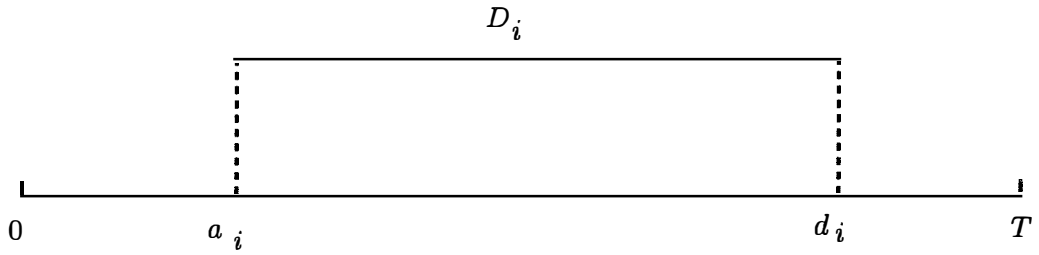

Figure 2. Instantaneous waiting time selected at random in [0,T].

In this example

T = length of fishing day ≡ length of survey day

D_i = length of fisher's trip

a_i = arrival of fisher i

d_i = departure of fisher i

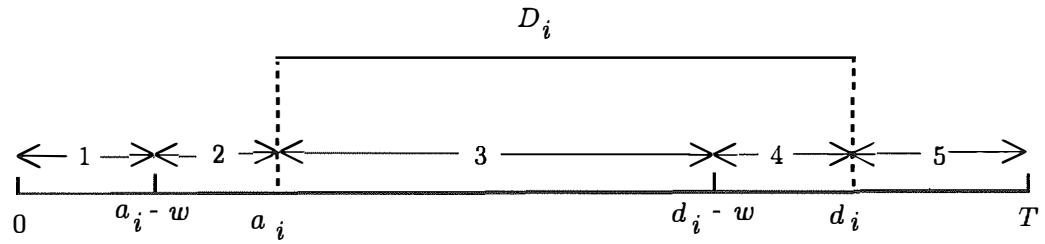

Figure 3. Effect of a randomly located waiting time on the duration of the agent's encounter with the trailer.

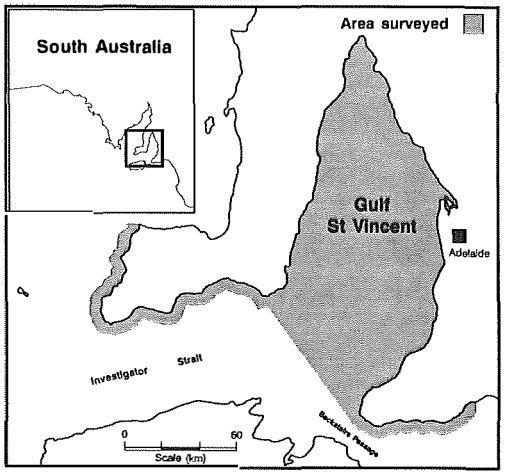

Figure 4. Location of the fishery being surveyed by means of the 'bus-route' method in South Australia.

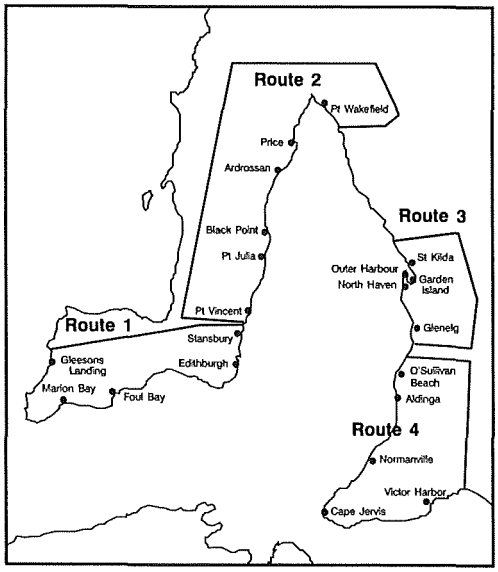

Figure 5. Subdivision of Gulf St Vincent fishery into individual 'bus-routes'.

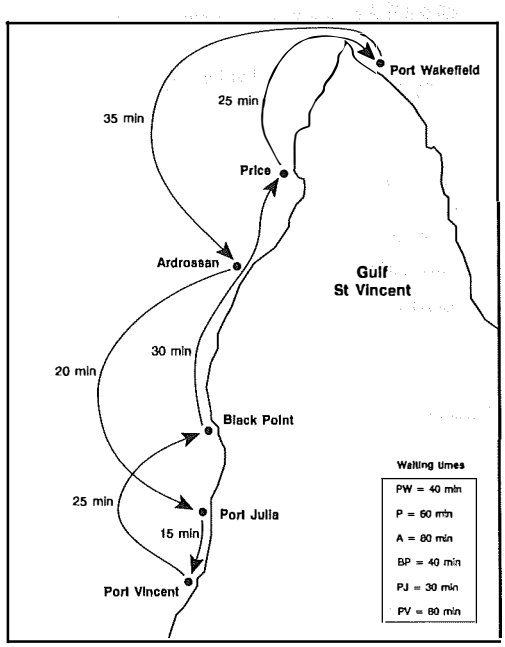

Figure 6. 'Bus-route' 2 showing circuit design, waiting times at ramps and travel times when T = 8 hours.

Tailoring survey design to information requirements

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Abstract

Apart from studies to collect base-line participation rates, the design of truly cost-effective recreational fisheries surveys is a necessarily complex process. Where catch and effort data are required, conventional population survey methods are largely unsuitable and while on-location creel surveys better address such factors as species identification and recall problems, they represent an inherently more expensive method. In many widespread or less-popular fisheries, such costs can be clearly prohibitive.

However, an exhaustive approach to the design process can often produce alternative designs to maximise data utility from limited research budgets. Often this involves some compromise and occasionally, a study may not be proceeded with. But in all cases, such decisions should be made after a balanced review of data requirements, research options and available information.

Literature reviews, secondary datasets and pilot-testing are key components here. Qualitative information can also assist in determining sampling stratification factors and intensity—especially where innovative methodologies are concerned. Yet, operational factors such as staff recruitment, workload structures and travel options must also be considered in a total design approach.

Catch and effort data are essential prerequisites for fisheries research and management. Economic assessments and attitudinal data are also important. Typically, these data are more readily obtained for the commercial components of a fishery, due mainly to the substantially smaller and more accessible target audiences involved. (Note: when compared with research in many other disciplines, most commercial fisheries data collection is extremely inexpensive).

In the past, the comparatively high cost of recreational fisheries research together with modest budgets, have understandably resulted in a lack of detailed information for this sector—and therefore on a *total fishery* basis in many cases. As resource sharing and other management issues increasingly emerge over time, so does the need for *total fishery* data and therefore, more cost-effective research methodologies for the recreational sector.

Although 'screening' surveys of the general population can readily provide data such as participation rates, species targeting and broad measures of effort, more detailed information necessitates the use of more sophisticated research instruments.

On-location creel surveys are undoubtedly the preferred method where detailed catch

and effort data are required, especially for precise species identification and size data. Respondent recall problems, response bias and other factors associated with *non-sample error* are also minimised.

Yet, as the focus of a potential study broadens in terms of time and space, the comparatively high component costs of creel survey fieldwork impact significantly on overall cost-effectiveness. The use of more efficient field methods (such as aerial head-counting of large/inaccessible areas) and careful stratification and refinement of sampling frames can offset these effects to some extent. However, in many widespread or less popular fisheries, these costs often remain prohibitive.

In the development of any innovative research methodology, a *total design* approach is clearly needed to achieve optimum cost-effectiveness and in many cases, the resource requirements of a rigorous development phase may seem excessive. Yet, invariably the value of this investment is realised in ultimate data utility and especially so, where large fieldwork budgets are involved in the survey proper. (Note: 'comparability breaks' can result from even minor modification to a research instrument after commencement of enumeration and are often the direct result of inadequate development work).

Although a sometimes tedious process, adherence to the following design strategy will optimise cost-effectiveness from any survey design:

Key design components

Initial output specification: having defined the study objectives, a more detailed list of potential data elements is then prioritised in terms of e.g: (1) essential; (2) highly desirable; and (3) desirable, if little or no additional cost is involved. Such priorities should also be attached to relevant cross-tabulation/disaggregation requirements to assist with later sampling frame development. However, where possible, methodological options should not be considered at this stage (i.e. to avoid being 'technique-driven').

Desk research: conduct literature searches and identify/review appropriate secondary datasets (principally for benchmarking/validation purposes). Where appropriate, explore methods employed in other subject matters for similar assessment purposes. Explore/conduct initial qualitative assessments to establish relevant hypotheses (e.g. discussions with various local 'experts' regarding effort concentrations in time and space).

Initial design: develop broad methodology options and review in terms of cost/benefit and output specifications. Select preferred option (sometimes after brief field testing) and apply a *total design* approach, including: staff recruitment, training and management; field and office quality controls systems; and data processing/analysis procedures.

Initial pilot-testing: conduct initial testing as appropriate, including: questionnaire length, comprehension and ambiguities; *sample-take* and field resource assessment; and operational/logistics problems. Maximise validation work in terms of 'ground truthing' new methods and hypotheses—especially from any qualitative work relevant to that particular season.

Re-design and further testing: review testing results and modify design as appropriate. Except for minor amendments, conduct appropriate re-testing. Validate design

against output specifications and if necessary, conduct full 'dress rehearsal' testing before committing to enumeration. (Note: with many innovative survey designs, it is only at this stage that precise funding requirements can be determined for the study. The adoption of a two-stage approach to the development and implementation phases can therefore obviate many problems here, including extreme cases where a suitable methodology may not emerge from the development process and the study is to be discontinued).

Even in cases where a study is merely being repeated to measure change over time (e.g. a repeat creel survey of a particular estuary), certain elements within the above process are important. For example, options often exist in terms of sampling structure and intensity (e.g. 'peak' *vs.* full seasonal comparability; total harvest estimates *vs.* cpue comparisons only). Cost/benefit analysis of output options is therefore an important component of every survey design.

The following examples provide a brief summary of the design challenges and resultant solutions for three different recreational fisheries research projects:

Example 1: Game and sportfishing survey

East coast of Australia 1993/94—in conjunction with Pepperell Research & Consulting, to obtain data on total angler numbers, targeting, socio-economic and attitudinal data

Design Problem: cost-effective accessing and quantification of *non-club* members, from a comparatively rare-event fishery. (Note: no difficulties existed in terms of club members here.) Use of (otherwise) preferred 'screening' methods was cost-prohibitive, e.g. surveys of general population or boat registrations.

Solution: preliminary 'screening' surveys of: customers in known game/sportfishing tackle shops; subscribers to fishing magazines/mail order catalogues for game/sportfishing tackle; and some boat ramp studies to provide ratio of club member to non-club member anglers, and sampling source for the survey proper.

Example 2: Recreational prawning survey

Four coastal lakes—1991/94 for NSW Fisheries Research Institute, to obtain detailed catch and effort information, including size frequency data

Design Problem: as a first-of-its-kind study internationally, no literature or previous methodologies available to assist with design. Also no empirical secondary data available e.g. to identify effort concentrations in time and space. Night vision problems cause comparatively slow head-counting—especially on large expanses of 'open' water. Need to maximise field resource usage.

Solution: extensive qualitative research (interviews with local tackle shops, fishing inspectors, commercial operators and recreational prawners) enabled firm hypotheses to be formed for each estuary in terms of effort concentrations in time and space—especially regarding seasonal changes. Subsequent field observation and pilot-testing strongly confirmed these hypotheses (for that time of year), enabling confidence in hypotheses for other times. Substantial effort concentrations allowed for frequent

count/ interview runs of very small survey areas on each estuary, without expense of military-grade night vision equipment. Less frequent 'whole estuary' count runs consistently confirmed effort coverage levels of virtually 100% on each estuary.

Example 3: Fishcount 95

General population survey—Northern Territory 1994/96, to obtain participation rates, catch, effort, expenditure and attitudinal data—for both residents and visitors

Design Problem: logistics of NT render conventional creel surveys cost-prohibitive. Reliable catch, effort and expenditure data needed from household-based survey method, covering the range of recreational fishing activities and seasons. Necessary compromises, such as lack of size frequency data, to be accounted for through other, parallel research.

Solution: multi-faceted design developed and tested with second-stage diary system for anglers. Combination of telephone and face-to-face interviewing techniques employed, using a monthly 'wave' sampling system covering a full twelve month period. Drawing on methods used successfully in other disciplines (e.g transport and household expenditure surveys), the diary system focuses on absolutely minimal respondent burden, by maximising the role/responsibilities of the interviewer. Through a range of additional research modules and validation work (e.g. parallel creel surveys of selected areas), utility and validity of data will be cost-effectively maximised. For the first time, *total fishery* data will be available for an extensive range of fisheries in the Territory. (Note: as at March 1995, five monthly 'waves' of enumeration have been completed with response rates in excess of 90% already achieved).

Conclusion

An exhaustive approach to the design of any recreational fisheries survey is critical to overall cost-effectiveness. In monetary terms alone, any resultant increases in development costs are offset by efficiencies gained in the implementation phase—especially where innovative designs and larger fieldwork budgets are involved. Even in the simplest 'repeat' survey, a brief cost/benefit analysis of sampling options will optimise outcomes from a limited research budget.

Detailed output specifications are a vital first step to the design process, as is a rigorous but 'open-minded' approach to identifying relevant secondary datasets, qualitative information and methodological options.

Particularly where innovative methods are concerned, a *total design* approach is critical to ensuring that all components of the design (including field management and quality control systems) are carefully integrated and tailored to specific needs. Comprehensive pilot-testing is also important to validate new methods, test hypotheses and provide accurate resource requirements for the study proper. Further to this, a planned two-stage approach to the design and implementation phases can obviate difficulties with advance budget estimation and funding.

By thoroughly tailoring a study design, true cost-effectiveness will be achieved. In many cases, the benefits are substantial—not just in terms of absolute cost minimisation, but importantly through improved data quality and utility.

Discussion of Session 2

Recorded by S.G. Ayvazian

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Nick Caputi, the session chairperson, opened the session with an introduction to measuring catch and fishing effort. Three panel presentations followed, each with a short question and answer period. Following the concluding paper, the chairperson opened the floor for more general discussion and questions.

In his introduction, Nick Caputi spoke of the difficulties in obtaining recreational fisheries catch and fishing effort information as compared with commercial fisheries information. Much of the difficulty is due to the unregulated nature of recreational fishing. In Western Australia, several methods are employed or will be employed in the near future, to generate information on recreational fishing. These methods include: an Australian salmon and herring creel survey, fisheries officers' creel surveys, Volunteer Fisheries Liaison Officers' creel surveys, anglers' logbooks, mail and phone surveys, Australian Bureau of Statistics population surveys and angling club competition day records. Each of these programmes was detailed with the benefits and potential drawbacks discussed.

Stephen Malvestuto of Fisheries Information Systems, Inc., Auburn, USA, presented information on the estimation of angler harvest rates for recreational fisheries, using creel surveys. Measuring harvest rate (hpue= the number of fish harvested per hour of fishing,) has been difficult from creel surveys alone. This results from the sampling biases associated with various types of creel surveys. The author made four comments on sampling design: 1) sample at least 50–70% of the days within time blocks, 2) division of survey period into time blocks is important and will improve precision of the estimators, 3) day-type stratification is of little advantage to hpue. Within-day stratification might be optimum for ratio estimators, and 4) optimum allocation of samples across monthly time blocks is difficult because weather and fishing patterns change from year to year.

To Aldo Steffe's question as to whether his data were based on multi-species fisheries, Stephen Malvestuto replied that the data are from a multi-species lake fishery. Colin Buxton asked why the day-type stratification did not improve effort estimates. Stephen Malvestuto explained that while weekday fishing effort is less than weekend fishing effort, there is not a systematic difference. The ratio estimators were not always consistent between weekday and weekend day. Richard Tilzey asked if he

had considered environmental factors such as wind strength and rain. Stephen Malvestuto indicated that he had not measured those variables during the present survey; however, environmental variables should be measured and examined as covariates, as well as characteristics of the anglers. Nick Caputi mentioned stratifying by 'good' *vs.* 'bad' weather days. Stephen Malvestuto acknowledged that he was interested in this technique, and historic weather information may provide the basis for predicting the number of bad weather days per month.

Jodie Woolcock and *Martine Kinloch* presented the theory and application of the bus-route sampling method for estimating angler effort. Jodie Woolcock began by describing theoretical aspects of the design, which was developed by Robson and Jones in the USA for large recreational fisheries covering a wide geographic area, with many access sites. The basic design includes an interviewer who travels around the survey area in a predetermined cycle, stopping at fishing access sites along the way. The survey agent waits at each access site for a predetermined amount of time and records the amount of time each trailer is present. This information is used to estimate fishing effort. The survey design can be customised for better results.

Martine Kinloch described the creel survey currently underway in South Australia. The Gulf of St. Vincent has an area of more than 7000 km^2 and a perimeter of about 500 km with 35 major boat ramps. This large area was subdivided into 4 units, with each bus-route approximately 200 km. The fishing day length and the number of survey days varies by season. The waiting times vary for each bus-route. Computer simulation of estimates of fishing effort using bus-route formulation were based on 12 000 records and indicated that the method was accurate, precise and unbiased. This research is in the early stages and will continue in the Gulf of St. Vincent through 1994 and commence in Spencer Gulf in 1995.

Murray MacDonald pointed out that there was no way to get precision around estimates unless independently derived. Martine Kinloch replied that we can look at accuracy using computer simulations. In South Australia, surveying was undertaken for a certain number of days within each stratum; if another body of water was to be sampled you could extend the estimates. Stephen Malvestuto inquired whether the short waiting time was a limitation to the adequate collection of data. Martine Kinloch replied that the 1 and 1.5 hour waiting times provided sufficient opportunity to collect information. During the winter months the number of trailers was low, but so was the fishing effort.

The third speaker in the session, *Laurie West*, addressed customising survey design to suit the information requirements of the survey. He pointed out that recreational fishing surveys stand out as the most difficult type of survey to organise. This is usually due to modest funds, the mobility of fish and anglers, the difficulty of angler recall information and the fact that the survey often has to be designed before the funding is received which makes it difficult to know how much to budget for. To circumvent some of these difficulties, he suggested the following key design components: 1) prioritised output specifications which enable a cost-benefit analysis of research options, 2) desk research including literature searches

and secondary data sets (some may be qualitative and highly seasonal), 3) develop a broad approach and keep your options open when first designing the survey—do not be technique-driven, and 4) initial testing and fine tuning required to validate against output specifications.

General discussion followed the presentations by the panel speakers. Problems and solutions were presented by Dennis Reid, Julian Pepperell and Roland Griffin for three recreational fishing case studies around Australia. The recreational prawning survey detailed catch and fishing effort in four New South Wales estuaries for three summers between 1991–1994. The problem was the lack of secondary data to identify effort concentrated in time and space. This was a particular problem as it was difficult to get accurate counts from this predominantly night fishery. The solution was to combine field observations, pilot testing and qualitative data to provide a more detailed assessment of the fishery. Game and sportfishing surveys were conducted on the east coast of Australia in 1993–1994 in conjunction with Pepperell Research. The data to be collected included the number of anglers, socio-economic background and attitudinal data. The problem was cost effectiveness in accessing and quantification of non-angling club members from a comparatively rare event fishery. The solution was to develop a tackle shop survey which was placed in shops specialising in game fishing. Interviewers were also enlisted to question anglers at tackle shops. Subscription lists to angling magazines were accessed and some boat ramp studies were conducted. The limitations of the survey design were acceptable. Lastly, Fishcount 1995 is a general population survey being conducted in the Northern Territory between 1994–1995. The participation rate, catch, fishing effort, expenditure and attitudinal details will be collected from residents and visitors to the Territory. The problem is the geography of the Northern Territory which makes normal creel survey methods and costs prohibitive. Reliable catch and fishing effort data will be required from household survey methods, though difficulties with recall information remain a problem. The solution to the Northern Territory's survey is to develop a multi-faceted design with a second-stage diary system for anglers. This will be a minimal burden to the angler to fill out and will maximise the value of the data for the survey.

Kim McClymont pointed out that you need to explain to anglers what you are doing and impress the need to provide honest answers to catch and effort questions. Training for the interviewers is critical to get the cooperation of the anglers. This sort of training and research has not been traditional in fisheries. Laurie West replied that Kim McClymont was quite right and quipped that we didn't need a Dirty Harry training of field crew.

Dennis Reid asked about the use of fisheries officers for survey work. Can the role of research be separated from enforcement? Nick Caputi answered by stating that research and enforcement roles were separate and that the fisheries officers are on the beaches observing the recreational fishery and the provision of information from the enforcement group to research was not a problem. However information flow in the reverse direction may be a problem. Because the enforcement division in WA is beginning to collect information on the number of officer-angler contacts as a per-

formance criterion, we can not afford to miss the opportunity of collecting additional data. Laurie West added that the fisheries officers' data have proven useful to validate data for the unrecorded sector.

Nick Caputi asked Stephen Malvestuto if computer simulation data could be used to check hpue data. Stephen Malvestuto replied that he had not done this, nor had he seen anyone else check these estimators. Frank Prokop asked Stephen Malvestuto if he had taken into account the fact that hpue estimates include angler-induced mortality of released fish. Stephen Malvestuto replied that was not necessary for crappie because it is a food fish. There is, however, catch and release information for largemouth bass. In tournaments great care is taken to return the fish live and in good condition. This may not be the case with the general angling population and there would be mortality associated with catch and release.

Murray MacDonald enquired whether anyone from the panel could comment on estimates of total catch instead of using hpue estimates. He referred to Bob Kearney's reference to generating estimates of catch by multiplying by other estimators which themselves have error rates. This compounds errors associated with the estimates given that effort may be more variable than catch rates. Wouldn't it be better to improve the precision of the effort estimates? Stephen Malvestuto replied that he gets quite precise estimates of fishing effort, so he is trying to get good rate estimators. The real issue is how to obtain more precise rate estimators and if we can do that we are likely to see better precision on the harvest. Murray MacDonald asked a related question of Martine Kinloch and Jodie Woolcock about the bus-route method. Here you are generating estimates of effort, but to get to estimates of total harvest you need to multiply those estimates by cpue, with no precision estimate around the effort value. How do you end up with some sort of precision estimate for your harvest value, and does that provide a significant improvement over estimates from roving creel survey method? Martine Kinloch suggested that precision estimates could be generated from the sample data and you have the same kinds of problems for harvest. She did not know how this method would perform compared with the more traditional access point survey, but imagined it would be very much the same for both methods.

Richard Brumley asked Martine Kinloch to comment on the underlying assumption of the bus-route method, that every boat has gone out to fish. Martine Kinloch replied that of course, not all boats are out fishing. The interviewers note whether launched and retrieved boats are recreational or commercial fishers or not fishing, and this is used as a basis to estimate the number of boats fishing. This problem can be magnified if the waiting times at the access points are short.

Ted Loveday asked Stephen Malvestuto who paid for recreational fishing research in the United States? Stephen Malvestuto replied that traditionally there were several avenues for funding including licence sales revenue, and sales tax on fishing gear. The federal government receives this money and reallocates it to the states. The individual states can then appropriate the funds according to their research or educational needs. Some states (e.g. Missouri) have diverted tax revenue from specialty items, like softdrink, to recreational fishing.

Session 3

Measuring catch and effort—the practice

Session Chairperson:	D. McGlennon
Sesson Panellists:	A.S. Steffe R.K. Griffin P.E. Davies N. Trainor
Rapporteur:	M.A. Kinloch

Chairperson's Introduction

D. McGlennon

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The methods used to collect data on recreational fishing are determined by a number of factors—such as the type of information required, the temporal and spatial scale of the study area, the characteristics of the fishery and the resources available (personnel, funds and equipment). These factors have led to a wide variety of methods being used in past Australian studies.

Large-scale surveys, such as Statewide and national surveys, have generally been conducted by omnibus or general population surveys, where a random sample of the target population is interviewed and their responses extrapolated for the total population.

Roving and access site creel surveys have been extensively used, particularly in estuarine and marine inshore waters. The choice of creel survey method has been determined largely by the geographical characteristics of the fishery, with a variety of combinations used in different areas.

Where the target population is known and accessible (e.g. via licence or registration details), data have often been collected by questionnaires, with the mode of delivery most frequently by mail or self-administered. Other methods of contact, such as telephone surveys and personal interviews, have been used relatively infrequently.

Other methods used occasionally include diaries or logbooks, aerial surveys and analysis of historical data sets, such as long-term records of angling clubs and charter boat operators.

A substantial literature exists for the sampling design and analysis of recreational fisheries data. While the majority of past surveys have conformed to well established principles, the final sampling designs have varied considerably. The need for variety, both in choice of method and sampling design, is forced upon researchers attempting to fit theoretical sampling designs into field-based programmes.

This Session will examine some of the problems associated with common sampling methods. These will be highlighted by panellists in the context of studies with which they have been involved, with suggestions about how these problems have been, or potentially can be overcome.

A survey of recreational trailer boat fishing in the marine waters of New South Wales—a case study

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Introduction

Many user-groups participate in the marine recreational fishery in New South Wales waters. These groups can be classified conveniently according to harvest methods (angling or spearfishing), fishing platform (boat-based or shore-based), boat size and possible range (trailer boats or cruisers and gameboats or charter boats), and finally by the access point used to reach the fishery (boat-based—ramps, marinas, moorings, private jetties, direct ocean launching across beaches; shore-based—ocean beaches, rocky headlands, man-made breakwaters).

These diverse groups within the recreational sector serve to illustrate the complexity and difficulties that are met when trying to assess the entire marine recreational fishery. We have restricted this paper to a discussion of a current boat ramp-based survey of trailer boat anglers who fish in the marine waters of NSW, even though we are also currently assessing other components of the marine recreational fishery.

This paper serves several purposes:

1. To provide a brief description of the aims and methods of this ongoing recreational fishing survey of trailer boat anglers;
2. To present some preliminary results of the recreational catches of trailer boat anglers;
3. To provide an example of the importance of collecting data about the directed fishing effort of anglers engaged in multi-species fisheries.

Background and aims of trailer boat survey

When planning this study we had little information about the size of this multi-species recreational fishery. The available anecdotal evidence suggested that the size of the recreational catch made by trailer boat anglers in marine waters was large. However the impact of the recreational sector on the resource was unknown. We carried out several pilot studies to assess the suitability of different survey designs and used the results of these pilot studies to allocate the limited resources in a cost-effective way.

The trailer boat survey has two main objectives:

1. To estimate total harvest, fishing effort and harvest rates, of recreational anglers; and
2. To compare recreational and commercial harvests and assess the relative sizes of these user-groups.

Survey details

The trailer boat survey is expected to span two years (September 1993 to the end of August 1995). At each selected site our trained field staff survey anglers and record all completed recreational fishing trips on 6 weekdays and 6 weekend days per quarter (season). This gives sampling fractions of about 10% for weekdays and about 20% for weekend days. Data from our pilot studies showed it was not cost-effective to sample at night or before 0900 hours. Thus, we defined the sampling day unit as being between 0900 hours and sunset. Note that many fishing trips completed after 0900 hours would have fished during the night/dawn period.

We have divided the NSW coastline into three regions, North, Sydney metropolitan, and South, and within each region we selected four survey sites. We chose Kingscliff, Evans Head, Coffs Harbour and Crowdy Head within the northern region. We have covered all four of the large ports (Broken Bay, Port Jackson, Botany Bay and Port Hacking) within the Sydney metropolitan region. We selected Wollongong, Ulladulla, Bermagui and Eden as survey sites within the south coast region.

At each survey site, we located a field officer at the boat ramp with the most offshore fishing traffic. This was done to maximise the number of interviews obtained. The field officers in the northern and southern regions also monitored the level of recreational fishing effort at their port by recording all completed recreational boating trips during rostered survey days. This was more difficult to do in the Sydney metropolitan region because of the many access points within each of the large port systems. We overcame this difficulty, for each metropolitan port, by placing an observer on one of the headlands to census the numbers of recreational fishing vessels that returned from sea.

What is the catch?

We have confirmed that the marine recreational trailer boat fishery is a diverse multi-species fishery. To date over 140 species of finfish, ranging from great white sharks (> 4 m) *Carcharodon carcharias* to tiny girdled parmas (about 8 cm) *Parma unifasciata*, have been recorded in the landed catches of recreational anglers throughout NSW. We have summarised the landed catches of recreational anglers, in terms of numbers of individual fish harvested, for the first two seasons of the survey (Table 1). These data show clearly that there are large differences among sites in the species composition and proportional contribution of important fish species in the recreational harvest (Table 1). How can these differences in recreational harvest among sites be explained? There are three main related reasons to explain the observed patterns. Firstly, we know that there are latitudinal differences in the relative abundances and the catchability of fish species among sites. This is clearly demonstrated in the cases of snapper *Pagrus auratus* and eastern blue-spotted flathead *Platycephalus caeruleopunctatus* (Table 1). Snapper have dominated the

harvest in the north of the State, whereas the eastern blue-spotted flathead has dominated the landed catch in the southern and central parts of the State. Flathead species accounted for over 30% of the observed total landed catch during the first two seasons of the survey.

Secondly, anglers assign different subjective values to different fish species (a social phenomenon) and these perceived values vary among sites and regions of the coast. For example, the eastern blue-spotted flathead is highly prized in the south of the State and, as expected, many recreational anglers target and harvest this species. In contrast, anglers in the north of the State have low regard for this species resulting in little targeting and small catches by the recreational sector. It is interesting to note that the eastern blue-spotted flathead is abundant in these northern waters as it is a large and regular part of the retained commercial bycatch of trawlers engaged in the offshore king prawn fishery.

Thirdly, anglers target their fishing effort at favoured species (directed fishing effort). It is a complex combination of factors which influences the species targeting of anglers. The expectation that many recreational anglers have when they go fishing strongly influences their choice of target species. For example, a selected fishing location may have a reputation for producing large individuals of a certain species and it is not surprising that anglers would tend to target that species at that location. The directed fishing effort of most anglers would also be linked to the relative abundance and catchability of a species at a particular site and its perceived value by those anglers.

Directed fishing effort

Multi-species recreational fisheries are characterised by the diversity of specialised methods used to target individual species or groups of species. The methods used by anglers will obviously also influence what they catch because all of the available species in the area are not equally vulnerable to capture using a single fishing method. For example, an angler who is trolling for large pelagics (billfish, tunas, dolphin fish) is unlikely to catch any seafloor associated species such as flathead or snapper. Thus, each available species in an area has an unequal probability of capture and hence catch rates for individual species or groups of species derived from total fishing effort (undirected effort) data are biased and inadequate because they dilute the real catch rate for all components of the recreational fishery. This makes it more difficult to detect changes in the fishery and may even mask trends among sites and trends over time.

In multi-species recreational fisheries we need to know about the directed fishing effort of anglers and the catch rates associated with these targeted populations of fishes. We have done this in our survey by partitioning the fishing trip into its various distinct categories of fishing. We ask anglers to estimate the amount of time and associated catch when targeting squid, baitfish, pelagic fish, reef fish, and sand fish. We also have a category to cater for those anglers who are unable to identify exactly what they have been doing. Table 2 gives an example of the importance of estimating directed fishing effort. The data show that for these two sites on the north coast of NSW there are large differences in the directed fishing effort of anglers (Table 2). These differences must be considered

when trying to make comparisons of catches and catch rates between these sites.

When directed effort data are used to partition multi-species fisheries it also becomes necessary to consider the concept of 'incidental catch'. Many anglers have expressed the view that the diversity of species available to them in offshore waters and the unpredictable nature of the landed catch on any given fishing day are important variables which add to the enjoyment of their fishing trip. Although these anglers are targeting their fishing effort at favoured species they still welcome the added bonus of incidentally caught non-target species. These incidental catches are important components of the harvest in multi-species fisheries and it is common for the same species or groups of species to be taken during more than one distinct category of fishing. Thus, for species that are taken incidentally it is possible to calculate more than one catch rate. Examples of this are provided for snapper and eastern blue-spotted flathead catches from Crowdy Head (Table 3). Eastern blue-spotted flathead are more commonly caught when targeting fish over sandy habitats but they are also taken occasionally by anglers targeting reef associated fish. A comparison of the catch rates of eastern blue-spotted flathead taken whilst sand fishing and reef fishing confirm this assertion (Table 3). The reverse is true for snapper. They are more commonly caught by anglers targeting reef associated fishes than by anglers targeting sand associated fishes. The catch rates of snapper taken during reef and sand fishing reflect this (Table 3).

Conclusions

- The marine recreational trailer boat fishery is a diverse multi-species fishery.
- There are large differences among sites in the species composition and proportional contribution of important fish species in the recreational harvest.
- Directed fishing effort data and associated catch rates for distinct categories of fishing are needed when assessing multi-species recreational fisheries. These data allow meaningful comparisons of catch and catch rates to be made among sites and over time.
- The incidental catch taken by anglers in multi-species recreational fisheries is important.

Table 1. Species composition and proportional contribution, based on the number of landed fish, of the observed recreational harvest of trailer boat anglers for the period September 1993 to February 1994 inclusive.
(n = individual numbers of fish observed in anglers' catches.)

Northern region

Kingscliff (n = 544)

Common name	**Taxon**	**% Catch**
Snapper	*Pagrus auratus*	48.7
Silver trevally	*Pseudocaranx dentex*	10.3
Kingfish	*Seriola lalandi*	5.7
Yellowfin bream	*Acanthopagrus australis*	5.7
Blackspot goatfish	*Parupeneus signatus*	4.2
Other spp.		25.4

Evans Head (n = 1795)

Common name	**Taxon**	**% Catch**
Snapper	*Pagrus auratus*	53.4
Teraglin	*Atractoscion aequidens*	19.8
Red Scorpioncod	*Scorpaena spp.*	4.7
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	3.3
Mulloway	*Argyrosomus hololepidotus*	2.1
Other spp.		16.7

Coffs Harbour (n = 1819)

Common name	**Taxon**	**% Catch**
Snapper	*Pagrus auratus*	24.2
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	23.2
Kingfish	*Seriola lalandi*	6.7
Slimy mackerel	*Scomber australasicus*	6.4
Silver sweep	*Scorpis lineolatus*	5.7
Other spp.		33.8

Crowdy Head (n = 2966)

Common name	**Taxon**	**% Catch**
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	53.2
Redfish	*Centroberyx affinis*	19.9
Snapper	*Pagrus auratus*	5.6
Tiger flathead	*Neoplatycephalus richardsoni*	3.9
Blue morwong	*Nemadactylus douglasii*	2.5
Other spp.		14.9

Table 1. (continued) Species composition and proportional contribution, based on the number of landed fish, of the observed recreational harvest of trailer boat anglers for the period September 1993 to February 1994 inclusive.
(n = individual numbers of fish observed in anglers' catches.)

Sydney region

All sites combined (n = 4825)

Common name	Taxon	% Catch
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	14.4
Silver trevally	*Pseudocaranx dentex*	13.2
Snapper	*Pagrus auratus*	10.6
Yellowtail	*Trachurus novaezelandiae*	7.3
Silver sweep	*Scorpis lineolatus*	5.9
Other spp.		48.6

Southern Region

Wollongong (n = 3679)

Common name	Taxon	% Catch
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	15.5
Silver sweep	*Scorpis lineolatus*	15.5
Slimy mackerel	*Scomber australasicus*	11.7
Snapper	*Pagrus auratus*	8.2
Sergeant baker	*Aulopus purpurissatus*	7.3
Other spp.		41.8

Ulladulla (n = 3488)

Common name	Taxon	% Catch
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	52.2
Blue morwong	*Nemadactylus douglasii*	7.7
Redfish	*Centroberyx affinis*	6.9
Maori wrasse	*Ophthalmolepis lineolatus*	4.9
Snapper	*Pagrus auratus*	3.5
Other spp.		24.8

Bermagui (n = 2455)

Common name	Taxon	% Catch
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	43.3
Tiger flathead	*Neoplatycephalus richardsoni*	13.1
Slimy mackerel	*Scomber australasicus*	9.2
Skipjack tuna	*Katsuwonus pelamis*	4.2
Blue morwong	*Nemadactylus douglasii*	4.0
Other spp.		26.2

Eden (n = 2661)

Common name	Taxon	% Catch
Eastern blue-spotted flathead	*Platycephalus caeruleopunctatus*	41.1
Slimy mackerel	*Scomber australasicus*	7.7
Yellowtail	*Trachurus novaezelandiae*	6.5
Tiger flathead	*Neoplatycephalus richardsoni*	6.3
Silver sweep	*Scorpis lineolatus*	5.7
Other spp.		32.7

Table 2. Proportional composition of directed fishing effort for recreational trailer boat anglers at Evans Head and Crowdy Head (Northern region) for the period September 1993 to November 1993 inclusive.

	Evans Head (n = 208.5 boat hr)	**Crowdy Head** (n = 293 boat hr)
Type of fishing		
Reef	91.8%	42.6%
Sand	2.9%	39.2%
Pelagic	2.6%	5.8%
Baitfish	1.0%	3.4%
Squid	0.0%	0.0%
Cannot determine	1.7%	9.0%
Total	100.0%	100.0%

Table 3. Mean daily catch rates (number of fish per boat hour, n = 8 days) and standard errors for eastern blue-spotted flathead and snapper landed by recreational trailer boat anglers that were targeting reef fishes and sand fishes at Crowdy Head (Northern region) during the period September 1993 to November 1993 inclusive.

Eastern blue-spotted flathead—*Platycephalus caeruleopunctatus*		
Type of fishing	**Mean**	**Standard error**
Reef	0.16	0.08
Sand	5.43	0.67
Snapper—*Pagrus auratus*		
Type of fishing	**Mean**	**Standard error**
Reef	0.58	0.13
Sand	0.04	0.02

Recreational fishing surveys in the Northern Territory—1978 to 1993

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Abstract

Surveys to assess levels of recreational fishing activity directed at barramundi in the Northern Territory have been conducted since 1978. Three survey methods have been used: roadside interviews, roving creel surveys and access point surveys. The roadside survey, which is essentially a large scale access point survey, has been used to estimate annual recreational catch and effort for the Mary River/Kakadu region in 1978/79 and in 1986, with repeat surveys on two long weekends each year. Roving creel surveys and access point surveys have been used in the Mary River from 1987 to 1994 and in the lower Daly River from 1987 to 1990. Results are presented for the Mary/Kakadu region and the utility of the various methods is discussed.

Introduction

Barramundi *(Lates calcarifer)* is a well known and very popular sport fishing target in northern Australia. It is also the subject of substantial commercial fisheries in Queensland and the Northern Territory. In the Northern Territory the commercial fishery has been dramatically reduced over the past fifteen years, both to reverse overexploitation of the stocks and in recent years to provide a greater share of the available resource for the recreational sector. When management of the barramundi resource in the NT was upgraded in 1979 (Grey and Griffin 1979) the recreational sector was acknowledged but afforded little consideration in the management scheme. With the rapidly expanding population of the NT, and Darwin in particular, at the time the recreational sector was clearly important but no data were available on its extent or impacts. Surveys to assess the level of recreational catch and effort were initiated in 1978 to address this problem.

Survey methods

Since 1978 three survey methods have been used to obtain data on recreational catch and effort, mainly in the popular fishing areas close to Darwin. All those surveys have focussed on barramundi fishing. They were:

- roadside interviews
- roving creel surveys
- access point surveys.

One general survey of households throughout the NT was conducted in 1986 to provide information on participation and expenditure related to recreational fishing.

