PROCEEDINGS OF THE

3rd World recreational fishing CONFERENCE

Northern Territory AUSTRALIA

21-24 MAY 2002

REGIONAL EXPERIENCES FOR global SOLUTIONS

HOSTED BY

AMATEUR FISHERMEN'S ASSOCIATION OF THE NORTHERN TERRITORY

Northern Territory Government

Department of Business, Industry and Resource Development

REGIONAL EXPERIENCES FOR GLOBAL SOLUTIONS

THE PROCEEDINGS OF THE 3RD WORLD RECREATIONAL FISHING CONFERENCE, 21-24 MAY 2002, NORTHERN TERRITORY, AUSTRALIA

Edited by

APM Coleman

Fisheries Group

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FOREWORD

This publication is not so much the end of the 3rd World Recreational Fishing Conference but the continuation of a long, and hopefully, successful 3-yearly international event. Recreational fishing is, and will continue to be, an integral part of the lives of millions of people and this event can help make their sport and recreation a more enjoyable and rewarding experience.

World wide our industry is massive and the backbone of thousands of communities, towns and cities – we need to capitalise on this and grow the industry for the benefit of all. That growth has to be 'smart' and must ensure that in generations to come they can still enjoy this wonderful pastime.

The comments and feedback I have received from the delegates at this event was extremely positive and personally, very satisfying. Three years in the planning and with tremendous support from the Fisheries Group of the Department of Business, Industry and Resource Development in the Northern Territory of Australia, the conference proved to be a resounding success.

The theme of 'Regional Experiences for Global Solutions' should not be lost on those who met and exchanged their knowledge and ideas in Darwin. The important thing is to use this new extended network and build on the knowledge base from around the recreational fishing world.

We have set ourselves some challenges for the immediate future. The establishment of the World Recreational Fishing Forum for the exchange of information and to have carriage of the three yearly world conference and, the creation of an international code of conduct for recreational fishing are two important and necessary steps for our industry to take.

I would like to extend my sincere appreciation to Anne Coleman as my Co-Chair of the Organising Committee for her ideas, energy and drive during the planning of this event. Special thanks also to Annette O'Grady who as part of the team provided great support and initiative for the conference.

Without the support of sponsors this Conference would not have been possible. Many sponsors helped to make the event a success and the support of the sponsors is greatly appreciated. They were: Fisheries Research and Development Corporation, Department of Agriculture, Fisheries Forestry Australia, Woodside Energy, South Australian Department of Primary Industries and Resources, Northern Territory Department of Business Industry and Resource Development, Castlemaine Perkins, Northern Territory Department of Sport and Recreation, Fisheries Western Australia, University of British Columbia Fisheries Centre, National Oceanic and Atmospheric Administration, Queensland Department of Primary Industries, NSW Recreational Fishing Trust, Reidy's Lures, Alvey Reels and the Amateur Fishermen's Association of the Northern Territory.

I look forward to seeing you all in Norway in 2005.

Fair weather, good tides and tight lines

John Harrison
Executive Officer
Amateur Fishermen's Association of the Northern Territory, and
President
Recfish Australia

Keynote Speaker

THE COMPLEAT ANGLER AND THE MANAGEMENT OF AQUATIC ECOSYSTEMS

Tony J. Pitcher

Fisheries Centre, University of British Columbia, Vancouver, British Columbia, Canada

Abstract

In a crowded world, those who fish for fun will be compleat only if they do not harm aquatic ecosystems and if they fish in harmony with other resource users. This paper present elements that can be used towards building a comprehensive ethical framework for recreational fishing. The ethics of fisheries have been analyzed into five components: ecosystem, distributive, productive, restorative and creative justice. For sport fisheries, these ethical components are discussed in relation to sustainability and the rebuilding of depleted and damaged aquatic ecosystems.

Evaluation of the benefits of sport fisheries has generally been rooted in an economic modality, yet ethical considerations must go beyond cash values. Caring about ethics is pragmatic: fair allocation decisions are more likely when the trade-off between economic benefits and ecological impacts is transparent. On an individual cognitive level, ethical behaviour helps to maximize the dream-per-fish ratio in humans, a desired product of angling recognised since Isaak Walton subtitled his book "The Contemplative Man's Recreation".

The Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fishing provides internationally agreed and comprehensive ethical guidelines against which all fisheries may be judged: the paper suggests that over 90% of the items in most of the twelve articles of the FAO Code apply to recreational fishing.

Responsible fisheries should aim to provide accurate information about their ecological impacts: examples are presented from sport fishery catches in Canada and Kenya. Moreover, responsible fisheries should be able to know what their economic and social benefits are: examples of how this may be achieved are presented from a newly published book on this topic (Recreational Fisheries: ecological, economic and social evaluation, Pitcher and Hollingworth, 2002).

A novel quantitative technique for evaluating the status of sport fisheries is introduced. Based on a multi-disciplinary rapid appraisal method called 'Rapfish', the paper presents some preliminary case studies. 'Rapfish' for recreational fisheries contains separate evaluation fields for ecological status, economic value (current and potential), social impacts, management performance and fishing experience. Each field contains five to nine attributes that can be scored rapidly in a preliminary fashion and refined later. 'Rapfish' uses a non-metric ordination, multi-dimensional scaling, to derive ratings for each fishery in each evaluation field. Uncertainty may be accounted for using Monte Carlo simulations, and the influence of individual attributes can be described quantitatively. 'Add-in' routines for the Excel spreadsheet software are available. Overall results may be presented as a multi-axis kite diagram for comparison with other fisheries, with historical analyses, or with the forecast impact of new policies. An explicit ethical field may be added to the 'Rapfish' evaluation if desired.

The paper suggests how an ethical framework will help anglers become compleat through being perceived as taking a full and responsible role in the management of aquatic ecosystems.

Introduction

An archaic spelling of 'complete', 'compleat' is defined (OED, 1999), as 'quintessential' and has connotations of calm and self-sufficiency. Piscator, the hero of Isaak Walton's elegiac book (Walton and Cotton, 1676) is the essence of such gentle sensibility. Watching us from the 1650s, Walton's Piscator would doubtless be horrified and alarmed at the scale of depletion in today's aquatic ecosystems (Christensen et al., 2001; Pauly, 1998). Those who have brought about the overexploitation of the world's aquatic ecosystems are, after a long period of ignorance and indifference, in the process of being brought to account in a dramatic fashion by public opinion (Pitcher, 2001). This paper looks at the role that compleat anglers may play while continuing their sport in today's threatened ocean. The principal message is to find ways to evaluate progress in achieving responsible and ethical sport fisheries (Pitcher, 1999a), and to be seen to be doing so by the public. Sport fishers must aid the rebuilding of depleted and damaged ecosystems (Pitcher, 2000).

The ethics of fisheries have been analyzed into five components: ecosystem, distributive, productive, restorative and creative justice (Coward et al., 2000). For sport fisheries, these ethical components are vital for sustainability, equity and the public perception of progress. Ethical analyses may be quantitative (Pitcher and Power, 2000), and application to sport fisheries

would be pragmatic, encouraging public perception of anglers as protectors, rather than despoilers of wilderness. Ethical behaviour is clearly a key to this, since the opposite brings fishers and their managers into disrepute (see Sullivan, 1999). Nevertheless, some issues, such as catch-and-release lead to an ethical dilemma. In North America catch-and-release has been adopted to aid fish populations (Policansky, 2002) and the principal issue is survival subsequent to handling and release. In Europe the perspective is more equivocal, and some countries, e.g. Germany (Steffans and Winkel, 2002) forbids catch-and-release, an attitude perhaps encouraged by an active anti-hunting lobby. Aboriginal North American tradition supports this view, young persons being taught by elders "not to play with your food" (Jones and Williams-Davidson, 2002).

The Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fisheries (FAO, 1995; Doulman, 1998) was developed during the early 1990s in response to the beginnings of serious concerns about the impact of fisheries. Its text was agreed amongst all UN governments in 1995, and, to date, over 20 countries have ratified. Of the 12 Articles of the Code, six cover general principles, one aquaculture and one, post harvest practices. The remaining four Articles are highly relevant to sport fisheries: fisheries management, fishing operations, fisheries research and integrated coastal area management. I examined the 53 clauses and sub-clauses of Article 7 'Fishery Management'. The material partitions into 110 discrete fisheries issues discussed by the Code. Of these, I found 62% highly relevant and 24% relevant, making 96% in all, relevant to sport fisheries. Compliance with Article 7 of the Code may be evaluated using a six-field rapid appraisal technique (Pitcher, 1999b). FAO is mandated to help evaluate compliance (e.g. FAO, 1990). Since their governments have already supported its development, I suggest that public perception of responsible behaviour would be enhanced if sport fishers adapt the existing Code of Conduct, in consultation with FAO, rather than invent a new one.