Roadside interviews

The most popular recreational barramundi fishing area in the NT has historically been the area east of Darwin between the Adelaide River and the East Alligator River. Much of that area is now known as Kakadu National Park. The total area, some 20 000 km^2, is accessible from Darwin via only one road, the Arnhem Highway. An interview checkpoint was set up on the Arnhem Highway at the western end of the survey area. Effectively this was an access point survey on a very large scale. Angler parties returning from the survey area were informed by a series of roadside signs that a survey was in progress and were requested to stop for a short interview. Those parties which stopped were asked to provide details of fishing locations, fishing time, catch (retained and released), fishing methods, type of equipment used, value of tackle and other equipment, frequency of fishing trips and area of residence. Details of vehicles with boats or fishing tackle evident, but which did not stop, were recorded. The apparent cooperation rate was very consistent with approximately 50% of fishing parties responding. Interviews were conducted from approximately 0900 hrs to 2100 hrs. In most cases very little traffic was observed after nightfall at around 1900 hrs and surveys conducted after 1986 ceased at that time.

From August 1978 to August 1979 surveys were conducted on 40 days randomly selected to cover both wet and dry season conditions and weekdays and weekends. In addition the Sundays and Mondays of four long weekends were also surveyed. Expansion of data from those days resulted in estimates of annual catch and effort (Griffin 1982).

In 1986 a similar 12 month series of roadside surveys was conducted on 43 randomly selected days and four long weekends. Stratification was similar to the 1978/79 series with the exception that a third seasonal activity stratum was introduced, fitting between the dry season and the wet season, a time known as 'the buildup' or *gurung* in the aboriginal seasonal scheme. Annual catch and effort for the survey area for 1986 was estimated (Griffin 1988).

Roadside surveys have been repeated on two of the long weekends, May Day (the first weekend in May) and Picnic Day (the first weekend in August), each year since 1987.

Roving creel surveys

From 1986 research and management efforts were focussed on the highly exploited Mary and Daly Rivers to the east and south west of Darwin. To provide detailed information on recreational catch and effort without the uncertainty of the 'missing 50%' factor of the roadside survey, roving creel surveys were introduced. Creel surveys are also able to provide good data on the size of fish taken. Initially it was intended that these surveys would cover the Mary and Daly Rivers as well as the four rivers in Kakadu National Park. To survey all fishing locations in the huge area of Kakadu was not possible and diminishing resources were concentrated on the Mary River and Daly River. Since 1991 only the Mary River has been surveyed. Analysis of results has concentrated on the Mary River. In the Mary River four areas are studied over two days on each survey. A system of stratification similar to the more recent roadside survey was used with

22 weekdays and 11 weekends sampled over three seasons. Some areas are essentially inaccessible for much of the wet season and zero effort for those areas is assumed for those times. At each location a count of boats and anglers was made on the water and as many parties as possible were interviewed. At all locations except Shady Camp almost all fishing was conducted from boats.

Access point surveys

One of the areas on the Mary River, Shady Camp, has essentially only one boat launching area, and surveys there were conducted as access point surveys only from 1992 onwards. As many as possible of the angler parties returning to the ramp between approximately 1030 hrs and 1900 hrs were interviewed. In most cases complete coverage was achieved.

Results and discussion

Only a selection of results is presented in this paper with the intention of illustrating some of the difficulties encountered as well as the value of such survey data to management of the fishery and the resource. More complete results are available in Griffin 1982; 1988; 1993.

Roadside interviews

The survey series in 1978/79 and 1986 produced estimates of annual catch and effort for the whole survey area and for major rivers within the area (Table 1). The earlier series was also used to estimate participation and to assess expenditure on recreational fishing for barramundi in the survey area.

In the climate of resource allocation controversy which prevailed in 1987 this kind of information was extremely valuable. It was shown that between 1979 and 1986 the proportion of the total barramundi harvest (commercial and recreational) taken by the recreational sector had risen from 29% to 34% by number or from 20% to 30% by weight. Thus it was clear that the recreational catch was a very significant and increasing proportion of the total harvest. As a result the Mary River was subjected to special management measures in 1988 (a two fish possession limit and a 50 cm minimum size) to restrain the impacts of recreational fishing in addition to the severe limitations imposed on the commercial sector.

The comparative surveys conducted on the May Day and Picnic Day Weekends have shown a considerable decline in the number of parties participating in fishing on those weekends since 1986 (Table 2). In 1978 and 1979 the total number of fishing parties observed at these weekend surveys was over 300. This decline is attributed to demographic changes and increased alternative recreational activities in Darwin in recent years.

Creel/access point surveys

Creel surveys and access point surveys have provided valuable data on recreational catch, effort and size of barramundi taken in the Mary River. For Corroboree Billabong and Shady Camp, the two major areas which account for around 85% of effort and 90% of catch, estimates of annual catch and effort are available from 1989 to 1992. For the whole Mary River reliable estimates are available for 1991–1992. These estimates show that recreational effort in the Mary

River has declined since 1989, contrary to the general perception that recreational activity is increasing. Annual effort has declined at Corroboree and remained relatively stable at Shady Camp (Figure 1a). The perception that effort is increasing probably results from the intense seasonal concentration of anglers at Shady Camp in March–May in recent years. It could be concluded that barramundi anglers are becoming more selective in the timing of their fishing excursions. The number of barramundi harvested annually from each of the major areas (Figure 1b) has declined slightly, reflecting the decline in effort at Corroboree, variations in recruitment and an increase in the minimum legal length in 1991.

The effectiveness of the size limit and bag limit regulations introduced in 1988 can be seen in the trends in cpue for the Mary River (Figure 2). Prior to 1988 the harvest rate (hcpue—fish kept per hour) and the total catch rate (tcpue—fish caught per hour including releases) were almost identical suggesting that most anglers kept all barramundi caught. The new restrictions resulted in a slight decline in the hcpue and an increase in the tcpue. Much of the variability in observed catch rates can be related to observed variations in year class strengths. The current hcpue is 2 to 3 times higher than in 1978. While tcpue has increased substantially, the proportion of parties actually catching a fish has somewhat paradoxically declined from 85% to 45%. It is suggested that this is due to large numbers of novice anglers attracted by reports of good fishing being largely unsuccessful due to poor timing or inadequate equipment.

Improvement in the quality of recreational fishing is also demonstrated in the increase in the size of barramundi taken. The proportion of barramundi of memorable size has increased steadily, almost 10% of the catch in 1992 being greater than 90 cm total length (or 9 kg).

Tourism is one of the NT's most important industries and barramundi fishing is an important component of that industry. Data on origin of anglers has provided information on the numbers and behaviour of tourist anglers in the Mary River. Participation by tourist and local parties has not changed appreciably since 1987 (Figure 3) but there have been increases in mixed groups (i.e. one or more visitors with one or more locals) and in parties using the services of a professional guide. Examination of catch rates of these groups shows that there is no difference between locals and tourists but the catch rate of mixed groups is significantly lower. This fact may in part explain the paradoxical fall in success rate observed.

Household survey

During 1986 a total of 804 households in six NT population centres were surveyed to determine patterns of fishing activity over the preceding 12 months (Cam Rungie/Touche Ross 1986). That survey found that 35.3% of respondents had been fishing at least once in the past 12 months while 29% viewed fishing as of major importance. The survey failed to provide adequate coverage of tourist activity and based its conclusions in relation to tourists on the activities of only 43 people on specialised fishing tours. It concluded that the recreational sector took 58% of the total barramundi harvest. This figure is considered to be an extreme overestimate caused mainly by inappropriate extrapolations of the tour-

ist component. The requirement to recall activities undertaken up to 12 months ago also suggests that recall bias is likely to be significant. While the survey produced figures in relation to expenditure and economic value of recreational fishing in the NT these figures, like many others of this type, should be interpreted with care.

Summary and conclusions

Surveys conducted by the various methods have provided valuable data on recreational fishing in the NT particularly in relation to barramundi which is the primary target species. Data on catch and effort have been useful in population modelling and in management of the resource as emphasis has changed from the commercial sector of the fishery to the recreational sector. Auxiliary data on angler origin are useful for planning of provision of facilities for tourists. The unbiased information provided is sometimes contrary to popular perceptions and in some instances has demonstrated that perceived declines in recreational catch rates were not real. In addition the detailed information from creel surveys has provided insight into changes in seasonal patterns of activity which can be related to changes in access, habitat changes and changing behaviour of participants.

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Table 1. Estimates of annual recreational barramundi catch (number of fish) and effort (angler hours) for the Mary/Kakadu region and for the Mary River.

	Mary/Kakadu region		Mary only	
Year	**Catch** (number)	**Effort** (angler hours)	**Catch** (number)	**Effort** (angler hours)
1978/79	26 000	173 333	11 700	78 000
1986	27 345	220 924	14 308	117 954

Table 2. Total number of fishing parties observed at Arnhem Highway roadside surveys—1986–1994.

	May Day weekend			Picnic Day weekend		
Year	Mary only	Total	% Stop	Mary Only	Total	% Stop
1986	141	235	61	98	145	63
1987	140	202	58	101	172	48
1988	69	103	52	76	148	50
1989	106	210	50	102	160	50
1990	104	162	50	114	160	49
1991	181	206	49	67	107	52
1992	83	110	57	73	99	56
1993*	60	69	54	47	56	45
1994*	38	97	45	33	48	33

* 1993 and 1994—long weekend Mondays only.

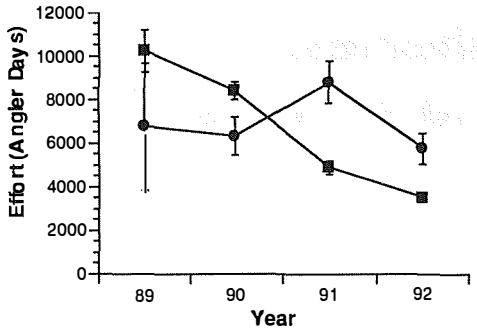

Figure 1a. Estimated recreational fishing effort at Corroboree Billabong (B) and Shady Camp (J). Error bar = one standard error.

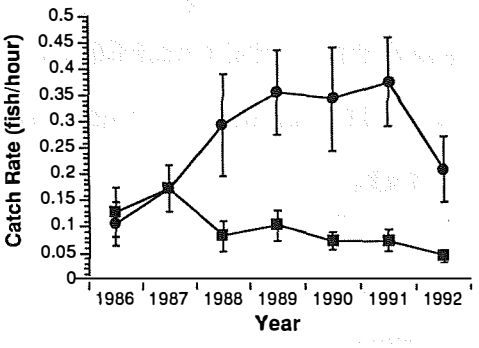

Figure 2. Angler harvest rate (B) and total catch rate (J) for the Mary River, 1986 to 1992. Error bar = 95% confidence interval.

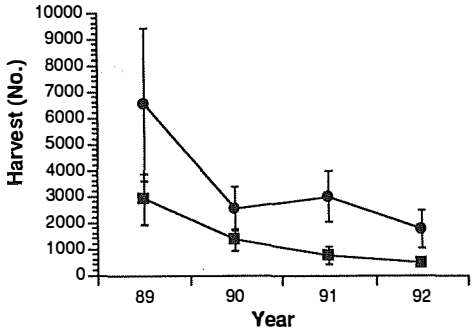

Figure 1b. Estimated recreational harvest of barramundi from Corroboree Billabong (B) and Shady Camp (J). Error bar = one standard error.

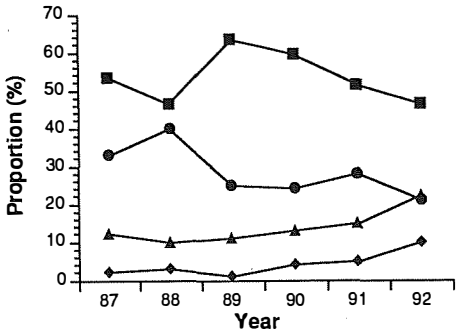

Figure 3. Proportion of fishing parties in the Mary River by angler origin.
B—Local; J—Tourist; H—Mixed local and tourist; F—Guided.

Mail surveys of Tasmanian inland water recreational fisheries: preliminary results and sources of error

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Abstract

Results of work in progress on the analysis of nine years of standardised Statewide Tasmanian inland fishery mail surveys are described in the context of sources of error and uncertainty in mail questionnaires. Initial results indicate a consistency in response rate, types of responses and realistic results, which allow some reliance to be placed on trends and relative fishery performance. Limited tests for bias due to non-return and recall suggest that these are relatively small. A relatively high return rate and consistency of response are likely to be at least partially influenced by the institutional setting of inland fishery management in Tasmania.

Introduction

Mail questionnaire surveys can be a low-cost source of extensive data on recreational fisheries. To what degree such survey techniques provide accurate, precise and repeatable data is strongly dependent on a number of factors, all of which influence the number and sources of error. While multiple sources of error are common to all fishery survey techniques, the mail survey has been frequently viewed as a tool of limited use and applicability. Under certain circumstances, however, routine mail surveys can be used to obtain reasonably reliable data on fishery trends and relative magnitudes. This paper describes such a situation for Tasmanian recreational trout fisheries, the sources of error and the means by which such errors may be quantified, as well as the institutional setting of fishery management, the survey methods and general results and the methods used to estimate sources of error. As this paper is intended only to present the initial results of work in progress, they are given only in summary form. A full treatment of results, errors and trends is to be published elsewhere.

The inland fisheries survey

Institutional setting

The Inland Fisheries Commission (IFC) is the sole agency responsible for the management of the recreational and commercial fisheries of Tasmanian inland waters. It is a semi-government agency, comprising: a Commission of three representatives

elected from each of three regional recreational fisheries Associations and one State government employee; a permanent staff of 20 personnel including eight enforcement staff. Commission members have a direct input into the activities of IFC staff and into policy development.

The IFC is responsible for the licensing of all recreational fisheries. Licences for trout fishing are issued by the IFC or by agents acting on its behalf, selling licences on commission. Licences for adults (> 17 years) are issued for a full season and for 1, 3 or 14 days with one licence issued for each individual angler. Licences are issued for juveniles (14–17 years) but not for children of less than 14 years of age. The majority of sales are for full season adult licences, typically numbering some 20–25 thousand per annum. The trout fishing season varies slightly in length depending on the species and water being fished, but for the majority of waters the season is of nine months' duration, from August to May.

Licences are issued with details of the angler's name and address, and carbon copies of all licences are returned to the Commission by agents for accounting purposes. Until the late 1980s, licence copies were not returned by agents until the completion of the fishing season.

The primary role of the IFC is the management of the recreational fisheries for introduced trout. Brown trout have established self-sustaining populations throughout Tasmania, with only a few exceptions (Davies 1989), and the majority of inland water recreational fisheries are brown trout fisheries that do not require maintenance through stocking. A limited number of rainbow trout fisheries exist, with most requiring maintenance or supplementation from stocking programmes.

Prior to 1985, only limited information was available on the status of the more than 500 lake or riverine fisheries in Tasmania. Nicholls (1957; 1958a; 1958b; 1961) described the characteristics of riverine brown trout fisheries based on a combination of licence form surveys and scale collections, but similar work of his on lake fisheries was never published. In 1985, it was decided to initiate a mail questionnaire survey of the population of adult angling licence holders. Following its initial success, judged by a high return rate, the mail survey was repeated annually. Subsequently, questionnaires were also sent to holders of other licence types (juvenile, 3, 14 day) on at least one occasion.

Survey aims

The aims of the survey were to provide summary data on the effort, visitation and catch rates from all waters in Tasmania, at low cost and with definable errors and biases, with an emphasis on:

- the assessment of trends, especially responses to stocking and environmental impacts;
- the relative ranking of waters in terms of effort and harvest;
- fishing methods and preferences of anglers.

The limitations and biases inherent within mail surveys (Brown 1991; Pollock *et al.* 1994) were implicitly recognised from the outset of the surveys.

Survey method

The survey method was defined by Brown (1991) as a *licence file survey*, in which addresses from licences are used for sampling. Thus, following the return of all licence copies, typically in May, a random selection of 2000 or 10% of full season adult licences was made (whichever was the greater). A standard questionnaire form on a single page (Appendix 1) was sent to the licence holders within 6 weeks of the end of the fishing season, accompanied by an explanatory covering letter and a reply-paid envelope. For the nine years of the survey conducted to date, the questions asked on the front of the form were the same, while questions on the reverse side varied in order to address specific questions of management interest.

Standard questions

The standard questions were aimed at providing routine information on angler visitation, effort, catch per unit effort and harvest in a standard repeated manner. The questions were in fact based on those first asked by Nicholls (1958a) in his surveys based on returns of licences with a questionnaire on the reverse side, so that longer-term comparison could be made with data derived by him over the 1945–1958 period.

Supplementary questions

The supplementary questions were aimed at addressing the following issues:

- Location and relative effort associated with angling 'spots' on rivers;
- The blackfish and lobster fisheries (waters, effort, catch);
- Catch of other species;
- Opinions on fishery management;
- Fisheries in farm dams;
- Other angler details (shack ownership, club membership etc.);
- Other details of fishing activities in specific areas (e.g. 'Western Lakes').

Returns were entered into a database and analysed to derive the following statistics for each of up to 175 lakes and 215 rivers and streams:

- Total number of anglers—derived by multiplying the ratio of the number of questionnaire respondents who fished the water to the number of returned questionnaires by the total number of licenced anglers.
- Total effort in angler days exerted—derived by multiplying the total number of anglers by the mean days per season for respondents who fished the water.
- Total harvest of each species—derived by multiplying the total number of anglers by the mean number of fish caught at that water by respondents.
- Mean catch per angler day—derived by dividing the mean number of fish caught by the mean days per season fished at that water.

Sources of error

In any mail survey there are several sources of error or variability (Pollock *et al.* 1994).

i) Questionnaire distribution

Errors associated with questionnaire distribution are primarily related to the random nature of the sample. Care must be taken to ensure that the pool of addresses drawn from the population is indeed random in

relation to factors such as residential region, which influences the choice of waters fished, experience and club affiliation, which may influence catch per day estimates. Similarly, the random nature of the returns must be assessed for these factors. This can be statistically evaluated for those factors whose distribution is already known, for example residential region.

ii) Questionnaire design

The design of a questionnaire, as with an interview session, is another potential source of error or bias. Consistency, simplicity and clarity are all key essentials in the formulation of survey questions. Maintaining a low number of pages and questions facilitates high response rates.

iii) Non-return bias

A major area of potential error in mail surveys is non-return bias. Return rates for questionnaires from interest groups are frequently higher (typically ranging from 20–60%) than for non-interest groups (ranging from 0.1–15%), but a large proportion of the population sampled does not respond. In recreational fishery surveys, the respondents may be more motivated, experienced and successful and may come from a more restricted geographic area or socio-economic group than occurs in the larger angling population. This can have serious implications for attempts to estimate population-wide estimates of effort and harvest. Outer bounds on errors due to non-return bias can be estimated, assuming extreme high and low performance for non-respondents (Pollock *et al.* 1994), although these bounds are unrealistically wide. Non-return bias may not, however, have a significant impact on the analysis of trends provided any such bias is consistent from survey to survey.

iv) Recall

A second major source of potential error in surveys relying on memory of fishing activities is recall bias. Many studies have shown that details of fishing trips are lost to a significant degree over periods of ensuing weeks. These recall biases may not have a single direction however, as anglers may exaggerate small catches, include party catches with their own, forget individual trips and erroneously reduce the size of large bags.

v) Data analysis

Questionnaire response data are frequently non-normal and skewed in distribution. The use of statistical tests without appropriate transformations or which are not satisfied by the data distribution can lead to major errors in analysis. Estimation of error bounds in survey data on angler numbers can be performed using the binomial distribution, while Poisson type distributions are typical of the catch and effort data.

Catch per unit effort data collected from recreational fisher surveys are typically recorded in terms of fish per hour. Such data cannot be collected from questionnaires based on several months' recall. The use of catch per day data derived from mail surveys therefore requires an assessment of the length of an 'angler day' which can vary depending primarily on the fishing method used and a range of other factors. As several fishing methods can be used at many waters, care must be taken in the interpretation of catch per 'angler day' data.

Results

General results of survey

Response rates for the standard survey were stable over the nine years ranging between 42 and 49%. One exception occurred in 1989, when an anomalously low return rate was experienced (33%) thought to be due to the addition of a complex new survey form, subsequently discarded.

Respondents reported fishing at over 230 rivers and 200 lakes. Typically 6–7 waters (including two rivers) accounted for 50% of the total fishing effort expended in the State (Table 1). The relative order of lakes and rivers in terms of effort and angler numbers was remarkably consistent from year to year, with major changes in relative position found for only a small number of lakes, all of which were subject to significant stocking events (e.g. Lake Crescent, Craigbourne Dam) or which suffered significant environmental impacts (e.g. Lagoon of Islands, Brushy Lagoon). Little change was noted in catch rates for most lakes over the nine year period, with some exceptions. In contrast, while the relative ranking of rivers in terms of effort was relatively stable, marked interannual changes in catch per unit effort were observed.

Estimates of total effort expended on trout fishing ranged between 400 000 and 500 000 'angler days' per year. Mean lake catch per 'angler day' ranged between 0.2 and 3.2 for brown trout and 0.05 and 1.1 for rainbow trout (for those waters containing those species).

Analysis of postal code data in returned questionnaires in 1986 indicated that most effort on rivers was expended by local residents or by residents of large towns within or neighbouring the catchments. Fishing in highland lakes was performed almost exclusively by lowland residents, with a strong regional bias. Of the major lakes, Great Lake and Arthurs Lake were primarily fished by northern residents (> 65%), while lakes of the Bronte system, Lake Pedder and Lake Sorell were primarily fished by southern residents (> 60%).

An examination of trends in effort, visitation and catch has shown results consistent with field staff observations, creel results and with expected responses to stocking. A preliminary examination of interannual fluctuations in survey catch figures for waters with self-sustaining populations shows significant correlations with independently derived indices of recruitment, for example in the St Patricks River (Davies *et al.* 1988; Davies and Diggle in press) and in Lake Sorell (Davies unpub. data).

Long-term trends in fishery performance can also be examined by combining results from the 1986–1994 surveys with those derived by Nicholls (1957; 1958a; 1958b; 1961; unpub. data) for lakes and rivers. While Nicholls' data were collected using voluntary return of licences at the end of the season, and response rates were lower than occurred in the recent surveys, the results are still comparable. A significant increase in anglers fishing for trout has taken place in Tasmania since 1945 (Figure 1). This has been accompanied in many waters by significant increases in angler patronage, harvest and effort (Figure 2A, B). Preliminary examination of plots of total harvest against total effort suggest that the fisheries of many lakes are not limited by fishing pressure (Figure 2C).

Sources of error

i) Questionnaire distribution

The randomness of address selection was evaluated in two years by comparing the distribution of postal codes in the 10% sample with that assessed for the whole population of adult licence holders. There was no significant difference between the sample and population distributions (Kolmogorov-Smirnoff test, $p > 0.5$).

The randomness of addresses in the respondent data set was also evaluated and again, no significant differences were found between the frequency distributions of postal codes in the respondent data and that in the original mailed sample.

ii) Questionnaire design

In the IFC surveys, simple questions were used in a consistent, single-page format for obtaining the standard fishery data in all years. Interviews with angling club members indicated that the questions were generally well understood and accepted. The 1989 survey included an additional five pages appended to the standard sheet. This led to a very low return rate (33%) and a statistically significant bias toward fly-fishers (as compared with data from all previous years, $p < 0.01$ by χ^2 test). The simpler one page design was reinstated for all future surveys.

In 1988 a supplementary question was asked about estuarine fishing. While few estuarine waters are included within the legal definition of inland waters under the Tasmanian Fisheries Act (1959), responses strongly indicated that respondents did not understand the meaning of the word estuary and this question was therefore discarded in future surveys. Care is taken instead in the interpretation of responses for several rivers for which estuarine fishing is known to be significant, but which are reported as rivers in responses.

iii) Non-return bias

As some 50–60% of questionnaires mailed were not returned, it was decided to evaluate non-return bias by the use of prompting letters (Brown 1991). Thus, prompting letters were sent out following the receipt of the majority of responses in 1987, accompanied by a second copy of the survey form and a reply-paid envelope. This elicited a further 322 responses. Data from these responses were analysed as for the unprompted responses, and ratios of numbers of anglers, catch per angler day and days per angler for the most popular waters did not differ significantly. This suggested that non-return, if present, is likely to be small.

iv) Recall

Specific tests recommended for recall bias include phone interviews or follow-up face to face interviews combined with the normal mail survey. These have not been conducted to date for the IFC survey, primarily due to cost. However a combined test for recall and non-return bias was conducted over four years using low intensity creel surveys on five occasions during the angling season on six popular waters. Anglers were asked to recall catch and days fished at that water up to the date of interview. No attempt was made to count anglers. Combined creel catch per day data were compared with survey data and showed no significant bias for all four years (regression slopes not significantly different from 1.0, all $p > 0.2$).

Bias was detected, however, when comparisons were made between survey data

for 1989 and the result of an intensive road-side interview programme for the Western Lakes, a predominantly fly-fishing area of small, neighbouring lakes. Catch per day data from questionnaires were, on average, twice as high as those recorded in the interview programme. This was at least partially attributable to the method of calculating mail survey catch per day figures for this region, as many anglers fish more than one lake per day in this region.

v) Data analysis

To date, analysis of the data has been focussed on developing the summary statistics illustrated in Table 1. While mean figures derived from respondent data are appropriate for estimating total effort and harvest, they are not appropriate for further statistical analysis, which requires either data transformation or the use of median (or other percentile) values for non-parametric tests. Similarly, for reporting the survey statistics to anglers, the use of means is inappropriate due to the tendency of means to be biased upward by the infrequent high values associated with experienced or dedicated anglers. The experience of the 'average' angler at a water is better represented by reporting median values. The analysis of trends and differences using percentile values is currently being conducted for the IFC survey data set.

Discussion

In summary, the IFC mail survey produces a relatively high return rate (by comparison with other resource management mail surveys) which is remarkably stable from year to year. Tasmanian inland fishery management is of relatively low intensity. It does not rely on high cost stocking programmes, there are no highly detailed fishery regulations requiring detailed management information for assessing compliance or success and the main need is for 'broad brush' information on how waters are performing relative to one another and how they change with time. Recall and non-return bias in the mail survey, though not completely assessed, appear sufficiently low to warrant use of the summary statistics in a manner suitable for the current level of management. There is, however, a need to quantify error bounds for the summary statistics for each water as much as practicable.

The size and consistency of the return rate, the consistency of the data from year to year (both between survey years and between survey and creel results) and the general acceptance of the survey in the angling body is in large part a reflection of the institutional setting of Tasmanian inland fishery management. The close association between the IFC and its 'client body' and the fact that a semi-autonomous agency exists dedicated almost exclusively to the management of inland fisheries engenders a generally good working relationship between the bulk of the angling body and the IFC. This, combined with the high level of interest by many trout anglers in their sport, enhances angler participation in providing information relevant to management.

It may still, however, be of value to increase the return rate—although only after validating the need by conducting a detailed assessment of non-return bias through interviews (Pollock *et al.* 1994). Increasing return rates can be achieved through a variety of mechanisms including a reward system.

Given the wide coverage of waters achieved from the mail survey, it has proven to be an inexpensive, reasonably representative, consistent way of collecting fishery data as a basis for assessing short and long-term trends and relative fishery performance. Due to the low level of staff resources within the IFC it acts as a valuable alternative to high intensity creel surveys, although it does not replace them for the detailed evaluation of specific fisheries and should not be used beyond its limitations (Brown 1991).

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Table 1. Summary results for the IFC mail survey for the 1991/92 season for waters with ≥50 respondents. Catch/day and days/season/angler values are means.

Water		Effort	N Anglers	Days	Catch/ day	Harvest	Catch/ day	Harvest
Type	Name	(Angler days)	(Full season)	(n/ angler/ season)	**Brown trout**		**Rainbow trout**	
Lake	Sorell	56 700	7 650	7.4	1.6	92 200	0.1	6 850
Lake	Arthurs	46 000	6 650	6.9	2.3	106 450		
Lake	Great	38 750	6 600	5.9	0.8	30 700	0.3	12 500
River	Derwent	21 100	2 950	7.2	0.9	19 150		400
Lake	Brushy	19 650	2 800	7.0	0.3	6 300	0.6	11 900
River	South Esk	18 250	2 600	6.9	1.5	26 800		300
Lake	Pedder	15 200	1 300	11.5	1.6	24 650		150
River	Mersey	13 750	2 100	6.6	0.9	12 650		400
River	Macquarie	11 900	2 050	5.8	1.3	15 750	0.1	1 000
Lake	Crescent	11 650	3 000	3.9	0.6	6 600	0.2	2 700
Lake	Bronte	11 300	2 850	3.9	1.2	13 650	0.1	1 100
River	Meander	11 000	1 650	6.7	1.8	19 550		150
River	Leven	10 500	1 450	7.2	0.9	9 900		
River	Brumbys	10 400	1 850	5.6	0.8	8 100	0.1	1 300
Lake	Crescent	9 129	1 921	4.7	0.4	3 750	0.2	1 693
Lake	Little Pine	8 450	1 750	4.8	1.4	11 500		
Lake	Leake	6 400	1 050	6.0	0.7	4 400	0.1	650
Lake	Echo	6 350	1 650	3.8	1.7	10 800	0.1	700
Lake	Augusta	6 250	1 250	5.0	1.4	8 900	0.4	2 400
Lake	Bradys	6 150	1 900	3.2	0.6	3 700	0.1	550
River	North Esk	6 000	1 150	5.1	1.6	9 450		200
River	Tyenna	5 200	1 150	4.4	1.2	6 400	0.3	1 650
Lake	Penstock	4 950	1 050	4.6	1	5 000	0.2	750
River	St Patricks	4 850	1 400	3.4	2.7	13 000		50
Lake	Rowallan	4 600	1 200	3.8	2.1	9 800	0.2	1 000
Lake	Binney	3 800	1 050	3.6	1	3 950		50
River	Huon	3 750	1 050	3.6	0.6	2 200		100
Lake	Meadowbank	3 250	1 050	3.0	0.7	2 150		50
Lake	Woods	2 950	1 050	2.9	1	3 050		

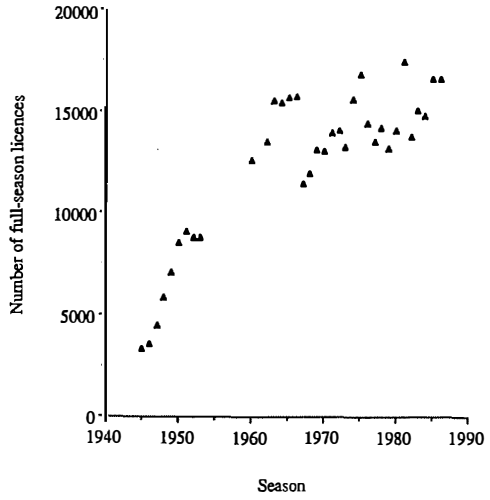

Figure 1. Trend in annual full-season licence sales for Tasmanian inland water trout fisheries.

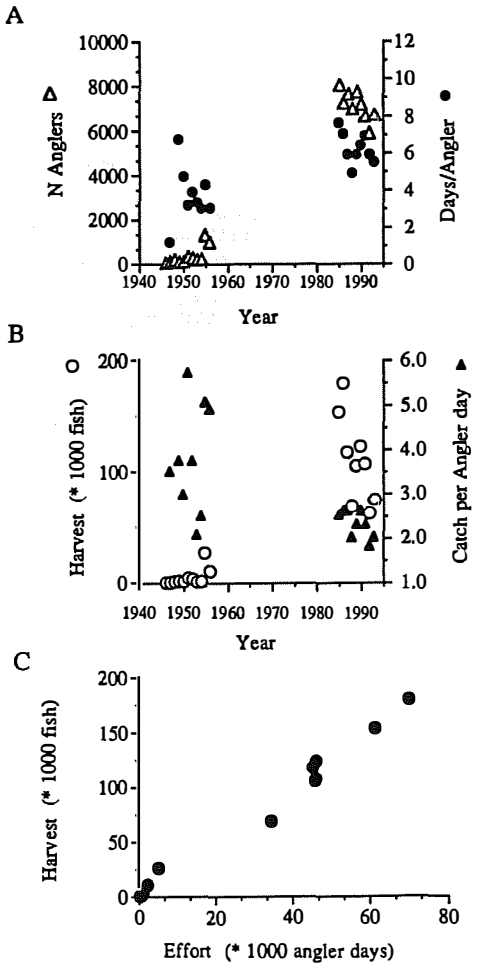

Figure 2. Plots of summary fishery statistics for Arthurs Lake against year (A, B) and of total harvest of brown trout against total effort (C).

Inland Fisheries Commission 1989/90 Questionnaire

1. What is your postcode? _____

2. In the table below we would like you to detail your trout fishing for the 1989/90 season, for STREAMS and RIVERS ONLY - please combine information for freshwater and estuary catches for each stream or river.

(a) In the first column (headed LOCATION), please list all the streams or rivers that you can remember visiting during the 1989/90 season;

(b) In the second column (headed NUMBER OF DAYS FISHED), please indicate the total number of days that you spent fishing at each stream during the season;

(c) In the third column (headed TOTAL NUMBER OF TROUT CAUGHT), please indicate the number of trout that you personally caught at each stream during the season;

LOCATION STREAMS ONLY	TOTAL NUMBER OF DAYS FISHED	TOTAL NUMBER OF TROUT CAUGHT BY ME
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

3. In the table below we would like you to detail your trout fishing for the 1989/90 season, for LAKES ONLY. Please fill in the table in the same way as for rivers. PLEASE NOTE that a separate sheet is enclosed for WESTERN LAKE waters.

PLEASE WRITE YOUR TOTAL CATCHES FOR RAINBOW, BROWN AND BROOK TROUT SEPARATELY.

LOCATION LAKES ONLY	TOTAL NUMBER OF DAYS FISHED	TOTAL NUMBER OF TROUT CAUGHT BY ME		
		BROWN	RAINBOW	BROOK
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

PLEASE TURN OVER THE PAGE

Appendix 1. Standard questions asked in the Tasmanian inland fishery mail survey.

Recreational fishing information systems: 'It's about time, it's about space'

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Background

Implementation of comprehensive recreational fisheries information systems is a new development throughout Australia. The National Recreational Fisheries Working Group, in its draft 'A National Policy for Recreational Fishing' acknowledged the need for a long-term database and provided detailed discussion on the types of information needs which may be prerequisites to the development of recreational fishery management strategies.

In summary, the Working Group concluded that:

> 'Methods have to be devised to ensure long-term data collection throughout Australia's recreational fisheries. Time series data are crucial for environmentally sound management. To conserve and enhance our fisheries we need to build up an ongoing national information base—a store of knowledge.'

The recent Queensland Government inquiry into recreational fishing (Recommendation 67) concluded that a comprehensive database should be developed to monitor the catches of popular fish species and to estimate angler effort, as part of an overall programme aimed at sustainability of those species.

In Queensland, a dedicated recreational fisheries programme was commenced about 18 months ago. Over this period substantial amounts of data have been collated and several initiatives implemented to provide information. In particular the major sources of data now available include:

Charter vessel logs	1993–present
Club records	1952–present
Tagging	1965–present
Surveys	Boat ramp, creel, telephone, etc.
Vessel Registrations	1970–present.

Discussions with other fisheries agencies highlighted that each is in a similar situation. That is, they are trying to quickly bring recreational fisheries systems up to the standard of commercial fisheries systems but are being hindered by the inherent problems associated with integrating diverse datasets and the high cost of development. The Standing Committee on Fisheries and Aquaculture (SCFA) Fisheries Statistical Working Group (FSWG) recently concluded that a cooperative

development would be of immense benefit to each agency and save time and resources as against developing individual systems and the costs invariably associated with 're-inventing the wheel'.

The concept

The need for accurate and readily available recreational fishing statistics has been identified as a major priority by the FSWG. At a recent meeting the FSWG concluded that the status of recreational data in Australia was poor. In summary, it could be characterised by the following comments:

- not much of it
- no consistent format
- not continuous
- many data sets lost, forgotten or just unused
- data are generally inaccessible
- time series analysis using multiple data sets is very difficult.

Further, State representatives on the FSWG highlighted several common factors with regard to the development/implementation of recreational fishing programmes in each State. These include:

- each agency is committed to recreational fishing programmes
- although each agency has substantial commercial fisheries information systems, no agency has developed a comprehensive recreational fisheries database
- the cost of establishing a comprehensive relational database for recreational fishing to the standard of the major commercial fisheries databases is substantial and excessive for a single agency
- a cooperative development would be of immense benefit to each agency and save time and resources developing individual systems
- there is strong need for a comprehensive relational database by each agency. Similarly, there is also a strong need for the information to be available at a national level.

Objectives

The major objectives of the concept are:

- To provide the tool to facilitate the 'build up of an ongoing national information base—a store of knowledge', as recommended by the National Recreational Fisheries Working Group.
- To ensure the database meets the standards set by the Fisheries Statistical Working Group.
- To ensure the database can be integrated with commercial catch and effort databases.

It should be stressed that the concept does not imply a central database, each agency has total control. Furthermore, it is not about data collection/analyses.

The need for a coordinated approach to a comprehensive information system

A comprehensive information system would:

- ensure management decisions are based on sound information. In addition, it would provide the structure that would allow recreational fishing data to bridge the now substantial gap in terms of quality, coverage and availability as compared with commercial fisheries data collection

- provide a common structure for the collection, processing, storage and retrieval of recreational fisheries data
- be suitable for use by all fisheries agencies irrespective of their current facilities (i.e. mainframes, mini-computers or PCs) through the incorporation of a custom third party front end (a comprehensive and user friendly interface for users to access the database) (Figure 1)
- provide a 'user friendly' environment for the retrieval and analyses of such data
- adopt national coding and validation conventions as recommended by the FSWG
- ensure the data meet the standards set by the FSWG. This would be a major step forward in adopting the AFC (19th meeting, 21 July 1989) objectives to improve coordination of fisheries data throughout Australia. It also addresses the AFC resolution that each State introduce a strategy to provide for the collection, preparation and publication, in a timely manner, of a long series of validated catch data for all recreational and commercial fisheries and effort data for those species of importance or potential importance
- ensure recreational data would be compatible with major commercial fisheries databases.

Development of a national standard for a recreational fisheries database would provide a common structure for the collection, processing, storage and retrieval of recreational fisheries data. Such a standard would enable common baseline data to be stored by each agency. This would ensure that the minimum catch and effort data are available for each agency to assist with management of the major recreational fisheries in each State or Territory.

At its November 1993 meeting in Melbourne, FSWG representatives endorsed the proposal that the FSWG would be the most appropriate vehicle for adopting a national approach to this project. The structure recommended for progressing the project is provided in Figure 2.

In summary, the FSWG would provide the forum for progressing development of a national standard and coordination of the major work undertaken by the Developers' Group in consultation with the Client Group.

Benefits

Implementation of the concept would save each agency considerable time and money. It would provide the opportunity for recreational fisheries information systems to reach the standards of commercial fisheries information systems in a very short period and in a cost effective manner. The cost to develop and implement a recreational fisheries information system comparable with commercial fisheries information systems, particularly in the time frame achievable through a national approach, is beyond the resources of any single fisheries management agency.

It is worth noting that the predecessor to the current FSWG recommended a similar concept for commercial fisheries in the late 1960s. Unfortunately, this was never accepted and it has now taken more than twenty years and considerable cost to reach the now acceptable arrangements for national commercial fisheries information.

Development of a common structure and implementation of the final application on each agency's existing hardware and software would be a significant step forward in ensuring that national standards are achieved and maintained.

Another significant advantage of the concept is that its success would not be conditional on immediate, universal adoption. Some agencies will be able to implement such a system immediately while others may take longer. Each agency would have the option of implementing the entire information system or just those components applicable to their individual needs. In addition, the concept provides the opportunity for agencies currently considering substantial upgrades to their existing computer facilities to do so without incurring the substantial costs associated with redeveloping their existing software.

Adoption of the concept would enable agencies to implement a comprehensive information system to take full advantage of the rapidly accumulating data on recreational fishing activities, which is only surpassed by the growth in demand for analyses of those data. The draft National Policy for Recreational Fishing highlighted the need for management decisions based on, amongst other things, sound information covering fishing activity and catches by recreational anglers. There is a recognition that the collection of recreational angler catch and effort information is one of the critical areas in fisheries management requiring urgent attention.

Finally, while there are significant benefits for each individual agency there are also significant advantages at the national level. In particular, each agency would have the opportunity to adopt a system that is of a national standard without incurring significant costs which characterised the *ad hoc* development of commercial fisheries information systems during the 1980s.

Support

Extensive consultation with both government and non-government bodies has been undertaken and support for the project has been strong. Support has been forthcoming from the following organisations:

- Queensland Fisheries Research Advisory Committee
- Australian Recreational and Sport Fishing Confederation (ARSFC)
  - the 'peak' national recreational fishing body
  - the Australian National Sportfishing Association (a member of ARSFC) has supported the project. In particular, the Queensland branch has already developed a substantial tagging database which is being adopted by Victoria. They have offered their expertise and system to the project
  - The Queensland Sport and Recreational Fishing Council (QSRFC), a member body of ARSFC, has also supported the concept and offered any assistance necessary.
- The FSWG strongly supported the project at its recent meeting (25–26 November 1993)
- Each State fisheries agency has indicated its support.

Summary

A coordinated approach to establishing such a database would provide major bene-

fits to all fisheries agencies. It would provide each agency with a comprehensive and integrated Recreational Fishing Database that is of a national standard in a realistic timeframe. In particular, it would save each agency time and resources developing individual systems and the invariably associated costs.

Three inherent features of this concept have consistently been identified each time it has been openly discussed at workshops and would ensure its success:

1. The concept of utilising the Standing Committee on Fisheries and Aquaculture (SCFA) Fisheries Statistical Working Group (FSWG) to progress the concept at a national level is a significant achievement for coordinated fisheries research and development in Australia.
2. The concept of the Extended Project Team to undertake the task is extremely sensible. Incorporation of a Developers' Group and Client Group within the Extended Project Team will ensure a logical progression. Further, it will ensure that input from each agency will be extremely high.
3. The concept of individual ownership at the conclusion of the project (i.e. each agency receives its own copy of the application) is attractive to all agencies. All agencies favour this approach rather than a centralised database.

Implementation of the concept would undoubtedly save each agency considerable time and money. It would provide the opportunity for recreational fisheries information systems to reach the standards of commercial fisheries information systems in a very short period and in a cost effective manner.

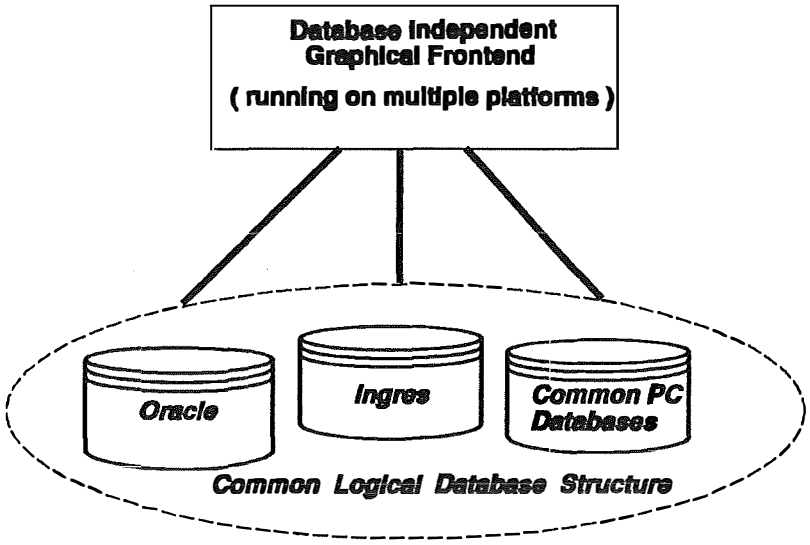

Figure 1. Proposed application structure.

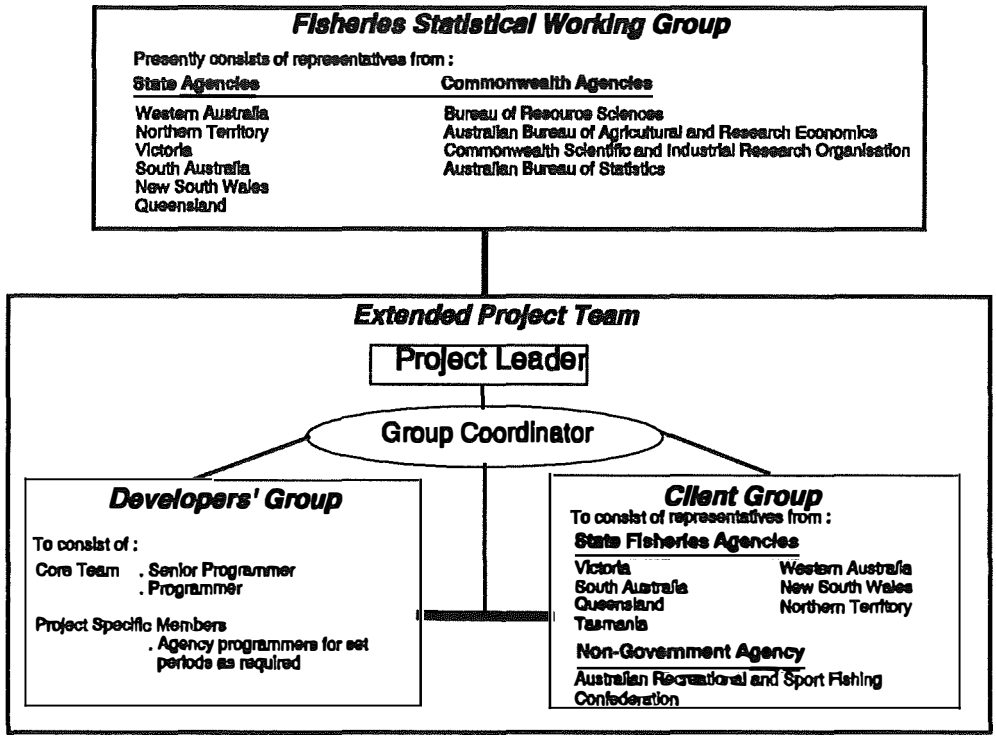

Figure 2. Proposed structure for progressing the project.

Discussion of Session 3

Recorded by M.A. Kinloch

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Following each presentation, questions were addressed to individual panellists. At the end of the presentations the floor was opened for general discussion.

Aldo Steffe's presentation was followed by several questions about the results of his survey in NSW. Albert Caton was interested to know how far offshore the recreational fishery extended and whether Aldo Steffe had been able to obtain information on specific catch locations. Aldo Steffe replied that each site had been divided into 3 x 3 nautical mile grids and that fishers had been asked which grid they had been fishing in. This allowed them to determine the spatial pattern of fishing effort although they were not attempting to link catches to individual grids. Fishing takes place both inshore and on reefs up to 12 nm offshore. Very often many of the boats are in the same grid.

Dorothea Huber asked Aldo Steffe to comment further on the distinction between the inshore and offshore fishery and also on the importance of tunas and billfishes in the catch. Aldo Steffe responded that whilst they are aware that large boats launching at the ramp were clearly headed for offshore reefs, no distinction is made between the inshore and offshore catches. He had seen billfishes in the catch at certain locations but they were numerically a minor component.

Referring to the regional differences in species composition, Julian Pepperell was interested in Aldo Steffe's idea of social preferences for fish and wondered whether he had asked people specifically about their reasons for harvesting particular fish species or if it was based on anecdotal evidence. Aldo Steffe confirmed that he had asked and that there were definite differences between regional, social and ethnic groups in their target species.

Alex Julius asked whether Aldo Steffe intended to repeat the survey in two or three years time to see if the fishery had improved or declined. Aldo Steffe replied that this was the reason why it was so important to obtain precise estimates of targeted catch rates as this allowed an objective comparison of fishing quality to be made between years. If estimates were too sloppy, the survey would not have sufficient power to detect an effect.

John Keesing queried the high proportion of 'rare events' in the catch composition in the metropolitan region and wondered if it was related to sample size. Aldo Steffe explained that a high proportion of highly-skilled anglers work out of one particular

boat ramp in the Metropolitan region and they are able to target fish quite specifically. Also, that region is characterized by a multi-species fishery resulting in diverse catches containing a few individuals of a number of species whereas in other areas with more specialized fishing, people catch high numbers of one particular target species such as snapper.

Frank Prokop asked Aldo Steffe what effect bag limits might be having on the skewness of the catch data particularly for species such as snapper and flathead. Also, is he recording catch per fisher or catch per boat as management is targeted at the individual angler. Aldo Steffe replied that they record the total boat catch but also the number of people in the boat. He felt that catch per angler was of little value as often the number of people in the boat is 'fudged' when anglers have caught several times their bag limit. He could not comment on the effect of bag limits as he had not yet subjected the data to detailed analysis.

After *Roland Griffin's* presentation, Rod Lenanton pointed to the high catch rates of barramundi in the Northern Territory survey and asked how much these high rates were dependent on the survival of released fish. Roland Griffin replied that there was no doubt that the survival of migrating juvenile fish caught and released in large numbers at a particular barrage contributed greatly to the availability of older fish upstream, or that some fish are being caught more than once.

Barry Pollack wanted to know whether Roland Griffin had been able to estimate the total recreational catch for comparison with the commercial catch. Roland Griffin replied that he had estimated the total catch in the Mary River and it is in the order of 9 tonnes, although he suspects that this might be an underestimate as many people are now taking up night fishing possibly more successfully. This will need to be addressed. The commercial fishers are not allowed to fish in, or within 5 km of, the Mary River but from a nearby region their catch is 19 tonnes.

Don Gartside enquired whether Roland Griffin had noticed any impact on the recreational catches as a result of restrictions on the commercial fishing industry. Roland Griffin replied that the increase in barramundi catch rates does coincide with exclusion of commercial fishing within the Mary River and with buy-back schemes to reduce overall effort substantially. However, there have also been several good wet seasons in the same time period and rainfall is strongly correlated with recruitment of barramundi. It was therefore not possible to separate out the individual effects and it was likely that increased catch rates were the result of a combination of the two factors.

The discussion moved on to the area of a national recreational fishing database. Stefan Sawynok, who helped to develop the Queensland Sportfish Tagging Program, commented that a similar system to the one proposed by *Neil Trainor* was envisaged for the National Tagging Database. It would operate on the same principles of having a common platform for information storage and retrieval and would have enormous advantages for both researchers and recreational fishing groups in terms of easy access to information of a consistent standard.

John Garvey asked Neil Trainor how you could ensure that after spending large sums of money to set up a national recreational fishing database the government would continue to fund the data collection proc-

ess. Neil Trainor felt that with the recent recognition of the importance of recreational fishing and the seriousness of the resource allocation issue, it will become increasingly necessary to have access to reliable recreational fisheries information.

Aldo Steffe asked Neil Trainor how he would approach the problem of standardisation of data as, for example, there were many alternative ways of calculating fishing effort or catch rates. Neil Trainor agreed that survey data would be the hardest to deal with as standards were still evolving as evidenced by this Workshop. It is an area that would require the combined expertise of each agency involved to resolve. However, there are still a lot of common elements, for example, club records, tagging databases, charter vessel programmes and compliance reports, which should be more compatible.

John Keesing wondered who would be responsible for managing and maintaining the individual, customised, agency databases once they had been set up by the developer group. Neil Trainor replied that this had not yet been addressed.

During more general discussion Aldo Steffe was asked by John Darby if he asked fishers whether they enjoyed their trip so as to determine if angler enjoyment is declining over time. Aldo Steffe responded that they were not asking for attitudes or opinions although they did carry a comment sheet. One of the reasons for this was that it was necessary to keep interview duration down to a minimum so as to maximise the number obtained as there is often a peak retrieval period during which several boats return to the ramp at once.

On that note, chairperson David McGlennon called for comments from the floor, and in particular from recreational fishers, on what constitutes fishing quality and whether in fact it is useful to attempt to measure it. Baden Hopgood, Chairperson of the Victorian Recreational Fishermens' Advisory Council, didn't think that as a general rule you could measure fishing enjoyment as it was all things to all people.

In the US, Steve Malvestuto explained, they consistently ask anglers to rate their fishing success as good, fair, poor, or excellent and try to correlate these ratings with harvest rates. In some cases, e.g. where fish are being caught for food, they are strongly correlated; in others, such as catch and release fisheries, they are not. They also ask anglers how satisfied they are with the facility they launched from and questions about the state of the environment. Thus, there might be some simple rank type data that can be collected to get at socio-cultural information.

Mike Cappo thought that it is fundamentally important to study angler motivation but that one should seek collaborators in the fields of anthropology and sociology rather than dabbling in areas in which we have little expertise. He stressed that there are people interested in getting involved in such work.

Barry Jones was of the opinion that the most satisfying aspect of fishing was the knowledge that the fish are there and one has a chance of catching them irrespective of whether or not one is successful every time. Alex Julius agreed but stressed that for people who spend a lot of money to go, say, barramundi fishing in the Northern Territory, there is a certain expectation of

catching a fish which, if not met, leads to disappointment.

Tim McLarnen pointed out that one factor which had so far not been mentioned was that ethnic background has a large part to play in determining not only target species but also attitudes toward fishing. He asked if Aldo Steffe had looked into this. Aldo Steffe replied that whilst not investigating it specifically, the influence of certain ethnic groups had clearly spread and more people are now, for instance, targeting squid. Rudy van der Elst followed this up by saying that setting management targets in South Africa was proving to be a big challenge because of social and ethnic differences in enjoyment and motivation. Satisfying the needs of a wealthy recreational angler may not suit the needs of an artisanal fishing community. Attempts had been made to extract this kind of information from different fishing groups with varying degrees of success. It was found for instance that ski boat fishers wanted a diversity of fishing experiences and catches.

David McGlennon suggested that it was necessary to make some progress on this issue in order to set management objectives in the future. Up till now the focus has been on biological management and this may at some stage become less important. Enjoyment on the other hand has not been quantified enough to set management goals. He asked how the managers of recreational fisheries are judging their own performance success if they are not utilising some of these criteria.

Frank Prokop responded to this by saying that over time the agenda for recreational fisheries management has shifted away from purely biological stock assessment into consideration of socio-political issues. It is important to find a compromise between what is biologically necessary, socially acceptable and politically expedient. Most fisheries agencies are therefore trying to devolve the decision-making process as much as possible to the client groups and involve as many people as practicable in deciding management aims to improve the chances of reaching a generally acceptable solution.

Gary Henry has been investigating what makes a good angling experience in NSW where anglers claim that catch rates are declining but effort and expenditure on fishing are increasing. He is doing such things as improving access to impoundments and getting anglers involved in things that they consider worthwhile such as education and stocking programmes. Recreational fishers also like to be involved in management aspects including data collection, analysis and dissemination. He suggested that there is a whole range of aspects of recreational fisheries management which anglers are keen to participate in and which are divorced from simply providing a sustainable catch.

Andrew Sanger believed that in Tasmania one of the reasons why their freshwater fishery has been so popular is that they have provided a broad range of specialized fisheries close to major population centres. He felt that offering a diversity of experiences is important in satisfying anglers.

John Smith spoke about the high level of apathy and disinterest about management amongst recreational fishers generally. Public meetings are very often poorly attended and when submissions are sought on matters of their interest, response rates are very low.

Laurel Teirney described an attitudinal survey conducted in the freshwater river fishery in New Zealand in which anglers were asked to rate rivers according to certain values such as scenic beauty, solitude, ease of access, proximity to home, catch rates, size of fish, etc. Results showed that 'wilderness' rivers were valued highly for their scenic beauty and the size of fish caught, while the amount of fish taken was of low importance, whereas in 'recreational' rivers the onus was on high catch rates. A multiple regression showed a relationship between catch rate and area of fishable water, perhaps due to food availability. This led to a process of selection of nationally important rivers for protection in which all anglers were involved.

Laurie Gwynne added that amongst the 4000 submissions received during the recent Queensland State Government enquiry into recreational fishing, a recurring theme was conflict and conflict resolution. It was clear that a conflict-free fishery was something that anglers would value. As a result, the QFMA was now considering a number of commercially-free fishing areas which may go some way towards satisfying some anglers. David McGlennon pointed out that despite this, there are plenty of recreational-only fisheries where anglers are dissatisfied. It seems there is an evolution of complaints beginning with commercial fishers and progressing on to other things once they have been excluded.

Murray MacDonald asked Peter Davies about the use of data obtained through recall questionnaires, in particular the confidence that is placed on catch and effort estimates. Work in the United States suggests that people's ability to accurately remember such details declines rapidly within a matter of days or weeks. Peter Davies replied that he was well aware that these estimates would be 'rubbery' and that creel surveys were likely to yield more accurate results. However, they were a cheap tool which could be useful for monitoring trends and were standard from year to year.

Andrew Sanger commented that in the case of the Tasmanian trout fishery the anglers were a dedicated group and were able to recall catch details accurately. Roland Griffin on the other hand had found recall bias to be a major problem in a 1986 household survey in the Northern Territory. This would be addressed in a forthcoming survey by regular fortnightly phonecalls to obtain information before it was forgotten. David McGlennon questioned why they did the survey on an annual basis rather than, for example, monthly, with a smaller sample size. This would help to overcome the problem. Roland Griffin replied that this was an historical system based on the licensing process.

Julian Pepperell then asked Steve Malvestuto to comment on the five-yearly National Marine Recreational Fishing Survey which takes place in the United States and which relies on angler recall.

Steve Malvestuto described it as a complemented survey where, because of the recognition of the difficulty of obtaining accurate species harvest information through the mail or by phone, hundreds of staff are hired to conduct a random, stratified sample of landings at sites along the coastline. This is complemented by a phone survey which is used to obtain total effort estimates within each stratum as a proportion of the population in the area.

Stratum estimates are multiplied by harvest rates to give a total harvest figure. Thus, two different survey techniques are used in tandem to produce an efficient and cost-effective sampling method. It supplies national statistics five-yearly so that trends can be monitored. On the whole, it has proved to be very useful and the information generated is felt to be reliable. The data do not provide site-specific intensive information for regional fisheries management so many of the states must supplement with their own marine recreational fishing surveys for certain bodies of water.

Rob Day was concerned that, considering that the normal intention in gathering recreational fishery information was to provide management advice, there should be a representative of the management arm associated with recreational fishing surveys who could liase with fishers about how the information will be used in management and how they can be involved in the implementation of management actions. Laurie Gwynne felt that this was the role of management advisory committees which should be highlighting and coordinating research directions.

David McGlennon brought the discussion back to the subject of a national survey, which Australia does not have at the moment, and asked whether there was any support for one. Frank Prokop replied that it had been a very strong recommendation from the National Recreational Fishing Policy that such a survey be instigated; however, disagreement exists amongst the various fisheries management agencies as to who should fund one. He agreed that a regular national survey could provide valuable baseline information and should be seen as a high priority for funding applications and he suggested that perhaps this Workshop could strengthen the push for that. David McGlennon pursued the topic by asking Frank Prokop what information managers, in Western Australia for instance, would get out of a national survey, that they didn't already have. Frank Prokop replied that several positive outcomes had been identified by the committee and were listed in the appendices to the NRFP discussion paper. Not the least of these was a continued time series of participation rates to see whether there had indeed been a recent explosion in recreational fishing effort as alleged or if it was actually a recent realisation on the part of government of the extent of recreational fishing. Furthermore, it would elicit spatial and temporal patterns in concentrations of fishing effort. (For instance, in NSW and Qld, fish stocking programmes have resulted in increased fishing effort in freshwater impoundments). This kind of knowledge would allow changes to be made in the emphasis of research and management to reflect such shifts. David McGlennon responded to this by asking whether it was true that one would, in fact, obtain information that it was worthwhile to measure from a national survey, citing the example of the highly consistent participation rates found in all surveys.

Nick Caputi felt that it was essential to establish a long-term database such as we have for the commercial fisheries although it remained to be decided what model should be adopted. It was likely to be more cost-effective to do this on a national scale. Ross Winstanley followed up by saying that the group of people involved in drafting the NRFP were emphatic in their view that there was a lot of value to be had out of a national survey and unanimous in feel-

ing that the Commonwealth Government could best financially benefit recreational fisheries programmes by finding a periodic national survey of socio-economic values.

Colin Buxton finished the Session by describing the creel survey being conducted by the National Linefish Research Group into all aspects of linefishing in South Africa. Their questionnaire covers four categories of information: angler information, catch and effort information, economic value and angler attitudes, not only to fishing but also to management and compliance, in order to discover how they perceive management decisions. He ended by stressing that you cannot simply force regulations on people; they must feel that they are actively participating in the management of their own resource.

General Discussion—Day one

Chairperson: R.D. Tilzey
Recorded by K.J. McLoughlin

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Chairperson Richard Tilzey summarised the main points made during the Session and expressed his disappointment that a national recreational fishing licence had apparently been abandoned as a management option. Revenue from such a licence could be returned to the State of residence on a *pro rata* basis, with pressure being applied to the Commonwealth to contribute funding proportionately. It was generally agreed that there was very little chance of obtaining direct funding from Federal treasury.

Ross Winstanley indicated that there is no national recreational fishing licensing in the USA. There are inland licences in all states and various marine licences in the coastal states. The national recreational fishing policy developed in the USA, however, was used as a model for the development of Australia's national recreational fishing policy (due for release at the end of 1994). In the consultation that took place in drafting Australia's recreational fishing policy there was conditional support from many sectors for some form of licensing, but widespread cynicism about the introduction of a national licence. He indicated that in Victoria, where there is a licence requirement for amateur inland fishers and rock lobster fishing, there is support for licensing. Discussions have taken place with the Victorian Minister in respect of establishing a peak body for recreational fishing. Ross Winstanley is of the opinion that if general recreational fishing licensing is to come about in Victoria, then it will come about through such a peak body demanding it and demanding a say in how the funds raised are spent.

Richard Tilzey, from the Chair, urged that any funds raised through national licensing should be paid into a trust fund of some description rather than into consolidated revenue.

Barry Pollock pointed out that there has been a dramatic turnaround in the attitude to licensing in Queensland, to the extent that the recreational fishing sector now supports the implementation of a general licence and that a State licence could soon be seriously considered. There has already been a recommendation that all private pleasure vessels should be licensed, with a portion of the funds raised going towards funding recreational fishing.

In support of Ross Winstanley, Baden Hopgood suggested that many recreational fishers in Victoria, especially those in organised clubs etc., are in support of licences. Although many individuals are opposed to

licences when first asked, if time is taken to explain the reasons for them and the benefits they could bring, then support usually follows. Kim McClymont added that from his experience in Western Australia as a fisheries inspector, when the message was given that licence fees are to be used directly for management and research then there was strong support for licensing. Richard Tilzey indicated that in NSW a recent survey had shown strong support for a freshwater licence. He felt that this was not the case with saltwater anglers and that overall licensing in NSW continued to be seen as politically unpalatable.

Albert Caton questioned whether the discussion was about a licence or a research levy. The Chair thought that calling it a research levy might be a good idea, but added that no matter what we call it, we need to communicate that the key issue is finding out about recreational fisheries and sustaining them.

John Garvey was supportive of the idea of more feedback being given to fishers to gain support for licensing. He maintained that a positive approach would be to use licence fees to produce catch reports that could be used by anglers. The Chair agreed, suggesting that the best data collection systems are those with the best feedback.

Richard Tilzey raised the lack of a common purpose and inability to speak in one voice on major problems facing both commercial and recreational sectors. In the South East Fishery, for example, the situation has been described as boat against boat, port against port, and State against State. He was supportive of Frank Prokop's comment on devolving decision making to client groups. However he was wary of devolving too far, as it may lead to a rash of splinter groups. Frank Prokop responded, suggesting that we are going to have to try it. The consequences of not doing so may be that decisions are made completely out of the control of fisheries departments, resulting in a win-lose situation for one or other of the client groups. This is happening increasingly in inshore areas where there are low value commercial fisheries and highly prized recreational fisheries. As recreational client groups are gaining an awareness of the direct benefit that being involved in management can have on their fishing experience and quality of catches, greater demands are being placed on politicians, managers and scientists for real-time information. In a lot of cases this process cannot be slowed, even if we would like it to be, because external forces are driving it. What we need is to work closely with the recreational community to come up with agreed priorities that are mutually beneficial to them and the stocks, whilst being in accord with the philosophies of fisheries management agencies.

Richard Tilzey ended the discussion for the day by thanking contributors. He closed by pointing out that there were other users of the resources that had not been touched upon in the discussion to date.

Session 4

Socio-economics of recreational fishing

Session Chairperson:	B. Kaufmann
Sesson Panellists:	P. Lal P.L. McLeod D.L. Baker
Rapporteur:	S.B. Bolton

Chairperson's Introduction

B. Kaufmann

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This Session entitled 'Socio-economics of recreational fishing' covers a sometimes neglected aspect of data gathering and resource allocation of recreational fisheries.

Presentations by three panellists, representing national and State organisations, and the University, will be followed by more general discussion of this important topic.

What's the value of fish in the recreational and commercial sectors?

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Abstract only

Continued growth in the popularity of recreational fishing is adding to the pressure on fish stocks in Australia. The result has often been increasing competition for and conflict between recreational and commercial fishing sectors over reducing stocks. In this environment, various measures of the value of fish in the recreational sector have been used to compare with that in the commercial sector and to justify reallocation of fish from one sector to another.

The purpose of this paper is to briefly examine the different measures of the value of fish to the recreational sector commonly used and to discuss the effects of using these value measures of recreational fish for reallocating resources between the commercial and recreational sector. Amongst the value measures examined are the expenditure and the value, net of costs recreational fishers will be willing to pay (although they may not actually pay) to go recreational fishing. What constitutes an economic value and what is an appropriate measure of the economic value of fish in recreational fishing when comparing with that in the commercial sector for the purpose of reallocating fisheries resources is also discussed.

The role of recreational and commercial values in the recreation and commercial management of multi-use fisheries—application to Western Australian salmon

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Introduction

Allocation of fish species within and between competing user groups is emerging as perhaps the most important fisheries management policy issue of the next decade. In Western Australia a variety of allocation issues are emerging. In particular, the allocation of the Australian salmon and herring resource between and within the competing user groups has acquired a high profile. The recreational sector has argued that there is increasing recreational demand for these species, that the recreational value of the species is high and that the current arrangements for determining access or allocation are inappropriate. They are perceived as being inequitable.

On the other hand the commercial sector has argued that there is a significant misunderstanding regarding the stock position for these species and their behaviour. They argue that the difficulties experienced at some times at some locations by recreational fishers are not a function of commercial activity but are rather attributable to the unique biology of the species and lack of education of recreational fishers as to when and where to fish. They argue that with appropriate education of recreational fishers both commercial and recreational fishers can share the resource for the foreseeable future. In addition they note that commercial restructuring of the industry as a consequence of declining returns is already reducing effort.

Both commercial and recreational fishing groups recognise that the recreational fishery has been developing steadily, but that there are inadequate data on the catch and participation levels or on the economic value of the recreational fishing activity. At the same time they recognise that there is still considerable work to be done to further refine our understanding of the biology of these species, especially herring.

Resource allocation: the management challenge

Fisheries management has traditionally concentrated on exploitation of fish stocks by a single user, commercial fishers.

The common property nature of fisheries has meant that stock depletion and resource rent depletion have been the focus of management, with a variety of management options being developed to correct for inefficient commercial exploitation.

These include:

- licensing to create limited entry fisheries and regulate fishing effort
- licensing to create output control in the form of total allowable catch quotas extending to individual transferable quotas.

Only recently have recreational fishers been recognised as posing a threat to some fisheries. As a consequence there are restrictions on recreational fisheries including:

- gear restrictions, closed areas and seasons
- output controls including bag and size limits.

In Western Australia, the above basic approaches have been adopted to apportion the catch between commercial and recreational fishers. Detailed regulation of the commercial sector using a mixture of input controls has evolved while the recreational sector is regulated with a mixture of bag limits, size limits and gear restrictions. In some cases, the fishing activities of both user groups are regulated to take place during defined times and seasons. This time allocation is usually designed to share the catch more equitably and also prevent spawning stocks from being overfished.

The range of restrictions that are currently applied to each sector have evolved and been implemented in a somewhat *ad hoc* manner, reflecting the traditional emphasis on commercial management and the recent growth in recreational demand. That is they have been implemented in response to specific concerns about biological sustainability, or about the level of conflict or potential conflict between recreational and commercial fishers, as these issues have arisen.

A general framework with a consistent approach to resource allocation between competing users based on clear definitions of resource security and access rights and setting out the principles for resource sharing and the processes to be used to reallocate resource stocks has not yet emerged in Western Australia, or elsewhere.

Current regulation of Australian salmon and herring

Australian salmon and herring are typical of the general situation. For Australian salmon, there are licences for commercial operators. On the west coast these licences entitle the holder to fish any available beach whereas on the south coast, each licence is tied to a specific beach. Commercial operators have priority on all beaches. Licences are transferable under specified conditions and transfers need to be endorsed by the Fisheries Department. There were controls through a Total Allowable Catch (TAC) but this is not currently being used.

The recreational fishers of Australian salmon must comply with bag and size limits, must give priority on beaches to commercial operators and are not allowed to net.

The current regulations, especially the restriction to fish from beaches, are believed to place an effective limit on commercial catch potential for any given number of operating licences.

Most commercial salmon licence holders also have herring endorsements. The commercial herring licences are currently tied to the related south coast salmon licences. These commercial herring licences are transferable under specified conditions and the transfer must be endorsed by the Fisheries Department. For the recreational fisher there are bag limits.

In the case of Western Australian salmon, the licensing has been area based to restrict effort even further. On the south coast commercial fishers are licensed to designated beaches. On the south west coast, they are licensed to the area but not specific beaches. Up until two years ago there was a TAC. Licences are transferable.

Competition between commercial and recreational fishers

Recreation demand is increasing all around the world. This has created intense competition for the resource between commercial and recreational fishers. This creates a major management problem in the form of resource allocation.

The questions arising out of this allocation issue are:

- how can recreational and commercial exploitation be jointly managed to prevent overexploitation of the resource?
- what access rights do commercial, recreational and other groups have to the resource?
- what is the objective of allocation and what decision rules will best allocate fish stocks between competing groups both spatially and temporally?
- which management regimes will best suit the achievement of the allocation objective?

Western Australian salmon and current concerns in regulation and allocation

Over recent years, concerns have emerged regarding the effectiveness of the current management regime for the Western Australian salmon and herring fisheries. The concern is that the regulation does not adequately deal with the emerging and potential future competition for the resource between commercial and recreational fishers and that it does not cause the resource to be shared fairly and efficiently between the two user groups.

Extent of recreational demand

Detailed information on the level of recreational fishing activity and the level of recreational catch for salmon and herring in Western Australia is not currently available, and there has been considerable debate as to the extent to which the recreational sector is beginning to infringe on commercial activity.

A creel survey is currently being undertaken through the Fisheries Department and is scheduled for completion in the 1995 season. This will provide harder data on the numbers of recreational fishers and the extent of their catch.

However there is strong anecdotal evidence for increased recreational demand backed by some statistics. The 1987 ABS survey of recreational fishing activity (Australian Bureau of Statistics 1989), documented the extent of recreational fishing. It estimated

that up to 30% to 40% of the population over 15 are recreational fishers. It also indicated that 40% of recreational fishers target herring as their preferred fish and that 12% fish for salmon. Herring is now widely regarded as the most important recreational fish species in Western Australia.

The emergent competition for the fish resource has been most intense in fisheries close to the metropolitan area.

Fish access versus beach access

There is a growing recognition of the importance of understanding the nature of access and competition for access. In particular for salmon, there is a need to recognise the distinction between beach and fish stock access.

Fishing for salmon in particular requires access to both the fish stock and to a location from which to fish. Not surprisingly therefore some of the emerging conflict discussed revolves around access to beaches. This applies to both the commercial and recreational fishers wishing to fish the same shore, but also to non commercial beaches where recreational fishers conflict with some environmental protection groups in seeking access to beaches. The issue of beach access currently and in the future is tied to the overall management policies for the coastal environment and associated areas. Many of the potential fishing beaches are in, or require access through, National Park land and this may conflict with the management policies that agencies such as the Department of Conservation and Environment (CALM) wish to follow in these areas.

Fishing entitlements

Recreational or commercial fishers do not have individual explicit entitlements to the annual salmon and herring catches in Western Australia. The commercial sector is regulated by licensing the number of fishers. This is combined with regulating the area in which they can fish and restricting their operation to working from the beach. Control of salmon catch has been controlled in the recent past with a TAC quota, but as noted previously, this approach has not been used in recent seasons. The TAC concept was opposed by the commercial sector as a management device for the fishery.

In the absence of a formal TAC, it has been argued that when reallocation is desirable or desired, it can be difficult for recreational fishers to negotiate directly with commercial users for a greater share of the catch because there is no explicit recognition of what rights each sector has to the fish resource.

Under the current approach, if it is thought desirable or necessary to give recreational fishers a larger share of the salmon or herring resource, then it is necessary for the government to intervene. The government is able to take the necessary decisions that will result in a resource shift. However, in the absence of well defined rights associated with licences even this can be complicated when issues of compensation arise.

Economics and resource sharing

The emergence of resource sharing or allocation issues in a sense gives economics its strongest rationale for involvement in fisheries management because competition for scarce resources is the fundamental business

of economics and, even more important, is the *raison d'etre* of markets.

From an economics perspective the appropriate approach is relatively straightforward. Essentially it is to bring market discipline to the allocation of stocks between competing uses either in the form of

- actual markets based on defined property rights, or
- implicit markets based on cost benefit analysis and direct allocation.

It is the practical implementation of either of these two approaches that is the real issue, in particular defining the appropriate role of government.

The problem

Most management regimes do not create clearly defined property rights to effective shares of the harvest, so that resource shares vary with effort by each group. This is always likely to lead to conflict and will generate fundamental questions about access rights. Security of access and tenure is in most markets a prerequisite for allocation efficiency, but is not an attribute of many fisheries.

Elements of an ideal solution: market allocation

Based on this definition of the problem, then from an economic perspective the elements of an ideal economic solution that accounts for efficiency and equity are relatively straightforward. They are to:

- replace common property with private property rights to the greatest extent possible, subject to the rights of the fisheries manager (the Government) to adjust the harvest in accordance with an overall management plan
- establish the private property rights in a way that transcends the commercial and recreational activities, that is it recognises the rights of both non commercial and commercial players in the total allowable catch, and
- use the establishment of private property rights to create a market in the form of tradable quotas or catch share.

There are clear advantages to this approach. These are generally well known and include:

- bringing commercial and non commercial activity within the common management framework
- fish stocks will be allocated through trading to those groups that value them most
- a basis for compensation for existing commercial licence holders exists
- trade drives allocation not direct government intervention
- biological control (usually allowable catch reductions) can be 'purchased' through intervention in the market to achieve marginal adjustments within the management plan.

While the above advantages need to be fully appreciated they are often all that are emphasised. However, the potential economic benefits of such a system need to be put into perspective and balanced against the costs associated with such a system. In particular we can point to some clear difficulties including:

- transactions costs

  Markets have to be policed and prosecuted, and policing recreation compli-

ance with a market share allocation could become very costly, almost impossible in some cases. Depending on the value of the fishery, the transactions costs could dissipate the increase in net economic value generated by the management system.

- initial allocation

  The initial allocation needs to be determined in a way that is equitable and contains an element of certainty. This presumes that the 'biological' information is such that a current and future allowable catch regime can be set down to initiate the market. For established fisheries there are likely to be commercial licences in operation that establish some kind of allocation.

- asymmetry in transactions costs

  Related to the allocation and transactions costs issue. The default is that existing fishers with licences and in some cases defined catch quota are usually commercial fishers. Resource allocation changes are likely to be towards recreational fishers. There may well be asymmetries in the transactions costs, which make it relatively more difficult to organise recreational fishers to 'bid' for licences than to elicit bids from commercial fishers.

- thin markets

  Apart from some rare exceptions, most quota markets in which recreational resource allocation is an issue are likely to be very 'thin' markets. They are unlikely to provide the robustness needed to guarantee that prices represent opportunity values.

- ownership concentration

  In many cases, especially thin markets, ownership and control may become concentrated and collusion may occur, further jeopardising the price determination process.

- independence in initial allocation

  The fisheries authority setting the initial aggregate and individual allocations needs to be independent.

Unfortunately, these difficulties militate against any simple market solution for resource allocation. In most cases, some form of direct allocation would seem to be favoured, combined with market transactions where appropriate.

The clear objective emerging from economic analysis is that fish stocks need to be allocated so as to maximise the value of the fishery to society. Fundamentally this is an efficiency objective and would allocate and reallocate fish between competing uses according to where the marginal value was highest. This is exactly what a competitive market does, and it is this process that is the benchmark for direct allocation intervention.

Relevant values and lack of values

It is important to realise that if direct allocation is to determine resource allocation shares, then the relevant economic assessment is cost benefit analysis. That is each competing use needs to be assessed in terms of the net benefits conferred on society in economic terms from its use of the resource.

For example for commercial use, we need the net economic value of the fish resource reflecting competitive market prices and the opportunity of all resources required to

produce the commercial output. For recreational use this means assessing the net willingness to pay by recreational fishers, that is gross willingness to pay, less the costs of 'producing' the recreational fishing experience.

This poses particular difficulties for recreational activities because of the lack of markets. Expensive techniques such as travel cost model and contingent valuation surveys are needed to assign relevant values. These approaches must be able to account for the fact that for recreational fishing there are joint outputs and inputs. For example for Western Australian salmon, the actual catch and the quality of the experience, including location, are relevant joint outputs while the required resources include both access to fish stock and access to beaches from which to fish.

As a consequence the usual situation is a lack of relevant values to input into resource allocation deliberations.

It is important to note in this context that economic impact studies will not suffice to make the decision. They are however valuable in identifying regional economic or distributional implications of alternative fishing activities.

Relevant management regimes: lessons based on Western Australian salmon

The situation of Australian salmon, currently being considered by the Australian Salmon and Herring Resource Allocation Committee (ASHRAC) in Western Australia, illustrates all of the above issues, and indicates the key elements of an acceptable resource allocation process.

No clear property rights; establish benchmark rights

In the absence of a clear definition of the rights and entitlements that go with a licence, in most cases a commercial licence, optimal resource reallocation is difficult to achieve. It is difficult to know just what the commercial fisher is losing and what the recreational fishers are gaining. Hence it is difficult to assign acceptable values to the 'rights' in order to achieve market based reallocation. This issue has been recently recognised in Western Australia when the Fisheries Portfolio Review recommended as part of its implementation programme the establishment of a working group to investigate issues of security of access in fisheries.

Stock versus amenity, resource sharing management

Any allocation process must begin from an understanding of the stock position. For example for Australian salmon, the assessment is that stock is fully exploited but not under threat. Therefore we have a resource sharing issue based on relative economic and social values between competing uses. This presupposes either the availability of data on which to base these relative value assessments or the existence of a process (usually market based) than can establish them.

Management without values: appropriate approaches

For most fisheries the values needed will not be available, especially for recreational activity. Moreover in many cases they will be expensive to obtain and the cost may not be justified. For Australian salmon, there is no detailed knowledge of the recreational catch and no real knowledge of recreational values, although the creel sur-

vey mentioned previously and an associated contingent valuation survey will clarify the position.

However, for many fisheries, although values are not available, the direction of change is clear based on limited evidence and differential growth rates in demand.