The majority of existing evaluations of sport fisheries are concerned with economics (Rudd, 2002). Tracking total expenditure adds up the various market transactions involved in sport fisheries (payment of licence fees, boat and guide hire, sales of rods, travel and fuel costs, magazines). But, where it has been tried, this is surprisingly difficult. Some annual figures are: Germany, US$1 billion (Steffens and Winkel, 2002); England and Wales' freshwaters, US$3.4 billion (Lyons et al., 2002); Sweden, US$281 million (Toivenen, 2002); Denmark, US$60 million (Toivenen, 2002); one South African sport fishery, US$250 million (Griffiths and Lamberth, 2002). But large-scale surveys cost a lot (Lyle et al., 2002; Duffield et al., 2002; Gentner and Lowther, 2002) and "apart from plain money and work, a multinational survey takes more time than you think" (Toivenen, 2002).

Contingent valuation methods (CVM) generally produce lower values for sport fisheries than expenditure: in one Nordic survey willingness to pay (WTP) for fishers was about 42% of expenditure (Toivenen, 2002). But WTP methods are not robust in the face of changes in earning power – for example the amount you might pay this week may not be the same next week after you have lost your job (Pitcher and Hollingworth, 2002). WTP is also challenged by international currency exchange. For example, a US citizen big-game fishing in Kenya spends more money in one day than a local person might earn in 5 years, so these two actors have very different WTP responses.

A more robust methodology uses the 'method of paired comparisons', also termed a 'damage schedule' (Knetsch, 1994). Surveyed participants are asked to choose the more desirable of a pair of alternatives, but no direct monetary value questions are asked. By taking all possible pairs, the rank order and degree by which each option is preferred can be estimated (see Chuenpagee et al., 2001). Rudd et al. (2002) mentions an example where monetary values may be included in the choices. The technique deserves further exposure, especially perhaps when evaluating sport fisheries in developing countries.

Kearney (2002) draws up detailed balance sheets of costs and benefits for ecology, economics and social fields. In Kearney's ecological balance sheet, 8 from 15 (53%) issues have been tackled; from the economic balance sheet, only 3 from 10 (30%) are addressed; and from the social balance sheet, 5 from 18 (27%) issues receive some mention: overall, only one in three of the key issues have been tackled. It is alarming that so few of the key issues have been rigorously researched.

Is the fishery sustainable? Is it managed according to best practice? How well is management doing? What is the conflict status? What is the overall status ? None of the existing methods covers the full range of such questions and hence, in this paper, a novel multidisciplinary method for evaluating sport fisheries is presented. A rapid appraisal technique, Rapfish (Pitcher and Preikshot, 2000) is adapted for use in quantifying perceptions of status in five fields: ecological, economic and social status, management performance and fishing experience. The method is based on a multidimensional scaling ordination that is anchored by a number of fixed reference points, including the best and worst possible scores. The influence of individual attributes can be analysed by a step-wise procedure, and Monte Carlo simulations can be performed to address model uncertainty. 'Add-in' routines for the Excel spreadsheet software are available from the author.

For this paper, participants were asked in a questionnaire if they strongly agree, agree, are neutral, disagree or strongly disagree with a series of questions such as: "Fish caught in the sport fishery are of comparable size to what might be found in a pristine fishery". Answers were assigned values on linear scale that were then normalised before the Rapfish computations.

Ecological evaluation of status included questions on the following attributes; assessment status of fish stock, habitat status, size/age limits, minimisation of by-catch, protection of spawners, exotics/introduced species and food web effects and mortality of target species.

Economic evaluation included; total profit, local economic benefit, expenditure category, cash value of local jobs, angler contribution to foreign exchange earnings and marketing.

Social evaluation included; breadth of social benefits, conflict status, social value of local ownership, social value of local jobs, co-management and security of tenure.

Evaluation of management performance included; aims of regulations, effectiveness of regulations, compliance with rules, equity of access, collection of data for management, habitat protection/restoration, communication of rules and management costs.

Evaluation of fishing experience included; size of fish, catch rate, perceived ecological impact, crowding, facilities, perceived value for money and regulations.

In a pilot trial, nine respondents scored 17 fisheries (Canada, nine; Kenya, four; South Africa, two; USA, one and Mexico, one) and the data was subjected to the Rapfish analysis. For all fields, the calculated leverage of individual attributes on the Rapfish status scores was less than 5%, showing that the multivariate analysis is well behaved. Monte Carlo simulation suggested that model error was around 10%.

The Rapfish ordination provides two values for each evaluation field: one a status score and the other a value that expresses distinguishing features among the fisheries. An example is given in Figure 1 (and it's legend). Kite diagrams can express the multidisciplinary status of selected fisheries at a glance (see Figure 2 and it's legend).

Anglers, especially older ones, tended to rate a fishery lower than managers, while boat owners rated a fishery higher than non-owners. Where the same fishery was scored (for example the Cape Town big-game fishery), perceptions differed by about 20% in all fields except angling experience, where it could reach 40%.

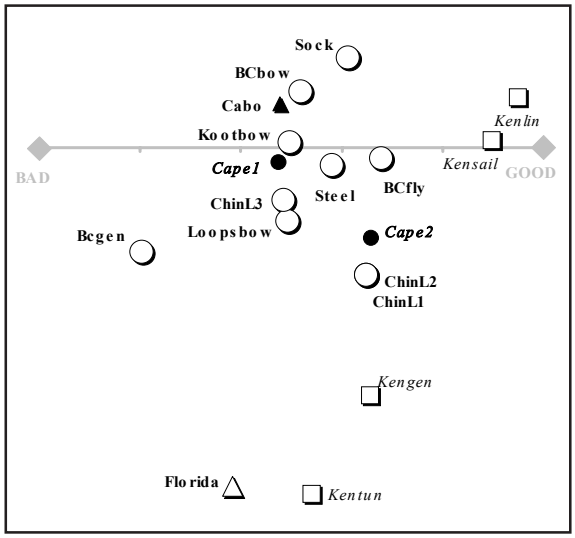

Figure 1. Fishing experience ordinated by the Rapfish method for 17 sport fisheries. Horizontal axis (grey) indicates status, from worst (left) to best (right). Vertical axis expresses other distinguishing features uncorrelated with status. Symbols indicate different countries. Fisheries are: **Florida** = Florida, USA, multispecies marine; **Cabo** = Cabo san Lucas, Mexico, marlin; **Cape1, Cape2** = Cape Town, gamefish, respondents 1 and 2; **Kenlin, Kensail, Kentun, Kengen** = southern Kenyan coast marlin, sailfish (northern coast), yellowfin tuna, gamefish; **BCgen** = all southern British Columbia (BC) sport fisheries, (older fisher); **Bcbow** = BC rainbow trout small lakes; **Loopsbow** = Kamloops rainbow trout; **Kootbow** = Gerard rainbow trout, Kootenay Lake, BC; **BCfly** = BC fly fishing; **Steel** = BC steelhead (sea-going rainbow trout); **sock** = BC sockeye; (all from fisher/managers) **ChinL1, ChinL2, ChinL3** = three BC marine lodges, salmon (fishers).

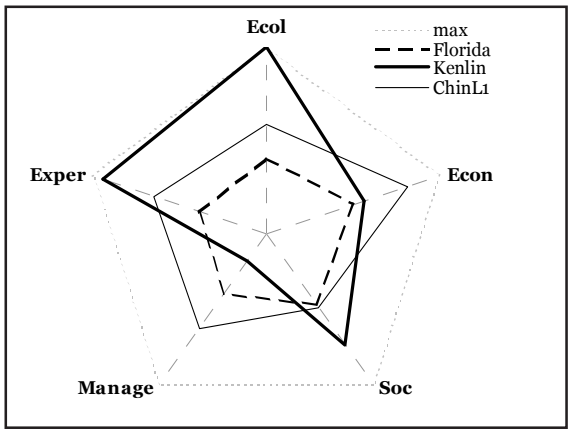

Figure 2. Rapfish kites can provide a characteristic multi-disciplinary signature for perceived fishery status. Here a five-point Rapfish kite diagram summarizes three selected fisheries. Each of the five axes represents a status score obtained from a Rapfish ordination in one of the five evaluation fields, as indicated by the labels. Maximum possible scores lie on the outer rim. Fisheries are: **Florida** = multispecies marine; **Kenlin** = southern Kenyan coast marlin, **ChinL1** = a BC marine gamefish lodge.

The most interesting results came from ranking the fisheries using the status scores in each field. Kenyan fisheries (two respondents, four fisheries) rated highly in all fields except management, which one respondent noted was "virtually absent". The Florida USA multi-species fishery ranked in the lowest quartile in two fields and in the lowest third in the other three fields, ranking lowest overall. Table 1 shows the correlation coefficients among the ranks of fisheries in the five evaluation fields. Fishing experience corre-

Table 1. Spearman correlation coefficients among rankings of 17 fisheries on five Rapfish evaluation fields. Open box = significant at 95% level (2-tailed). Shaded box = significant at 99% level (2 tailed tests).

	economic	social	management	experience
economic	0.29			
social	0.51	0.19		
management	-0.09	0.26	0.29	
experience	0.71	0.63	0.56	0.26

lated very significantly with perceived ecology and economic status, and significantly with social status, but not at all with management performance. The work reported here is a pilot study using a small number of respondents. A full survey using this 'Rapfish for Sport Fisheries' could examine the distribution of scores across different angler groups, and the view of the general public could also be included.