Thin markets

For most fisheries, independent assessment of market transactions will be needed because of the small number of licences likely to be traded. Any allocation process must be able to cope with this problem.

Dynamic framework needed

No simple market or direct allocation will work. A resource sharing framework is needed that reflects the above points and which establishes a reallocation process that can account for the emergence of new pressures over time and for the dynamic adjustment that will therefore be required.

Further reading

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If sustainability fails, who loses most?

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Abstract

A fishery may be 'sustainable' over a wide range of harvest/abundance regimes with an associated value at each level. We employed Contingent Valuation Methodology (Willingness-to-Pay approach) to obtain estimates of the value of the lower River Murray fishery recreational and non-consumptive sectors relative to the commercial sector at current stock levels. Respective estimates of $A9.6m, $A45.2m and $A1.1m per annum indicate the importance of considering non-use values in fisheries management. Since the non-consumptive sector will lose absolutely in the event of stock collapse/sustainability failure, it has the most to lose. The recreational and commercial sectors are likely to be buffered from absolute loss (e.g. through increased emphasis on the experience component of recreational angling, through government assistance to the commercial sector).

Fisheries management in Australia is almost exclusively concerned with servicing two broad client groups; commercial fishers and recreational fishers. The key associated issue is the allocation of harvest between these groups. Our research indicates that there is a third user group, i.e the non-consumptive sector, whose interests need to be considered and prioritised. To illustrate this we use the example of the native fish stocks of the River Murray in South Australia and consider the outcomes eventuating from a loss of sustainability in this fishery.

To allocate a resource efficiently it is necessary to have some indication of the relative values of the resource to all the potential interest groups. To be able to estimate true indications of these values we need to consider the composition of the total economic value of the resource.

What is total economic value?

The composition of total economic value of a resource can be broken down into several broad types:

1. Use value
   a) Actual
      i) Direct (consumptive)
      ii) Indirect (non-consumptive)
   b) Option
2. Non-use value
   a) Bequest
   b) Vicarious
   c) Existence

Use value, as is self explanatory, is derived from using good(s) or resource(s). In the case of fish this can be either directly, as in fishing, or indirectly by observation of some form (physically, books, film). While

an individual may not currently undertake any of these activities they may derive value from the knowledge that should they wish to, they have the option to do so (Randall 1987).

Bequest value is an altruistic concept whereby individuals derive utility and satisfaction from endowing future generations with a resource (Young 1991). Vicarious value is similiar but in this case individuals derive value from the availability of a resource for use by others. Existence Value (Randall and Stoll 1983) reflects the utility and satisfaction derived by an individual purely from the continued existence of a resource. In the current example they may gain benefit from the knowledge that there are native fish stocks present in the River Murray, even though they may not ever envisage using them.

The terminology used and the degree of breakdown varies slightly in the literature. For the case in hand we have chosen to group the above categories into two types of value, based on their practical impact on the resource:

1. Direct use value.

   Comprising of that value derived from activities that involve the consumption of native fish.

2. Non-consumptive value.

   Comprising of that value derived from activities that do not involve the consumption of native fish together with the associated non-use value.

Who are the value holders?

The common perception is that those who can derive value from native fish stocks are commercial and recreational fishers. While there can be no doubt that they are indeed major users, this view ignores the fact that native fish are also an environmental resource whose value can be derived without consumption. Australian native fish are in fact a common property resource (Krutilla and Fisher 1975), owned by the community, and administered by the State. To date governments have generally chosen to focus management on the consumptive aspects of the resource. A more accurate view is that all of society derives value from native fish stocks and that society can be divided into the following user groups:

1. Commercial fishers
2. Recreational fishers
3. Non-consumptive sector (i.e. everybody else).

How to quantify value?

When allocating resources it is desirable to be able to quantify the value(s) of the various groups involved, preferably in monetary terms, as this provides a readily understood means of comparison within western cultures. There are several economic assessment techniques available to accomplish this, such as market methods, hedonic measures (Streeting 1990), Travel-cost method (Pearce *et al.* 1989) and Contingent valuation (CVM) (Mitchell and Carson 1989). While the first two of these methods are currently more commonly employed, only Contingent Valuation is suitable when attempting to quantify the total economic value. This is because CVM is the only method able to provide an estimate of non-use values (Young 1991).

The Contingent Valuation Method is a direct approach to estimation, based on the premise that an indication of the value of a

good or resource to an individual can be obtained by 'asking' that individual. The aim is to disclose an individual's willingness-to-pay (WTP) for a benefit and/or their willingness-to-accept (WTA) compensation to tolerate a loss of benefit. This can be done either by a questionnaire approach or using experimental techniques where an individual's response to stimuli is observed under 'laboratory' conditions (Pearce *et al.* 1989). The aim under both approaches is to simulate a market for the good in question.

Methods adopted

In the case of non-consumptive users, it was necessary to estimate values which would be primarily non-use, therefore CVM was the only option available. It was also the most appropriate method for recreational fishers as there is a well established non-consumptive element to the overall experience (Glass and Muth 1987).

While both WTP and WTA approaches were used, there are a number of limitations with the use of WTA. As this case investigates a potential loss of benefit, WTA questioning would appear theoretically to be appropriate (Coker and Richards 1992). In practice, this and other studies have found that WTA produces consistently larger results than WTP (three to five times larger (Cummings *et al.* 1986)). There are several postulated causes for this variation which include the constraint of income under WTP (Dixon and Sherman 1990), a higher degree of strategic bias evident under WTA (Brookshire and Coursey 1987), rejection of the WTA property right (Mitchell and Carson 1989), and prospect theory (Kahneman and Tversky 1979; 1982).

While it was expected that more conservative results would be obtained from a WTP approach, WTA was also assessed to provide an indication of the magnitude of any difference and to see if the key value determinants were the same under each approach.

In the case of commercial fishers the net value was most effectively obtained by the use of market methods (Lal *et al.* 1992 pp 36–37). Gross market value of the commercial catch was used as a *defacto* indicator of net economic value. The demand for commercially caught fish in Australia is very price elastic (Pascoe *et al.* 1987) implying minimal consumer surplus[1]. The associated annual production costs were not readily available, but anecdotal and observed evidence suggest that they are minimal (e.g. fishers are local or home based; boat, gear and running costs are low relative to most other fisheries).

This approach does not include any non-consumptive benefits to commercial fishers such as the enjoyment of the fishing lifestyle, the anticipation and capture of fish and the tradition of fishing (Holland *et al.* 1992). As there are only 40 commercial fishers, these additional values were assumed to be minimal relative to cumulative market value.

Survey

In order to obtain estimates of value, questions were included in a survey which

1. A measure of benefit to a consumer, net of the sacrifice he or she has to make, from being able to buy a good at a particular price; the difference between the amount a consumer is prepared to pay for a good (rather than go without) and the amount actually paid (Department of Finance 1991).

formed a part of a broader project. The survey was conducted using a personal interview survey method to obtain CVM estimates, with all interviews conducted by the same person. This allowed an opportunity to form an opinion of the degree to which respondents understood the hypothetical situations and also to reduce variability due to extraneous influences such as personality and presentation.

The survey sample was drawn from the population of Adelaide and the Riverland region of South Australia. The sample was stratified, to detect any variation in value between the locations on or about the river and suburban Adelaide. These two areas represent 77.8% of the total population of South Australia (4.6% in the Riverland/ Murray Mallee region and 73.1% in Adelaide)(South Australian Yearbook 1993 pp 48–49).

The survey questions were designed to:

1. Estimate the average net non-market dollar value that individuals place on native fish stocks in the lower River Murray;
2. Identify the key variables explaining the magnitude of this net value to individuals.

The questionnaire involved questions relating to the following variables:

- place of residence
- age
- sex
- was respondent a recreational fisher?
- if yes, did they fish in the River Murray?

These were then followed by CVM questioning using an iterative bidding approach (Dixon and Sherman 1990 p 39). In each case the interviewee was read the following statement:

> 'Scientific evidence indicates that the native fish species in the River Murray have declined significantly in the last few decades (e.g. Murray cod numbers have reduced 95% from 1950s levels). This decline is continuing unabated with several smaller species now extinct in South Australia.
>
> In order to develop a strategy to resolve this situation, we are seeking information on people's priorities for action. Therefore, please consider the following scenarios and answer the subsequent questions as if they were real situations and you would actually have to pay the amounts that you state.'

The following scenario was then presented:

> 'Without any remedial action being undertaken, all native fish in the River Murray will be extinct within twelve months.'

Interviewees were then asked either:

> 'What annual payment would you be willing to make to prevent this occurring?' (WTP approach)

or

> 'What annual payment would you be willing to accept to be indifferent to this situation?' (WTA approach).

The starting point for bidding for WTP questions was $2000 followed by bids of $1000, $500, $100, $50, $10 and zero. Once a 'yes' response was obtained, further

questioning followed to narrow down the WTP of each interviewee. For the WTA surveys the order of bids was reversed.

Survey results

A total of 216 surveys were conducted in locations along the River Murray (n = 100) and in Adelaide and suburbs (n = 116) between March and June 1992.

Selected on a random basis 115 interviewees were presented with questions using the WTP approach, with the remainder presented the WTA version.

WTP version

Stepwise regression analysis disclosed that of the independent variables, only RMFISH (does the respondent fish recreationally in the River Murray?) was significant in explaining variation of the dependent variable DOLLAR (the annual amount the respondent is willing to pay to prevent extinction of all native fish) ($p < 0.001$, F Ratio = 32.27).

The resulting function is:

$DOLLAR_{WTP} = 42.46 + 160.80$ RMFISH

RMFISH (yes = 1 and no = 0).

Data analysis revealed no outliers for DOLLAR responses.

WTA version

The WTA data contained one outlier ($50 000 p.a.) and six negative bids, where the respondent indicated that they would be WTA an annual amount less than their current annual expenditure. Zero bids (3) were included as realistic bids as it was apparent to the interviewer that these respondents would not require compensation.

As for the WTP group, the only significant independent variable contributing to an explanation of the dependent variable DOLLAR was RMFISH. ($p < 0.01$, F Ratio = 8.03). The resulting function was:

$DOLLAR_{WTA} = 675.64 + 986.82$ RMFISH

RMFISH (yes = 1 and no = 0).

As expected the results under the WTA approach are of a much greater magnitude to those of WTP. However, in both cases the only statistically significant variable was RMFISH.

Summarising the WTP results on an individual basis:

	($ per annum)
Recreational Fishers	203.26
Non-Consumptive Users	42.46

Applying these figures to the population of South Australia over the age of 15 years we obtain an estimate of the total economic value of the native fish stocks of the lower River Murray to recreational fishers and non-consumptive users. This could then be compared with that of commercial fishing as derived from using market indicators.

An estimate of the annual dollar value of the commercial fishery was obtained by averaging the value of the catch over the last eight financial years (SA Department of Fisheries Annual Reports 1983/4–1991/92) using constant prices (1991/92). Value data prior to this period are not comparable. Whilst production is somewhat variable due to the influence of environmental conditions, beneficial and unusual flood conditions over four of the eight years are

likely to have exaggerated the longer term mean value.

Based on these data the average annual value of the commercial fishery is $0.54 million (1991/92 prices).

Estimated dollar values are based on prices provided by South Australian processors which are generally less than those obtained for freshwater species on the Melbourne market. As a large proportion of the catch is forwarded to the higher priced Melbourne market, the gross returns may be as much as twice as high as those estimated (Rohan 1987), that is, the average annual value could be as high as $1.1 million. We have used this latter figure in our comparison of user group values.

Results on user group basis:

	($m per annum)
Recreational Fishers	9.6
Non-Consumptive Users	42.7
Commercial fishers	1.1

Discussion

Initially these figures may seem large and disproportionately so in the case of the non-consumptive sector, but they need to be seen in context. The hypothetical situation under consideration is the total loss of native fish stocks and hence the loss of all related activities. The figures are the net value of the loss to each group, not the gross value. In the case of the two consumptive sectors there are potential offsets to the loss of native fish stocks.

Commercial fishers in this situation would be faced with a potential loss of income and employment. However, this could be partially overcome by shifting effort to target non-native species. There is also the likelihood, in the case of a total industry collapse, of government assistance in some form, as is often the case in the Australian primary sector. Finally, assuming that the native species do not disappear overnight, due to the high price elasticity, the increased prices that fishers would receive for the reduced catch could offset losses. This of course would only apply while there were sufficient stocks to warrant an industry.

Recreational fishers would lose because there are less fish to catch, therefore it is harder to get a feed and the overall fishing experience may become less enjoyable. However, for many fishers this may not actually diminish the experience as the actual act of catching fish is only one aspect of the activity (P.A. Management Consultants 1984). A major part of the enjoyment is related to the atmosphere and the environment where the activity takes place. These aspects may also be degraded with the loss of the native fish and this loss is similar in nature to that experienced by non-consumptive users. The losses that are purely related to the act of catching fish can also be partially offset by changing the target species to non-native species or by fishing elsewhere. In fact, for some fishers, a decline in native stocks may actually enhance the experience as the challenge of catching these species is increased. This only applies while there are still fish to catch.

It was apparent to the interviewer that the majority of respondents view the River Murray as a vital environmental and economic resource and that the health of the fish stocks is a key indicator of the health of the river and its environs. Thus the extinction of all native fish stocks would result in a loss to non-consumptive

users due to the perception that, without native fish, the environment would be severely degraded. There is no potential for any offset to this loss.

It is clear from this that, faced with a total loss of native species, society as a whole loses and that the non-consumptive sector loses most. In this situation it makes economic sense for those resources at the disposal of fisheries management to be used to address the needs of the non-consumptive sector as their marginal utility[2] is by far, the greatest. That is they are the group who would derive the greatest satisfaction from each additional fish at these low levels. The problem is that management of fisheries is primarily designed to address the needs and interests of the consumptive sectors, in particular, harvest allocation. If the likelihood of native fish extinction became a possibility it is probable that management would address the problem from the perspective of the consumptive interests. This consumptive approach would only be likely to achieve the socially optimal result by good fortune, while failure to overcome the problem may result in the collapse of the fishery.

This scenario illustrates a deficiency in the management structures in operation in most fisheries. They are designed to operate in sustainable fisheries where the main issue is harvest allocation. They do not allow for a situation where the resource is under threat and the greatest marginal benefits would be gained by meeting non-consumptive needs. Management's first priority should therefore be to ensure long-term sustainability. It is essential that non-consumptive interests should have a significant influence in the management process. Once a structure that accurately represents society's values is in place current management measures should be reassessed to see if they meet society's needs efficiently.

In conclusion while the scenario used in this study was hypothetical, in many freshwater fisheries including the River Murray, extrapolation from current trends unfortunately indicates it is a highly likely scenario. It is to be hoped that fisheries management overcomes the deficiencies illustrated here and realises the opportunities for broadening funding bases, increasing community participation and support, and predicting socially optimal stock levels identified through this economic assessment approach.

Acknowledgements

The authors acknowledge the support of the South Australian Research and Development Institute (Aquatic Research). This research was funded by the Murray-Darling Basin Commission under the Natural Resource Management Scheme and through its vision for the future of the River Murray's native fish.

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Discussion of Session 4

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John Gartside commenced the discussion by asking David Baker what he would expect to find if he applied his contingent valuation method to the commercial sector as well. He observed that the evaluation didn't include the opportunity costs that the commercial sector are foregoing, arguing that they have a direct market value. David Baker thought that, in this case, the market value was a good indicator. He believed that it was picking up the opportunity costs because most of the commercial fishers in South Australia were involved in the fishery for other reasons than simply making a profit.

John Gartside responded that logically you should also value the number of fish caught by the recreational sector using exactly the same measure, i.e. the market value. He was also concerned that contingent valuation has some very alarming findings, with people making judgements about things that they don't immediately have to pay for.

Lindsay Harwood asked Paul McLeod what is the value, or if there is a value component for the commercial fishery 'lifestyle'. When you actually look at reallocating the resource financially, do you consider the lifestyle value of the fishery? Paul McLeod replied that it was in a way a $64 question but he regarded two things as important. First, if you are going to be consistent and chase the marginal valuations of the activity, then you need to take some account of the lifestyle valuations of commercial fishers. However, you have to disentangle from that whether or not the lower rate of return they are accepting for being in the industry in a commercial sense is already fully accounted for in the lifestyle adjustments that they have made. But he thought that it came back to his original point, the need for management frameworks. In terms of getting a framework which will work, he thought it inconceivable that you could easily manage allocations without putting some weight on the lifestyle choices of the fishers, particularly when you have things like grandfather clauses, because they would be willing to pay something in order to maintain their lifestyle.

As an aside to the previous question about contingent valuation and commercial fishing, Paul McLeod suggested that you could apply survey-based approaches to commercial fisheries to get some idea of the value they placed on their lifestyle separately from their commercial valuation. He commented that there was a risk that there is always going to be a temptation for people who have a lifestyle to say that its value is

super high, e.g. there is no price whatsoever which would cause me to vacate my beach or vacate my licence. That is certainly not going to be true but the difficulty is how do you actually factor in the lifestyle component in a sensible working arrangement on allocation.

Albert Caton commented that in the discussion on resource allocation there was an aspect of compensation that had not been covered. For instance, if you have a group that fishes down a stock (whether it is a recreational group or commercial group) and, following allocation between the two groups, payment is sought for that allocation, there is a question of loss and the payment for that prior loss. He also suggested that it need not just be fishers responsible. For example consider a marina development. If habitat is degraded by the building of the marina then both the recreational and commercial fishers might be expected to pay each other for the diminished resource, whereas the developer gains from the value of the land and sales from that investment and yet pays nothing. How are you going to take this into account?

Paul McLeod gave two answers. First, the straightforward answer is that those who have actually lost the resources should be compensated. From a legal point of view, however, lawyers would probably argue about the legal rights of fishers and whether those rights were in perpetuity. It does put the onus on fishery managers to consider the concept of what the licence really implies. What is it? Is it an annual licence? If it is a licence in perpetuity, then that should be compensated.

Secondly, from an economist's point of view, in the case of a marina developer, for example, provided the externality costs are taken into account when the marina was developed, then we can say they have paid for it. Where they haven't paid for it, this is in fact a classic example where we find overdevelopment. The developers do not pay for the actual cost of their activities.

Rob Day felt that decisions on allocation are going to be influenced and the assigned values are going to be continually influenced by the amount of information that is present. It seemed to him that the process is incomplete unless you can actually value the information that is needed and create a market for that information.

Paul McLeod responded that he thought this was right but not necessarily a major problem. The characteristics of markets is one of the reasons that economists extract market solutions for most problems that they come across. Markets have this great capacity to handle the dynamics of a situation as more information becomes available. Consider the mining sector, for example, where there are continuously new discoveries, new technologies for mining. There are many things that change continuously and new information is something that markets assimilate very well. What he was suggesting was exactly that sort of process being replicated in terms of allocation of resources. You can't ever expect to be able to say we have all the information and therefore the allocation we've made is the correct one for the future. However, he was uncertain as to whether or not it was worth going down the full market track completely, by establishing, for example, tradeable property rights, rather than trying to emulate it to some extent through a management framework. Information needs are an important part of that process.

Rob Day didn't share this faith in markets and argued that they seldom provide information ahead of time. Barry Kaufmann agreed that markets are not perfect but what are the options? If you forced him to compare a market to perfection, perfection is going to win every time. However, a commanding control situation is far from perfect as well; governments making allocation decisions worry him a lot. So clearly markets are not perfect but they may be the best alternative.

Paul McLeod stated that he wasn't trying to suggest that you should use markets because they are perfect but agreed with Barry Kaufmann's point that markets are very powerful instruments for sending out appropriate signals to get people to do certain things. It doesn't necessarily mean that every allocation decision has to be a market but, he reiterated, it has to try to pick up and emulate the sort of forces that a market would create. He disagreed with Rob Day's point about markets and information. We tend to say that markets don't worry about the future or markets don't seek out information but in fact one of the great things that markets do is they stimulate a whole lot of research and development. They often identify what needs to be done for the future and they elicit the sort of responses that make it happen. Some industries operate with exceptionally long time frames.

Charles Barnham asked Paul McLeod about the costs of communicating frequent changes and enforcing the result of those changes. Paul McLeod replied that it depended on the processes in place. With a fairly robust market structure, for example, a fisheries department participates by buying back some tradeable quota and just storing it. Or if you decided that the available harvest could be increased you could auction some quota. These are fairly commonly used practices in the water industry where you have tradeable quotas. If you don't have this situation but an allocation based more on direct intervention then there is a major problem in terms of communicating information. First, on things that have to be changed and second, on actually going about changing them. If you are not going to go down the route of trying to create markets because, say, of the high transactions costs you have to put in place a management structure. A process which is ongoing, can elicit information and make the appropriate adjustments, and communicate it. He did not have the answers as to how this is best done but thought that it was an important challenge. He also added that one of the things that is quite important in the WA salmon committee is that it is recognised that in a lot of cases the information that exists between the people who are competing for the resource is asymmetrical. Each of them has a quite different knowledge about the fishery and one of the prime requisites for having a sensible outcome is for both sides of the equation to understand the basic information about the fishery. One of the things that has emerged is that education is a particularly important component of any allocation issue.

Laurie Gwynne stated that he thought David Baker had overlooked one significant user group, Aboriginal Traditional Fishers and asked him if he had any thoughts on the value that they might put on the resource? David Baker responded that at the time of his survey he didn't take them into account and was still not quite sure whether they actually played a major

part in the Lower Murray. However, you definitely need to take this group into account. There is no doubt that there is a value which can be acknowledged by resource managers but to put a dollar value on it is very difficult at the moment.

Steve Malvestuto pointed out that although the orientation here was primarily to deal with allocation issues, in terms of recreational fishery management in the United States there were more basic issues that the recreational fishery managers were trying to deal with. These are simply trying to understand how the economic value of a specific resource changes in relation to biological changes and in response to management strategies. He suggested that one of the challenges for economists is to interact with fishery managers and come up with some key economic response variables. These could be incorporated into a typical creel survey interview in order to track and monitor economic change simultaneously together with a number of other biological and perhaps socio-demographic factors. This is a big issue in the United States now because it is hard for biologists, economists and sociologists to communicate mainly because of different terminologies. He continued that it is not difficult to put a question in an interview schedule that asks anglers what they spent for the trip and a willingness to pay for that trip over and above expenditures. If it is done in a statistically sound manner those values can be expanded fairly easily at least for the users of that particular resource. It is also important to understand this so that governments can evaluate the importance of the fishery relative to other economic enterprises in a state or a region. To get legislatures to allocate more money for fisheries management and research, you have to go in and lay dollar signs down on the table. It doesn't help much to go in and say we have 90 000 angler hours and we have 100 000 kilos of fish harvested from this system so please give us some more money for management and research.

Paul McLeod stated that the contingent valuation survey of the salmon and herring fisheries in Western Australia is actually being incorporated into the creel surveys. The way it is being done is that a sub-sample of the creel survey will be taken into the contingent valuation survey to check on these valuations. These will then be statistically related, it is hoped, with some of the variables from the creel survey. However, it takes a fairly long time to get through that process. Steve Malvestuto agreed, but thought that if biologists just knew how to incorporate some of this into their standard repertoire there would be a tremendous amount of information generated in a relatively short period of time.

Padma Lal commented that she thought a long term objective for recreational fishery managers would be to gain this information, adding that the commercial sector is already moving along those lines, trying to get annual economic indicators. Although the recreational sector still has a long way to go she acknowledged that we need to start somewhere. However, she cautioned that it is not just a case of putting in a question or two about how much people are willing to pay to go fishing. It has to be done very carefully to avoid producing numbers which are outrageously large and do not have much meaning. There is importance and value in including such questions but they need to be very exact. For example, what value are you actually deriving? Is it the recreational fishery? Is it

the value of fish? Is it the whole total experience of recreational fishing? Knowing exactly what value you are deriving for the appropriate use you want to put that information to is important.

Padma Lal commented on David Baker's presentation saying that she enjoyed this example of putting the theory into practice. It was the first time she had actually seen some bottom lines, the actual numbers. She was, however, a little concerned about the figures used to expand the survey results to cover the entire population. She wondered if this was valid, i.e. would all South Australians be willing to pay $43 per person. She was also surprised that the recreational fishers in South Australia who didn't fish in the Murray River had exactly the same willingness-to-pay figure as the non-consumptive user.

David Baker responded to the second comment first by saying that although not significantly different, those recreational fishers who did not fish the Murray were, in fact, willing to pay less. There was less of an environmental awareness by some recreational fishers than there was by people who never fished there or never even went there. The non-consumptive users actually expressed more interest (generalised from the people he interviewed).

With regard to the first comment, David Baker continued that he applied the results to all of South Australia because basically the majority of the State's population is in Adelaide. Rivers are an integral part of South Australia's life-line, so he thought it was reasonable to assume that everyone knows what the river is; how important it is to South Australia. That was the rationale for applying it to all of the population over the age of 15 and having the money to pay for it. It is important to remember that the situation which was proposed was quite an extreme one. It was about the complete loss of the river, and the feedback from the people interviewed was that they perceived that if there were no native fish in the river that was just the start. Therefore in $43 they were also talking to some extent about the environmental state of the river as a whole. The analysis also excluded people in NSW who are over the State border but put a value on the fishery, as well as the rest of the country. At an extreme level, people overseas may also value the resource. For example there are people in Australia, who put money into conservation groups who are trying to save the Amazon or save the pandas, or whatever. To some extent he believed he was being conservative concerning the group the figures were applied to.

Padma Lal replied that this point illustrated something that we all need to be aware of, particularly with contingent evaluation techniques. What is the population that is relevant? Here, the recreational fishers came up with a certain value, whereas the community came up with a much larger total value. A very similar example was what happened recently in Kakadu National Park where similar kinds of values were derived. It emphasises that what we have to look at is what value is being considered. In the case of recreational fishers they are concerned about the fish they will lose (in terms of catching them) whereas the community is talking about the value of the environment. Is this the same product we are actually valuing? Are we deriving a measure for the fish from the River Murray or are we actually deriving a measure for the value of that environment? This is very critical when you are trying to use

contingent valuation techniques to measure the non-market values. One has to be aware of it and, in designing questionnaires, take into account what is the product that you value.

Martine Kinloch directed a question to Paul McLeod concerning the increasing cost of fish to consumers that results from an allocation from the commercial to the recreational sector. Because the value of the commercial fishery is not only to the commercial fishers but also to consumers, how do you arrive at a stable situation?

Paul McLeod replied that fish in commercial use are not just valued in terms of commercial fishers but you try to value them in terms of their economic value to the community. This has to encompass what is called the consumers surplus associated with consuming those fish in whatever consumption patterns occur. The value of fish to the consumers is, therefore, part of the exercise. This point is really the challenge. When we talk about resource allocation we often talk about it as if it has to be an allocation or reallocation that once done cannot be undone. This is not necessarily undesirable but it is not unusual in markets to have continuous allocation and reallocation of resources according to the pattern of demand and supply. For example, if you have competing uses for a particular resource in the mining industry and one of those uses experiences an increased demand for their product they end up bidding higher prices for that resource. The result is it goes in that direction and not into another use. Unless you are operating with complete uncertainty, you would not expect to make initial reallocations that are far too large or far too small. He reiterated the need for a management structure which can handle that sort of problem. It is a dynamic process and you can't guarantee that what you have done today is right for tomorrow.

Session 5

Resource allocation—a forum

Session Chairperson:	C.M. MacDonald
Sesson Panellists:	T.D. Loveday B.C. Jeffries M.D. Ramsay J.R. Millyard P.P. Rogers
Rapporteur:	S. Conron

Chairperson's Introduction

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Good morning and welcome to the longest and possibly the most controversial session of this Workshop! In this Session I hope we will objectively explore the philosophy, rationale and operational requirements for applying resource allocation to the management of fish stocks and fisheries. However, the Session will be structured more as a public discussion forum than a scientific workshop in recognition of the primarily social and political nature of resource allocation issues.

Since the concept of 'Ecologically Sustainable Development' (ESD) gained national and international prominence in the 1980s it has become increasingly apparent that ESD-based management of fisheries and fish stocks—particularly those in estuarine and coastal marine waters—is as much about preventing or resolving conflicts between competing users as it is about conserving fish stocks and protecting the habitats/environments that support them. While stock conservation and habitat protection will almost always be the most important goal of fisheries management, achieving an appropriate allocation or sharing of available natural resources between competing user/interest groups will in many cases be the next most important goal.

The need to address resource allocation issues has been clearly identified in a number of recent fisheries policy development and strategic planning processes carried out in Australia. At a national level, the 1991 report of the national ESD Fisheries Working Group referred to resource allocation issues in sections dealing with intragenerational equity, returns to the community, and identification of the beneficiaries of resource management. The Draft National Policy for Recreational Fishing in Australia (1992) included a section on 'sharing the resource', and contained two Key Principles which recognise the right of recreational fishers and other exploitive and non-exploitive users to a fair and reasonable share of Australian fish resources.

At a State level, the five-year strategic plan developed by the former South Australian Department of Fisheries (1991) includes a specific goal to 'provide for an equitable allocation of the State's aquatic resources and maximisation of benefits to the community of South Australia'. The recent review of recreational fisheries management in Western Australia (1991) also recognised the fundamental importance of resource sharing, observing that 'fisheries management policies are as much about controlling the relative available catch

share between recreational and commercial fishers—and within groups of fishers—as they are about management for sustaining fish stocks'. A Victorian parliamentary committee recently (1991) conducted a public inquiry into the allocation of fish stocks in Victorian bays and inlets. The committee's terms of reference included a requirement to recommend optimum levels of commercial and recreational fishing with respect to resource conservation, equitable sharing of fish stocks, the economic welfare of the commercial and recreational fishing industries, and a regulated supply of fresh fish to Victorian consumers. No doubt similar processes have been occurring in other States/Territories.

In spite of these and other fisheries management processes involving extensive public participation, there still appears to be considerable confusion regarding the meaning of the term 'equitable resource allocation', the rationale and method(s) for deciding how fish stocks should be allocated, and the most appropriate management 'tools' for achieving specific resource allocation objectives. These areas of confusion need clarification if resource allocation goals are to be effectively incorporated into fisheries management regimes with broad public understanding and acceptance.

Resource allocation issues and decisions arise at a variety of levels in the overall hierarchy of aquatic resource planning and management processes (Table 1). At the highest level (designated Level I) the question arises as to whether particular fish stocks and/or the habitats that support them should be managed to achieve conservation and/or sustainable use objectives, or whether community interests are better served by allowing alternative uses which have adverse biological or environmental consequences. It should be remembered that the latter option is a legitimate alternative, as some sections of the community may believe that in some areas the benefits of urban, industrial, agricultural or tourism development outweigh the environmental costs or the diminished production of renewable resources.

Level I resource allocation issues are most likely to be encountered during the development of strategic planning frameworks for large areas of water and large amounts of aquatic natural resources. Recent examples of such strategic planning processes involving full public participation are the national Coastal Zone Enquiry conducted by the Resources Assessment Commission, and the State-wide Marine and Coastal Study currently being conducted by the Victorian Land Conservation Council.

Level II (Table 1) resource allocation issues arise in deciding how fish stocks and habitats which have been designated for conservation and sustainable use should be shared between competing user/interest groups in the community. The main categories of competing uses for fish stocks or aquatic habitats are recreational harvesting, commercial harvesting and consumption, commercial aquaculture, traditional uses (including harvesting), and non-extractive (conservation-oriented) uses. To date Level II resource allocation issues have usually been the ones which are most readily recognised and which generate the most animated public debate.

Assuming for a moment that Level II resource allocation decisions have been made and that available fish stocks and aquatic habitats have been appropriately divided or shared *between* competing users,

a third level of resource allocation issue (Level III) can arise in that there may be a desire to more equitably distribute resources—in this case fish stocks—*within* user groups. Examples of Level III allocation issues within the recreational sector include the introduction of bag limits to equalise individual catches within a specific fishery, or the designation of particular waters or fish stocks for specialist recreational fisheries. Examples from the commercial sector include the desirability of using commercial catches of some species for human consumption versus other uses (e.g. pet food, fertilizer, fishing bait), and the availability of popular commercial fish species for consumption on local markets versus the export of such species for premium prices. In each of these examples I am not attempting to make any value judgement on particular options, but merely pointing out that a resource allocation issue does exist.

To date resource allocation issues within user groups have generally not had a high public profile, either because they have not been recognised as significant issues, or because they have been avoided as being too difficult to tackle. However, with increasing competition between individual users for limited available fish stocks and habitats, Level III (within-group) allocation issues could become as urgent and demanding as any other type of problem which fishery and aquatic resource managers will be required to deal with.

Before introducing the guest speakers and panellists for this Forum session, I would like to present a list of topics or questions which I believe need to be addressed if we are to have a productive discussion of the concept of resource allocation in fisheries management. They are:

1. What does the term 'resource allocation' mean when applied to fish stocks and their habitats? (This topic should include discussion of the concepts of 'common property resources' and 'equitable sharing' of access to or benefits from these resources).
2. Where and how does resource allocation fit into the broader spectrum of biological, social and economic goals for the use and management of fish stocks and aquatic habitats?
3. Under what circumstances does it become desirable or necessary to make decisions regarding the allocation of fish stocks?
4. Who are the 'stakeholders' (i.e. user/interest groups or beneficieries) when resource allocation decisions are being considered?
5. What information should be collected and what criteria (biological, social, economic, political) should be used to determine how fish stocks are allocated?
6. How can resource allocation decisions be translated into specific fisheries and aquatic habitat management arrangements. In particular, what kinds of management 'tools' are available to fisheries and aquatic habitat managers to implement resource allocation decisions?
7. What kinds of monitoring can be undertaken to determine whether or not specific resource allocation targets are being met, and whether or not resource allocation objectives need to be modified in response to changing community attitudes?

I have no doubt that additional such topics will be raised and I look foward to some lively discussion during this Session. But

first, however, our guest speakers will provide us with some views on fisheries resource allocation from the perspective of particular user/interest groups. The commercial sector will be represented by Ted Loveday (Queensland Commercial Fishermen's Organisation) and Brian Jeffries (National Fishing Industry Council); the recreational sector by Mal Ramsay (Australian Recreational and Sport Fishing Confederation) and John Millyard (Australian Fishing Tackle Association); and fishery managers by Peter Rogers (Executive Director, Western Australian Department of Fisheries).

Table 1. Types of resource allocation issues and options or examples within each type.

Level I	Strategic	i)	Conservation and/or sustainable uses of fish stocks and aquatic habitats.
		ii)	Non-renewable use of aquatic natural resources.
		iii)	Permitting 'development' which has adverse environmental consequences.
Level II	Between user groups	i)	Sustainable recreational harvesting of wild/cultured fish stocks.
		ii)	Sustainable commercial harvesting and consumption of wild fish stocks.
		iii)	Commercial aquaculture.
		iv)	Traditional uses of fish stocks and aquatic habitats.
		v)	Non-extractive use/appreciation of fish stocks and aquatic habitats.
Level III	Within user groups	e.g.	Bag limits to equalise individual recreational catches.
		e.g.	Designation of particular waters or fish stocks for specialist recreational fisheries.
		e.g.	Use of commercial fish catches for human consumption versus 'other' uses (pet food, fertiliser, bait).
		e.g.	Local consumption or export of popular commercial fish species.

Fisheries resource allocation—a commercial perspective—I

T.D. Loveday

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You will all know the old Chinese blessing, or curse, 'may you live in interesting times'. Well, fisheries biologists can look forward to living in very interesting times in future. The same can be said for fisheries economists and fisheries managers in general.

I don't think anyone working in government fisheries departments around Australia, will lack challenges or media attention over the coming months and years. However, you will be comforted by the thought that during these times there will be commercial and recreational fishing representatives keeping you close company and suggesting simple, logical ways for you to overcome these challenges.

The decisions of fisheries managers will come under unprecedented scrutiny. It is interesting to see that groups like the Fishing Tackle Association have employed consultant biologists to advise them and sometimes act as spokespersons for them in relation to fisheries management. The angling media have been primed to carry a coordinated message on major issues. I understand that was evident in debate leading up to the passage of the new Fisheries Act in New South Wales, where the concept of 'property rights' was widely publicised as handing all the fish over to commercial fishers and allowing commercial fishers to order anglers off the fishing grounds. I would be interested in hearing whether any fisheries managers ever thought that was the case or whether that argument involved just a little bit of exaggeration.

The angling media is also becoming far more hostile. Commercial fishers are regularly projected simply as the enemy. And as all the fisheries managers are said to be in bed with us, presumably they are something even worse.

You might have seen the hostile reaction from the Fishing Tackle Association, when the federal recreational fishing steering committee, suggested a $20 saltwater angling licence. Now, an annual licence fee of $20 a year doesn't seem like a lot of money—not compared with the 2000 to 3000 million dollars a year we are told anglers spend on fishing in Australia every year. However, we believe there is plenty of exaggeration in those spending figures and maybe it is a fact that the average angler can't afford something less than 40 cents a week for a licence. However, that's another argument for another forum.

Of course all this is relevant to resource allocation. Fisheries biology may be science but fisheries resource allocation is politics.

The fundamental question seems to be: 'What is a *fair* allocation?' It depends which side of the fence you're on, doesn't it?

In stark contrast to many amateur lobby groups, commercial fishers have never argued for exclusive access to the resource. We firmly believe that, providing the resource is properly managed, there is room for both the seafood industry and genuine recreational anglers.

For many years the commercial industry has been focussed on ensuring that harvesting of the resource was sustainable. This has resulted in the industry initiating many stringent management measures with severe impact on operators—all in the long term interest.

The trend in recent years to include amateur groups in the fisheries management decision-making process is welcome. For too long these groups have had the luxury of standing outside and throwing rocks at almost everything to do with fisheries management, and particularly commercial fishing.

How many self imposed restrictions have the amateur lobby sought on anglers in the last decade or two? It's about time anglers had their say, but most importantly it's about time they shared some of the responsibilities and some of the pain that goes with managing fisheries.

However some substantial changes of attitude are required before a constructive and cooperative approach to managing fisheries of interest to both commercial fishers and anglers can be achieved.

Negotiating with most amateur fishers is like negotiating in quicksand—there never seems to be a bottom line. Close this river to commercial fishing today, close that bay next week, and within a predictable time-frame have no commercial fishing within sight of land. And then, presumably, get to work on the offshore trawlers and long-liners.

It won't surprise anyone that commercial fishers are not going to accept a situation where the industry, or even part of it, is eliminated, and where the majority of the community—who never, ever, wet a line even once a year—can no longer buy fresh local fish unless they pay for it over the back fence or at work from someone who is an angler.

And excluded from this debate so far are the many businessmen and women who have large amounts of money invested in the bricks and mortar and equipment needed to process and sell the catch, and service the fishing fleet. The allocation debate is focussing on commercial fishers but they are just the first of several groups who depend on commercial seafood catches.

And at the end of the line is the consumer. What is really being debated is not the allocation between commercial fishers and anglers: it is the allocation of fish between the 10% of people who catch enough seafood for their own needs and the 90% of people who do not—90% who get their seafood requirements, requirements that are increasing every year, through the commercial fishing industry.

And who would benefit from allocating more of the resource to anglers? Apart from the fact that most fish would be taken by the frequent, skilled angler, and not the genuine recreational fishers, angling has social value as an outdoor activity. But, given Australia's climate and open space,

we are not exactly short of opportunities for socially-valuable outdoor activities, apart from recreational fishing.

Is it so that more people will go fishing and join fishing clubs?

That's a perfectly legitimate goal for the office-bearers of fishing clubs, but it is no reason to exclude fresh fish from the shops and axe people's livelihoods.

Is it so that more fishing tackle can be sold?

That may be a legitimate goal for tackle retailers and importers, but they are not in competition with commercial fishers. They are in competition with the people who import and retail tennis racquets, and golf clubs, cricket bats and surfboards—although to make fishing look more attractive and generate more spending on fishing tackle, the theory seems to be that commercial fishing needs to be got rid of.

They are competing for the average Australian's recreational dollar, a share of disposable income. And that dollar will still be disposed of, will still flow through the recreational economy, whether it is spent on a fishing rod or a surfboard, or any other type of sporting equipment.

It is an interesting observation that while anglers' representatives argue that a fishing licence is not needed because anglers already pay so much money in sales tax on fishing gear, the same total amount of sales tax would still be spent at the end of the day if all the money went on tennis racquets, surfboards and other recreational equipment—but usually without making such demands on a limited, publicly-owned resource such as fish stocks which need such careful and expensive management.

This Workshop is valuable in focussing on facts and figures. More importantly on what facts and figures will be required in future to ensure that fisheries are managed on a sustainable basis, and to put some common sense into the allocation debate.

This is certainly something commercial fishers will welcome. We have nothing to fear from factual data. Introducing less emotion and more facts into the debate will help everybody. Most importantly, at the end of the day, it will help the resource, which in the long run will benefit everyone.

So what are some of the key areas in which these facts must be gathered?

Firstly, what is the amateur catch? How can it be measured?

While almost all commercial fisheries have logbook systems or some other data collection mechanism in place, very few data are available on amateur catches.

How many managers and biologists in this forum have been placed under pressure by the amateur lobby using commercial catch data as an excuse to further restrict commercial fishers, whilst at the same time the data on recreational catches were non-existent or negligible?

There are many cases where commercial fishers have been subjected to increased restrictions, only to find later that studies on total amateur catches indicate that they are many times the commercial catch.

Secondly, what is the value of the recreational catch?

An argument often used by the amateur lobby to convince governments to stop commercial fishing is that amateur fishing

is worth more to the economy than commercial fishing.

Figures loosely used to substantiate this are exaggerated and have little relevance to the real value of amateur fishing to the economy.

The basis of these figures is often a study undertaken by PA Consultants in 1983. The findings of this study have been used to influence politicians and fishery managers by almost every amateur lobbyist I know, and in almost every forum around the country. I suppose the old adage that if you keep on saying the same thing often enough (whether it's right or not) people will begin to believe you, has certainly worked to some extent in this instance.

Quite frankly the commercial industry has itself to blame for letting this myth go unchallenged for so long. The preliminary findings of an independent review of the PA study, which was recently commissioned by Queensland Commercial Fishermen's Organisation are as follows:

- The study aimed at measuring expenditure incurred in recreational fishing in Australia; however, expenditure on recreational activities does not correspond to the economic value of that activity.
- It is not correct to infer from the PA study that recreational fishing is 'worth' $2.2 billion a year to the national economy.
- The use of expenditure figures to measure recreational activity values was superseded long ago—virtually all studies of recreational activity reported in the literature over the past thirty years, which are numerous, have bypassed using figures on expenditure incurred, in favour of more informationally correct approaches.
- The study was built on an outmoded theoretical foundation which is not appropriate to correctly measuring recreational activity values.
- Comparing figures on expenditure incurred, with those for other recreational pursuits, or indeed market-based activities such as commercial fishing leads to misleading conclusions. It is not only inappropriate but downright dangerous.

As well as highlighting problems with using expenditure figures, the review has found major problems with the expenditure figures themselves. For instance:

- A problem with the study is the correct allocation of expenditure to recreational fishing where multi purpose items or expenses are involved, and where parties involved comprise a mixture of participants and non-participants.
- The approach the study has taken includes all expenditure on a trip regardless of whether or not recreational fishing was incidental to the trip.
- The study generously allocates costs of multi purpose capital equipment to recreational fishing.
- The PA study has therefore attributed as many dollars as it possibly can to recreational fishing.
- A further problem is the correct attribution of overexpenditure, for instance when anglers stay in expensive hotels and/or purchase luxury 4 wheel drives. Clearly enjoyment factors apart from recreational fishing are at play here.

There are many more problems, but I don't need to go into further detail at this stage. I believe I've made my point.

The bottom line is that the PA study may well provide an indication of the maximum possible expenditure on all types of recreational (and some other) activities by persons who throw a line in the water either regularly or only very occasionally. However the study does not give an indication of the value of recreational fishing to the economy, in fact it has very little if any relevance to it.

Other types of information on recreational fishing that are urgently required include:

- When the appropriate allocations of the total resource have been determined how can the amateur catches be controlled?
- How effective are tools such as bag limits?
- What are the relative impacts of recreational and commercial fishing on species which are most surrounded in controversy?

These are important issues. Gathering and analysing information to put some rationale into this debate is essential.

Commercial fishers continue to recognise the importance of biological research, stock assessment etc., and this type of research, particularly in areas which have direct relevance and potential benefits to the industry, must continue to receive priority from funding bodies.

However the types of Research and Development issues discussed at this Workshop and which must be addressed to take the emotion out of the allocation debate must also be given high priority.

Let's face it, all the biological information in the world won't mean a thing to commercial fishers if at the end of the day they don't have access to the resource because this type of vital data has not been obtained and allocation of the resource is not based on fact.

And after all it is commercial fishers who pay a significant contribution to the overall cost of fisheries research in this country; it is those same funds paid by the industry that are responsible for attracting large amounts of the government contributions.

For at least as long as the five years I have been involved with the Queensland Commercial Fishermen's Organisation, fisheries managers in Queensland have been saying they need to have more facts and figures about the recreational catch. A start has been made now on gathering those facts and figures, but this effort must be urgently stepped up.

Finally, one of the ultimate tests for fisheries biologists employed by government departments is this: what happens when good fisheries management collides with good politics?

Of course *you* know that in the long run good fisheries management *is* good politics. But not all politicians have the luxury of looking at the long term. For many the horizon is no more than three years. In my experience in those situations, the biologists' scientific, ethic and professional pride have won out, and I really have no doubts they will again in future.

Congratulations to the Society for convening this Workshop. I am sure the discussions here over these days will help to advance the cause of rational fisheries management in general and rational resource allocation in particular.

Fisheries resource allocation—a commercial perspective—II

B.C. Jeffries

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The National Fishing Industry Council represents all sectors of the commercial fishing industry in Australia, including catchers, processors and aquaculturists. Ted Loveday has outlined the position of commercial fishers in the current debate with recreational fishers over allocation of access to fish stocks, and I'm not going to expand on that. What I want to focus on is how we resolve the debate, because it seems to me that if we continue to wait until we get more and better information then we are still going to be debating this issue a decade from now. The fact is that even a decade from now we are still not going to have enough data to be comfortable about making resource allocation decisions. We have got to somehow get a consultative process going now. As unscientific as some consensus 'deals' on resource sharing may be, the fact is that we are more likely to arrive at workable resource sharing arrangements by doing such 'deals' at the State and federal levels than we will by doing nothing until we get all the necessary data. That's not to say that we shouldn't bother collecting the data—indeed, we should be focussing more resources in this area—but we cannot wait until we have got everything before we start making resource sharing decisions.

What we are trying to develop in the commercial fishing industry in Australia is a culture based on pride in the industry. In my experience I have seldom seen two groups with more pride and sense of common identity than game fishers and marine biologists, and I think a similar outlook would be of great benefit in the commercial sector.

I believe that in recent years the commercial fishing industry has generally become a bit more sophisticated in its approach to the issue of sharing fish resources with the recreational sector. My personal view two years ago was that we should never promote the idea of recreational fishers paying licence fees. The rationale for that view was that if recreational fishers had to pay for the use of a resource they would want a bigger say in the management of the resource, and that was the last thing the commercial sector wanted! However, there is no use in the commercial sector thinking that the recreational sector is going to go away because it won't happen. We are all entitled to a fair share of available fish stocks and we are just going to have to co-exist. Such co-existence should be possible because, when you look at it, we share common views on many more fisheries issues than those which we dispute. For

example we both want to conserve fish stocks and protect fish habitats, we share some of the old hunter-gatherer mentality of our ancestors, and we share a common confusion over the meaning and future implications of the latest crop of fisheries management concepts such as 'ecosystem management' and 'maintenance of biodiversity'! Some of us also share dreams of stock enhancement of highly valued target species such as snapper, King George whiting, tuna, barramundi or whatever else it may be.

I have also seen in the United States that the development of strong local recreational fishing associations has resulted in greatly improved consultative processes for fisheries management, and I think this is something that needs to be promoted in Australia. Already we have a strong game fishing association, but we do not have good regional recreational associations. If we are going to come to a set of arrangements on sharing of fish stocks, then the commercial sector has to feel that those arrangements are going to remain in place for some time and that the recreational sector is sufficiently organised and cohesive to stick to its part of the bargain. Unless the strong local or regional recreational associations I mentioned are in place, it is difficult to have any confidence in a system of negotiated resource sharing arrangements.

So far I have been talking as though commercial and recreational fishers are the only two groups involved in the debate over allocation of fish stocks. Of course the situation is usually far more complex than this, as there are people out there who want access to fish resources for purposes other than fishing. I will use three short personal experiences to illustrate some of these other aspects of resource sharing. The first is from New Zealand, where I heard a brilliant speech by the Chairman of the Waitangi Treaty expounding the view that the fish resources of New Zealand belong to the Maoris, and that if other user groups such as the commercial or recreational fishing sectors want access to these resources then they should have to pay for it. Now I'm not saying that the 'Maori experience' will be duplicated in Australia, but it does illustrate that there are other groups in the community who will claim ownership or interest in fish resources and who will want us both to pay for access to the resource.

The second experience is that I attended a meeting in Hobart a month ago to discuss options and strategies for conserving and managing populations of albatross—particularly the Wandering Albatross. There were at least 15 people around the table who devoted a substantial part of their life to protecting albatrosses, and properly so. But in pursuing their cause these people were, and will continue to be, promoting measures that will impinge on the interests of both the recreational and the commercial fishing sectors.

The third experience arises from my involvement in the tuna industry in South Australia. We have a member in our Association who game fishes for six months of the year in Queensland and farms tuna for the other six months of the year. What a perfect life! But again, the development and promotion of inshore tuna farming by this person and others is sure to impinge on the interests of both recreational inshore fishers and the pre-existing commercial capture fishery for tuna. Integration or chaos—call it what you like!

Returning to my theme of the need for consultation, last week I saw yet another proposal to measure the value of competing uses of local fish resources, presumably to be used as a basis for making resource allocation decisions. In this case the South Australian fisheries management agency (David Hall's group) was proposing to measure the value of commercial and recreational fisheries for King George whiting in South Australia. Having seen this approach many times, and not disputing the value of it at the regional level, I just wish it was that rational and that easy. The fact is that resource allocation decisions are made in the political arena based on a variety of considerations in addition to measures of the value of fish catches, and this will probably still be the situation a decade from now. The need for regular and ongoing consultation on the development and refinement of resource sharing arrangements is vital because, as we all know, the average attention span of politicians is somewhere between five minutes and the next election!

The problems of arriving at workable arrangements for sharing of fish resources become even greater as more and more commercial fisheries are placed under Total Allowable Catch (TAC) and quota management, as they are in New Zealand and are becoming so in Australia. New South Wales in particular will provide a fertile test of how the public comes to terms with a new fisheries management system which formally divides fish resources between the commercial and recreational sectors. An interesting problem arising from this process is how the recreational sector lives within its TAC, but that's not a question I can address today.

The other problem with introducing TACs for different fishing sectors and individual catch quotas is that allocation of fish stocks becomes a legal process. In fact, commercial fishers consider individual catch quotas to be valuable property and thus they have a very strong incentive, if not a constitutional right, to ensure that the commercial TAC remains as high as possible.

The pressure to develop workable resource sharing arrangements is increasing. It's not just the demands for quality fishing opportunities from an increasing number of recreational fishers. The increasingly sophisticated structure and management of the commercial fishing sector is also putting pressure on the recreational sector to become better organised so that their views are more effectively represented during fishery management processes.

What type of consultative mechanisms do we need to deal with fisheries resource allocation issues? From what I have seen there are plenty of models available, so there is no excuse to delay the process by claiming that we need more data or that it is too hard. One model that really does appear to work is the concept of Integrated Management Committees (IMCs) in South Australia. The marine scale fish IMC in particular has five recreational fishing and five commercial fishing representatives. While the IMC process is sometimes haphazard, a majority of the 'deals' done appear to produce workable resource sharing arrangements. Furthermore, most of these agreements are not just struck at the lowest common denominator, because they are negotiated between people who have experience in their respective areas, who know the feelings and wishes of the groups they represent, and who also look at

the longer term implications of various resource allocation options. This system seems to work in South Australia and I think it can work in every other State and internationally.

A second consultative mechanism is that used by the East Coast Tuna Management Advisory Committee, where representatives of the recreational sector are invited to participate in deliberations over the management of fisheries for tuna and billfish. Admittedly, effective consultation is sometimes clouded by emotional issues such as access to marlin, and resource sharing arrangements are not always decided in the most scientific manner, but again workable agreements involving genuine concessions can be achieved. Our main concern in this case is that the commercial industry is providing most of the concessions for an increasing number of species. I keep asking the recreational representatives on the Committee to 'promise me that marlin is the last one and that this is not the slippery slope to yellowfin tuna etc.'. To their credit the recreational representatives have admitted that they cannot give such an undertaking, rather than making commitments they can't meet.

A third and more formal type of consultative mechanism comes from New Zealand, which appears to be addressing fisheries resource allocation issues better than many parts of Australia at the moment. A very detailed written agreement on the sharing of Bay of Plenty fish stocks has been negotiated, signed, sealed and delivered by representatives of the peak New Zealand recreational fishing council and local commercial purse seine operators. It has also been given some implicit endorsement by the Minister for Fisheries. The explicit and formal nature of this resource sharing arrangement means that it is much more likely to be adhered to, and that's the type of arrangement we need to somehow reach in Australia at the State and Commonwealth level.

A fourth consultative mechanism involving broad community participation is that used by the Great Barrier Reef Marine Park Authority (GBRMPA) to develop or review management plans for the Great Barrier Reef region. GBRMPA is a Commonwealth Government management agency and was not set up specifically to accommodate recreational and commercial fishing interests. However, the consultative mechanism does work in that it provides GBRMPA with information on how a broad range of interest groups want to use the aquatic resources of the Great Barrier Reef, and thus gives an indication of what the most appropriate resource sharing arrangements might be.

Having considered alternative mechanisms for arriving at acceptable resource sharing arrangements, the next step is to look at ways of adjusting existing resource use activities to meet new allocation targets if necessary. In fishery terms this inevitably means that some people will want to buy others out. For example, some local government councils in Australia are already considering buying out parts of the commercial fishing sector, and to some extent even the recreational sector, in areas under their jurisdiction. What we need in Australia, and which I have not yet seen, is a set of rules and/or mechanisms which allow changes in fishery resource allocations in an orderly and just manner.

The biggest problem is establishing a mutually acceptable price for buy-outs. For

example, a number of commercial net fishers operating in Coffin Bay, South Australia could be bought out of their fishery if only someone was willing to pay their asking price. The fact is that the longer we delay tackling the need for adjustment in some fisheries, the more entrenched people will become in their current positions, the more they will feel that there is a legal and political obligation to settle the issue in their favour, and the harder the problem becomes to solve. There has got to be a willingness, particularly at the State Government level, to confront these problems, and we can learn from consultative processes such as the East Coast Tuna Management Advisory Committee, just what trade-offs are necessary to achieve resource allocation adjustments in, for example, the tuna and billfish fisheries off Queensland.

As a commercial fishing industry representative I feel we really are better educated these days to accept trade-offs, whether they be buy-outs to meet changed resource sharing arrangements, or other controls for other fisheries management purposes. That's not to say that there is any single rationale or magic prescription for solving resource sharing and other fundamental fisheries management problems, but there are a lot of models around (particularly in the United States and to a lesser extent New Zealand) that should be looked at and used.

So there you have it. There *are* ways of fixing the fisheries resource allocation problem. There is nothing awesome about it; it is just a matter of both the recreational and the commercial fishing sectors having the will to sit down and come to an agreement about it. That's happening where I come from in South Australia, and it has the very strong support of the State fisheries authority. When all is said there is really no excuse for us not coming to terms with one another and fixing the problem now. We don't have to wait a decade for more data because the solutions are to a significant extent already within our grasp.

Fisheries resource allocation—a recreational perspective—I

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I would like to comment on several specific issues and problems which frequently arise when we talk about how best to allocate or share fishery resources.

The first point is in relation to funding. The Final Report of the national ESD (Ecologically Sustainable Development) Working Group on Fisheries estimated that in 1990–91 about $114 million was spent on fisheries research and management, representing about 10% of the gross value of commercial production. Table 1, reproduced from the Fisheries ESD Report, gives details of fishery value and expenditure for each State/Territory and the Commonwealth. The expenditure in Table 1 seems like a significant amount until you find out that it includes some spending on recreational fisheries and other programmes not directly related to commercial fisheries. It is much smaller again if you take out expenditure on commercial crustacean and mollusc fisheries (e.g. rock lobsters, prawns, scallops, oysters).

On the recreational side, P.A. Management Consultants estimated that in 1984 just over $2 billion was spent by recreational fishers in pursuit of their sport. I know this figure has been criticised by some as being too 'rubbery', but it is the only one we have, and we think it is conservative. If we project this figure forward assuming a modest but consistent increase in numbers of recreational fishers, then annual spending on recreational fishing is now probably closer to $4 billion than the original estimate of $2 billion. Remember that we are looking only at expenditure here as a measure of the value of recreational fishing.

During the development in the early 1990s of a national policy for recreational fishing in Australia it was estimated that State and Commonwealth governments collectively spent about $23 million per year on recreational fisheries research and management. This represents less than 1% of our estimate of recent total annual expenditure by recreational fishers. The national recreational fishing policy document also identified the need for an additional amount of about $21 million to be spent to bring recreational fisheries research and management up to acceptable levels.

There is also a need to have a look at the funding situation fishery by fishery. A good illustration of this is the east coast tuna fishery, where the domestic commercial longline component is valued at approximately $9 million whereas annual expendi-

ture by sports anglers is estimated at about $205 million. Management and research has until now focussed mainly on benefits to the commercial fishery, and I believe there is a need to have a look there to see if something can be done to step up the amount of management and research done on the recreational side of the east coast tuna fishery.

The main reason I have raised the issue of funding is to emphasise that if we want to achieve all of the goals for recreational fishing that have been discussed in this Workshop and will continue to be discussed in the future, then someone has got to come up with some extra money.

The next point I would like to discuss is what we mean when we talk about sharing or allocating access to fish stocks. The Brundtland Report to the World Commission on the Environment and Development defined Ecologically Sustainable Development (ESD) as those actions which 'meet the needs of the present without compromising the ability of future generations to meet their own needs'. I've heard this goal expressed in several other forms during this morning's Workshop proceedings.

Fisheries resources are common property. This means they belong to all members of the community, and yet no individual has exclusive rights to either the whole or part. Governments are responsible for effectively managing these resources on behalf of current and future generations. Proper allocation of access to these resources, together with other biological, social and economic goals, is a fundamental requirement for responsible use and management of fish stocks.

The issuing of a licence to catch fish does not give ownership of the fish to the licensee, only the right to go fishing for particular species or stocks using particular fishing methods. Allocation of fisheries resources between competing users does not necessarily mean 100% one way or the other. Already we have many examples where fish resources have been more appropriately shared through the use of management tools such as bag limits, restricted fishing areas, licence buy-backs, and the declaration of fish sanctuaries and areas of protected habitat.

Some of the circumstances which may make it necessary or desirable to consider allocating fishery resources include:

Stock depletion—which could be caused by overfishing by commercial or recreational fishers, or by loss of habitat, or by water pollution, or by many other things.

Competition for fish stocks—for example in waters adjacent to large population centres, where constant conflict between commercial and recreational fishers may require resolution.

Economic considerations—for example where the economic value of a recreational fishery is considerably higher than the economic value of a commercial fishery based on the same fish stock. Such circumstances don't necessarily mean that a change in allocation will automatically occur, but they do act as a flag that says maybe we should look at the situation to see if there is any need for changes to existing allocations.

Finally, I want to look at some examples of what has already happened in the area of fisheries resource allocation. A very simple one is in Moreton Bay, southern Queensland, where commercial trawlers

are not allowed to operate between 6.00 pm each Friday and 6.00 pm the following Sunday, leaving the Bay available primarily to recreational fishers on weekends. In my opinion that is a form of resource allocation, because time periods have been designated during which recreational anglers can have access to fish stocks without interference from commercial trawlers going back and forth.

Another interesting case is at Red Cliffs Peninsula (also in the Moreton Bay area), where the local council has proposed the closure of nearshore reefs to commercial gill netting. This fishery is comparatively small, and so a quarter of a million dollars has been made available to assist commercial fishers to move their fishing activities away from the nearshore reefs. The Council's reasoning for this proposal was that the nearshore reefs, being close to beaches and boat launching ramps, would be of greatest benefit to the community if they were primarily available to anglers and other recreational user groups.

Allocation of fish stocks in the South Australian section of the Murray River has been progressively towards the recreational fishing sector as the commercial fishery declines through retirement and subsequent withdrawal of licences.

Another form of resource allocation can be seen in the abalone fisheries of Western Australia. As I understand it, commercial abalone divers have rights to fish during the week while recreational fishers have rights to take abalone on the weekends. However, in order to control the overall catch, recreational fishers can only take abalone during a two hour period each day, and there is also a bag limit.

In the Northern Territory, barramundi resources were in effect allocated when the Government closed the Mary and East Alligator River systems to commercial fishing, restricted access to the Daly River system, and at the same time imposed a bag limit on recreational catches to protect valuable stocks.

When the 200 nm Australian Fishing Zone was declared in 1979, the Commonwealth Government bowed to pressure from the recreational fishing sector and excluded foreign commercial vessels from longlining in waters off the North Queensland coast commonly known as the 'Cairns Area'. It was argued that the benefits to the Australian public of having a recreational game fishery for marlin and other species in this area were far greater than those derived from allowing foreign access to these resources. Mainly through the Australian Fisheries Management Authority (AFMA), this area has subsequently expanded to include waters off Townsville, and longlining has also been prohibited in an area off Frazer Island, off parts of the NSW coast, and out to 50 nm around the Australian coastline.

Overseas there are many examples of fish stock allocation, such as the red drum fishery in Texas and the Atlantic salmon fishery in Newfoundland and Labrador. In the latter fishery the Canadian Government has expended $39.1 million to buy out 3000 salmon fishing licences.

These are illustrations of issues and problems associated with allocation of fisheries resources, and ways of dealing with them. No doubt there are many more issues and options, and I hope we can develop some of these further in the discussion sessions of this Workshop.

Table 1. Gross value of fishery production (GVP) and expenditure on fisheries management and research in Australia in 1990–91.

Agency	GVP ($m)		Expenditure ($m)			Expenditure as % of GVP		
	Total	Fin Fish	Management	Research	Total	Management	Research	Total
NSW	82.6	21.2	10.0	6.5	16.5	12.1	7.9	20.0
VIC	67.4	21.7	10.6	2.8	13.4	15.7	4.1	19.9
QLD	167.1	66.2	11.7	4.2	15.9	7.0	2.5	9.5
WA	365.6	29.4	7.7	3.7	11.4	2.1	1.0	3.1
SA	93.7	16.8	4.6	3.4	8.0	4.9	3.6	8.5
TAS	114.0	41.4	1.6	2.5	4.1	1.4	2.2	3.6
NT	7.4	6.1	1.4	0.7	2.1	18.9	9.5	28.4
AFS*	238.8	109.5	18.3	11.0	29.3	7.7	4.6	12.3
CSIRO	—	—	—	11.5	11.5	—	—	—
OTHER	—	—	—	1.6	1.6	—	—	—
NATIONAL	**1136.6**	**312.3**	**65.9**	**47.9**	**113.8**	**5.8**	**4.2**	**10.0**

* AFS = Australian Fisheries Service, predecessor of the Australian Fisheries Management Authority (AFMA) as manager of Commonwealth fisheries

Fisheries resource allocation—a recreational perspective—II

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The Australian Fishing Tackle Association (AFTA), which I am representing today, is an organisation for individuals or companies involved in the wholesaling and retailing of recreational fishing equipment in Australia. Both AFTA members and the commercial fishing industry have vested commercial interests in fishing activities (one group by obtaining and selling fishing tackle, the other by catching and selling fish), but these interests have also tended to place the two groups in opposition over a variety of issues such as allocation of access to fish stocks. The commercial fishing industry also appears to be aware of this situation, judging by their criticism of our lobbying activities over the past three years!

Up until three years ago the fishing tackle industry as a whole was somewhat lazy and complacent about fisheries issues, and tended to rely on recreational fishing club members to represent the interests of all sectors of the recreational fishing community. Whilst the club anglers have done a great job, we decided about three years ago that it was time for the fishing tackle industry to stand alongside them and give them every assistance to ensure that recreational fishing received its rightful amount of attention from governments and fisheries managers.

There is an urgent need to measure the extent of recreational catching of fish in Australian waters. If we can achieve reliable estimates of the overall recreational catch for specific fisheries, and if these are large in comparison with commercial catches of the same stocks, then this should tell fisheries managers that these recreational fisheries are important and recreational interest groups should have a large say in the management of these fish resources. It is also important to remember that recreational catches which are large even by commercial standards do not, by themselves, mean that something is necessarily wrong and that catches should be reduced. It is possible that the fish stocks can sustain these rates of exploitation.

Bag limits and other controls on recreational fishing catches have their purpose, and are fine when warranted. However, imposing limits merely for the sake of having limits is not necessarily good fisheries management. We think that some bag limits have been unnecessarily imposed on recreational fisheries through a combination of inadequate scientific research and a 'shoot-from-the-hip' response by fishery managers to community concerns. We think research is absolutely essential for any proper fisheries management decision. The

Australian Fishing Tackle Association supports the concept of bag limits or other controls on recreational fishing, but only if it can be demonstrated that the fish stocks in question are (or are likely to be) subject to excessive fishing pressure, and if the proposed bag limit or other measure is likely to rectify the situation. Furthermore, we support limitations on recreational catches only if commercial catches of the same species are appropriately limited at the same time. We have yet to hear of a case of severe fish stock depletion due solely to excessive recreational fishing pressure, but we are aware of commercial overfishing on many stocks and species.

Having pointed out our differences with the commercial fishing industry, and having acknowledged that some of our lobbying may have been a little over-enthusiastic, we nevertheless believe that commercial fishing and recreational fishing interests can and should co-exist. We accept that a member of the public should be able to walk into a fish shop and buy commercially caught fish at a reasonable price. What concerns us most is that some parts of the commercial industry do not appear to be operating in an economically viable manner, and some commercial fishing practices (e.g. fishing in nursery areas) are unlikely to be in the best interests of stock conservation or of other user groups. In those commercial fisheries where there are significant numbers of operators who are not really making a profit and are not commercially viable, I believe even the more far-sighted commercials would agree that there needs to be a reduction in numbers of participants in order to improve catches or profitability for more efficient operators and businesses.

In the past a majority of recreational fishers tended to be 'meat hunters', meaning that their main aim was to catch and keep as many fish as they could. For many club anglers, the only measurement of skill was the pounds or kilos of fish that they could catch. This attitude is now changing thanks to education programmes supported by club anglers and the Australian Fishing Tackle Association, and the advent of television programmes such as the Rex Hunt show where fishers are encouraged to return fish not needed for personal use to the water—with or without a kiss! This more responsible use of fish stocks is where our industry would like to see recreational fishing going.

Resource allocation—a management perspective

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There has been a long held ideal by countries such as North America and Australia, that all fish resources are owned in common by the community, and that access particularly for fishing should be free and open to all who wish to participate.

Within Western Australia and Australia, it has long been recognised by administrators, fisheries biologists and the occasional economist, that these ideals of open access, in pure form, allow fishing pressure to increase to such an extent that fish stocks become depleted and economic returns from using the resource are dissipated.

This observation has been used to justify government intervention in the implementation of management arrangements for commercial fisheries, recreational fisheries and even traditional user group access.

I think we are all familiar with aspects of commercial and recreational fisheries management, including limited entry fisheries, use of quotas, various forms of input controls and so on. In the recreational fishing area we are also familiar with the concepts of bag limits, licensing, size limits and possession limits, measures which can also be used to control access or share resources within groups.

To this potpourri we can add demands for marine parks, aquatic ecotourism, passive use of fish stocks, and space and therefore access for aquaculture purposes.

Government intervention is primarily aimed at the implementation of management strategies which balance the needs of various users of fish stocks with the end objective of ensuring that fish stocks are sustained and used efficiently.

It is fair to say that much of what has occurred in the past within Australia on resource sharing has not been performed with a great deal of competency.

This I think is due to a lack of vision and a piecemeal approach to management based on minimising the political 'whinge' between user groups, and a stock-based management orientation focussed primarily on managing commercial fisheries.

The resulting management of resource sharing has been characterised by corrective measures being unsystematic in nature, minor in scope, piecemeal with internal inconsistencies, influenced by short term political considerations, unfair to some vested interest groups and seldom effective for long.

Whilst such a view is perhaps a little unkind it is a realistic picture of 'what exists' today due to a lack of a cohesive policy framework for decision making on 'resource sharing' and therefore access rights.

The key policy questions to be answered on resource sharing include the following:

- What legal access rights do commercial, recreational, traditional and other user groups have to the resource?
- If a variety of user groups have rights to the resource, are these equal or do some groups have priority?
- What decision criteria should be used to allocate fish stocks to competing users?
- What management strategies or process of consideration should be used to achieve the desired allocation?
- How does one effect a reallocation with quota or input based managed fisheries?
- Is an economic rationalist approach to decision making the appropriate model for decision making?
- Should fisheries managers themselves be divested of the resource allocation role and if so to whom?

1. Access rights

Most of the commercial fishing sector throughout Australia does not have unrevokable rights of access to fish stocks. In the main, access rights are of a statutory nature with duration limited to the life of a fisheries management plan as a 'privileged right' or to some other specified time period.

Where limited entry management plans are effectively in place, licences have acquired a value (in WA licence values for essentially input managed fisheries are in excess of $2 billion). Even under quota arrangements change can be effected by varying the unit entitlement. The only guaranteed right of commercial fishing access that I am aware of is that provided for in the recently introduced NSW fisheries legislation. Even the magnitude of that right is subject to review, although without extinguishment.

Through such management arrangements commercial fishers have succeeded in gaining at least quasi property rights by statute. They are however, limited in their ability to claim compensation under common law where resource use changes are effected by management plan changes.

Recreational fishers, at least in the Australian context, have virtually no legally defined rights to resources other than the freedom of access. Licensing either directly or through sale of tags provides the only primary means of allocation. These elements of allocation will become more important in the future.

2. Priority of use

Little thought is being given to this question. Issues of access have largely been dealt with on the basis of political priority and are driven by political/economic solutions to what are largely perceived as local issues. In the most sophisticated form, marine parks are being proposed as a means for solving the multi-purpose facets of human activity for recreation extending beyond fishing into other forms of water recreation, including ecotourism.

The cynics in the system would argue that marine park formulation has very little to do with conservation but more to do with the establishment of a platform on which to base ecotourism investment or realign quasi property rights to 'passive' users.

In relation to the commercial/recreational resource sharing debate, apart from an approach of incrementalism in decision making, there is little real substance to the present framework of decision making.

New Zealand, which is seen by some as the great leader in the allocation of access rights, has essentially ignored the management of recreational fisheries to the advantage of commercial fisheries. In New South Wales, at best the system proposed could be described as one of promise for the future.

Within Western Australia, all that has happened has been the management of the present: slow but long term adjustments through incrementalism, the acquisition of territory through marine parks, some licence buy backs and adjustments in share by default.

Whether a more planned approach will result in a better outcome is yet to be determined.

3. Decision criteria for allocation/ the economic solution

As much as the pundits may wish, there are no simple criteria. One cannot walk away from the history of development and the 'existence' of what is. To do so is being unrealistic and smacks of idealism.

The economists have developed a number of approaches towards providing answers on resource sharing issues. These include:

Cost benefit analysis—this provides a comparison of the economic costs and benefits of different sharing options. In recreational fisheries, benefits are usually measured as expenditure on catching, and opportunity costs provide some measure of what others would have been prepared to spend.

Multiplier or input output analysis attempts to assess the impact of various resource sharing options on the economy of a State, region or community.

It considers how options will affect employment, spending and incomes. It recognises that other people and industries outside of the fishery are also financially affected by sharing options.

It looks at how employment, expenditure and earnings of the fishers affect employment, outputs and income of the community.

This approach also uses precalculated indices.

Difficulties arising with both cost-benefit and input-output analyses include:

- They don't encourage 'win-win' solutions.
- They assume willingness to pay or spend is the best measure of community attitudes on resource sharing, and
- Implicitly more power to obtain common property resources is given to those active in the market and with dollars to spend.

The *marginal value approach* looks at the amount competing users would pay to catch the next fish. It recognises that, for recreational fishers, the first fish caught is more valued and that they would be willing to pay less for each subsequent fish caught.

Under this approach resource shares are decided by the point where the marginal values for competing users fall to the same level.

The problems with this method are:

(i) Different fishers have different time perspectives.

(ii) Commercial fishers are more species-orientated; recreational fishers are often 'bag'-orientated.

(iii) The methodology doesn't handle more than two competing users well. Sometimes it will allocate no share to some competitors for shares.

The *free market model* assumes free market forces will decide the best allocation of common property resources such as fish stocks. Government's role is therefore to ensure market forces work. Competing users would compete in the market for shares. To be effective this requires the allocation of resources to all users and let the market do its job—a recipe equally headed for disaster.

The problem with this approach is:

- Only those with financial power can play in the market.
- It assumes players are able to have equal financial power: it doesn't allow for some having more financial resources than others.
- The action of players in the market may not be rational and may not always reflect their long run values and preferences; they may just react to the market and the actions of other players.

The *total value approach* tries to cater for what is for the 'public good.' Unlike the other models it also tries to take account of the needs of future generations.

It considers the net present value to the community of the resource and its potential earnings.

Methods to value the resource include:

- existence value: the value in knowing the resource exists
- option value: the value of retaining the option of using the resource later
- bequest value: the value in leaving the resource to future generations
- replacement value: the estimated costs to restore the resource to its existing state if it was lost (assuming restoration is possible).

These approaches try to take account of moral and ethical considerations. These 'contingent' values are determined by surveys.

The reality however is that governments often make resource sharing decisions by considering the net present value of votes. Governments look at the value of a popular decision now, compared with a decision that would prove popular later.

Costs include lost votes and benefits include retained or gained votes, especially in terms of marginal seats. The dilemma for governments is that votes later may not be to their advantage.

So where to from here?

The truth is we cannot afford the real costs of analyses and have real difficulty in obtaining all the data needed to make informed decisions on resource allocation. This is not to say we should not try. As a minimum, fisheries managers need to be better positioned to provide government with economic and social impact advice on resource sharing issues.

For some fisheries, a disciplined economic analysis should help to improve understanding, to provide the basis for judgements and to establish 'rules of thumb'. For others, fisheries economic analysis cannot proceed but judgements need to be made

using the array of available information whether inside the management agency or alternately held by the community.

In the end resource allocation judgements will need to be based on a combination of political and economic, social and resource use issues. The real underlying problem is then the appropriate acceptable balance of these issues.

4. Management strategies for achieving allocation or reallocation

To be honest much of the allocation has already happened.

One of the major difficulties for fisheries managers is that for most of Australia's fish stocks, little is really understood about recreational fishing impacts. For example, not enough is known about their economic value or potential worth as an export earner from international fishing tourism. Similarly little is known of the total recreational catch of most species.

Reallocation of fish resources is also not easy noting there is an increasing body of law supporting the view that commercial fishing access is a quasi property right.

Changes in commercial fisheries management which give effect to shifts in resource use are increasingly open to claims of compensation. Such claims, when one looks at the level of investment by commercial fishers, are not unreasonable and should not be lightly dismissed.

The solution partially rests in having legislation which allows both the voluntary acquisition of commercial fishing rights (e.g. quotas, limited entry licences or units of effort) as well as compulsory acquisition schemes. Payment of adequate compensation to fishers who leave the industry by voluntary or involuntary means is politically sensible. The difficulty is deciding how much to pay and if a value should be put on a fisher's lifestyle.

Within Western Australia legislation is being introduced to strengthen compulsory acquisition powers and to expand the funding base. This ultimately will allow harbours to be built, mining developments, marine parks, and expanded recreational fishing opportunities to proceed albeit at some expense, with commercial fishers being appropriately compensated without the prospect of legal action.

In other words change can proceed with orderly adjustments.

These powers also have the advantage of providing a means for economic readjustment within specific industry sectors. They provide for both immediate and longer term measures, and they work for both input and output controlled fisheries.

To be effective, these strategies depend on the development of trust and effective consultative arrangements between and within various user groups.

Another approach which also has the potential for reducing user conflict is that of geographic and time separation of fishing activities. This is being practised substantially by all Australian fisheries agencies. However, a greater focus on the future and planning for change in use would enhance the application of this solution.

5. A proposed model for resource sharing decision making

Ultimately, in developing an approach for decision making on resource sharing, the question should be asked as to whether fisheries managers should be primarily responsible for recommending such decisions to government.

In posing this question, I think it is fair to say the fisheries manager's prime responsibility is to manage fish stocks within the context of government fisheries objectives.

It is also true to say that, whilst Fisheries administrators have had to address resource allocation issues in the past, it has occurred often through default and largely incremental decision making. Some fisheries administrators have possibly also undertaken the task better than others.

The community today is also taking a greater interest in decision making and is wanting to have more say on the future use of marine resources. The demand for participation is being driven by commercial interests in aquaculture, tourism development, some local government councils, Aboriginal communities, recreational fishing, commercial fishing, and of late the conservation movement.

The complexity of issues involved in adjusting resource allocations usually means that the measurement of benefits and the case for change are at best undeveloped and difficult to establish. By their very nature such issues differ depending on the situation.

As the pressures on Australian marine resources and marine areas increase, the political weight of resource allocation decisions and their associated complexities could distract fisheries managers away from their main responsibility, i.e. stock management.

The time has come to establish an independent body, at least in Western Australia, that can assess the case for adjustment in resource allocations. It should be expert based with some community representation and perhaps fisheries agency representation. Alternatively, it could consist of an expert in administrative law and community representatives who could call on expert advice as needed.

Such a policy group could formulate advice to government on issues of resource allocation that are referred to it. In considering issues before it, a public hearing process and draft report submission process ought to be part of the procedural requirements. In this way, the entire community has an important input into the process and any findings are subject to public scrutiny.

In providing such a mechanism for determining resource allocations there would also be a need to specify 'thresholds' for referral of issues. Ministers should not allow every issue with the potential to have some impact on resource sharing to be referred to such a group. To do so would be far too expensive and time consuming. Only major strategic issues of resource allocation or reallocation should be considered by such a group.

This proposed approach is not an attempt to divest the governments or the Fisheries Agencies of their responsibilities in fisheries management. Rather, it is a way of ensuring that those in the community with an interest in, or claim on the resource, have an opportunity to have an objective hearing.

A case for 'change' will always be related to the costs of such change (particularly if

compensation of commercial fishers is involved) and the mechanism proposed above has the potential to remove 'politics' as the major instrument of change. It will also assist in policy decision making on resource sharing, as the process becomes accountable and is undertaken for the correct reasons.

This proposal, together with the details of legislation already specified, could provide an effective evolutionary process for government and fisheries agencies to deal much more effectively with the evolving issues of resource sharing.

Discussion of Session 5

Recorded by S. Conron

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Discussion of this Session on Resource Allocation was confined to a single period after presentations by the five panellists had been completed. The Session Chair, Murray MacDonald, opened the discussion by reiterating some of the key issues and problems associated with allocation of fisheries resources (see Table 1 in the Chairperson's Introduction), and asked participants to attempt to focus on these key issues during the limited discussion time available.