Anglers can act not only as willing sentinels of abundance and change, but also as providers of well-managed data records and tag returns. Can sport fishers help responsible fisheries by providing good data? An early example was the use of the Kenyan sport catch of yellowfin tuna which allowed the estimation of age specific, annual, total mortality rates and hence provided an annual stock assessment (Pitcher and Hemphill, 1989). Indian Ocean yellowfin tuna were found to be overexploited long before official stock assessment based on commercial catch rates came to the same conclusion, but the method appears not to have been followed up.

In British Columbia (BC), the sport fish catch is estimated in two ways. Official catch figures are provided by a regional creel census (including helicopter surveys) and log books from lodges and fishing guides provide annual figures. But these data are regarded as suspiciously low by commercial fishers and others. Every five years a Canadian government questionnaire reaches 15,000 anglers, including those who have visited BC from foreign countries. Angler survey data, adjusted statistically for non-respondents, reports up to double the catch estimated by creel. The angler survey data match better with a number of indicators, including cross-border records of halibut and chinook salmon reported to US border patrols and other estimates of fishing mortality.

So, the good news is that data from anglers can help in managing responsible fisheries. But the bad news is that, for some species, like coho and chinook salmon, relatively unregulated anglers can impose a higher mortality than commercial fisheries, which are heavily regulated. Likewise, in the USA, anglers impose a higher mortality than commercial fisheries for ten key species, and for four of these (dolphin fish, *Coryphaena*; yellowtail, *Seriola*; spotted sea trout, *Cynoscion* and red drum, *Sciaenops*), significantly more (Gentner and Lowther, 2002).

In conclusion, in order to be compleat in a depleted and threatened ocean, modern day anglers need to pursue their sport following ethical guidelines. Moreover, anglers have to begin to evaluate their ethical status and their compliance with the FAO Code of Conduct, as adapted for sport fisheries. Compleat anglers will ensure that the perception of sport fishing has high ecological, economic, and social status. They will also evaluate management performance in achieving a positive perception amongst anglers, managers and the general public. Compleat anglers will take a full role in a modern thalassocracy of respect and care for fragile aquatic ecosystems threatened by human activity. As Isaak Walton says at end of his book: "[The Lords praise] on all lovers of virtue, and [who] dare trust in his providence, and be quiet, and go a-angling"

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Theme 1

ESD and ecological approaches to management

RECREATIONAL FISHING, EXTRACTIVE INDUSTRIES AND ESD: THE CHALLENGES THAT LIE AHEAD

Margaret Moore

World Wide Fund for Nature, 1st floor 9 Church Street, Hawthorn, Victoria 3122, Australia

Abstract

In today's climate of regulating and managing extractive industries, recreational fishers must seek to demonstrate that their fishing activities are being managed in a way consistent with the principles of Ecologically Sustainable Development (ESD).

Some years ago, World Wide Fund for Nature (WWF) challenged the commercial fishing industry and management agencies to demonstrate how viable their industry was in the long term. WWF asked the question of the Australian industry, given the overfished status of a majority of fisheries globally: "were the wild capture commercially targeted species being harvested in Australia in a sustainable manner to ensure the long- term viability of the fisheries?"

The response from the Australian industry and management agencies was in the affirmative, but demonstrating sustainable fisheries management was more difficult. While Australia had spent 1991 developing ESD principles through sectoral committees, and the term appeared in the charter under which many of the fisheries management agencies managed, there appeared to be no universal understanding of how it should be applied within management regimes.

This is changing, in the past 3 years, since the advent of the Environment Protection and Biodiversity Conservation Act in Australia, the commercial industry and managers have focused in on what ESD in management means and how it can be effectively applied.

If the recreational fishing industry is to be taken seriously, and given the number of methods of resource extraction that it embraces and the numbers of people participating, it should be, the challenge for recreational fishers is how it will apply ESD widely to managing their activities and change many of the laissez-faire arrangements that they presently enjoy. This will be explored and addressed during the Conference with a view to obtaining wide support and agreement on the responsible way forward.

Introduction

"*Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased, ESD therefore is not simply concerned with optimal resource management but with the full spectrum of factors involved in environmental, economic and social development.*" (The National Strategy for Ecologically Sustainable Development 1992 nominated definition of ESD).

In Australia, recreational fishing is a very popular pastime for up to one third of the population. It is estimated that at least 5 000 000 people extract about 30 000 tonnes of seafood per annum (FRDC, 2000) and recreational fishing in salt water aquatic environments represents about 73% of recreational fishing activity (Environment Australia, 2001). The results of the National Recreational and Indigenous Fishing Survey will be published shortly to provide further information for decision-makers and managers.

The challenge for the industry is to recognise that in some cases the recreational catch by volume, of a particular species, equals, and even exceeds, that taken by the commercial fishing industry. (FRDC, 2000).

Many of the audience present here derive much pleasure from recreational fishing in its various forms, many are members of associations and are aware of the environmental impacts caused by unregulated fishing, but we need to keep in mind that there is a much larger group who do not belong to any group or association. These people may or may not be receiving the responsible environmental messages disseminated in newsletters and fact sheets. Concerns about extracting large amounts of wild capture species are as follows:

Taking any species from the wild impacts on the ecosystem and the biodiversity within it. An example is the catching of large pelagic species over reefs. In many cases these larger species have an important role, that of predator, within the ecosystem. So taking

the larger species, without any investigation of the long term impacts is putting that ecosystem at risk. Many recreational fishers are observing and reporting that where they once found plenty of fish, they are now thin in the water.

So often the blame is laid at the feet of the commercial operators. However, the commercial fishing industry is managed and in the past 5 years, the accelerated rate of changes to their management arrangements, has required them to develop and apply far more prescriptive management regimes. The Australian commercial industry has undergone a faster rate of change than any other industry anywhere in the world.

Not only do they have to comply with management measures, they have to pay for a major part of the management. Into the budget which they have to meet, is built the application of gear restrictions and modifications, bycatch mitigation device implementation, compliance measures and enforcement. In many cases now, the vessels are tracked in real time through vessel monitoring systems, and catch and bycatch is logged by the crew and verified by on board observers. They also have limits on their access to the resource. It is interesting to know that of the commercial catch, 88% of the volume is exported, the rest supplying some of the local market.

Recreational fishers on the other hand have enjoyed largely unfettered access to the resource. They are able to go almost anywhere within the freshwater and marine aquatic systems and fish for whatever species they can catch, including some of the commercially targeted species, with minimal requirements imposed as to registration, licence fees, bag limits, size and seasonal availability, particularly relating to freshwater fishing access. It has only been in times of excessive drought conditions that rivers have been closed to anglers, in some States there is no registration or licencing of recreational fishers.

Major problems with an uncontrolled industry

Probably the most important downside of an unregulated industry is simply not knowing what amount of impact and damage is being done by the fishers to the marine and freshwater ecosystems and the species contained in them.

To add to the problem, audiences of radio and television are urged to "throw in a line". The presenters, many of whom own recreational fishing gear shops, report on the fun that can be enjoyed even by young children. In many cases, there is no mention of any obligations to practise responsibility towards the environment. Very little information is passed on to the audience on how to handle the fish to reduce stress and perhaps increase the likelihood of survival if released. The recreational fishing associations need to review those who broadcast to radio and TV audiences to monitor and counter some of the messages that are or are not being put across these very powerful communications media.

Releasing the catch to the wild is also an unknown cost/benefit. Fishers have no idea how many of their catch and release fish survive. It may make the fisher feel better but no one knows about the fish. Certainly, some of the survival rates of fish from deeper water are very much in question. In the US, the results of some of the catch and release mortality rates in competitive fishing, show that many released fish do not survive for very long (Schramm, 2001). The catch, release and survival of fish must be investigated in much more detail before we can take any comfort from the notion that the impact is less because the fish are released.

There appears to be an inconsistency in the level of engagment between the industry and the management agencies. In the State of Victoria, VRFish has a representative on the Fisheries Co-Management Council sub-Committees, this helps put the industry in touch with major concerns of the managers of the fisheries, but it is not enough. The industry must now be proactively seeking to become regulated. The data gathered in the commercial fisheries allows TAC setting decisions to reflect the known stock status. In the absence of data the TAC is set at the most precautionary level. If we build in to the data the known take by recreational fishers it will lower the TAC accordingly. But limits on access and catch must be applied to the recreational sector as well as to the commercial sector.