Gary Jackson asked panellists to comment on how to fund the research and monitoring programmes needed to facilitate more effective management of recreational fishing in Australia. He noted Brian Jeffries' earlier comments that a reasonably good system of funding and management of commercial fisheries exists in South Australia, but considered that research and management of recreational fisheries in the State is still poorly funded. For example, commercial fishing industry representatives are often funded to attend Management Advisory Committee meetings whereas the recreational representatives generally pay their own way and give up their free time. This problem must be addressed because key recreational fishing representatives in South Australia are becoming more reluctant to participate in the management process if it means giving up yet more of their own time and money. The State Government does not seem to be addressing this issue.

Ted Loveday responded that the funding issue was a matter for discussion between governments and the recreational fishing industry. He saw a role in this process for a recreational equivalent of the Fisheries Research and Development Corporation to establish a funding mechanism for recreational fisheries research and management, but he didn't see the commercial fishing industry having any involvement in this.

Peter Rogers commented that in Western Australia some revenue had been raised through the licensing of high value recreational fisheries, and that attempts had been made to ensure that the revenue so raised was kept in a specific fund to be applied against the costs of recreational fishing research and management. He also pointed out, however, that politicians tended to have reservations about the use of licences or other levies to raise revenue for recreational fisheries management because of the potentially adverse electoral consequences. This meant that Governments have

generally steered away from the licensing option unless there is no other solution.

Peter Rogers went on to say that another source of funding is available in the form of modest appropriations by Governments from consolidated funds. He felt that in Western Australia both Government appropriations and 'user pays' strategies were going to be needed to ensure adequate long term levels of funding for recreational fisheries research and management. Organisations with responsibility for or interest in effective recreational fisheries management should persevere in their requests for the implementation of recreational licensing or other revenue schemes, even if Governments initially reject such proposals. The appropriate Minister should be encouraged to go back to Cabinet and persuade them that he/she is trying to manage an important natural resource and that the job cannot be done without adequate funding. It can be pointed out that if revenue is not generated from licensing then it will have to be obtained in some other way.

Chris Hole took up the issue of assessing the relative economic values of commercial and recreational fisheries and achieving shifts in resource allocation through buy-outs of access entitlements. He cited as examples several northern hemisphere Atlantic salmon fisheries where there have been private buy-outs in Norway and Iceland and a government buy-out in Canada. In the latter case the government gave notice to commercial salmon fishers in 1991 that the commercial fishery would close in five years time. The government also indicated that those who chose to leave the fishery within 12 months would receive compensation equivalent to the value of their best annual catch over the previous six years. Those who chose to leave the fishery in year two of the five-year phase-out period would only get 70% of the value of their best annual catch, and so on until the end of the phase-out period when remaining commercial fishers would be removed with no compensation.

In the Canadian case the recreational fishery was comparatively easy to assess and monitor because anglers had to buy fish tags—limited to eight per angler per season—as well as a licence, and they could only get access to the salmon waters if they were accompanied by a guide provided by a fishing lodge or a club or a commercial tackle store. At the end of the fishing trip or season unused tags could be returned to the point of purchase, providing a fairly accurate estimate of the total recreational catch. Of course the fishing lodges and clubs also knew how much each angler spent on their salmon fishing trips. Estimates of total recreational fishing expenditure derived from these sources were about 25 times the market value of the commercial catch.

Chris Hole felt that there were probably several cases in Australia where fish resources could be allocated exclusively to specialised recreational fisheries, and he pointed out that steps had already been taken in this direction with barramundi fishing in the Northern Territory. However, he felt that more hard data were needed before this type of resource reallocation could be used more extensively.

Ted Loveday responded by reiterating Brian Jeffries' point that any type of resource allocation mechanism, to be successful, must include not only consultation and trade-offs but also commitment to the

outcomes and a sense of security that the arrangements will last. He also expressed a concern that frequently when buy-outs or other types of reallocation of fish stocks were being discussed, a significant portion of the community with a direct interest in the effects of such proposals—i.e. fish consumers—were being forgotten. The problem is that allocation of fish stocks has become primarily a debate between the commercial industry and a minority of the community (10–30%) that catch fish for sport or recreation or to provide their own seafood requirements. He recalled comments made earlier in the Workshop regarding the dietary values of seafood, and suggested that allocation of fish stocks is an issue that should really be debated by 100% of the community rather than 10–30% of it. In that context Ted Loveday remarked that any independent body established as per Peter Rogers' proposal to advise government on resource allocation issues will need to include strong representation of seafood consumer interests or else this sector of the community will be left right out. He claimed that even the tourism industry in Queensland is now starting to realise that it relies on the commercial fishing industry as much as the industry relies on it. The commercial fishing industry is happy to see tourism growth because it wants to sell more seafood, and tourist facility operators don't want to have to fly in seafood from farther afield than the tourists!

Murray MacDonald asked Peter Rogers or Brian Jeffries to clarify how the interests of the broad spectrum of users and owners of fish resources would be accommodated in the management advisory mechanisms which they described in their presentations—particularly with respect to making decisions about resource allocation.

Peter Rogers reiterated that in the past a lot of resource reallocation decisions were made by fisheries administrators and governments without much knowledge of community views on these issues. This process is increasingly seen as being inappropriate because resource allocation issues have become more complex and fisheries managers are more frequently in the invidious position of having to make decisions or recommendations when they cannot afford the cost of going out and obtaining the necessary information and analyses on which to base these decisions or recommendations. The most logical alternative is to have a process which allows for more direct involvement of community stakeholders, and where more timely resource allocation judgements can be made and a course of action can be set after assessing available information, rather than waiting until more detailed information is obtained.

The other principle which Peter Rogers outlined in his earlier presentation, and which is now being embodied in Western Australian legislation, is the provision of a variety of mechanisms for achieving shifts in resource shares and for funding adjustments required as a result of such shifts. Of particular interest is the notion that those who benefit from the resource reallocation should contribute to the costs of adjustment. For example, in the discussion earlier this morning about a harbour development, the logical people to fund the resource share shift because of the harbour development are in fact the proponents of the harbour development. The same principle applies if a marine park is to be established resulting in the exclusion of several commercial fishers. It is not sufficient simply to recognise the disadvantage arising from such a decision and reallocate

the affected commercial fishers somewhere else in the system, possibly generating new problems. What is needed is a mechanism whereby the costs of resource reallocation adjustments arising from the establishment of the marine park are seen as part of the overall costs of achieving a better allocation of natural resources in the longer term interests of the whole community, and are therefore built into the total costing of the marine park concept in the first place.

One problem for Australia is that many of the rights and entitlements in the commercial fisheries area are already considered to be fairly secure, both in law and in terms of commercial values. Furthermore, if these rights and entitlements are considered to be property, then the holders would expect under Australia's constitution to be compensated for loss of property unless that element is overturned by specific legislation which removes the right to compensation in relation to resource reallocation decisions. The real dilemma, however, is that politicians and the business community reasonably recognise that the commercial fishing industry, like any other commercial enterprise, has huge investments already tied up in goodwill values—rightly or wrongly—and that this factor can no longer be ignored or avoided when debating resource allocation issues.

Frank Prokop agreed that any fishery resource allocation decision which adversely affected the rights or entitlements of a particular user group was likely to attract claims for compensation. This did not mean, however, that all resource reallocation decisions necessarily resulted in management adjustments which had adverse impacts on rights and led to compensation claims. For example, the weekend closure of Moreton Bay to commercial fishing is a partitioning of access to the fish stocks rather than a complete removal of commercial access, and may not necessarily attract compensation.

Frank Prokop also pointed out that in any resource allocation process involving community input—such as the expert advisory body proposed by Peter Rogers—it is extremely important that each group represent its own interests. In this context it is no more appropriate for the commercial fishing industry with its business motives to be representing the interests of fish consumers with personal motives, than it is for the real estate industry to represent the interests of home owners! On the other side of the coin there is also a tendency for some in the recreational fishing community to believe they are speaking on behalf of all the rest of the community that is not involved in the commercial fishing industry—including non-consumptive users. In resource allocation debates both groups therefore claim about 95% community support for their position, and that's probably one of the reasons why we have such prolonged and heated conflicts over this issue. Frank Prokop thought that there was considerable merit in Peter Rogers' suggestion that independent advisory bodies be established to provide expert assessments of resource allocation issues at arms length from the political lobbying and decision-making responsibilities.

Ted Loveday acknowledged that most people would agree that fish stocks are a community-owned resource and that everyone has a right to represent their own interests in the resource allocation debate. However, he was concerned that not all user groups were sufficiently aware of their

entitlements, or of the impact of different resource allocation outcomes, to be able to effectively protect their interests. As an example, he asked where the equity was for fish consumers in allocating some fish stocks exclusively for recreational fishing—i.e. allowing access to the resource only for those who wished to catch their own fish.

Roland Griffin noted that the Northern Territory is seen as something of a leader in the resource allocation debate, although it was a pity that none of the fishery managers at the forefront of making these resource allocation decisions was at the Workshop. In the Northern Territory the barramundi is viewed by some sectors of the community as a species which should be allocated exclusively for recreational fishing. However, there is a recognition by the government and by a majority of the recreational fishing sector that there is a need for a commercial barramundi fishery. Not everyone wants to catch a barramundi, but most tourists want to eat one. The commercial fishery is much smaller now (only 27 operators) than it used to be, but it is economically very profitable.

There have been a number of areas closed to commercial barramundi fishing, although not all have been for the purpose of allocation to the recreational sector. Kakadu National Park waters were closed by the Commonwealth in accordance with their policy for national parks. The Mary River was closed mainly because of concerns over declining stocks caused by excessive fishing pressure. An unforseen consequence of these closures is that they encouraged commercial operators to move into Arnhem land, effectively reallocating barramundi stocks away from the Aboriginal communities in that region. The desirability of this consequence needs to be carefully assessed.

There is a perception that recreational barramundi fishing is adversely affected by commercial catches from the same stock, and as soon as a river is closed to commercial barramundi fishing the recreational fishing immediately improves. This view is not consistent with observations from the Daly and Roper Rivers, where seasonal commercial closures were introduced purely for resource allocation reasons. The annual commercial catch from each of these two rivers has not changed since before the closures, yet the recreational fishing has improved. We need to look for another reason for that improvement because the commercial fishers are still taking just as many fish. The most likely reason is that we have had better recruitment because we had more rain.

Roland Griffin recalled a discussion earlier in the workshop on the topic of 'willingness to pay' to get access to fish resources. He noted that the barramundi reallocation process in the Northern Territory included a commercial licence buy-back scheme. At one stage a commercial licence was available on the open transfer market for about $140 000 whereas the guaranteed government buy-out price was $125 000. It was put to the recreational fishing sector that they might like to buy the licence and then sell it to the government for a nett cost of $15 000. Divided up amongst 30 000 anglers that amounted to only 50 cents each. The recreational sector did not take up the offer, so it appears they were not willing to pay 50 cents each to remove a commercial licence.

Murray MacDonald asked for a more specific and detailed description of the basis on

which some Northern Territory barramundi stocks and rivers were allocated exclusively for recreational fishing.

Roland Griffin responded that in the case of the Mary River, commercial netting was prohibited after an extensive study conducted by himself had shown that the barramundi stock was severely depleted. Severe restrictions on the recreational catch were introduced at the same time. In the two other cases where commercial fishing was removed barramundi stocks were regarded as quite healthy, the commercial fishery was improving, and there was very little information available on the recreational fisheries. So in those cases basically there was a political decision to allocate the resource to the recreational sector. Whether that was economically or socially the best thing to do is a matter for others to debate.

Murray MacDonald suggested that this might be a good point to change the focus of the discussion. He observed that there had been a good discussion earlier in the Workshop about the use of economic models for making resource allocation decisions, and he raised the point made by Peter Rogers that, depending on their underlying assumptions, these economic models could produce resource allocation decisions that are not necessarily equitable. He also thought that all of the economic models appeared to be based on the fundamental premise that nobody starts off with any intrinsic rights of access to or benefits from the fish resources. He asked for comments on these observations from economists among the workshop participants, and also for comments from anyone else suggesting alternative criteria for arriving at resource allocation decisions apart from economic ones.

David Hall observed that around Australia fisheries resource sharing issues arise primarily in relation to freshwater and inshore marine scale fish. Certainly some issues arise with respect to crustacean and mollusc species, but these are small in number compared with scale fish. He also expressed the view that the majority of resource allocation decisions made to date have been based mainly on political considerations, and have been influenced strongly by the amount of lobbying done by various interest groups. Politicians by their very nature respond to political pressure, a point acknowledged by Ted Loveday when stating that to some extent the commercial industry could only blame itself for not exerting enough political pressure to prevent adverse resource allocation decisions.

David Hall cited the example of the Coffin Bay King George whiting fishery which was subjected to a marginal value analysis by an economist several years ago. The results of this analysis indicated that increased nett community benefit could only be obtained by increasing rather than decreasing the share of the whiting resource allocated to the commercial sector. In spite of this finding the South Australian Government effectively closed Coffin Bay to commercial net fishing, allowing short term continued access only to those commercial fishers who are heavily dependent on the Bay for their livelihood.

This resource reallocation decision appears to have been made primarily in response to political pressure exerted by tourism, local government and recreational fishing interest groups. That is the way the political system operates and there is no use in particular interest groups complaining about it if they are not prepared to advo-

cate their own interests more effectively during resource allocation debates. If, as commercial fishing interests claim, a large percentage of the public rely as fish consumers on Coffin Bay commercial whiting catches, then both interest groups have failed to gain sufficient community support and exert sufficient political pressure in support of their position. David Hall also wondered if this and other resource allocation decisions might have been different if the commercial fishing industry as a whole—including the valuable shellfish fisheries—had presented a united position on resource allocation, rather than leaving it to the scale fish operators because most of the problems arise in that sector.

Ted Loveday queried the apparent emphasis on economic value of fisheries as a basis for management decisions, and expressed the concern that preoccupation with this approach may result in more important management issues, such as stock conservation, being ignored or inadequately dealt with. There is no doubt that there has been increasing pressure on fish stocks from recreational fishing in recent years. If fisheries management is going to continue being dominated by the notion that the commercial fishery should be wound back purely because of the increasing number of recreational fishers, then the arguments and conflicts over resource allocation will probably continue for another fifty years.

A classic example of this problem is in Pumicestone Passage, Queensland where a dispute over management and allocation of fish stocks may lead to the first court case on fishing property rights in Queensland. The commercial fishery in this area was limited to 12–18 licences in 1981, and the operators were told they would not be replaced when they left the fishery, meaning the commercial fishery would eventually be phased out. It was recognised in Ministerial correspondence at that time that the main management problem in the area was the impact of expanding recreational fishing effort. A report put out by the Government last year once again identified expanding recreational fishing effort as the biggest threat to the maintenance of Pumicestone Passage fish stocks. In spite of this there have been no restrictions put on recreational fishing in the Passage since 1981 and there is a continuing push to get rid of commercial fishing. Ted Loveday thought that surely any good fishery management system would be about identifying and dealing with the important problems such as resource conservation, rather than being preoccupied with the removal of one user group in order to avoid the undesirable political consequences of a resource allocation debate.

John Millyard was sceptical of the suggestion that the commercial fishery was not well enough organised to effectively pursue its interests in the resource allocation debate. The fishing tackle industry had for years observed the commercial fishing sector undertaking high powered lobbying of governments all round Australia, usually with the assistance of highly paid professionals. He thought that the recreational fishing community was not nearly so adept at representing its own interests, but it was beginning to catch up. He felt that further lobbying of politicians and fisheries managers was necessary if a fairer deal was to be obtained for recreational fishers. Recreational fishers had only recently begun to participate in resource allocation debates in a meaningful way, but from now on they

would be presenting their points of view with increasing frequency and vigour.

David Hall repeated his earlier point that, even with an agreed resource allocation and management system in place, it will be Ministers and other politicians who make the resource allocation decisions and, as with scale fish in South Australia, it will be political considerations rather than careful analysis of available data that will determine the nature of these decisions.

Ted Loveday agreed that fisheries had in general been managed on the basis of which interest group had put the most pressure on the relevant politician. He thought this system was illogical and sometimes counterproductive, but the commercial fishery had nevertheless learnt to 'play the game' in order to protect its own interests. He wished the fishing tackle industry well if they intended to spend money lobbying politicians. However, he suggested that recreational fishers would serve themselves better if they could develop an organised structure; appoint delegates to negotiate resource allocation arrangements or 'deals'; and convince their own fraternity to stick to any agreed resource sharing arrangements. In his opinion that is the only way towards progress on the resource allocation issue.

Murray MacDonald endorsed Ted Loveday's comments and reiterated Peter Rogers' point that in the absence of any defined or agreed mechanisms for making fisheries resource allocation decisions it is likely that such decisions will continue to be made by politicians primarily on the basis of political expediency. If any alternative processes are to be developed they are going to have to come from forums like this discussing just what resource allocation is about and what kind of mechanisms are going to give the best results. If we don't continue to have these sorts of discussions and reach agreement on alternative resource allocation processes, then there will be no developments in this area.

Rudi van der Elst, after listening to the Workshop proceedings so far, was coming to the conclusion that at least some of the controversy associated with resource allocation in Australian fisheries was attributable to a lack of clearly defined goals for the management of species and for the fisheries based on them. Specification of management goals and user group aspirations should be part of the process of resolving resource allocation issues, and the focus should not be just on economic considerations but also on artisanal and subsistence considerations. He identified some cases in South Africa where differences of opinion over resource allocation were initially perceived to be a major source of user conflict, but where closer examination revealed that clear definition of management goals and minor adjustments to existing shares of the resource could resolve these differences.

Rudi van der Elst returned to the idea of designating some fish species as recreational only—a concept which was successfully promoted in South Africa several years ago. During this process some fish species were easily identified as being solely or primarily used by recreational fishers, whereas other species were primarily commercial. Negotiations over the large number of species which were of both commercial and recreational significance involved a lot of bartering and trade offs. However, they eventually ended up with a list of species that are genuinely de-commercialised on

which recreational fishers can plan quite actively, and a large number of other species where recreational access is limited and where the commercial sector can promote itself. This has gone a long way towards solving resource allocation problems in South Africa, and it would be worth looking at in Australia.

Laurel Teirney indicated that a wide range of fisheries resource allocation mechanisms had been tried in New Zealand but nothing had been formalised. One very successful technique had been identified, however, and that was getting competing interest groups to sit down around a table to discuss their differences. Once people are around the table they start to examine the real issues in a more constructive manner. They often find that they have far fewer differences than was originally supposed, and they almost invariably share a common concern for the state of the fish stocks. Under these circumstances the lack of trust between traditional Maori users, commercial fishers, recreational fishers and environmentalists tends to diminish, but the negotiating process is helped along by having an independent facilitator and by providing research advice and administrative support.

Laurel Teirney emphasised that the key to these round-table negotiations is to identify the real fishery management issues—any other approach is a waste of time. For example, there was a recent case of declining recreational catches of blue cod in the Marlborough Sounds. Recreational fishers blamed the commercial operators and called for the closure of the commercial fishery. However, recent monitoring of commercial and recreational catches revealed that the annual commercial blue cod harvest was about 10 tonnes whereas the recreational sector was taking about 200 tonnes. Consequently, the Fisheries Minister was no longer pressured by the recreationals to remove commercial fishing, and the recreationals were so concerned about the amount of blue cod they were taking that they were happy to accept a significant reduction in the bag limit for this species. So really it is a matter of bringing everyone together and sharing the available information and being jolly sensible.

Bayden Hopgood agreed with Laurel Teirney regarding the value of face-to-face discussions and negotiations in resolving resource allocation issues, and he disagreed with proposals that the recreational sector should become more militant and confrontationist in pursuing its interests. He believed that in Victoria, at least, there was a State-wide trend towards discussion and negotiation between recreational and commercial fishers, and that this was the only way in which many resource allocation issues were going to be resolved

The Session Chair drew the discussion to a close at this point due to time constraints, and he thanked the panel speakers and the Workshop participants for their enthusiastic contributions.

Session 6

Management of recreational fishing

Session Chairperson:	P.P. Rogers
Sesson Panellists:	A.C. Sanger
	H.L. Gwynne
	D.A. Hall
Rapporteur:	F.B. Prokop

Chairperson's Introduction

P.P. Rogers

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Thank you to all participants for enthusiastically participating in discussions.

I have an announcement that a National Fisheries Managers Workshop will be held on 18–21 October 1994, at the Conference Centre, Bribie Island, Queensland—Convenor Noel Taylor Moore. A recreational fisheries management pre-workshop will be held as part of this programme.

Management of Recreational Fishing in Australia has changed considerably over the last 3–5 years and we have seen some significant changes, not the least of which has been the advancement of the National Recreational Fisheries Policy which is reaching a state of finalisation and fairly shortly will become a public report.

The management of recreational fisheries includes a number of ingredients, such as:

- data collection
- biological research
- process of consultation enhancement
- funding
- rules controlling fishing
- education
- resource sharing issues
- access requirements, etc.

All of these things combined are a bit mind boggling.

I think it is fair to say that Recreational Fisheries Management in Australia is on a journey. It is on an early part of that journey; probably in its first 3–5 years, although in some areas like trout fishing in Tasmania, recreational fisheries management has been there for a very long time.

We have three speakers this afternoon. Wayne Fulton extends his apologies and his substitute will be co-author Andrew Sanger from the Inland Fisheries Commission of Tasmania. We also have Laurie Gwynne from Queensland and David Hall from South Australia.

Management of recreational fishing in inland waters in Tasmania

W. Fulton and A.C. Sanger

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Tasmania's freshwater recreational fisheries have been under some form of administrative control since 1862. A unique feature of this control is the statutory provision for input from angling organisations to management of these fisheries, i.e. consultation has long been a routine process.

Close liaison is maintained with anglers with the result that satisfaction with management performance is generally quite high compared with other States. Commitments to research and data collection are extensive.

Efficiency of operation is also ensured by financial arrangements. All recreational fisheries management functions are funded from angling licence fees and include administration, research, management and enforcement.

The various components of these management arrangements in Tasmania are briefly outlined.

Inland recreational fishing in Tasmania

Tasmania has had an authority of some form responsible for recreational fishing in inland waters since 1862. Whilst initially this organisation was primarily responsible for the administration and development of recreational trout fisheries, it is today responsible for freshwater fauna in total with the following primary functions:

- management, regulation and protection of recreational trout fisheries;
- regulation, development and management of commercial fisheries in freshwater—these are primarily a wild fishery for eels, and some involvement with the trade in aquarium species;
- regulation and development of fish farms in freshwater;
- regulation, protection and management of other recreational fisheries including the freshwater lobster, whitebait, river blackfish and other species;
- protection, management and conservation of all freshwater fauna throughout the State, including the endangered galaxiid species.

In relation to its present role in the administration of recreational freshwater fisheries, the Inland Fisheries Commission (IFC) is generally acknowledged by trout anglers at least as being amongst the most successful in the country.

It is therefore worthwhile to briefly examine some of the elements contributing to the perceived success of the organisation.

Finance

The recreational trout fisheries in Tasmania are funded entirely from angling licence fees or other income generated by way of commercial sales or research grants. No Government funding is received at all for administration, research, management or enforcement of these fisheries.

As a consequence, the fees are perhaps high by Australian standards at $38 for a full season licence with various concession and short term options. Licence fees have been loosely linked to the Consumer Price Index (CPI) but other political imperatives, such as impending elections or changes to funding arrangements, have also had an impact one way or another. Opinions on value for money do vary somewhat with keen anglers regarding the fee as fair. However, this view is obviously not shared by everyone as there is a definite link between fee increases and licence sales figures (Figure 1).

With such a dependence on licence fee income the Commission has an active programme to attract new participants as well as to hold present anglers.

Research

Research effort is focussed across the full scope of the agency's responsibilities but funding sources largely dictate what can be achieved.

Specific trout management questions are addressed from internal funds.

Whilst the biology of trout species is generally well researched, there is still a great deal to be known about the reasons for such things as variations in growth rate and abundance between waters and variations in angler returns.

Recent IFC research on factors affecting recruitment of trout in rivers has established a link between flow and life history stage to recruitment success. This may offer the opportunity to add some certainty to recruitment in drought years, by regulating flow during critical periods and/or stocking in poor recruitment years.

Questions relating to other areas can usually only be pursued if external funding sources can be arranged. These may also have some spin-off value to recreational fishers such as the work on stream flows.

The Commission's record has been extremely good in attracting external funding with endangered fish research being a good example.

A unique consultancy arrangement between the IFC and the State's power generating authority, the Hydro-Electric Commission (HEC), has also been arranged. Through this arrangement various applied research projects of relevance to recreational fishers, the IFC and the HEC have been successfully undertaken. For example, the severe eutrophication problem experienced at Lagoon of Islands was investigated and solved with mutual benefit to anglers and other water users.

Data collection

Keeping track of where people are fishing and what they are catching is central to the management of recreational fishing. This also provides feedback on the success or otherwise of stocking programmes.

A number of methods are used by IFC including:

- postal questionnaire;
- creel census;
- direct population estimates;
- spawning migration assessment.

The central data collection procedure has been a postal questionnaire of licensed anglers which has been conducted annually since 1985. This method has its detractors but is generally acknowledged as being best suited to high value/low catch fisheries such as trout. Other validation procedures have also been used in conjunction with the questionnaire. Provided the limitations of the results are appreciated, routine information on fishing pressure and catch returns can be effectively monitored over time for all of the State's major fisheries.

The questionnaire also offers real advantages when specific issues arise at short notice, because at least some information on effort and catch is available for all major waters.

Two specific examples which have come up recently are the development of a catchment management plan for the Lake Sorell area and the proposal to drain Lake Pedder. Both of these lakes support significant recreational fisheries, and the fishers' point of view in the debate needs to be backed up with statistics from the questionnaire.

Information on other issues such as minor fisheries (freshwater crayfish and blackfish), boat usage and angling related expenditure have also been periodically collected at the same time as the routine trout fishery information.

As indicated, creel census is used but not extensively as it is usually too expensive to conduct exhaustively.

Direct population sampling by electrofishing or gill netting is also employed. Many of Tasmania's streams are amenable to quantitative sampling using electrofishing equipment whilst gill netting is primarily used for growth rate assessment in lake populations.

Spawning fish have been routinely monitored in a number of lakes with data sets in excess of twenty years being available from several sites.

Consultation

Angler consultation is mandatory for the Inland Fisheries Commission because of its structure. The Commission itself consists of a four person board, three Associate Commissioners and a Government appointed Chairperson. Two of the Associate Commissioners are nominated by angling groups whilst the third is an angler-nominated Government appointee. The Chairperson is responsible for the day to day operations of staff.

Each of the three regional angling associations has direct representation on the Commission and therefore direct input to policy and decision making. There is in turn a hierarchical structure of angling clubs at local level such that ideas or opinions generated at this level can feed through a local/regional/State structure to and from the Commission.

Commission staff at all levels have considerable involvement with angling clubs both in a consultative way as well as for education purposes.

However, it is still a fact that less than 10% of licensed anglers are involved in the club system and consequently other avenues for consultation are not ignored.

Formulation of management rules

There are a number of ways in which changes to management rules are generated:

- Government policy directives;
- staff generated changes;
- angler initiated changes.

Depending on the reasons for the change, varying degrees of consultation would be involved and the actual pathway may also vary.

The specific rules may be contained within a three-tiered Act/Regulation/Order system with some less specific rules being simply a policy directive of the Commission. The latter is being used less frequently in recent years although there is a move to what is probably only a more formal system of informal policies, known as 'The Management Plan'.

Stocking arrangements

Most of Tasmania's major lakes contain self-supporting populations of brown trout. Similarly, river fisheries are generally self-supporting.

If any lakes do require additional recruits the first resort is for improvement of spawning habitat. This has been successfully applied to major fisheries such as Great Lake and Lake Sorell.

Other lakes that do not have suitable spawning habitat may be stocked regularly, with the questionnaire information or other surveys being used to assess the success of these stocking programmes.

Additionally, rainbow trout are frequently used in storages closer to population centres to provide a readily catchable resource for the less dedicated angler or for those without the means to travel to the lakes. The emphasis in these areas is on return to the angler. Waters that do not provide reasonable returns generally receive minimal attention. Once again, the questionnaire data are useful in assessing the success of rainbow trout stocking.

Angler involvement in stocking is encouraged either through assistance at time of release of IFC-reared stock or through club participation in regional rearing units. The rearing units obtain trout fry free of charge from the Commission and rear them to a more advanced stage prior to release in certain waters.

Education

Numerous avenues are used for education purposes:

- angling club meetings;
- newsletters, annual reports;
- media—including television, radio and newspapers via news, interviews, articles or advertising;
- open days;
- displays at various shows, exhibitions or special events;
- direct contact via staff.

It is very difficult to say which is the most effective and no one method has anywhere near 100% coverage. For instance, the 'Angling Code', which is a condensed ver-

sion of rules and regulations handed out with every licence, is not 100% effective in getting the message across to every angler even on basic rules.

There is still a need for continued education in relation to codes of practice and general ethics, but there is no doubt that anglers' attitudes are changing in relation to many key issues; for example:

- litter is decreasing but remains a problem in some areas;
- the 'stocking is the only answer' mentality is slowly changing;
- the fishing experience itself rather than just the catch is becoming much more important.

Compliance

A relatively strong commitment to enforcement remains necessary in Tasmania although generally speaking the number of offences related to recreational fishing is slowly decreasing for a similar level of policing effort.

It is also a fact that the role of enforcement staff is slowly changing. From a strict policing role some twenty years ago, a greater involvement in research and management functions, as well as public relations, has emerged in recent years. In our experience this type of change can be dictated as much by the particular staff involved as it can by management requirements.

In relation to enforcement, it is definitely a significant advantage for the management agency to also have the responsibility for enforcement as is the case in inland waters in Tasmania. This allows for much better control and liaison and also has definite feedback advantages between anglers and management.

Summary

In general, anglers are very supportive of the present structure and operation of the Commission. The fact that anglers have the opportunity to contribute to Commission policy etc. is seen as a major plus by them. Funding remains a contentious issue, with many anglers calling for greater government assistance to the Commission, and relief from ever increasing licence fees. However, for those anglers who make the most of the number and variety of fishing locations and experiences available, the licence fee is generally accepted as reasonable value. The fact that all IFC income for trout is derived from anglers' fees means that the Commission staff must strive to meet anglers regularly, listen to their suggestions and complaints, and attempt, where possible, to solve problems as they arise. This has probably diverted resources away from strategic issues. However, with the questionnaire survey, a regular population assessment programme for both rivers and lakes and a fairly intensive enforcement presence, it is hoped that real problems can be detected early, and appropriate plans made to research, manage and enforce within the limits of our relatively small funding base.

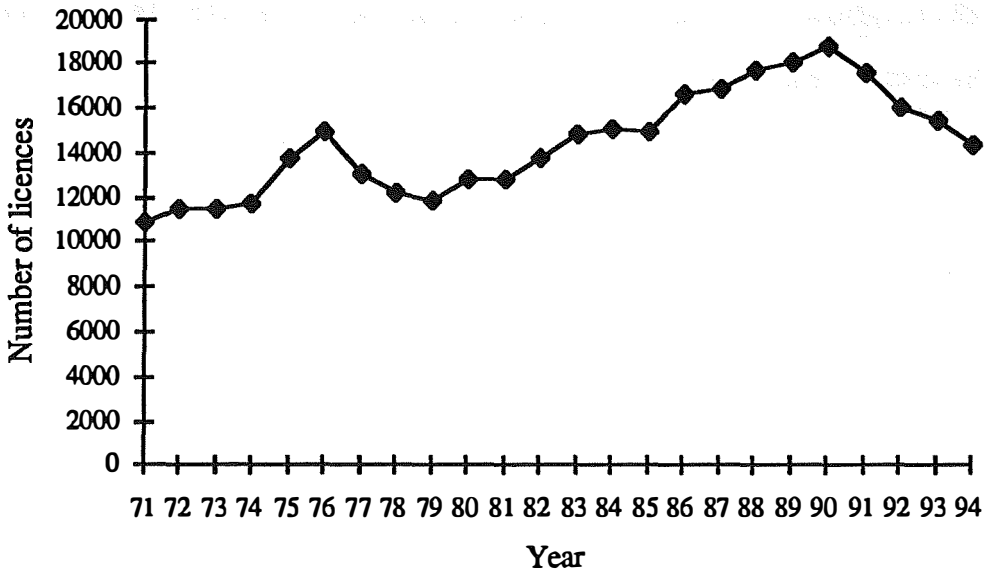

Figure 1. Trend in the number of full season angling licences, 1971–94.

Management of recreational fishing in Queensland

H.L. Gwynne

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Recreational fishing in Queensland encompasses a range of leisure activities from, fishing for yabbies with a piece of meat on a string in a muddy water hole in the west through to heavy tackle game fishing off north Queensland. It is considered to be one of the most popular and largest outdoor recreational pursuits.

We are reliably informed that there are between 700 000 and 1 million recreational anglers in Queensland alone. These figures comply with estimates from other Australian states and overseas which suggest that approximately one-third of a population participate in recreational fishing. The popular definition of a recreational fisher is a person who has been fishing at least once in the past twelve months.

Recreational fishers in Queensland are presently concentrating their efforts in marine environments along the east coast and freshwater impoundments.

Queensland has 65 dams, weirs and barrages that have been stocked with golden and silver perch, barramundi, Australian bass, Murray cod, East Coast cod and saratoga depending on their geographic locality and suitability of species.

Many of these impoundments also hold substantial wild stocks of angling species. Queensland has a 9000 kilometre coastline of which is still accessible to anglers and 2000 kilometres of coral reefs which are popular recreational fishing destinations.

It is estimated that recreational fishing is worth $800 million annually in Queensland alone.

It is little wonder then that in late 1992 the Queensland Cabinet instigated the Inquiry into Recreational Fishing in Queensland which became known as the Burns Inquiry after the Deputy Premier Tom Burns who conducted the inquiry.

The inquiry sought to identify key issues and the types of management arrangements required to address these issues. In excess of 3000 people at public meetings and over 4000 written submissions delivered a clear message to Government that the legitimate needs of recreational anglers must be met in future fisheries policies.

The Burns Inquiry has served to promote an expectation that the recreational fishing community will be treated as equal partners in the development of management regimes for the sustainable use of fisheries.

However, it was also recognised by the Inquiry that many of the issues raised by the public during the meetings and

through submissions could only be addressed by the injection of considerable additional funding.

A number of funding options were considered by the Inquiry ranging from licence fees for licensed bait and cast nets, to fees on a *per capita* basis for large commercially organised fishing competitions.

Most options were rejected either because they would not produce sufficient revenue or were politically unacceptable.

The concept of a general recreational fishing licence was rejected by Government and a seemingly more politically acceptable alternative was sought. The favoured option eventually accepted was to impose an additional charge on private pleasure boat registration fees. There are approximately 115 000 such vessels registered in Queensland, and this number is increasing annually by 3%. Many anglers do not favour the proposal as less than 30% own or fish from vessels and those vessel owners will be supporting shore based fishers. Additionally a considerable number of private pleasure craft are not used to take fish, for example, ski vessels.

In relation to fisheries management strategies the clear message from the bulk of submissions to the inquiry was that fishing pressure on some species in some areas had reached critical levels. The inquiry therefore made a number of recommendations which address both the commercial and recreational effort.

The Burns Inquiry highlighted the need for increased and better consultation. The Queensland Fish Management Authority includes one recreational fisher who has in the past forwarded the views of all recreational fishers in the State. The composition of the Board is to change to be expertise based. Anglers now have equal representation on Fishery Management Advisory Committees (MACs) with the commercial sector. The Inquiry has recommended that another tier of consultation be established on a zonal or regional basis. The future establishment of Zonal Advisory Committees (ZACs) will enable 'grass roots' proposals to be progressed through MACs to Government.

The Inquiry also recommended that a Fisheries Policy Council be established to provide the Minister with independent and strategic policy advice and that it be representative of all aspects of fishing and associated activity.

The saying 'Recreational Fishers are fisheries managers' is slowly becoming a fact of life in Queensland, but has a long way to go. The recreational fishing fraternity is becoming better organised and more vocal and in due course will be a powerful lobby group. This will be accelerated if recreational fishing licences are introduced in the future with subsequent funding being provided to enable employment of full time representatives and lobbyists.

In the meantime who manages recreational fisheries? The Queensland Fish Management Authority has the responsibility for management of all fish resources in Queensland. It achieves its objectives through consultation with interest and user groups, but is possibly failing the 95% of anglers who are not represented under the umbrella of fishing clubs and associations.

Angling clubs and organisations have a major role to play in fisheries management through representation of members. However, in Queensland this aspect of club life

is not well exploited by either members or management agencies. Clubs could become more active in promoting angling and the ideals of fish management. Many are formed as social clubs with limited membership often opposed to, and largely uninterested in, management regimes, until they perceive their activities to be threatened by proposed changes.

The tools available to managers for the management of fisheries have remained constant. We still rely on the old favourites such as size and bag limits, closures, licences and apparatus constraints. Whilst all these tools are effective in controlling activities in the recreational fishery, without appropriate catch and effort data it is impossible to determine the level of effectiveness.

Recent innovations in data collection include Charter Vessel logbooks. Presently there are approximately 110 charter vessels voluntarily keeping an approved logbook. Most of these vessels are involved in the demersal fishery on the Great Barrier Reef. They conduct charters ranging from 1 to 28 days duration, but averaging four days. This logbook scheme has enabled the Queensland Fish Management Authority to assess the impacts of the charter fleet which were previously unknown. The information has assisted both the Authority and the charter vessel fleet in establishing appropriate bag limits for charter vessel clients.

In order to improve data quality an extensive reporting back mechanism has been developed including quarterly summary reports and a report on the individual charter boat's operations which is sent to each operator.

Currently there are 5000 boat days of fishing recorded for some 90 boats submitting logsheets for 1300 fishing trips ranging from 1 to 28 days.

Fishing club data are being collected from a number of clubs throughout the State. Typical data include numbers of anglers, numbers and weight by species of fish caught, fishing location and weather.

The Queensland Boating and Fisheries Patrol, the enforcement agency in Queensland, continues to provide data about recreational fishery sightings, numbers of anglers interviewed, catch rates by species and some fish size information.

A number of data bases are presently used to store and analyse these data. The Burns Inquiry concluded that a comprehensive database should be developed to monitor catches of popular fish species and to establish angler effort throughout the State as part of an overall programme aimed at the sustainability of these species.

The Great Barrier Reef Marine Park Authority has undertaken or commissioned a number of angler surveys adjacent to the reef, and ongoing State-initiated research programmes into mackerels, snapper and other estuarine species provide valuable data.

It has been reported that every major fishery world wide is either fully exploited or overfished and I don't believe Queensland is any exception. Recreational effort in Queensland is said to be increasing at a rate of 7.5% annually. In other words it doubles about every ten years. In light of this, the question 'where to from here' springs to mind.

The 'soft' management options of the future will include a greater education programme preferably at primary school level

but also through the media in the form of television advertisements, natural resource education programmes and direct involvement with the public through seminars, conferences, research programmes etc.

The development of angler Codes of Practice espousing the fishing ethic of 'take only what you need' and other voluntary arrangements will be more widely used. The aim should be to build an ethic of conservative use and to change attitudes towards sustainable practices.

The harder management options will become increasingly necessary and will include the introduction of recreational fishing licences. This can certainly be 'sold' to the public on the basis of low fee levels, exemptions for the young and aged, ensuring funds do not go to consolidated revenue, involving anglers in the management and distribution of funds, providing representation on Management Advisory Committees, and material benefits to anglers including access to fisheries resources, artificial reefs and fishing piers.