In Western Australia, the management agency is developing future management planning which would incorporate and factor in all sectors – commercial, indigenous and recreational. This will provide a fair allocation of the resource across all sectors.

Many of the spatial planning mechanisms for the marine environment are rejected out of hand by the recreational fishing industry. They fight fully protected areas in which no extractive industry is allowed. In Victoria, after 10 years or so, we are finally getting a small percentage of the coastal and marine environment fully protected. While the recreational fishers were very vocal in their opposition to no take zones some of their number expressed their support for them. WWF is of the opinion, based on mounting evidence from overseas where such areas are being monitored (Roberts et al), that protected areas can provide important conservation and recovery tools as a critically important part of the spatial management of the coastal and marine environment.

What are the upsides of the industry?

Many of the fishers who are supporters of WWF, or who contact the organisation, are concerned about the unregulated nature and unsustainabliity of their industry. Many of them want fully protected areas implemented for the long term benefit of the marine biodiversity.

Others keep a watching brief on coastal wetlands, riparian vegetation and estuarine areas which are most at risk from land based sources of pollution and poor management practices. Some belong to associations where this is being highlighted in disseminated information. WWF will partner some of these groups to work to address these mutual concerns. But providing reports on impacts on the environment whilst useful, is outweighed presently by the inertia and inconsistent approach within the industry to accept change in the form of regulation, management, limited access, compliance and higher fees to resource enforcement.

So what is WWF's challenge for your industry?

For the recreational fishing industry to contribute to ESD it will need to demonstrate that it is addressing the following:

Institutionalise the industry globally, through the development of, within the United Nations (UN) Food and Agricultural Organisation, a Code of Conduct for Responsible Recreational Fishing. This will allow the industry to reach and regulate in more countries than it currently does.

Form a comprehensive National Association which includes all of the recreational fishing methods and develop a responsible Communications Strategy that controls the messengers and the broadcast messages.

Apply regulation and sustainable management to your industry. The voluntary codes of practice are a good start, but if they remain voluntary, many in the industry will ignore them. Make them strong, prescriptive and above all make them enforceable.

Accept the need for managing the "recreational take" in the context of the management of the stocks.

Accept the need for fully protected freshwater, coastal and marine areas of high biological value.

Introduce realistic fees for resourcing the management and research needs of your industry.

Finally, the industry must consider if it wants to grow at this point in time, or whether it would be better to take a step back, improve practices, and institute all of the above.

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ASSESSING THE IMPACT OF RECREATIONAL FISHERIES ON NATURE USING A VULNERABILITY APPROACH AND GIS IN FLANDERS, BELGIUM

Alain J.P. De Vocht[1] and Bart Denayer[2]

[1] Centre for environmental sciences, Limburgs Universitair Centrum, Universitaire campus, gebouw D, 3590 Diepenbeek, Belgium
[2] AMINAL, Dept. Bos en Groen, Provinciale Visserij Commissie, Universiteitslaan 1, 3500 Hasselt, Belgium

Abstract

An inventory of the public angling waters and fishing methods in the Flemish region of Belgium has been made. A methodology was developed to assess the impact of recreational fisheries on the environment, based on a vulnerability approach. Information on the current use of public waters for fishing was gathered for Flanders, a region in Belgium with 70 000 licensed anglers on public waters. Fishing methods were assessed for angling intensity and visualised in a geographic information system.

The different fishing methods were evaluated on their effects, based on their impact and negative effects. Information on the environment (ecotopes, species) was gathered from (digitally) available sources in Flanders. The vulnerability of aquatic and semi-aquatic ecotopes plus bird and fish species was determined on their value for the environment, rarity and sensitivity for fishing activities. All aspects of fishing, including reaching the fishing site, were considered fishing activities.

An analysis of the vulnerability of the environment towards fishing activities has been made and the potential negative effects of trampling vegetation, disturbing breeding birds or waterfowl and possible negative effects of fish stocking, are shown on maps in the geographic information system. The results form a new basis for an integration of inland fisheries in the policy for nature and environment in Flanders. Potential negative effects can be addressed and considered in co-management. Additional local and temporal regulations are proposed as mitigating measures.

Introduction

Recreational fishery management in Flanders (Belgium) is based on fishery management plans, a code of good practise and the impacts of recreational fishing on wildlife. Principles such as sustainability and the precaution principle are being implemented. In this study implementation of these principles was examined in order to assess the potential impact of recreational fishing and to adjust the management of recreational fishing for these impacts. The main objectives of the study were to develop a practical methodology to evaluate the potential environmental impacts of recreational fishing along public waters in Flanders and to integrate existing environmental information and knowledge into potential impact maps to detect potential effects of recreational fishing on the environment and wildlife. The impacts and potential effect of recreational fishing on wildlife were summarised. An inventory of the actual status of recreational fishing (methods, angling pressure) on public waters used for recreational fishing was made. Criteria for assessing the ecological value and sensitivity of the environmental system were formulated. An analysis of the vulnerability was conducted and public waters were classified into a function of vulnerability. Finally propositions to achieve ecological sustainable recreational fishing were formulated.

Methodology

A vulnerability approach has been used to assess the potential effect of recreational fishing. Vulnerability integrates the sensitivity of an environmental system (part of a river, pond, marsh) to a potential impact group (e.g. angling) with the biological or ecological value of the environmental system.

Vulnerability does not predict the impact, but translates specific geographical information of ecosystems to a (presumed) sensitivity regarding different impact groups.

The potential negative effects of trampling bank vegetation, disturbing breeding or wintering birds, ground baiting for carp fishing, competition angling, stocking and (re)introduction of fish were investigated. Figure 1 summarises the different aspects of the study. First a database holding information on recreational fishing in Flanders was established. Then maps with ecotopes vulnerable to trampling or disturbing breeding birds and distribution maps of wintering birds and 'red list' fish species (Kuijken, 1999) were made.

In order to assess the vulnerability to trampling or damage to the bank vegetation by recreational fishing, a map of ecotopes along recreational fishing waters has been retrieved from the biological valuation

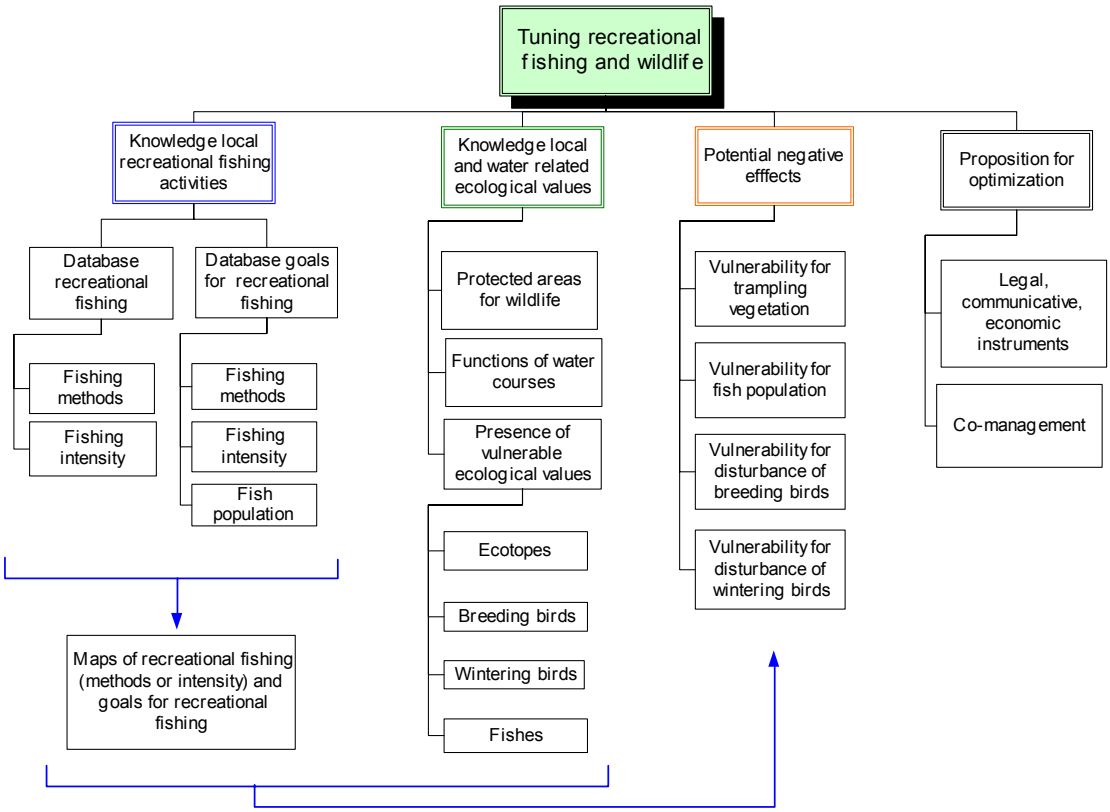

Figure 1. Overall scheme of the general methodology.

map (Institute of Nature Conservation) and the hydrographical map from Flanders (AMINAL, Dept. Water). The biological value and rarity was evaluated for the ecotopes by computing both the valuation and rarity score for the main two vegetation types present. Twenty percent of the scores of the second vegetation type were included, to allow for the second vegetation type being less prevalent. Scores for biological value and rarity varied between 1 and 3.

Rarity was computed as in Kuyken (1999) by the percentage presence of the vegetation types within Flanders. The biological value and rarity score were added for each of the two vegetation types in the ecotopes, resulting in a total score of the ecological value (EV). The score of the EV could vary between zero and 7.2. This valuation was divided into three classes.

Sensitivity of the ecotopes was assessed using a score from 1 to 3 for the two most distinctive vegetation types in the ecotope. Sensitivity of an ecotope ranged from zero up to 3.6, and was divided into three classes. Sensitivity was rated as: 1, non-sensitive or low sensitivity to recreational fishing activity; 2, slightly sensitive or sensitive to recreational fishing activity; and 3, very sensitive to a recreational activity. The matrix of the EV and sensitivity classes indicates the vulnerability (Table 1).

Disturbance of fauna

A selection of animal species was made. Selection criteria were the relevance of the species (bound to water), the value for conservation as determined in the (Red list species in Flanders (Kuijken, 1999)), the availability of overall distribution data and sufficient knowledge on the sensitivity to disturbance

Disturbance of breeding birds

In order to assess the potential disturbance of breeding birds, the bird species were assigned to their breeding ecotopes. The summed score of the sensitivity for each ecotope was calculated. This score was used as sensitivity score for the ecotopes to assess disturbance of breeding birds. The calculations were carried out for the two first ecotopes of the map unit. The scores for both ecotypes were summed, using 20% of the score of the second ecotope. This score, which ranged from zero upto 54, was divided in to three

Table 1. Vulnerability matrix showing classification in order of sensitivity and ecological valuation. The vulnerability values can be described as follows: **1**, not vulnerable; **2**, low vulnerability; **3**, vulnerable; **4**, very vulnerable.

Valuation	Sensitivity		
	1	2	3
1	1	1	2
2	1	2	3
3	1	3	4

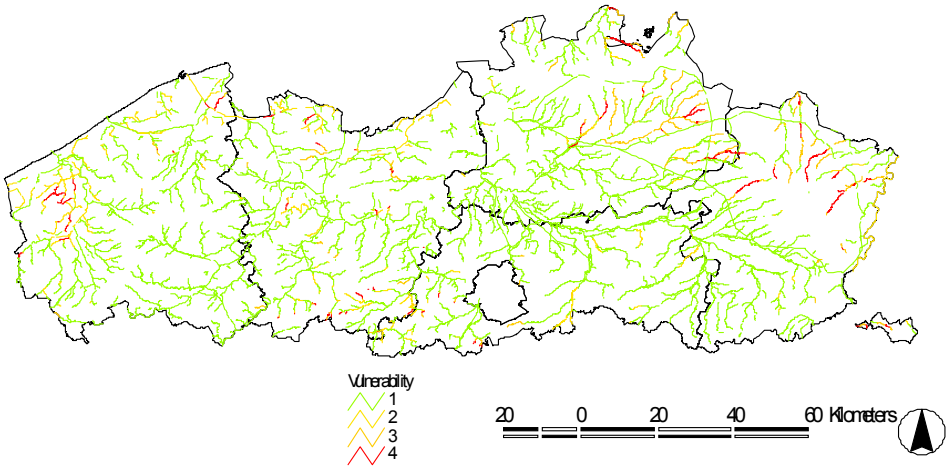

Figure 2. Map showing the vulnerability for trampling of the bank vegetation for waters used for recreational fishing in Flanders (Belgium).

classes for convenient use. There was made no distinction in the biological value of the 23 bird species used. So the sensitivity represents the vulnerability as well.

Disturbance of wintering birds

The vulnerability of wintering birds to recreational fishing was assessed by superimposing recreational fishing areas on the areas where more than 1% of the total North-West-European populations in Flanders reside or where more than 20 000 water birds are present in winter (17 species).

Assessing the possible impact of stocking fish

The analysis of the vulnerability of fishes to fish introductions was investigated by selecting segments of watercourses and water bodies where protected and red-list-species (17 species in total) are present. These areas were superimposed on areas where fish stocking has taken place the last few years. No information on the frequency of introduction or the species introduced were taken into account.

The analysis only indicates where a potential negative impact of fish introduction can be expected. A specific investigation should be carried out to identify the extend of this possible impact.

Results

As a result, a full list of vulnerable or very vulnerable sectors of watercourses has been made. The geographical information system makes it possible to extract maps based on administrative boundaries or river basins, on full or local scale, showing the vulnerability of the bank vegetation to trampling, the vulnerability of breeding or wintering birds and the vulnerability of fish populations to stocking or (re)introduction of fish.

Conclusions

About half of the vulnerable ecotopes are located within protected areas (EU directive areas). The method allows to quantify and localise the potential negative effects of recreational fishing in Flanders. The maps form the base for a more informed implementation of the precaution principle and the tuning of recreational fishing and wildlife on a more local scale. Recreational fisheries legislation appears to be more suitable (flexible) to protect wildlife than nature conservation legislation. Fine adjustment of the management of recreational fishing in relationship to wildlife can be achieved by establishing local co-management.

Acknowledgements

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SPEARFISHING – IS IT ECOLOGICALLY SUSTAINABLE?

Adam Smith[1] and Seiji Nakaya[2]

[1] Australian Underwater Federation (AUF) C\ 4 Seaward Cres, Townsville QLD 4810, Australia
[2] Department of Environment, PO Box 917, Nuku'alofa, Tonga

Abstract

Spearfishing or underwater fishing is an activity that generates emotion and debate. Is it the most ecologically sustainable method of catching a fish or is it an activity of environmental vandalism and needless slaughter? Proponents argue that spearfishing is ecologically sustainable because a diver is restricted to shallow water, a diver is very selective and can target the size and species of his\her capture without the negative impacts of other fishing methods such as bycatch, bait, loss of gear and damage to habitat.

Scientific research supports the view that spearfishers catch a very small proportion of fish – less than 1% compared to recreational and commercial fishers and that fishery indicators such as catch per unit effort (CPUE) and average weight have remained stable over time. I present data from several surveys of spearfishing (mostly competitions) in South Australia, New South Wales and Queensland which support these statements. Opponents argue that spearfishers have been partly responsible for the decline of some species such as grey nurse sharks and also scare fish, which are important for scuba diver tourism.

This presentation overviews methods, catches and management of spearfishing throughout Australia. There have been major changes in the past 50 years, such as the banning of SCUBA spearfishing, formation of the Australian Underwater Federation (AUF) to self-regulate the sport, protection of large 'icon' species such as groupers and wrasses, increasing amount of marine parks, and blue-water hunting for pelagic species. It is anticipated that there will be pressures for further restrictions on spearfishing and these will be supported if there are valid environmental reasons, but will be opposed if they are biased and unjustified.

It is concluded that the future management of spearfishing by voluntary organisations such as the AUF and statutory fisheries departments appears to be based on sound principles of sustainability.

Introduction

Spearfishing or underwater fishing is an activity that generates emotion and debate. Is it the most ecologically sustainable method of catching a fish or environmental vandalism and needless slaughter? Proponents argue that spearfishing is ecologically sustainable because a diver is restricted to shallow water, is very selective and can target the species and size of the target without the negative impacts of other fishing methods such as bycatch, bait, loss of gear and damage to habitat.

There is scant information on spearfishing. Scientific research and anecdotal information supports the view that spearfishers catch a small proportion of fish - less than one percent compared to recreational and commercial fishers, and that fishery indicators such as catch per unit effort (CPUE) and average weight have remained stable over time. We present data from several surveys of spearfishing (mostly competitions) in South Australia (SA), New South Wales (NSW) and Queensland (Qld) which support these statements, and we provide some long-term data on CPUE and average weight of a popular species, the coral trout.

Methods and results

A search of the international scientific literature covering 1971-2001 indicated there were 84 200 articles on fishing and only 145 of these had any reference to spearfishing. The number of relevant articles is much fewer. The first published scientific article on spearfishing in Australia was by Saenger and Lowe (1975) and there appears to have been only one PhD thesis on spearfishing in Australia (Nakaya, 1999). Most of the research has been on spearfishing competitions in NSW or Qld (Table 1), using catch records or questionnaires. Modern Australian spearfishing competitions involve seven to 104 competitors (Nakaya, 1999; Smith, 2000) and have restrictive rules that allow only one of each eligible species to be taken and also prescribe minimum weights during a set time (generally five hours). Catch rates of 0.09 to 2.57 fish per diver hour have been reported (Table 1).

Table 1. Comparison of catch per unit effort (CPUE) of spearfishing studies in Australia.