These options in themselves will not be sufficient in the long term to ensure equitable distribution of stocks. In some fisheries it will be necessary to limit access by anglers through ballots, 'first in first served' arrangements and other methods.

Management of quota will become a reality for anglers. Recreational fishers may find themselves negotiating with other users for a portion of the available catch. In such cases the recreational quota will usually be set through bag limits, sale of tags, open seasons and the like.

When recreational fishing licences become a reality they will be a source of increased funding for recreational organisations. This will result in increased political 'clout' through lobbyists. It will also greatly increase awareness of recreational fisheries in the political arena with greater pressures being placed on commercial fisheries although the rationale for this may be absent.

The commercial industry catchcry of who will feed the masses will be overrun by the push from anglers to have the commercial effort out of sight—over the horizon.

To maintain sustainable fisheries for future generations greater emphasis on education and consultation will be necessary. Fisheries managers will require public administration skills and enhanced analytical abilities. Conflict resolution will become a normal part of management and the level of expertise and knowledge displayed by individual anglers will become focussed and be a major impact on future management arrangements.

These changes will not only be evolutionary but necessary to conserve fish resources which are subject to greater pressures on their environment.

Managing recreational fishers—changing the mindset

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Fisheries agencies worldwide, and particularly in developed nations like Australia, spend substantial amounts of money on research, compliance, policy development and restocking programmes aimed at improving the management and quality of recreational fishing.

Much of this expenditure is wasted, however, through a lack of recognition by the angling public and the general community of the need for regulation of their activities and the importance of compliance with these regulations. A high level of involvement by the general community is needed to enable a level of self-regulation of fishing activities. This would seem a natural course to take, in one form or other, particularly given the low likelihood of offence detection across our vast nation.

Some community involvement programmes such as 'Neighbourhood Watch' and Landcare have been extremely successful in reducing local crime rates and improving the ecological sustainability of agricultural production respectively. I think that as fisheries managers we should look closely at the structure, support and history of these two programmes and develop a suitable community involvement programme that has the following broad aims:

1. Improving the level of compliance with fisheries management regulations through higher levels of community understanding, 'people' pressure and offence detection/reporting;
2. enabling more objective and accurate assessment of the management needs of the 'grass roots' recreational fishers in particular, as well as the general community;
3. enabling recreational fisher input into reducing the ecological and environmental impacts of agricultural, industrial and domestic developments of our fisheries resources; and
4. monitoring the effects of fishing on fish stocks at the local level.

If we look at existing fisheries extension programmes in Australia of the present time, one must really question the extent to which various State agencies are able to get community recognition and understanding of fisheries management issues through 'normal' extension strategies i.e. schools programmes, publications, media involvement, Boat Shows etc.

Western Australia has commenced a voluntary liaison officer programme with some success. I would be interested to learn whether any other States have

developed their own community involvement programmes for fisheries resources management.

In South Australia, we are severely limited in our extension resources—in fact for the last twelve months or so we have been without a dedicated fisheries extension officer/manager. I have recognised the need for a well defined fisheries extension programme and have managed to initiate two developments in this area to date:

1. Replacing the Department's 'SAFIC' magazine, which had a technical and commercial focus, with 'Southern Fisheries' which is directed more at the recreational sector. 20 000 copies are produced every quarter and are available free through registered fishing tackle stores and selected roadhouses. Although initial costs are high ($2.40 per copy) cash flow projections indicate the likelihood of a full cost recovery through advertising and sponsorship by the eighth edition; after two editions we are on target; and
2. Combining with a local fishing media identity (Bruce Harris) to develop a 'Fishcare Certificate' course through his long running popular fishing schools. These are well attended and this approach should improve the awareness levels of a significant number of people. It is also hoped that 'graduates' will form the basis for a fisheries volunteer programme and for developing the proposed community 'Fishcare' programme in South Australia.

The main components of the fisheries extension process are as follows:

1. Communicating information and technology.
2. Fisher and community group involvement.
3. Non formal adult education and training.
4. Problem definition and feedback to research.
5. Facilitating the achievement of government goals for the recreational fishing sector.
6. Providing feedback to fishery management committees and government policy formulators/advisers.
7. Providing advice to individuals.

Enabling these extension activities to occur requires the following actions:

1. Empowering local fishing groups and communities.
2. Assisting fishing communities in accessing and interpreting information for decision making based on increased self-reliance.
3. Developing partnerships between government fisheries agencies and the community, fishing bodies and clubs etc.
4. Having community development, social equity and environmental issues recognised as part of government policy.
5. Linking science and research to the community and thereby capturing the benefit of new information.

Just as the community-based Landcare programme has been a useful measuring stick for the success of agricultural research, development and extension programmes across Australia, a community involvement programme is needed to enable this to be achieved in the fisheries arena. If we look at the Landcare programme for a moment, the relevance of the approach in terms of

sustainable fishing and environmental issues is obvious and the results are impressive.

I have deliberately avoided discussion on the important issue of funding but suggest that we again look closely at a funding structure incorporating State, Commonwealth and user contributions similar to Landcare.

A direct link between Fishcare groups and Landcare groups in terms of environmental matters that relate to land use in riparian zones could well be through recognition of the problem by Fishcare groups and scientists and, if the problem relates to agricultural practices, provision of funds to Landcare groups to remedy the problem. An example of this would be the impact of agricultural run-off and high nutrient loading on seagrass beds in Upper Spencer Gulf. Figure 1 demonstrates how Landcare groups could link with environmental aspects of the Fishcare programme and splits Fishcare into a recreational development programme and a fish habitat programme.

There are a number of issues specific to the sustainable development of recreational fishing that would be relevant to the recreational development programme. Examples include community involvement in compliance and research programmes, restocking activities and the construction of artificial reefs. These developments would focus on improving the variety and quality of fishing available to recreational fishers, particularly in waters adjacent to capital cities.

The fish habitat programme would deal specifically with fish habitat and pollution issues, including assisting with remedial action associated with industrial, domestic and agricultural pollution. This would not conflict with the objectives of the existing Ocean Rescue 2000 programme or 'Coastwatch' groups but rather would complement these programmes with outcomes directed towards fish and fish habitat. The potential advantage of this approach over Coastwatch groups that are orientated specifically towards conservation and the environment is that recreational fishers are a high participant group of committed recreationists that may only become actively involved if they can see the programme in outcome terms that are specific to their recreation. This may produce a higher level of community involvement and more effective results than could be achieved by a programme that had purely a conservation and environmental ethic, and which sought to involve 'ordinary' members of the community.

In addition to conducting recreational fishing developments and environmental work, there is also a need to empower community fishing groups (who may initially be existing fishing clubs) to monitor the effects of fishing and make recommendations to peak management committees on fisheries policy issues.

As has occurred in North American waters in particular, there is a strong movement in South Australia for decision making with respect to our fisheries to revert back to smaller geographic areas.

People are insisting on control over that which affects the communities they live in.

Community advisers are needed to respond to these new interests by encouraging communication between groups, industries and government to enable critical input into fisheries management planning. The objective is to move fishery resource protection essentially from a reactive to a

proactive endeavour. In South Australia we have used regional fisheries officers to coordinate 'team meetings' with interested members of the community in a partnership approach with some early success.

It is hoped that autonomous community groups will eventually stem from this approach but a considerable effort is needed in terms of training, communication and administration of an extensive volunteer programme and funds and resources are a real limiting factor at present.

In summary then, I am proposing that senior management in each State sit down and work out in some detail how we can empower community and recreational fisher groups to enable more effective problem recognition and management of both our important recreational fisheries and the environment and habitat which supports them.

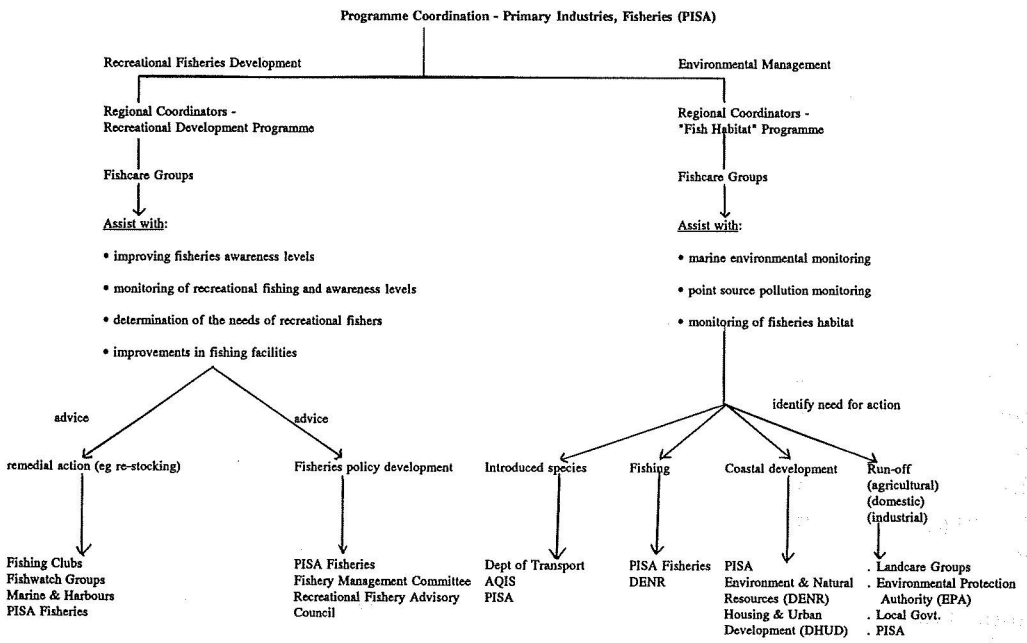

Figure 1. Proposed fishcare programme structure.

Discussion of Session 6

Recorded by F.B. Prokop

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Peter Rogers, Session Chairperson, thanked the speakers for their informative presentations. He then offered a challenge to recreational fishing communities and government—to empower clients to help the process. Funding for recreational fisheries will be insufficient in the proposed National Recreational Fishing Policy which needs addressing.

The question is: How do you do more with less?

Peter Doherty opened the comments from the floor, speaking as a Queensland boat owner and recreational fisher. Regarding the research levy, he wanted to know if there were any revenue targets and if matching funding from the government was an option?

Laurie Gwynne replied that this funding mechanism was a political decision. Revenue targets have not been planned but it is hoped that $1.3m will be available after the second year. The plan is for a $6 levy in the first year on all boat registrations and then a $12 levy from the second year. There was no mention of matching funds.

David McGlennon commented that management of the largely recreational fisheries such as jewfish and tailor in WA, and snapper and whiting in SA appears to have failed. He asked David Hall why he thought this had happened and how the decline is measured.

David Hall responded that he was speaking from his own experience. There was overwhelming anecdotal evidence of stock declines in inshore marine scale fish species around Australia. Keith Jones has shown that catches of King George whiting and snapper in South Australia are down. David Hall did not know the reason for the decline, which is complicated because there is no measuring stick to quantify declines of recreational catches.

David McGlennon added that he was not happy with catch rates. Under free access for recreational fishers catch rates will decline. He wanted to know what constitutes a satisfying recreational fishery?

David Hall felt that stewardship and ownership of the resource should be taken by the recreational fishing community. Tailor management is particularly interesting.

Andrew Sanger felt it appropriate to give a plug for recreational fishing licences as a communication mechanism with recreational fishers.

Peter Rogers expanded on David Hall's point about tailor. There is some evidence of growth overfishing for tailor. This leads to the question of how to manage the species. There is no database. Government agencies are trying to get improved recreational catch information on tailor in WA and Queensland.

Barry Pollock wanted to know the panel's views on recreational licensing given that there is significant opposition to any licence and a high rate of non-compliance with the licence requirement.

Andrew Sanger replied that the non-compliance rate was in the low hundreds compared with 28 000 recreational licences bought. A significant factor is the perception and feeling of maybe being caught.

Kim McClymont drew upon his experience in WA, Queensland and New South Wales. Education is getting better, but much more effort is needed including schools-based programmes. The question is, how much extra is needed? There have been some attitudinal changes to education, especially in the enforcement area.

David Hall observed that we are operating in a climate of declining budgets. There are high operating costs for fisheries programmes. For example, a 15% staff reduction in SA makes it hard to shift resources to education. However, an emphasis is needed on extension and education.

Laurie Gwynne added that a specific programme in Queensland—EDFISH—targets schools. FISHCARE programmes are an initiative from the Burns Inquiry. They have not been implemented to date but are being developed.

Peter Rogers provided a Western Australian perspective on education and extension. Western Australia spends around $2m on recreational fisheries education, research, operations, etc. The question is how to get better value. There is a need to re-examine the existing use of resources. As an example, there were 35 Volunteer Fisheries Liaison Officers (VFLO's) last year in the metropolitan area. 150 are planned this year for the entire State. These volunteers will talk about the recreational fishery and management objectives to establish ownership of the resource. This will create self managers for change to reflect increasing community valuation of fisheries resources and their management. With 300 000 fishers, the Fisheries Department needs help.

Andrew Sanger sounded a warning regarding research staff undertaking work for education which takes them away from research programmes. There is a need to allocate time for researchers to adequately undertake this education and extension work.

Dennis Reid returned to the funding issue. He asked Andrew Sanger if they have a more flexible system such as 5 or 10 day licences in Tasmania.

Andrew Sanger described the range of licence categories currently in use in Tasmania, including:

$38	full season
$10	junior (14–17)
$16	pensioner
$20	14 day
$12	3 day
$7	one day

Ted Loveday warned not to get carried away about recreational licensing. The gov-

ernment is trying to pass on its funding obligations. Commercial fishers don't mind paying their way but not everyone else's management costs and fees. Regarding recreational licences, recreational fishers need to know what the fee is to be used for. The angling media should be responsible in their reporting. He warned that some licence money would be used for what should be funded with core consolidated money. Recreational fishers should keep expectations reasonable in a number of areas.

Rob Day returned to the education theme and advised that for education, there was a need to work with education establishments. An opportunity exists to cooperate for increased effectiveness.

Stephen Malvestuto gave his perspective on US funding sources for recreational programmes which include a tax on equipment. These funds are re-allocated to States for specific programmes. 10% is used for public education, which targets recreational fishing education at secondary school level.

Julian Pepperell felt that a Total Allowable Catch (TAC) on the recreational sector was not possible through bag limits. This issue was debated in New South Wales with the concept of a Total Allowable Recreational Catch (TARC) being removed from the property rights legislation. There is a problem monitoring real time recreational catch. He posed the question—Do recreational bag limits really limit total catches or do they just shift the emphasis and balance of the total catch to the commercial sector?

Laurie Gwynne believed that an option for the future would be to put a limit on the number of anglers who get access to the fishery through mechanisms such as tag times for access. This type of management won't happen tomorrow. Recreational fishers will first try to move commercial fishers out but the recreational sector can expand to fill the void and could still need increased management.

Alex Julius asked two questions. Firstly to Andrew Sanger. How much does it cost to administer licences in Tasmania? Secondly, to David Hall. Angler's evidence based on experience is dismissed as non-scientific. How important is this knowledge?

Andrew Sanger replied that administration costs were modest. They include the Commissioner, a secretary and three assistants involved in administration. The only direct cost of licence administration is the 5% commission paid to agents.

David Hall responded that the value of anecdotal information depends on the context, particularly if the information is not consistent with known science . If anecdotal evidence is the only information that is available, it must be given weighting depending on its context. Managers need to run with the best information and can't wait the lag time for definitive information. Anecdotal evidence can be highly important. There is a need to make better use of this information.

Murray Johns was interested in the chart on Landcare presented by David Hall and commented that the adoption of a Fishcare program would mainly benefit the recreational sector. A more holistic approach for all users may be to adopt Marinecare.

David Hall commented that a Fishcare approach would be useful from two perspectives:

1. Regulation of recreational fishing and the needs of recreational fishers.

2. General marine/ocean care type of approach. South Australia has a programme called Coastwatch which is being coordinated by the Environment and Natural Resources Department. The Fisheries Department is talking to the Landcare people on a regular basis. The SA Fisheries Department has had input into the schools curriculum of the Ecologically Sustainable Development programme. Secondary schools are trying to develop a fish programme, but the holistic marine habitat environmental approach will be closely linked to the Landcare programme.

David Hall believed that we need a specific recreational fishing education programme separately from that but he was not sure how the two would be combined. The link between the Fishcare group and the Landcare groups is dollars and therein lies the problem. Fisheries somehow have to get government recognition of the responsiblity for aquatic based education including recreational fishing and to get funding to kick start the whole thing.

Roland Griffin commented that education was important in the Northern Territory. However, magistrates don't consider fishing offences to be serious. People fish to get away from it all. They don't want too many regulations. Managers need to be careful not to over-regulate.

Laurie Gwynne agreed that there is a need to educate magistrates. In Queensland a statement from the prosecutor giving the reasons for management regimes is handed to magistrates. This serves as an education tool for magistrates. It has been successful and has resulted in a doubling of the amount of fines.

David Hall added that there was a commonly held view among recreational and commercial fisheries regarding the low levels of fines. The Canadian sanctions board has used input from benefactors and industry in the determination of fines. However, magistrates generally don't want to be educated.

Lindsay Harbord, Chairman of the Western Australian Recreational Fishing Advisory Committee (RFAC), provided information on the cost effectiveness of Australia Post as a licensing collector in WA. It costs $1.30 for each renewal of licence and $1.75 for each new licence issued. $5 all up would include all administration costs within the Fisheries Department.

Peter Rogers gave a run down on WA annual recreational licence fees. It costs up to $50 per annum for an umbrella licence for all 5 licence categories. There is currently high compliance, at 96–98% for marron and 92% for the recreational abalone fishery.

John Smith reiterated the common view that there is a need for improved education. Landcare has some coastal groups which can be built on and used.

John Millyard from the Australian Fishing Tackle Association stated that there are 2000 tackle outlets Australia-wide available for education which can be better used.

Peter Rogers then closed the session by thanking everyone for this session and invited everyone to put hands together for the speakers.

General Discussion

Session Chairperson:	R.H. Winstanley
Sesson Panellists:	J.G. Pepperrell
	N. Caputi
	D. McGlennon
	C.M. MacDonald
	P.P. Rogers
Rapporteur:	R.H. Winstanley

General Discussion

Chairperson: R.H.Winstanley
Recorded by R.H.Winstanley

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The Chairperson suggested that, in this Session, the Workshop should concentrate on the directions that recreational fisheries assessment and management programmes should be headed in the future.

Some discussion was needed on the strategic directions to be followed at a national level, including the need for recreational fisheries information, and for consistency and comparability between data collections from various parts of the country. We should include reference to some of the specific requirements for, perhaps, a national recreational fisheries survey at regular intervals. We should also consider the future role of recreational fisheries licensing as a platform for databases for recreational fisheries survey and assessment programmes, as well as for providing funding which, inevitably, is an issue that all discussions of recreational fishing programmes identify as the key.

We might also explore further broadening our definition and understanding of what constitutes 'the catch' to include subjective elements such as recreational fisher satisfaction—however we might define and measure that.

And we should certainly address future directions of technical matters, for instance investigations to account in greater detail for the variability that surrounds the estimates we make of harvest, harvest rates, catch rates, and so on, as well as the integration of the trends in catch rates with observations of environmental change and with habitat assessments.

To begin, he invited the Session Chairs from the two days of Workshop to make some points on the future directions that they believe we should be following.

Peter Rogers (Session 6)

Clearly, recreational fisheries management has changed significantly in its direction and understanding over the last three to five years. There will shortly be the launch of the National Recreational Fishing Policy. While the exact date has not been set, I do believe that there has been general agreement between the States and the Commonwealth in terms of the precise wording, and like all these lovely pieces of documentation, they seem to trip up on the capital 'F' word called 'Funding'.

From what I have seen over the past two days, there are a number of clear directions which are all-important.

First, I will touch on funding because I think that is a cornerstone in terms of any directions of change. Obviously, the concept of a national recreational licence is a dead issue. If you don't read the political thinking around Australia, you might continue along that course. The real thinking is that the States will take the prime running on whatever policies they perceive are appropriate in terms of funding recreational fishing. Of course you are tied up with a whole mixture of strategies and problems which vary from State to State, and therefore the issue for recreational fishing, I think, is how you get into the minds of politicians and convince politicians about the values of recreational fisheries and their support, either through a licensing route, some other funding route or alternatively through appropriation, by making sure that there is at least the fundamental basis for support for things like data collection and so forth that come with an effective recreational fisheries programme.

The question of a national recreational survey has been raised on a number of occasions in the past. In my mind, if nothing else happens, a national survey must be funded addressing the significance of recreational fishing, and some steps taken, either in common across the States or at least at a national level, on the measurement of catches and on the measurement of the values of recreational fishing in a legitimate way for the benefit of the fisheries. That is an all-important step because it is part of the education of the wider community at large in terms of the overall significance of recreational fisheries. In terms of technical matters, things like improving estimates, variability, how we measure them and so forth are obviously essential and this is a direction that we have to take.

It is also fair to say, from the discussions over the last two days, that there are lots of different approaches and different ways of collecting information and the real challenge is actually coming up with cost effective and efficient ways of collecting that information. It seems to me that the power for that rests in the hands of the recreational fishing community. So the key issue then becomes how to get the recreational fishing community empowered to take charge of its destiny, as David Hall correctly pointed out, and actually move forward in a consultative and not acrimonious way—in a partnership with the commercial industry and other users of the resource to ensure that, at the end of the day, we have continuous sustainable resources for the benefit of the community at large, for the people of Australia in terms of their ownership.

Obviously, the issue of the ownership of the resource will continue to be a matter of legal debate which will be with us for the next two to three to five years as the various users of the resources flex their muscles and come to a common and acceptable understanding in terms of the rights of people, whether they are commercial or recreational participants, or Aboriginal users of the resources. Of course, the Mabo claim raises a whole new spectre of uncertainty in terms of future of resource use and allocation.

One of the most important issues, coming back to the empowering of the recreational community, is that there obviously has to be at least a minimum amount of funding for it to work. But obviously fisheries managers have to think very hard about their consultative frameworks, work out how they can actually bring that partnership

arrangement together, using the value of education and changing attitudes and encouraging good participation by recreational fishers, both in terms of policy decision making as well as in the collection of data, whether it be economic, biological or catch information. The realities are that there are stocks which vary from 100% commercial exploitation down to zero per cent commercial exploitation, with the converse applying in terms of recreational usage. Clearly there will be different ways of getting the best outcomes for recreational fishers.

Nick Caputi (Session 2)

I intend to stick to the catch and effort issues. What I got out of yesterday's Sessions is that we need a number of approaches to tackle the problem. I have outlined three or four.

Obviously, creel surveys have got a major role in terms of answering specific questions on resource allocation in certain locations in certain times. I think they are not going to be the answer to providing the major overview of catch and effort data at Statewide or nationwide levels. But they do have a major role in terms of answering specific questions.

Secondly, as Peter Rogers said, we have to look at establishing a nation-wide survey and if that is not successful, then I will be pushing for a Western Australian survey in terms of obtaining figures on catch and effort across WA, and across Australia if possible. And that has to be done on an ongoing basis, whether it is done every year or every two years—or every five years like the USA-—and that depends on funding.

Thirdly, we need to tackle the big illegal catch issue. There is no point in getting information on the 'official' recreational catch if we don't take into account the 'unofficial' catch. I think that has got to be tackled. For some fisheries, that is equally as important as the official catch.

And, finally, a matter that probably did not come out yesterday is that our experience with commercial catch and effort data is that, as an indicator of the abundance of fish, they are sometimes not very successful. So we should be aware that in some cases we may need to do fishery-independent surveys for some species if we want long term data on abundances. The catch per effort data may provide an indicator of what is going on in that area, but our experience with commercial logbook data is that they are not always as reliable as we think.

Julian Pepperell (Session 1)

I want to talk just a little about the first Session and the international perspective we have been privileged to have first hand. Usually we read about these things after they have been published in the scientific and 'grey' literature years after the event. When I first started in this area of marine recreational fisheries 19 years ago, I used to say that we had the advantage in Australia of living in the past in that we could look at what was happening in the USA to foresee what may happen here in say ten years time. We had the advantage of their experience with creel surveys, especially in the freshwater situation, with many of their fisheries managed on the basis of knowing the catch and the catch rate. They pioneered motivation surveys—asked the question: why do people go fishing? And they started five-yearly national surveys

back in 1965. So, when I started in 1975 there were three of those reports to study and wished that we could do the same in Australia. We, in fact, did the first national and State surveys, mainly population omnibus surveys in the late 1970s and early 1980s in NSW and Victoria, and in other States later on.

And we had that foresight of what was happening, particularly in North America. And I guess it was with some relief and confidence that we found that our results in terms of the proportions of the population who went fishing and the general demographics of the fishing population in Australia mirrored those of the USA and Canada.

But I don't think that that is the case now—we have caught up fast over the last five years or so. We are now all talking at the same level, partly because of better communication and partly because of necessity and the very recent realisation of the importance of recreational fishing.

Talking about education and the importance of people realising what we are trying to do with management, I think that the culture of recreational fishing is a big factor in the way people think and respond to and accept management regimes. The recent experience here in Australia—in some States at least—is that the introduction of bag limits has not been accepted very comfortably by fishers. There has been a lot of opposition and a lot of debate and many people have not necessarily embraced them. Whereas in the US of course, where people have grown up with bag limits for many generations, the mere suggestion that a bag limit might be raised, let alone removed, would be met by claims that they are sacrosanct. So it is a cultural matter and takes about a generation for these sorts of things to be accepted. If you are born into it, then it is part of your culture.

The point that I would leave you with is that you must really keep these lines of communication open, keeping a close watch on what is happening overseas. We don't live in a vacuum, and with electronic mail and international travel and meetings such as this, we can all learn from each other's mistakes and each other's successes. I think that it has been a great experience having that international contact here.

David McGlennon (Session 3)

Given that this is a Workshop, we are not likely to all share the same opinions, so I would like to offer something different, particularly on the national survey.

I remain to be convinced that a national survey can be of any real value. I certainly won't be convinced that it will be of value to estimate catch and effort, particularly when they are always measured by general population surveys with 12 months recall. And I think we need to consider very carefully just what information does come out of a national survey and how it is used and if it is really of any use. As an example, there were two undertaken in Western Australia in the 1980s. One in 1984 said that there was a 43% participation rate in recreational fishing. Three years later, another one said it was 27%. Now if they were real figures, that is a huge drop over three years. And yet I doubt if it was ever really considered that there was a 16 % drop in participation. So I would caution against simply putting money—and that is what it boils down to—putting money into a national survey for those sort of figures. Catch and effort data really must be col-

lected regionally, and I would much prefer to see funds and effort going into that.

Collecting catch and effort data is universally seen as being a very expensive exercise. But I think that if we all thought about what are the real issues in each of our States, it probably boils down to about two or three main species. With the baseline data that are available now we could probably find that there is a small window in time and space where a very large proportion of that catch is caught. And rather than thinking of creel surveys as large scale exercises every year, which we will never be able to fund, we should carefully consider doing shorter term surveys regularly, once we have isolated these windows, and using them as an index of how things are going. I would repeat what I said in Session 3, that long term data are what we really need.

The other thing that came to me is that a lot more work is needed on the recreational management side as far as defining objectives. Those objectives need to be considered in terms of what anglers are actually looking for. Unless management is aiming at some particular objective, then, in effect, it is going nowhere and a lot of the allocation issues will go on and on and on. Sure—there is no end point—it is not as if you will reach one and then everyone will go home, and that's the end. But at least if you know you are aiming towards something, there is some satisfaction in getting there.

Murray MacDonald (Session 5)

I will confine my comments to observations on this morning's Session on resource allocation.

It seems to me that there was fairly broad agreement that resource allocation, to use an allegory, is about basically slicing up a cake, working out who is going to get what share of the cake as opposed to determining the size of the cake, which is more to do with resource conservation and habitat protection.

The other thing that there seemed to be broad agreement about was that, however we decide to make these resource allocations, there should be broad community participation in this decision-making process. However, when we came to discussing mechanisms, there seemed to be less certainty about how we should go about deciding what the appropriate allocations should be. The two that came out of the discussions were, firstly, the economic approach in which attempts are made to place valuations on the various uses and then place those valuations into some kind of market mechanism whereby those who have the greatest willingness to pay, or the greatest ability to pay, end up getting a commensurate share of the resources. There was some question as to whether that ended up providing an equitable allocation of the resources. The alternative was the concept of having some kind of independent advisory group which consists of representatives of the various interest groups who would determine, based on available information about values within their various sectors, just what the best compromise might be in the interests of the community as a whole and make recommendations on resource allocation to governments. There is probably room for further work in defining just how these mechanisms might work—how they might actually achieve the stated goals of equitable resource allocation.

There appear to be more innovative ideas emerging in recent times about how you might go about allocating resources once you have decided what the appropriate resources are and we heard suggestions such as either publicly funded or privately funded buyback or entitlement transfer schemes. How that might work with respect to the non-extractive users, in particular, was not explored to any great extent.

And the final observation I would make, and it relates specifically to comments which Peter Rogers made in his presentation—and also David Hall pointed it out—that in the absence of any development of clearly defined and understood mechanisms for (a) deciding and (b) implementing resource allocation decisions, or allocations themselves, inevitably what will continue to happen is that these decisions will be made according to various political considerations. Now, if we are happy for that to continue, then we don't need to bother trying to develop these mechanisms. But if we want to try to influence that, to change it, to develop a system which has broad community acceptance—and that should in fact be pleasing to politicians as well—then we must continue to try and find ways of determining what is appropriate resource allocation.

Chairperson Ross Winstanley then opened the meeting for *general discussion*, starting with the theme of the conference—*'Recreational fishing—what's the catch?'*, and addressing the assessment of the recreational catch, the information needs, the strategic issues at a national level, and associated topics.

Rudi van der Elst referred specifically to what the last speaker, David McGlennon, had said. With our experience, and certainly this has come through various discussions here, he believed that we should all concentrate on systems that are already in place where we could utilise with minimum costs an input to our catch and effort systems. The second point was David McGlennon's suggestion about being confined to one or two key species at the moment. If we look back through some of the long term catch rates in South Africa, we find that there have been such incredible changes in the composition of catches over time, that there are species which we would love to have monitored and in fact don't exist any more today. Being too focussed might well lead to forfeiting the ability to monitor some of the catches.

David McGlennon responded that, although we would like to have comprehensive information on recreational fisheries in space or time or species composition or anything, it appears that we will probably never have the funds to do those full surveys all the time. He was looking at a way of doing it cost effectively in between the periods where we do.

Ted Loveday asked two questions: the first one to Peter Rogers, and the second one to the panel.

We have heard some comments about buybacks, and he wondered whether, in the legislation, anyone has ever given any thought that maybe the community and the industry might want to buy back the share that the recreational catch has got now of some species. It might be unlikely, but he thought it is something that needs to be put on the table because otherwise the industry is going to see this as simply a mechanism to eventually get rid of them.

Peter Rogers responded that there are two components to the WA legislation. There is the Fisheries Adjustment Schemes Act 1987, an amendment to which is right now in Parliament. In broad terms, the first part of the legislation relates to voluntary schemes which were restricted to commercial industry schemes. There are four schemes running there, most of which are about structural adjustment within the industry itself. The extension of that scheme is that we now broaden the funding base so that in fact sources of funding can come from wherever and schemes can be put for whatever purpose. In other words, funding can come from recreational licensing if there is such a source of funding. It can come by way of donation. It can come by way of mining companies. It can come by way of proponents of harbour developments and so on, as a means by which the community itself can, in the market place, give effect to resource share changes. That doesn't mean to say, by the structure of that legislation, that you can't get shifts back the other way, if you can recognise who the beneficiaries are. And the difficulty with that is that certainly the commercial industry could do that, but the Government as the custodian would have to say to itself: is there real benefit in terms of allowing that shift to occur? If the answer is yes, using whatever parameters in making that judgement, then that could happen. Peter Rogers supposed you could say, in what circumstances might that happen? It could easily happen with some of the very high value species which we have in Australia in terms of giving economic weight to the value of exports as an over-riding policy criterion, as distinct from the value of football or cricket, as against recreational fishing in terms of the domestic situation where it is about using disposable dollars rather than generating incomes. So from that point of view, that is all important.

The other element of course is that it can easily go the other way in terms of sport and recreational tourism where that has a real pitch in terms of export earnings, and of course that can cause the tourism industry or local government to also take a position, and provides a mechanism within that legislation to allow those sorts of adjustments to occur. The other element which he mentioned that morning was the powers for compulsory acquisition and they are more akin to the value of diamond mining. If you want to put a diamond mine which has an impact somewhere, and where, in terms of public interest, the public good far exceeds the private good—in terms of that sort of argument—there is a mechanism by which that can come about because at the end of the day, as we see it in terms of legislation, the rights extended to the community in terms of taking fish are a privileged right, it is not necessarily a right which is set in concrete forever.

Ted Loveday then questioned the mechanism by which those decisions can be made. We have heard a lot about economics, but it appeared to him that we have been heading down the track of comparing apples with oranges, and the question now is where do we go from here—do we need a lot of work on a system which can enable us to compare apples with apples which would be crucial in making the decision of allocating either way. It appears that we are really looking at too broad an issue in some cases and maybe we should be looking at what is the value of the fish to commercial fishers and what is the value of the fish to recreational fishing. And, within that scope, trying to come up with a system so

that we can compare apples with apples, because the bottom line is that the industry has to do a lot of economic work, for a lot of other reasons, things like gross value of production, and cost recovery. We are getting pressure put on us all the time for more and more funds. So we are going to keep doing it, and we are going to keep having a lot of economic data available—more and more and more—and if we need to use it to throw it in the ring for this debate, we will. So, we do need to put some work into a system that we can use to get apples compared with apples, and he was looking to hear some comments.

Ross Winstanley agreed that we need to be in a position where we can fully assess the community benefits in economic terms and the other terms we have discussed. These include the full range of economic benefits that flow from the commercial exploitation, the recreational exploitation and the non-consumptive uses of these resources, as Murray MacDonald has said, so as to get some sort of feel for what the community feels about the way those benefits should be derived through an allocation process. Again, that is something that we have not yet come to grips with.

Peter Rogers did not think there is a bottom line figure or a magic process which will give those figures, because the methodologies are so different. At the end of the day it has to be a community judgement which for the most part rests in the hands of politicians. The key to getting rational long term decisions in this difficult area is to actually take it back one step so that the wide breadth of information can at least be gathered and understood across the community in terms of available knowledge, available methodology and so on. And to make those broad judgements and recommendations on behalf of government. But that is not to say that government itself, which is the accountable body in terms of a democracy, does not make the final decision. He suggested that in terms of the very large decisions which involve significant shifts in resource use, if there is a degree of accountability tied to whoever benefits from the shift, and if it is a government arbitrary decision—and it is not market driven—on who actually pays for it, it will tend to tone down claims made in relation to resource share shifts. For the most part, he believed that most of them are fairly well in balance and it is only really where there is fundamental long term change in resource use that you will actually get a drive for significant change.

Murray Johns drew attention to some of the work of the Resource Assessment Commission during its relatively short life. One of the things that the RAC did—he believed during the Kakadu inquiry—was to try and work out a mechanism which would make all these decisions and quantify all the economic variables, social variables, political variables, to provide a faultless mechanism whereby you put the information in at the top and crank it around and the answer came out the bottom. Well, it is not surprising that they were not able to develop that model. The conclusion was simply that there are so many unquantifiable factors and even if you did quantify some of them, not everybody would accept them and they would want another re-run of them. The simple conclusion was that the decision-making mechanism that we have in this type of society, where so many of the decisions have to be made by politicians, is probably the best sort that we could have, because somebody has to make these

value judgements along the way. Now, we heard this morning that one of the ways that you can get at arm's distance from the politicians making these decisions is to get everybody to sit around the table and make their value judgements and put everything into the middle and come up with that resource-sharing decision—and that is a good way to do it too. But it is unlikely that, in our lifetime, anybody will come up with a 'you beaut' model which measures all these things.

Nick Caputi added that it is worth doing the economic studies separately for each of those sectors that are using the resource. But he doubted whether you will ever get a magic formula that equates the two. That may happen, but he could not see it at this stage. But that does not mean that you should not do these separate economic studies for each of the sectors. But trying to equate the two in terms of dollar-for-dollar is where you get into trouble.

Ron Lewis, commenting on the question of trying to establish what the recreational catch is, had not heard the question asked at all: 'Let's ask the recreational fisher'. Anyone who has been involved at all with an angling club, knows they keep all the records of all their angling competitions, all their angling outings. It's just a matter of setting out the criteria for the information wanted and educating the clubs to provide that information free. Ron Lewis's experience was that they would be more than willing to provide that information. It is a matter of you telling them what you want to know. Now, you can establish what percentage of the population those clubs cover, and you would get an enormous amount of information. You could get how many fish they put back—the whole information is there. And he was sure it could be done on a national basis far more economically than using creel surveys, etc. All their competitions are timed, all their material is weighed in, and then you only have to determine a multiplier figure relating recognised anglers to the general population. In angling clubs you certainly don't have elite fishers—you have all classes of fisher. The majority of people who are in regional angling clubs are, if anything, less experienced fisher. They are going there to try to find out how to do it. They fish regularly in the same location, season after season. The information that you could get from that, just by asking for it, would answer half of the questions that you have got here today.

Norm Hall recognised that the real reason why we are having a great deal of trouble in many fisheries is that we just don't have the catch and effort information. Now we are getting into strife with our commercial fisheries when we try and assess the data, simply because we do not have the information about the full catch. We get from many of the finfish fisheries, catches from the recreational sector which are up to about 30 to 40 % of the total. We cannot assess the state of the stock without the full set of information. The only thing we can do is to make huge assumptions which are erroneous that the fishery is remaining static, and that the proportion remains exactly the same. We basically are finding ourselves in a real mess if we try and keep going down this track without having a full set of information about the total catch. In most States, we have systems that collect information on a very broad basis and then supplement that with much more detailed information. As Rudi van der Elst has done with the fisheries in South Africa, and has

been alluded to by Ron Lewis, we basically need to collect all the information that is readily available in some sort of system within the State itself—it doesn't have to be a national system—and at least make sure that we start capturing information that becomes available. If there are recreational fishers who care to submit diaries and we can feed them into our system, at least we then start getting the basis of some sort of data base which we can use. Certainly we have to supplement this with our own detailed studies later on, but it is extremely important and we shouldn't let it go because we cannot manage the fisheries without those sort of data.

Lindsey Harbord, as a club angler for twenty years, would be very very fearful of using club data, as suggested, as raw data. You can collect club data and keep them as club data, but you can not ever extrapolate them across the general community, because experience has shown that club anglers fish far and above the average member of the community. Lindsey Harbord has been a club competition fisher for many many years, as have others at the Workshop, and he was sure they would agree that they generally catch more fish than the average. He would therefore be very fearful of using those data to represent the whole community. If you keep them as club data they can be used to look for trend changes, but to apply them to the whole community will lead to real problems.

Nick Caputi commented that Queensland has used club data extensively. WA is also starting to use club data and computerise them, going back twenty years at various locations. Unfortunately, while the data do give good catch rate information and trends over time, they do not give estimates of total catch and total effort which are also required. So clubs are a valuable source of data. They are being used, but they still need to be complemented with other survey information.

Richard Tilzey wanted to change the subject to the inescapable question of funding. Earlier that day, Ted Loveday spoke about shared resources, not just as a matter of shared access—but also as a matter of shared responsibility. The fact is that, for most stocks that are being shared at the moment, far and away the bulk of the management costs is being borne by the commercial catching sector. Hence, following on from that, it is implicit that recreational fishers have to pay—in one way or another—for a share of the resource, which then raises the question of licences. Peter Rogers, in his opening statement, was very emphatic that the national licence issue is dead. Richard Tilzey had not been privy to the conversations that brought that ultimatum. But quite a number of the States are going down the licence track, and it seems the logical way to go. The decision is, perhaps, not surprising, given that 95% or more of Australia's recreational fisheries lie under State jurisdiction, but he still wanted to know why Peter Rogers was so emphatic about it.