Study	Region	Period	CPUE	
			species	kg/person/hour
Smith, unpublished	Townsville (Qld)	2001	1.15 – 1.58	2.62 – 3.36
Smith, 2000	Coffs Harbour (NSW)	1995 - 99	0.09 – 0.23	0.49 – 1.09
Nakaya, 1999	Cairns, Townsville, Mackay and Yeppoon (Qld)	1979 - 96	1.20	2.9
Lincoln Smith et al., 1989	Sydney (NSW)	1975 - 76	1.45	–
Henry et al., 1988	Jervis Bay (NSW)	1988	1.40	–
Hyde 1986	Jervis Bay (NSW)	1984 - 85	1.28 – 2.57	–
Johnson, 1985a	Fleurieu Peninsula (SA)	1983 - 84	1.0 – 2.02	0.8
Johnson, 1985b	Spencer Gulf (SA)	1983 - 84	0.55 – 1.10	–
Saenger and Lowe, 1975	Bundaberg (Qld)	1963 - 74	0.10 – 1.46	0.3 – 3.9
Saenger and Lowe, 1975	Port Stephens (NSW)	1960 - 75	0.29 – 1.44	0.4 – 0.8

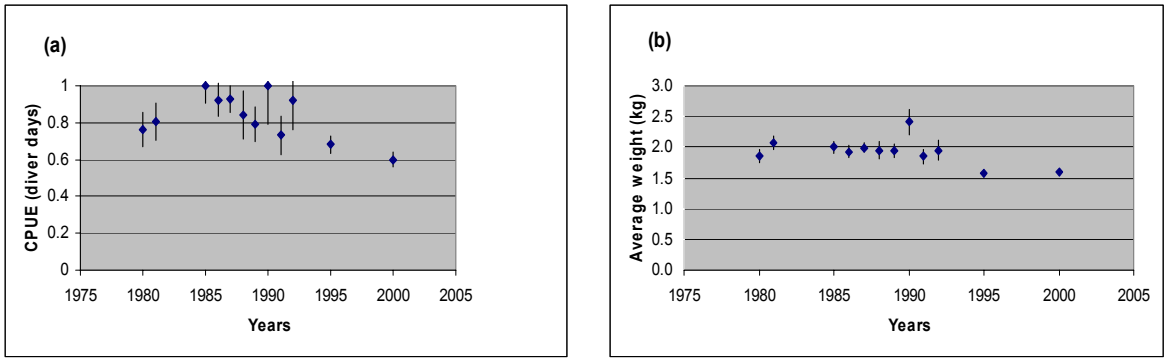

Figure 1. **a**, CPUE of coral trout; **b**, average weight of coral trout by competition spearfishers in the Great Barrier Reef Marine Park between 1980 and 2001.

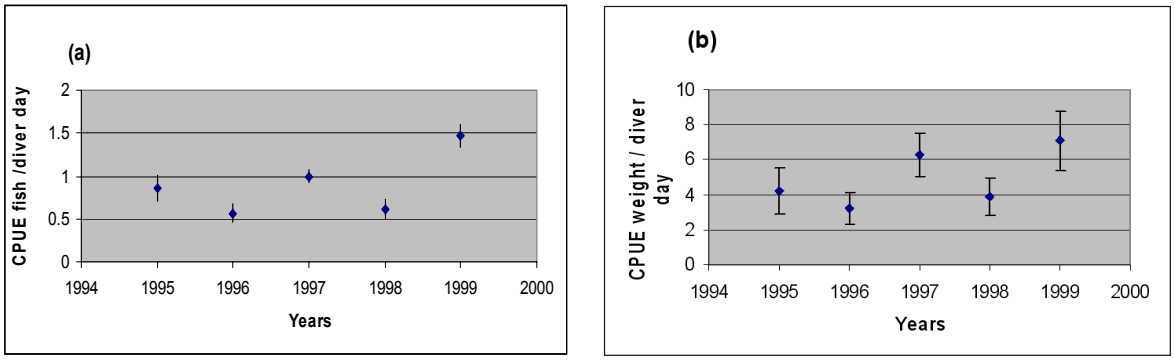

Figure 2. **a**, CPUE of pelagic species; **b**, CPUE of average weight of pelagic species by ABWC competition spearfishers in the Solitary Islands Marine Park between 1995 and 1999.

Table 2. Comparison of catch, effort, CPUE and average weight of five species at the 1994 and 2001 national spearfishing competitions held at Townsville, Qld. (NA: no data available)

Species	Year	Fish	Effort (diver days)	CPUE (species \ day)	Avg wt (kg)
Coral trout (*Plectropomus leopardus)*	1994	98	143	0.68	1.58
	2001	111	188	0.59	1.60
Barramundi cod (*Cromileptes altivelis)*	1994	23	143	0.16	2.47
	2001	44	188	0.23	2.52
Maori wrasse (*Cheilinus undulatus)*	1994	9	143	0.06	13.23
	2001	NA			
Napoleon parrotfish (*Bolbometopon muricatum)*	1994	14	143	0.10	12.41
	2001	NA			
Netted sweetlip (*Plectorhinchus flavomaculatus)*	1994	50	143	0.34	1.74
	2001	NA			

CPUE is considered to be an indicator of fish density. In theory, catch is proportional to fishing effort. Several studies have been combined to analyse CPUE data over a longer-term (Nakaya, 1999; Smith unpublished) and there is no overall trend in CPUE or mean size of several key species. However, it is interesting that the CPUE of coral trout has been around 0.8 fish per diver day since 1979, but appears to have declined by about 25% in recent years (Figure 1a). The average weight of coral trout has remained fairly stable at 2.0kg from 1980 to 1992, but appears to have declined by some 25% to about 1.5kg in 1995 and 2001 (Figure 1b). CPUE and average weight of barramundi cod appear to have increased slightly in recent years (Table 2). Some baseline data on CPUE and average weight is provided on three species of fish; maori wrasse, napolean parrotfish and netted sweetlip, that were captured at a national competition in 1994. These fish species were voluntarily removed from the eligible list for the national competition in 2001 (Table 2).

The annual Australian Blue Water Classic (ABWC) is a selective spearfishing competition which targets large pelagic species. The catch rates are very low with an average of only one fish per day (Figure 2a) and an average weight of 4 to 7kg (Figure 2b). There is no trend in CPUE for fish or weight, although the most recent year provided the highest values (Figure 2a-b).

A questionnaire was used to determine spearfisher's views about management of the Great Barrier Reef Marine Park in general and whether they were satisfied or dissatisfied with management of spearfishing (Nakaya, 1999). Overall, about 50% were dissatisfied with management because of weak controls on commercial fishing compared with recreational fishing. Specifically they were dissatisfied because they think they are discriminated against by being excluded from areas where line fishing is allowed (Nakaya, 1999).

Spearfishers were questioned also about their preferred management tools. The respondents strongly supported minimum size limits, preservation zones, bag limits and patrols/enforcement (Figure 3), were equivocal about stocking, rotational closures, maximum size limit, exclusion of certain types of fishing, and seasonal closures but opposed charges, licence, self-regulation and strongly opposed exclusion of all fishing (Figure 3).

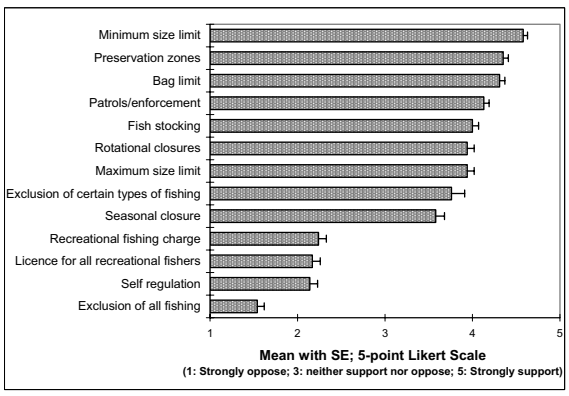

Figure 3. Support and opposition by spearfishers to potential managing tools.

Discussion and conclusions

There have been major changes in management of spearfishing over the past 50 years, such as the banning of SCUBA spearfishing, banning of commercial spearfishing, formation of the Australian Underwater Federation to self-regulate the sport, formal and informal protection of large 'icon' species such as groupers and wrasses (see Table 2), increasing numbers of marine parks, and blue-water hunting for pelagic species. These changes have occurred largely without the support of scientific information. It is acknowledged that good information is scarce, but available information indicates that spearfishing provides consistent results as there has been no demonstrable changes in CPUE or average weight of key species indicative of overfishing, although a recent 25% decline in CPUE for coral trout in Qld waters may be of concern. However, one of the difficulties in this example is that it is difficult to attribute this potential impact to spearfishing compared with the impacts of other fishing methods on the same species.