Peter Rogers explained that the reason he was so emphatic, is that it is the political reality, and that's the sadness of it at this point in time. When the Industry Commission came out with the cost recovery report on fisheries, they made the brave announcement of $20 in terms of a national recreational fishing licence. But the political response was that recreational licensing is not an option at a national level. And so, each State has to focus on other options

depending on its own particular circumstances and remembering that the States have the final legal responsibility for managing recreational fishing. It is to be expected that over the next few years there will be shifts in thinking and that each of the States will probably take a different approach to funding and they will take a mixture of strategies which will go towards addressing the issue. Partnering that with the recreational fishing community will be a key in terms of changing some of the State perspectives, because clearly it is the States which have the greatest interest in getting the right outcomes, largely because it is the States which are the primary beneficiaries.

Frank Prokop believed there is a tendency to concentrate on how far we have to go because there is enormous work yet to be done, without realising how far we have actually come with recreational fisheries. Really, it is less than five years ago since Frank Prokop sat down with people like Julian Pepperell and had their first disagreement about the subject of bag limits, and an almost unilateral decision was taken at that time that, in fact, bag limits would be imposed partly because they would be the best for the recreational anglers at the time. That had a fairly heavy cost and is still remembered less than affectionately by some sectors. But things have changed enormously since then and there has been a big effort to involve recreational fishers. When Frank Prokop first started, they were trying to a certain extent to apply commercial fisheries management models to recreational fishing situations, but the models were not working very well at all. Now recreational fisheries management models are being developed quite rapidly to try and incorporate the vast differences, many of which have been identified over the last two days. What has become clear from the discussion is that there is now an increasing recognition of the need for action even in circumstances where you don't have definitive information. Although everyone agrees with the need to try and collect the necessary information as quickly as possible, he thought it important to note the extremely rapid evolution of recreational angler attitudes towards management and stewardship of the resource personally, although there is still a fair way to go in that regard. We are at a particularly crucial point in time where the recreational fishing community is starting to take management responsibly where there is a very real danger that fisheries management agencies will be increasingly forced to make rapid decisions in a much more political climate than in the past. This will have some very big problems. Brian Jeffries made one of the most valid comments, which was that the recreational and commercial fishing sectors have far more in common than they have in differences and that they have to work much more closely—and that fisheries agencies have to facilitate the things that they have in common, because once you have established common ground and once you have a sound resource base, the allocation of that resource is far easier, particularly if the two sectors trust each other. And that is happening increasingly at the fishery level, though there are still sometimes some problems at the wider picture level. And although there is still some resentment between the commercial and recreational sectors, if you can look back at what has happened in the last five years, and look forward to what will happen in the next five years, many of those things will be ironed out. It will be very interesting to see what the turn of the century holds for recreational fisheries man-

agement in its position relative to all other facets of management.

Murray MacDonald endorsed Frank Prokop's remarks and added that one other development, certainly in the State of Victoria, and most likely in a number of other States as well, is that the requirement firstly for broad participation—certainly recreational and commercial participation—in management of our resources, is being pushed along by a very rapid increase in acceptance of the need for specific and detailed fisheries management plans for specific fisheries in specific areas. That's certainly the road that Victoria is going down at the moment and for two bays and inlets in particular—the Gippsland Lakes and Corner Inlet. It is remarkable in how short a period of time there has been such a tremendous change in some of the attitudes on both sides, purely because, instead of standing back and sniping at each other through the media, based on misconceptions or no information, the commercial and recreational fishing sectors are starting to sit down and talk to each other about their respective interests and needs, and finding that in many cases there really is not a conflict and that they have got more in common than they have in differences. And proposals are now starting to emerge which are joint proposals for management of these resources from both sectors. So Murray MacDonald thought that the requirement for detailed plans which explicitly state the objectives, including resource conservation objectives, resource allocation objectives, economic objectives particularly on the commercial side, is forcing both the user groups and, just as importantly, fisheries management agencies, to come to grips with the notion that we are all in the same boat and that there is no point really in fighting each other—that we have to cooperate.

Ross Winstanley expressed his thanks to Murray MacDonald and Frank Prokop, and then asked the meeting whether there were any other matters that had not been addressed over the past two days that should be recorded.

Aldo Steffe commented that a lot of motherhood statements seem to be made at meetings such as this, and felt he should talk a little bit about the down side of the science. What's the catch? Bob Kearney has already alluded to the fact that no matter what number you pull out, nobody can disprove that number. So we don't know what the catch is, we're only estimating it. We have heard a lot about the various methods we can use to estimate the catch. But they all have their various biases and imprecisions. It is often commendable to do multiple surveys of different methodologies in conjunction and then compare those estimates, but the bottom line is that we still don't know the answer, so when it comes to choosing which method is best, it is a very subjective answer. What he would like to suggest was that perhaps we should be looking at fictitious data sets based on real situations and then modelling those and then comparing methodologies to see which give the best answer, because we already know what the final answer should be. And then even on a smaller scale, do full censuses and then model those data and we would be in a better position to tell managers what the catch really is and therefore management would have to be better.

Ross Winstanley asked if anyone would like to follow Aldo Steffe's suggestion.

Nick Caputi thought the presentation by Jodi Woolcock and Martine Kinloch did that precise thing. They did simulate artificial data through various creel survey methods and basically that has been done and is being done.

Barry Pollock offered his comments about what he sees as being real problems with the recreational fishing sector in Australia. These are related to its size, its diversity and its general disorganisation—it's very hard to talk to it and to get sense out of it. It is not well organised. The club side of it is, but that is only about five per cent. In his view, the challenge for the sector, and for those who are trying to service it, is to help it to get organised. It is run by basically voluntary labour. People are expected to attend meetings in their own work time and to interact with the managers. We need to help them to get organised, just as the commercial sectors have become organised.

Ted Loveday, on a different issue, saw as a very positive opportunity that hasn't been explored all that much, stocking of freshwater impoundments for recreational fishing. While we sort all these other issues out, any area where we can relieve pressure should be taken up. The stocking of freshwater impoundments for recreational purposes certainly creates new opportunities and, because of the people involved in it, the aquaculture industry and depending on the species, the fishing industry itself, can all be beneficiaries right across the board. While we are spending all this money on obtaining data, we should be putting more resources into freshwater impoundments. He emphasised freshwater impoundments, as opposed to marine restocking because that is a whole different issue.

John Millyard followed up Ted Loveday's plea for freshwater stockings, by informing the meeting that the Australian Fishing Tackle Association has just launched an initiative called the Bass Australia Foundation whereby, in the first year—this year—the Association would put anywhere in Australia where it is allowed to put them, $60 000 worth of Australian bass. This programme was due to start the next day, with 80 000 bass going into a dam, with the approval of NSW Fisheries, in the Shoalhaven area. This will be continuing on a regular basis throughout Australia.

Kim McClymont referred to a matter in the resource allocation area that had been mentioned but not discussed in any detail, which was the effect of native title on resource allocation, and which has had a significant effect in New Zealand. One thing that needs to be done—starting now—is a lot of consultation with native groups and organisations in order to get some agreements before they have to go to court. The Jervis Bay marine reserve, has proved to be a real can of worms because there are claims already on the waters. This is an area that is going to have a significant effect on both the commercial and recreational sectors of the fisheries in Australia.

Julian Pepperell raised another matter which hadn't been discussed. Aquaculture! He was interested in Ted Loveday's plea for the rights of people who needed to buy fish that they couldn't catch for themselves. There is a lot of Atlantic salmon for sale in Sydney fish shops and in restaurants that people don't catch, but are farmed in Tasmania. Fishers have various opinions on whether, by shifting the paradigm to some extent towards aquaculture, and by getting commercial fishers involved in aquacul-

ture, you can relieve pressure on stocks in that way. It is worth thinking about and it is worth recording as one of the areas handled by the Fisheries Research and Development Council.

Ross Winstanley believed it would be fitting to finish the discussion as it had begun with a comment from one of the international participants, Laurel Teirney.

Laurel Teirney focussed her comments on some matters which had been covered, but were worth re-emphasising.

The first thing is to be very, very clear about why the information is needed. It is important to think carefully about the issues being faced in each of the States, so as to come up with what exactly is needed to be able to progress those issues. Somebody needs to sit down and decide if there is one message that might work. Then, because all of the messages could need quite different information, and they are not really comparable, you could start in one State and maybe then look at extending bit by bit across the rest of the country. Don't be put off because it all seems a bit too big to make the next step, because in terms of the information collected in New Zealand, it was achieved in two years flat, so it did not take very long at all, nor did it really cost that much. In terms of user group management, on any of the issues addressed, it has only been nine months basically from the time of sitting around the table until there was a plan on board and regulations changed. So there is not the huge barrier that people may think. Laurel Teirney's final question was: what are you going to do from here? You have got a really good group here in this room and we have heard a lot of really interesting stuff over the last couple of days and, personally, she would hate to get onto the plane and go back to New Zealand thinking only: 'Well, they had a really good conference'. It would be much better to say: 'Well, we actually had a plan of where to go from here'. Thank you.

Chairperson Ross Winstanley closed the General Discussion with thanks to Laurel Teirney and all who had taken part. Now it was Bob Kearney's opportunity to finally sum up the two day's proceedings.

Summing up

Summing up

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Before providing my assessment of the conclusions of this Workshop, I would like to take this opportunity to thank Dave Smith for having organised and run a very successful conference. Dave named those most responsible in yesterday's introduction and I believe they all deserve our heartfelt thanks. I have only one complaint, and it is in the opinion of many a serious one; why would anybody convene a meeting of anglers and biologists in Canberra when the trout season is closed?

I have been impressed with the enthusiasm and diligence of a very diverse audience. There has been active participation in the debate by a very large percentage of the participants representing many professions, biologists, other scientists, economists, anglers, commercial fishers, fisheries managers, the fishing tackle industry, the press and more. This diversity of backgrounds has given rise to many and varied, and sometimes conflicting, opinions. It is difficult to distil these into a summary that can be accepted as being agreed conclusions of the Workshop. Nonetheless I cannot shirk my responsibility to attempt to do so.

In the last two days we have learnt a lot from our international guests and from many excellent local presentations. I believe it is not appropriate for me to review individual talks, for indeed Richard Tilzey already did this for us late yesterday. Rather I would like to concentrate on summarising what I believe was agreed from the numerous discussions which followed the talks and panel presentations. To a large degree this has already been done by the panel session of Chairmen which has just concluded. I must admit I am somewhat apprehensive about trying to add to this panel's comments, particularly those of Peter Rogers, who very effectively summarised how he saw the proceedings to date.

We started yesterday morning to address the question 'What's the catch?'. I believe we did so aware that none of us knew the answer and that many of us did not know why we did not know. There was also no pre-conference agreement on what we would do differently if we did know. I was bold enough, or silly enough, to suggest a national, annual recreational catch figure of 50 000 tonnes. I did so with very questionable confidence. I also provided the figure with no estimates of statistical confidence. Immediately following my talk yesterday I was asked what confidence intervals I thought should surround the 50 000 tonne estimate. I declined to answer at the time but agreed to think about it. I suggested last

night to Dave Smith, out of session, that it should be 50 000 tonnes plus or minus zero. This is not intended to apply precision of the estimate but rather a matter of whether you add or take away a zero.

I have been heartened by the comments made at the conference that most people agree that the 50 000 tonnes is of the right order. Nobody has suggested to me that it is closer to 5000 tonnes or 500 000 tonnes.

Some aspects of the magnitude of the recreational catch that are agreed are: it is of the order of tens of thousands of tonnes, it is significant, it is less than commercial catches in some areas, it is comparable to commercial catches in some areas, and it is greater than commercial catches in some areas. There are few dissenters to the conclusion that the recreational catch must be taken into account in future management practices.

But how do we take account of recreational catches, particularly if we don't really know what they are? All we really have in the way of national data are a few bits and pieces and maybe a guess or two.

The deficiencies in the quantity and quality of recreational fisheries data need to be addressed: nobody has been seen to argue against this. There appeared to be unanimous agreement that more resources were required to address the general question 'what is the catch?' Much more work is needed in many areas but a few national priorities were identified. There was general agreement, but not unanimous, that a national survey of at least how many anglers there were, what they do and maybe what they spend would be an asset, particularly if done in such a way that it could be repeated to provide indices of change on approximately a five year cycle. It was noted that such a survey would be of only limited value for catch estimation. It was agreed that more national consultation on what data are most useful and how they are best collected would improve efficiency. There was support, even if not unanimous, for common data formats and computerised processing procedures.

The problem of funding any action to improve data on recreational fisheries arose repeatedly. There was agreement that funding was a huge problem but no agreement on how to solve it. There was majority opinion that recreational fishing licences were inevitable, but a national fishing licence was currently not the way to go.

The lack of information on recreational fisheries was not restricted to catch data. The scarcity of published papers on recreational catches and the almost complete lack of internationally peer reviewed assessments of the impacts of recreational fishing, or of resource assessments based on recreational catch, are indicative of inappropriate input from the country's leading researchers. The paucity of recreational data compared with those available on commercial catches has been a major contributor to the perception that the recreational catch is a minor part of the whole. The lack of data on recreational catches has also often led to the over-use of data on commercial catches. Because the commercial data are often all we have, they are too frequently assumed to accurately represent the status of the resource. The lack of an alternative greatly restricts the debate.

I do not believe it is being unkind to suggest that the standard of assessments based on recreational catch carried out in Australia to date has been poor compared

with those employing data derived from commercial fisheries. There has been a lack of rigour in the scientific approach to the assessment of recreational fishing. The very good news is that in the last few years the quality of recreational fisheries assessments has begun to improve markedly. I was personally particularly pleased with the growing use of pilot studies and the often drastic alteration of experimental designs which followed the gathering of preliminary data. Hypotheses testing is becoming the preferred alternative to merely providing a description of the fishery. However there is a long way to go before catch rates and catch trends in recreational fisheries are accepted as a primary tool for resource assessments and for monitoring the effectiveness of management action.

I have already mentioned the problems of funding and that there was much discussion but no real conclusions. At least the dialogue has been rekindled at the national level and most who have attended the Workshop will leave accepting that more funding is essential.

Funding is not the only issue that needs to be addressed. It was agreed that to improve quantity and quality of data on recreational fisheries, anglers need to become more involved in not only the data collection process but also more involved in the management process. To facilitate this a greater sense of ownership of the data collection and management process must be engendered in the angling community. I suggest that increased ownership of the data and awareness of its implications will greatly increase acceptance by the angling community that they are a significant player in the total resource conservation and management process. Increased awareness of the part that anglers play in resource use and conservation will lead to increased awareness by the angling community of the other problems that the resource faces, such as pollution, habitat degradation and commercial fishing. The quality of the debate is sure to be improved as a result.

Increased quality of data and increased awareness of the true requirements of recreational fishing and, of course of their implications, will lead to greatly increased use of recreational data in fisheries management programmes. As the quality of data, and analyses based on these data, improve, the potential uses of information on recreational fisheries will increase. I am confident that recreational fisheries statistics will be able to be used not only as indicators of the status of the fish resources but also of the status of the underlying ecosystems themselves. In the short term this is most likely to occur in our freshwater rivers and impoundments where recreational fisheries often represent the only economically feasible method of routinely sampling the end product of the ecosystem. Several projects have already commenced in different parts of Australia to have anglers actively involved in the collection of detailed recreational catch and effort and size composition data on a regular basis. One such data collection system with which I am familiar is that started by John Harris with bass anglers in New South Wales. While I was initially sceptical of the value of these data for resource assessment purposes fortunately I was not so sceptical as to prevent the project progressing. I am most impressed with the results to date and the possibilities for their use as indicators of the wellbeing of river systems.

Yesterday I suggested that many anglers were concerned that when more detailed figures on their catches were available the information would be used against them. While the debate of the last two days has confirmed that this fear occurs, it has also strengthened my belief that it should be easy to overcome. There is no reason why the average angler should fear the truth. Even if catches are high there is nothing inherently wrong with catching a lot of fish. The issue is whether those catches are sustainable. The goal of good fisheries management is to catch the maximum sustainable yield, or some approximation thereof, not just to know what this yield is and catch some fraction of it. Sustainable use of the resource remains a pipedream in the absence of knowledge of what the use is. The absence of data makes it impossible to accurately describe the problem, let alone suggest a solution. Management actions taken in ignorance will not often lead to long-term solutions.

In the last two days there has been considerable discussion on how to approach the current lack of data on recreational fishers. Many methods such as creel, diary and logbook surveys and boat-ramp and roadside interviews and fisheries independent surveys have all been acknowledged to have merit. It has also been stressed that we need long time series of quality data to truly address the issues of long-term sustainability and appropriate resource use. All of the methods discussed have their merits. There seems little alternative to a case by case assessment of what is required to best help the management process.

It was also acknowledged that it is not just a lack of research that has held back the management of recreational fisheries. It is only in the last few years that most States had appointed dedicated managers for recreational fisheries and that while the numbers of these managers were increasing they were still fewer than for commercial fisheries. At the Commonwealth level recreational fisheries receive insignificant acknowledgement in the total fisheries management process.

I greatly enjoyed the panel discussion on the problems of allocation of resources between commercial and recreational users. However I did feel that there might have been more discussion of allocation within user groups.

Differences of opinion on allocation priorities between competing resource users can be expected to resurrect the debate on just how much of the fish resource could be allocated to commercial fisheries in the form of property rights. Are the country's fish resources common property or even no property? Particularly relevant to this debate was the statement yesterday by one of our water resource managers of how much easier it becomes to allocate water rights when estimates of the sustainable yield are reliable. In most Australian fisheries not only don't we know what the sustainable yield is but we don't even know what is the current yield (catch). We certainly have a long way to go.

While the current share of the total catch that is attributable to recreational fisheries is not known with confidence, the assertion was often made in the last two days that this share will increase. Naturally this was disputed by some. How the share will be assessed and allocated was the subject of some of our livelier debates and led to the general, but not unanimous conclusion, that a cooperative approach between recre-

ational and commercial resource users was the most appropriate way to achieve an acceptable outcome for both groups.

Many more people are involved in activities which influence fisheries resources than merely recreational and commercial fishers. They include, but are not limited to: the legal custodians of the resource (mostly governments), traditional or Aboriginal users of the resource, observers, developers, polluters (we do sell licences to pollute in Australia), seafood wholesalers and retailers, restaurateurs, tourism organisers, tourists, consumers of seafood, aquaculturists and individual public figures and politicians, in addition to recreational and commercial fishers. Of these it appears to me that recreational and commercial fishers have much more in common than many of the other groups that impact the resource. They certainly share a common goal of more fish for the future, or at least no less than there are now.

Consultation must be the most profitable way to secure the future of the resource. But as soon as this consultation process begins, accusations by one group of excessive exploitation by the other will be resurrected. The debate will not be very old before the statement is made, 'where are the data to support your claim?'. Such a debate carried on in ignorance will not help to decrease the conflict.

Accurate data of what is the catch and whether the catch is changing are essential before we can identify whether we have a real problem and, if so, how bad it is and what needs to be done? There is no doubt that recreational anglers are a significant user of many of our fisheries resources and that they must become more involved in the management process. They must therefore become more involved in dialogue with commercial fishers and with managers. They cannot, and should not, be expected to contribute on an equal basis to this debate without equal data sets to support them. In the common interests of resource conservation and security of use, all parties must have access to accurate information on all of the significant factors, be they fisheries or otherwise, that impact the resource. Debate, or consultation, carried out in ignorance of the facts cannot provide solutions.

There were one or two suggestions in the last two days that confrontation between anglers and commercial fishers was inevitable. Unquestionably there will be some conflicts in the years ahead but in reality both groups are here to stay. The demand for fish for consumption and as a basis of many of our major industries such as restaurants and tourism is sure to increase. Moreover, there is a growing worldwide shortage of quality seafood. There is also a decline in the number of quality places to go angling. Australia will inevitably see a much greater demand for fish as both a source of food and recreation. Approximately 30% of Australia's fish consumers are anglers and a great majority of our anglers consume more fish than they themselves catch, or at least different varieties of seafood than they catch. While the number of anglers, at between 25% and 30% of the population, is indeed great, the number of consumers at close to 100% is much greater. The angling community is also dependent upon commercial fishing for much of its bait. Interdependence within the two groups is not going to diminish.

Much of the conflict that is currently topical results from wrong perceptions. Most of

the conflict can only be resolved with appropriate information on the real issues and education of all parties involved. Consultation and education are the ways of the future, not confrontation.

One subject that almost avoided the discussion in the last two days was aquaculture. There is increasing communication between commercial capture fisheries and aquaculture in Australia. The National Fishing Industry Council (NFIC) represents both groups. There are currently no formal links between angling bodies and aquaculturists. I would like to suggest that the relationship between anglers and aquaculture will grow for two primary reasons: Firstly aquaculture has already created many fisheries in Australia by providing fingerlings for stocking areas such as impoundments where no natural recruitment occurs. As the aquaculture industry continues to develop, commercial production of other species will open up opportunities for more successes and the creation of new fisheries, for example marine and estuarine fisheries for species such as mulloway and dive fisheries for shellfish such as scallops. When large scale aquaculture industries have developed, the cost of fingerlings which can be used for restocking, will decline. Secondly, if the percentage of Australia's total fish resources taken by recreational fishing does increase, then that available for consumption by the non-angling public must decrease, unless seafood is created from some external source. Aquaculture represents the only known alternative. Opposition to increased angling catches will be much greater if there is no alternative supply of quality product.

There was unanimous agreement of at least one issue, all of us have learnt something in the last two days. I repeat my sincere thanks to Dave Smith personally and to the ASFB Executive for a most timely initiative and a very well-run workshop.

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Workshop programme

Recreational fishing: what's the catch ?

Conveners: **Martine Kinloch, SARDI Aquatic Sciences**
Julian Pepperell, Pepperell Research and Consulting Pty Ltd

Day 1 (Tuesday, 30 August)

0900–0915 Welcome—Dr Russell Reichelt, BRS & Dr David Smith, President ASFB

0915–1000 Keynote address—Dr Bob Kearney, NSW Fisheries Research Institute

1000–1030 Morning Tea

1030–1230 **Session 1: International overview**

Chairperson: Julian Pepperell, Pepperell Research and Consulting

Rapporteur: Kevin Rowling, NSW Fisheries Research Institute

Panel Speakers:
Rudy van der Elst, Oceanographic Research Institute, Durban, South Africa. 'Strategies for data collection in marine recreational and commercial line fisheries of South Africa'

Stephen Malvestuto, Fishery Information Management Systems Inc., Auburn, USA. 'Measuring the response of recreational fisheries to management strategies in the United States: the role of creel surveys'

Laurel Teirney, MAF Fisheries, Dunedin, New Zealand. 'Determining the recreational share of New Zealand's marine harvest'

David McGlennon, SARDI Aquatic Sciences, Adelaide, SA. 'A review of recreational fishing surveys in Australia'

1230–1330 Lunch

1330–1500 **Session 2: Measuring catch and effort—the theory**

Chairperson: Nick Caputi, WA Fisheries Department

Rapporteur: Suzy Ayvazian, WA Fisheries Department

Panel Speakers:
Stephen Malvestuto, Fishery Information Management Systems Inc., Auburn, USA. 'Estimation of angler harvest rates for recreational fisheries using creel surveys: current limitations and options for improvement'

Jodie Woolcock, Dept of Mathematics, La Trobe University, Vic. and Martine Kinloch, SARDI Aquatic Sciences, Adelaide, SA 'An assessment of the 'bus-route' method for estimating angler effort'

Laurie West, Kewagama Research, Qld 'Tailoring survey design to suit information requirements'

1500–1530 Afternoon Tea

1530–1730 **Session 3: Measuring catch and effort—the practice**

Chairperson: David McGlennon, SARDI Aquatic Sciences, SA

Rapporteur: Martine Kinloch, SARDI Aquatic Sciences, SA

Panel Speakers:
Aldo Steffe, NSW Fisheries Research Institute, Cronulla 'A survey of recreational trailer boat fishing in the marine waters of New South Wales—a case study'

Roland Griffin, NT Dept of Primary Industries and Fisheries, Darwin 'Recreational Fishing Surveys in the Northern Territory—1978 to 1993'

Peter Davies, Inland Fisheries Commission, Hobart, Tas. 'Freshwater recreational fishery surveys in Tasmania'

Neil Trainor, Qld Department of Primary Industries, Brisbane 'Recreational Fishing Information Systems: it's about time, it's about space'

1730–1800 General Discussion—Day 1

Chairperson: Richard Tilzey, Bureau of Resource Sciences, Canberra

Rapporteur: Kevin McLoughlin, BRS, Canberra, ACT

Panellists: Session Chairs

Day 2 (Wednesday, 31 August)

0900–1030 **Session 4: Socio-economics of recreational fishing**

Chairperson: Barry Kaufmann, Chief Economist, AFMA, Canberra, ACT

Rapporteur: Steve Bolton, AFMA

Panel Speakers:
Padma Lal, ABARE, Canberra, ACT 'What's the value of fish in the recreational and commercial sectors?'

Paul McLeod, Dept of Economics, University of Western Australia 'The role of recreational and commercial values in the recreation and commercial management of multi-use fisheries—application to Western Australian salmon'

David Baker, SARDI Aquatic Sciences, SA 'If sustainability fails, who loses most?'

1030–1100 Morning Tea

1100–1300 **Session 5: Resource allocation—a forum**

Chairperson: Murray MacDonald, Victorian Fisheries Research Institute
Rapporteur: Terry Walker/Simon Conron, Victorian Fisheries Research Institute

Panellists:
Ted Loveday, Queensland Commercial Fishermen's Organization

Brian Jeffriess, National Fishing Industry Council

Mal Ramsay, Australian Recreational & Sportfishing Confederation

John Millyard, Australian Fishing Tackle Association

Peter Rogers, Executive Director, WA Fisheries Department

1300–1400 Lunch

1400–1530 **Session 6: Management of recreational fishing**

Chairperson: Peter Rogers, Executive Director, WA Fisheries Dept

Rapporteur: Frank Prokop, WA Fisheries Department

Panel Speakers:
Wayne Fulton, Inland Fisheries Commission, Hobart 'Management of recreational fishing in inland waters in Tasmania'

Laurie Gwynne, Qld Fish Management Authority 'Management of recreational fishing in Queensland'

David Hall, Primary Industries (SA) Fisheries 'Managing recreational fishers—changing the mindset'

1530–1600 Afternoon Tea

1600–1700 **General discussion**

Chairperson: Ross Winstanley, Victorian Fisheries Research Institute

Rapporteur: Geoff Gooley, Freshwater Fish Research Station and Hatchery, Snobs Creek, Vic.

Panellists: Session Chairs

1700–1730 **Summing up**

Dr Bob Kearney, NSW Fisheries Research Institute

Abstracts from ASFB 1994 Annual Conference

The different catch characteristics of the commercial, recreational and charter boat fisheries for snapper (*Pagrus auratus*) in Southern Queensland

W.D. Sumpton and S.M. Jackson

QDPI, Southern Fisheries Centre, PO Box 76, Deception Bay, QLD 4508

Snapper *(Pagrus auratus)* are fished by three fishing sectors in Queensland: commercial line fishers, recreational line fishers and recreational anglers fishing from charter boats. Queensland fishing regulations ensure that no particular sector has a competitive advantage since each sector has identical restrictions on fishing gear. Despite the similarities in gear there are major differences in the catch between these sectors and within the participants of a particular sector. As expected the largest variance in both catch rates and size composition of the catch was amongst recreational anglers, largely due to different levels of experience and expertise. Charter boats had the least variance in catch rates and size composition with catch rates remaining fairly stable seasonally. Surprisingly, significant catch differences between commercial fishers operating from the same fishing port and fishing the same area were also noted. These differences were related to the targeting of certain sizes to meet the demands of different markets. The biological sampling problems caused by size selective targeting are discussed.

The recreational flathead (*Platycephalus fuscus*) fishery in Moreton Bay, Queensland

D. Cameron

QDPI, Southern Fisheries Centre, PO Box 76, Deception Bay, QLD 4508

Tagging studies and roving creel surveys at two estuary entrances were used to investigate the recreational fishery for dusky flathead (*P. fuscus*) in Moreton Bay.

4900 dusky flathead were tagged and released throughout Moreton Bay by the QDPI/ ANSA Sportfish Tagging Program. 640 (13%) have been recaptured with 90% of recaptures made by recreational anglers.

A roving creel survey of 1632 anglers over 54 days was undertaken at the Caloundra and Jumpinpin estuary entrances during daylight hours in 1993. It was estimated that there were 460 000 recreational fisher hours of effort at these two areas during the survey period. Highest seasonal catch rates at Caloundra and Jumpinpin were .07 and .11 flathead/fisher hour respectively. These catch rates occurred during spring, which coincides with the peak spawning activity of the species. No anglers interviewed reached the proposed bag limit of 10 flathead/ angler. The total annual recreational catch of dusky flathead at the Caloundra and Jumpinpin estuary entrances was estimated to be 7.5 and 13.1 tonnes respectively.

On the basis of tag returns and roving creel surveys the recreational catch of dusky flathead in Moreton Bay is more than 5 times the annual commercial catch of 45 tonnes.

Recreational fishing—open platform information systems

S. Sawynok, Capricorn Applications

13 Davidson St., North Rockhampton, QLD 4701

The Sportfish Tagging Program, a joint project between the Australian National Sportfish Association and the Department of Primary Industries in Queensland, has generated a large data base of capture/recapture information. Computer software has been developed to service this data base.

There are considerable advantages in developing a common platform for data interchange in this area. Methods to achieve information sharing amongst recreational fishers and their organisations, fisheries agencies and other Government agencies, and Universities are discussed.

Development of a model of the Western Australian fishery for Australian salmon, *Arripis truttaceus* Johnston

B. Wise

Bernard Bowen Fisheries Research Institute, W.A. Marine Research Laboratories, PO Box 20, North Beach,WA 6020

The Australian salmon, *Arripis truttaceus*, is one of the more significant species for recreational fishers in Western Australia, and is also the basis of an important commercial fishery. The species is also caught by recreational and commercial fishers in South Australia.

To meet the requirement for management advice, a predictive model was developed to integrate available biological information and evaluate the sensitivity of model output to any inadequacy in assumptions about the salmon stock. The model developed was an age structured spatial model incorporating data from South Australian and Western Australian commercial and recreational fisheries. Salmon is a migratory species returning to Western Australia to spawn and consequently this aspect of its life history was incorporated in the model. The model structure is discussed with sample output to illustrate its adequacy to the Western Australian salmon fishery.

The recreational whitebait fishery in Tasmania

S.J. Chilcott and A.C Sanger

Inland Fisheries Commission, 127 Davey St, Hobart, TAS 7000

The Tasmanian recreational whitebait fishery is based on migrating juvenile galaxiids (*Galaxias spp*) and adults of the Tasmanian whitebait (*Lovettia sealii*). Harvests are made as juvenile galaxiids migrate from estuarine/marine environments into freshwater zones and as Tasmanian whitebait migrate into freshwater tidal zones of tributaries to spawn.

Tasmania supported a commercial whitebait fishery from the early 1940s to 1973, with the most significant harvests occurring in the 1940s. Declining catches from 1950 effectively ended the fishery because of lit-

tle commercial interest and participation. A formal closure occurred in 1974. A recreational fishery was introduced in 1990 and has operated for three years. There is an illegal fishery which has operated during this period and which is still continuing.

The fishery is regulated by gear restrictions, temporal regulations (season timing and length, diurnal restrictions), river selection, in addition to daily and total catch quotas. The fishery is managed to permit limited harvests of juvenile galaxiids and to minimise harvests of the Tasmanian whitebait.

The harvests and catch rates are monitored by limited creel surveys and questionnaire returns. Attempts are being undertaken to examine the effects of harvests on adult galaxiid populations. The primary management objective is to maintain harvests at sustainable levels without adversely effecting riverine galaxiid populations.

Reproductive biology and management of school (*Scomberomorus queenslandicus*) and spotted (*S.munroi*) mackerel throughout Northern Australia

G.A. Begg

Department of Zoology, University of Queensland, Brisbane, QLD 4067

School (*Scomberomorus queenslandicus*) and spotted (*S.munroi*) mackerel are morphologically similar species that co-habit inshore coastal waters. These species form important commercial and recreational fisheries throughout Queensland and the Northern Territory. Conflict between the fishing sectors and concern over increasing catches initiated this study. Samples were obtained from the east coast of Queensland and Northern Territory waters. Spawning seasonality, reproductive indices and sex composition were examined in relation to location, time and size of fish. Spatial and temporal differences were observed in the species reproductive patterns. School mackerel have an extended summer spawning period across its range. In contrast, spotted mackerel are in spawning condition during late winter and early spring throughout their northerly distribution. School mackerel initially spawn at a smaller size compared with spotted mackerel. Management implications from these reproductive parameters are discussed with reference to other biological aspects.

Developments in hatchery production of mulloway *Argyrosomus hololepidotus*

S.C. Battaglene

NSW Fisheries, Brackish Water Fish Culture Research Station, Salamander Bay, Port Stephens, NSW 2301

NSW Fisheries scientists are evaluating mulloway for aquaculture. Originally chosen because similar species are successfully cultivated overseas, mulloway are highly fecund, fast growing, euryhaline and have a good market profile and price. In addition to assessing the culture of mulloway to market size, initially in sea cages, research is also directed at assessing the potential for release of juvenile fish to enhance wild stocks.

Mulloway were bred for the first time in 1992 at the NSW Fisheries Research Centre (FRC) at Port Stephens. Wild-caught broodstock have been induced to ovulate with 1000 U/Kg human chorionic

gonadotropin as have fish held for 18 months in a large marine pool at the Fisheries Research Institute (FRI) at Cronulla. However, female broodstock held in 50 000 L tanks at FRC and in South Australia have not matured. To overcome this impediment new temperature/photoperiod controlled rooms have been installed at FRC and FRI to encourage spawning in captivity. Broodstock research has been funded by the Aquaculture CRC.

Some 10 000 juveniles of 50 mm were produced in 1993 and 6 000 fish are being held in sea cages to assess growth. While larval mulloway require live foods and are cannibalistic, juvenile fish appear amenable to crowding and artificial feeding. Fish kept in tanks grow to a mean weight of 540±194g in one year. Growout research is being funded by the Fishing Research and Development Corporation.

Using scale patterns and shape to identify wild and hatchery-reared fish

D.J. Willett

Southern Fisheries Centre, 13 Beach Rd (PO Box 76), Deception Bay, Qld 4508.

Stocking hatchery-reared fingerling fish into natural waterways is a widely practised management technique for enhancing recreational fish stocks. However, little work has been done to evaluate the efficacy of such programmes—primarily because no suitable marking system has been available to distinguish the stocked fish from those spawned in the wild. Recently however, the analysis of fish scale patterns and scale shape has shown potential for discriminating wild and hatchery-reared fish. This technique uses automated video digitising equipment to acquire circulus spacing and scale shape data, and discriminant function analyses to classify fish to their stock of origin.

The use of a scale recognition system to identify the origins of fish in natural systems holds many advantages over traditional marking methods. For instance, problems inherent in individually tagging large numbers of small fish are avoided. Scale features are permanent and do not affect survival, behaviour or growth; and scales can be collected by recreational anglers, which not only generates interest in the stocking programme but also reduces the cost of scientific surveys to retrieve the marked fish. In addition, fish can be released after scale samples have been removed; i.e. it is not necessary to kill the fish in order to retrieve the marker. This paper reviews the technique and its application in a few southern Queensland rivers.

Catch and Effort of spearfishers in NSW waters and implications for management

A. Smith and G.W. Henry

NSW Fisheries, Locked Bag 9, Pyrmont, NSW 2009

Competition and recreational spearfishers were surveyed by headcounts and interviews at Jervis Bay in southern NSW. Spearfishing effort, fish catch and fish catch per unit effort (cpue) were determined for both groups. Estimates of effort were more accurate than those obtained from previous studies due to investigation of precise diving locations and diver searching time. Usually unreported components of competition

catches (fish below minimum weights and duplicate species) were also estimated.

Competition spearfishers expended a greater daily effort, captured more species and achieved a higher cpue than recreational spearfishers. Recreational spearfishers fished a wider variety of locations, their estimated total annual catch was almost double the competition catch, and the average individual fish weight was larger. The most common species captured by both competition and recreational spearfishers was the red morwong, *Cheilodactylus fuscus*.

The implications of competition and recreational spearfishing catch and effort are discussed with respect to the management of aquatic reserves, protected species, bag limits, size limits, effects on rocky reef fish community structure, and the potential conflict between commercial and recreational fishers and SCUBA divers.

The recreational flathead fishery in the offshore waters of New South Wales—a preliminary report

J. Murphy and A.S. Steffe

Fisheries Research Institute, PO Box 21, Cronulla, NSW 2230

Recreational anglers who fish in the offshore waters of NSW target and catch a wide variety of fishes. The flatheads (Family Platycephalidae) are an important component of the total recreational catch. To date we have recorded 9 species of flatheads in the recreational catches.

The most commonly retained flathead species are: eastern blue-spotted flathead *Platycephalus caeruleopunctatus*, marbled flathead *P. marmoratus*, tiger flathead *P. richardsoni*, and dusky flathead *P. fuscus*.

We present some preliminary data on the relative importance of these four species to the recreational fishing sector and highlight some interesting biological observations.

Estimation of recreational prawning catch and effort for four NSW estuaries

D.D. Reid and S.S. Montgomery

Fisheries Research Institute, PO Box 21, Cronulla, NSW 2230

Estimates of catch and effort by recreational prawners are presented for four NSW estuaries (Wallis Lake, Tuggerah Lakes, Lake Illawarra and Coila Lake) for the summer seasons of 1991/92, 1992/93 and 1993/94. The aim of the project was to estimate the relative contributions of commercial and recreational prawning in these estuaries. The fishery was sampled by an intercept creel survey, based on stratification by moon-phase, tide and time of night. As part of the interview process subsamples of the catch were examined, to provide estimates of the length frequency distribution of the recreational catch and the composition by species. In addition to intercept surveys, a brief survey of recreational prawners at exit points was completed in the 1992/93 season for comparison with results from the intercept survey method. The estimated commercial and recreational catches are compared for each of the four estuaries.

NSW fisheries gamefish tagging program 1973–1993 —(poster)

K.L. Deguara

Fisheries Research Institute, PO Box 21, Cronulla, NSW 2230

In 1973 NSW Fisheries began a cooperative big-gamefish tagging program involving anglers throughout Australia who were members of registered fishing clubs affiliated with the Game Fishing Association of Australia (GFAA) and/or the Australian Sportfishing Association (ANSA).

Tagging is carried out on a voluntary basis by recreational anglers. These anglers tag fish that are recognised as gamefish by the GFAA, including billfish, tunas, sharks, kingfish and some other pelagic species. Both GFAA and ANSA have trophies and competitions which are designed to encourage tag and release. The Fisheries Research Institute supplies tagging kits free to anglers on request, or to tagging officers of clubs who distribute the kits to members.

Since the program's introduction, 148 088 tag cards have been returned. A total of 3 177 (2.1%) recaptures have been reported and verified. The main species or species groups tagged are; billfish (28 337), tunas (51 574), sharks (10 775) and kingfish (15 574). Despite a slight reduction in numbers tagged during the late 1980s, the 1990–91 fishing season showed an increase in numbers with 17 864 being tagged, the greatest number of releases recorded in any one year since the program commenced.

This poster summarises the results of the program up to 1993 and presents some of the more important data concerning movements of the recaptured tagged fish.