It is surprising that about 50% of spearfishers in Queensland are dissatisfied with management, but we believe that this figure would be less in other parts of Australia. It is suggested that managers need to consult spearfishers specifically and review current, perhaps inequitable, management arrangements.

Is spearfishing sustainable? A rigorous answer could consider whether spearfishing satisfies the Commonwealth Government requirements for a demonstrably ecologically sustainable fishery, which must operate under a management regime that meets two principles (Environment Australia, 2002). The first principle is: "A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability that the stock(s) will recover". We believe that spearfishing satisfies this first principle and does not lead to overfishing for most species. We have demonstrated stable CPUE and consistent average weights of key species. Also, there are over 440 species of fish that have been captured by spearfishers (Smith, 2000) and we have been able to find only anecdotal reports of local overfishing for one or two species such as blue groper or cods, with anecdotal and scientific evidence of recovery. The second principle is: "Fishing operations should be managed to minimise their impact on the structure,

productivity, function and biological diversity of the ecosystem". We believe that spearfishing satisfies this second principle and perhaps, is one of the most ecologically sustainable methods of fishing because it is selective, is restricted to shallow water, has no bycatch, uses no bait, causes no habitat damage, causes no harm to endangered species and causes no pollution.

Spearfishing is a method that has been used to catch fish for thousands of years. In modern times, spearfishing has evolved to become a recreational activity. The activity has been regulated heavily. It is anticipated that there will be pressures (political and emotional) for further restrictions on spearfishing and these will be supported if there are valid environmental reasons, but will be opposed if they are biased and unjustified. It is concluded that spearfishing in Australia is ecologically sustainable.

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Is recreational fishing in Australia ecologically sustainable ?

Neil R. Sumner

Department of Fisheries WA, Research Division PO Box 20, North Beach, WA 6920, Australia

Abstract

Recreational fishing is one of the most popular leisure activities in Australia with about one fifth of the population (3.4 million people) participating in recreational fishing one or more times per year. The number of days fished by recreational fishers (effort) has increased rapidly in recent years. This has been due to increases in both the population and participation rate. The recent growth in the population is expected to continue in future years. In addition to large increases in fishing effort, anglers have adopted modern technology in an attempt to increase the efficiency of recreational fishing. For many species the recreational catch is comparable with or may even exceed the commercial catch.

Recreational fisheries are difficult to manage due to a scarcity of information on the recreational catch, increasing fishing effort and difficulty constraining the recreational catches. Conventional management methods such as size and bag limits are ineffective for many species since the limits in place may not provide adequate protection for fish stocks and furthermore, these management measures assume that released fish survive. Attempts to limit fishing effort by the issuing of a limited number of recreational licences have not been socially acceptable.

The ecological sustainable development (ESD) assessment process requires an evaluation of the effects of the fishery on the target species and ecosystem and ensures that appropriate management measures are in place. ESD has become, either explicitly or implicitly, a major objective within most Fisheries Acts in Australia. There is no real difference in the requirements for the assessment of commercial and recreational fisheries.

The future health and viability of the recreational and commercial fishing industry is inextricably linked to and is dependent on the good health of our freshwater, coastal and marine systems. While it may be possible to manage fishing activities, other possibly more important factors are beyond the control of the management agency/industry. These include habitat modification, water quality, introduced species and diseases and altered environmental flows. Fisheries agencies will need to work closely with other agencies that have legislation to manage these threats to protect fish resources.

Introduction

Australia's fish stocks are considered to be in good condition by world standards, however, to maintain and improve this situation we must align our management to meet the challenges of the next decade. Recreational fishing is one of the most popular leisure activities in Australia with about one fifth of the population (3.8 million people) participating in recreational fishing one or more times per year.

Ecologically Sustainable Development (ESD) is: "using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased" (CoA, 1992).

ESD has become, either explicitly or implicitly, a major objective within most Fisheries Acts in Australia. Commercial and recreational fisheries are encouraged to undergo an ESD assessment. This is more urgent for commercial fisheries that require an ESD assessment for export approval under the Environment Protection and Biodiversity Conservation Act. However, there is also a need to assess recreational fisheries against these principles.

In addition to the direct impacts of the fishery on target species and indirect impacts on the ecosystem, achieving ESD will also require recognition of the impacts of the environment on fisheries from both natural and non-fishery human induced sources and incorporate these within management responses. For many recreational fisheries there are issues that may reduce or improve performance of the fishery that are outside of the direct control of the management agency/industry. These include water quality, habitat modification, introduced species or diseases and altered environmental flows.

The direct impacts of recreational fishing on fish stocks are considered together with other non-fishing activities, which are more important for many recreational fisheries.

Impacts from fishing activities

Australia's population is currently 19.5 million. It has been predicted that the population will reach 22.4 million by 2020 and 24.9 million by 2050 (McLennan, 1998). This is likely to place increasing pressure on fish resources since the demand for commercially caught fish will grow and the number of recreational fishers is expected to rise.

Impact of recreational fishing

In addition to an increasing population, the participation rate for recreational fishing has also increased. Surveys conducted in Western Australia (WA) show that participation for this state increased from 27% of the population in 1987 (Anon, 1989) to 37% in 2001 (Baharthah and Sumner, 2001). It is not known whether or not this trend will continue for future years. However, the high profile given to recreational fishing by the media in recent years is likely to have been a contributing factor.

Anglers have adopted modern technology to increase the efficiency of recreational fishing with 36% of trailered boats on the West Coast of WA fitted with an echo-sounder (25% black and white, 11% colour) and 12 % using a global positioning system to find fishing locations (Sumner and Williamson, 1999). Of boats that caught Western Australian dhufish, 56 % had a global positioning system on board and 61% had either a black and white or colour echo-sounder fitted (Sumner and Williamson, 1999).

Discussion

Standard management measures used to manage recreational fisheries include bag and size limits. Bag limits are effective in reducing large catches on occasions. However, surveys conducted in WA have indicated that very few fishers achieved the daily bag limits specified under present statewide recreational fishing regulations. Furthermore, bag limits will become even less effective if abundance of the species declines further.

Size limits are an effective catch control measure with substantial numbers of undersize fish of many species caught being subsequently released. However, the regulation of a minimum size limits allows the retention of the largest individuals, which are usually the most fecund. Bag and size limits are only effective for species that survive being caught and subsequently released.

Alternative management measures for recreational fishing will be required given the increasing need for more effective management. Access to the coast and the number and location of boat ramps can be restricted to control the distribution of fishing activities. This method is used to manage activities in national parks; however, it has not been widely used to manage recreational fishing. This is most likely because fisheries agencies do not have the power to directly control access, which is the responsibility of local government or other state government agencies where access through national parks is required.

Temporal or spatial closures or restricted fishing zones are commonly used for managing commercial fisheries, however, they have not been widely used to manage recreational fisheries in Australia. A closure to pink snapper fishing in the eastern gulf of Shark Bay has enabled this stock to recover from several years of intensive recreational fishing effort leading to severely reduced breeding stocks (Sumner and Malseed, 2001). A temporal closure in Freycinet Estuary within the western gulf of Shark Bay while pink snapper form spawning aggregations has been successful in reducing the catch of this species (Sumner and Malseed, 2001).

Token systems giving a recreational fisher a licence to catch a specified number of fish have been used successfully in the United States. This approach would be suitable for recreational fisheries with highly valued fish species.

The ESD assessment will need to take into account the catch of all retained species including any bycatch of non-targeted species (Fletcher et al., 2002a). Any impact on non-retained species, such as protected species, will also need to be considered.

Resource allocation between the various sectors is necessary to meet the ESD principles. Once all fisheries in a region have been assessed through the ESD process, the material could also be used to assist with future debates on the allocation of access amongst competing sectors (Fletcher et al., 2002b).

Impacts from non-fishing activities

In addition to fishing activities, potential threats to fisheries may also include anthropogenic impacts from non-fishing activities.

Habitat modification

Coastal developments have already caused the destruction of many nursery areas particularly in estuaries and embayments. Coastal activities that may impact on fish resources include the construction of canals and marinas for residential developments as well as industrial activities such as the construction of harbours and salt mining.

Habitat degradation may also be caused by activities that change the hydrology by reducing water circulation such as the construction of rockwalls for harbours, marinas and causeways. The altered circulation can cause the destruction of fish habitats and nursery areas such as seagrass beds. Furthermore, stagnant pools where algae accumulates and decays are no longer suitable habitats for fish species.

Water quality

Water quality is adversely affected by the discharge of nutrients caused by industry, run-off from urban areas, sewage outfalls, application of chemicals and fertilisers to catchment areas and increased sediment loads carried by run-off following land clearing. Algal blooms and eutrophication problems are prevalent in our waterways. Furthermore, there does not appear to be a feasible solution to increasing salinity levels in freshwater rivers, which is caused by large-scale land clearing increasing the recharge to saline aquifers and raising water levels. For these reasons many habitats are no longer suitable for aquatic native species.

Introduced species and diseases

Introduced species and diseases have already threatened many native species particularly in freshwater environments. Introduced exotic species may out-compete or predate native species. There are many examples where measures have been taken to control introduced species detrimental to freshwater rivers and lakes such as carp, redfin perch and tilapia.

Altered environmental flows

In freshwater areas, the use and removal of water from rivers and streams for agricultural and domestic use is seen as a major threat for many of the native species living in these environments. River systems that once flowed all year round now only flow for part of the year or only occasionally due to the construction of dams. Many aquatic species that once had a habitat consisting of the full river system now only survive in permanent pools. Furthermore, reductions to the environmental flows have exasperated water quality problems in many river systems.

Discussion

Unfortunately fisheries managers have little or no control over these factors and will need to work closely with other agencies to achieve ecological sustainability.

Conclusions

The future health and viability of the recreational and commercial fishing industry is inextricably linked to and is dependent on the good health of our freshwater, coastal and marine systems. While it may be possible to manage fishing activities, other possibly more important factors are beyond the control of the management agency/industry. These include habitat modification, water quality, introduced species and diseases and altered environmental flows. Fisheries agencies will need to work closely with other agencies that have legislation to manage these threats to protect fish resources.

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RECREATIONAL FISHERIES MANAGEMENT IN THE GREAT BARRIER REEF MARINE PARK

Phil Cadwallader

Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville, QLD 4810, Australia

The Great Barrier Reef Marine Park (GBRMP) is a large (343,500 km^2), multiple-use, marine protected area, with World Heritage status, in which recreational, charter, commercial and indigenous fishing activities occur. The day-to-day management of fisheries in the Marine Park is the responsibility of the State of Queensland. The Great Barrier Reef Marine Park Authority (GBRMPA) is a Commonwealth agency.

In keeping with its responsibility to protect the natural resources of the GBRMP, while providing for reasonable use, the GBRMPA contributes to the management of fisheries primarily through the use of management zones that restrict fishing activities in specific areas. These management zones recognise that different fishing methods pose different threats and have different impacts on the marine environment.

The GBRMPA has adopted a whole-of-ecosystem approach to fisheries management, to ensure the sustainability not only of target species, but also of non-target species and the ecosystems on which they depend. The GBRMPA negotiates with fisheries managers and stakeholders to ensure a whole-of-ecosystem approach is adopted, but if this cannot be achieved by cooperation and negotiation the GBRMPA is prepared to use its legislative mandate.

REVIEW OF HIGHLY PROTECTED AREAS IN THE GBR MARINE PARK – INTEGRATION OF BIOPHYSICAL INFORMATION WITH RECREATIONAL FISHERIES DATA

Darren Cameron

Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville, QLD 4810, Australia

The Great Barrier Reef Marine Park Authority's Representative Area Program aims to enhance protection of biodiversity by developing a network of highly protected areas that represent the range of habitats and communities in the Great Barrier Reef Marine Park. A comprehensive range of biological and physical information was used to define 70 reefal and non-reefal bioregions throughout the Marine Park.

Recreational fishing is a major activity in the Marine Park and is prohibited in highly protected areas.

In selecting the highly protected area network, the aim is to maximise biodiversity protection while minimising the impact on existing users and the wider community. This aim can be achieved only with the integration of a range of use and values data, including information on recreational fisheries. Recreational fisheries data at a variety of temporal and spatial scales have been provided by the Queensland Fisheries Service and recreational fishing groups with the cooperation of SUNFISH, the Queensland recreational fisheries representative body.

Software for the design of highly protected areas has been purpose built and tailored for use to incorporate all data, including recreational fishing data, in the Representative Areas Program.

ORAL HISTORY OF FISH AND FISH HABITATS IN THE GWYDIR RIVER, NSW

Craig Copeland[1], Emmaline Schoonveldt–Reid[2] and Ros Muston[2]

[1] NSW Fisheries, PO Box 154, Ballina, NSW 2478, Australia
[2] Quality Environmental Management, PO Box 113, Fairy Meadow, NSW 2519, Australia

The Gwydir River is a major river of the Murray-Darling system that has undergone significant change with the construction of the Copeton Dam in 1976. Much of the knowledge about fish and fish habitats of this system had not been recorded and as such, current efforts by New South Wales Fisheries to improve fishing in the river were hampered by the lack of baseline information.

This project has been developed to document what fish and fish habitats were present before the dam was constructed, in particular, by gathering the oral histories of recreational fishers in the Gwydir catchment. The key objectives of the project which ran from November 2001 to April 2002 were to: trial a method for documenting historical changes to fish and fish habitat within degraded rivers; to support the rehabilitation of the riverine aquatic fauna and habitats of the Gwydir catchment and its river through greater understanding of past ecological changes, the nature of the changes and their causes; create inter-generational community awareness of the ecological history of the Gwydir River and raise awareness of the natural resource management issues affecting native fish populations and the riverine ecosystem amongst the community.

This paper summarises the results of the project including a pre-dam catchment habitat map, some of the interesting oral histories, a review of how well the methodology worked and what value it may have in other locations.

Acknowledgments

The project was funded by the Murray-Darling 2001 Fish Rehab. Program, New South Wales Fisheries and recreational fishers in Moree.

SALTWATER INTRUSION ON THE MARY RIVER WETLANDS

Paul Jonauskas

Department of Infrastructure, Planning and Environment, P.O Box 30, Palmerston NT 0831, Australia

The Mary River wetlands cover an area of approximately 1 300 km^2. It is a highly productive area which supports multiple land uses such as pastoralism and tourism, as well as providing habitat for a large range of wildlife, including saltwater crocodile, magpie goose and barramundi.

Compared to most other coastal rivers in the Northern Territory, the Mary River is unique in not having a major tidal estuary as a river outlet for at least the last 2000 years. Until recently, wet season runoff from the river's 8 000 km^2 catchment emptied into its extensive lowland and floodplains, which are dissected with deep unconnected billabongs and braided channels.

Since the early 1940s the wetlands have undergone rapid changes with small tidal channels advancing inland, invading the freshwater swamps and billabongs. Aerial photo analysis has charted the change of these tidal channels over time from a length of 3 km in the early 40s to large tidal outlets that now extend 30 km inland. These large channels are now known as Sampan Creek and Tommycut Creek. Channels and gutters are continually forming, which to date, invade 24 000 hectares of freshwater swamps and floodplains.

Recent surveys suggest that up to 100 000 hectares of wetlands are under threat, if the process continues unabated.

Since 1987, the Northern Territory Government has conducted a major saltwater control program aimed at halting the expansion of these saltwater channels across the floodplains. To date, approximately 8 000 hectares of saltwater affected floodplain is showing positive signs of returning to its previous freshwater state.

OPERATIONALISING ECOLOGICAL SUSTAINABLE DEVELOPMENT THROUGH REGIONAL MARINE PLANNING

Steve Jackson

National Oceans Office, PO Box 2139, Hobart, Tas 7001, Australia

Australia's Oceans Policy was released in December 1998 to provide a framework for integrated and ecosystem-based planning and management for Australia's marine jurisdiction. It aims to promote ecological sustainable development of ocean resources while ensuring the protection of marine biological diversity. The key process by which the Government is operationalising the Oceans Policy is through regional marine planning.

The key drivers for the regional marine planning process are ecosystem based and multiple use management approaches. All ocean uses, including recreational and charter fishing, are considered together, to provide opportunities that offer the greatest long-term community benefit and maintain the ecological processes on which life depends.

As part of the regional marine planning approach, Australia's Exclusive Economic Zone has initially been divided into 13 large marine domains, which will be incorporated into Regional Marine Plans.

Planning for the first region off south-eastern Australia commenced in April 2000. The assessment phase of the planning process for this region has now been completed and options for integrated planning and management under the first Regional Marine Plan are being developed.

Scoping of the second region off northern Australia in liaison with the Queensland and Northern Territory Governments and other stakeholders will commence in 2002.

ASPECTS OF THE BIOLOGY OF MANGROVE JACK (*Lutjanus argentimaculatus*) IN AUSTRALIA, AND FACTORS AFFECTING STOCK ABUNDANCE AND DISTRIBUTION

Andrew J. Mc Dougall and David J. Russell

Department of Primary Industries, Northern Fisheries Centre, PO Box 5396, Cairns, QLD 4870, Ausralia

Mangrove jack (*Lutjanus argentimaculatus*) are found throughout much of the Indo-west Pacific and are a highly sought after food and trophy fish within their distribution in Australian waters. This paper presents important aspects of the biology of the species in Australia, and documents some of the impacts (both positive and negative) on this species by various outside factors and influences.

Mangrove jack have a unique and complex lifecycle that requires extensive migrations by both the larval and sub-adult fish. In eastern Australia, spawning occurs in offshore coastal waters, including reefal habitats, during the warm summer months. Larval fish migrate to the rivers and begin to settle from January onwards. Sub-adult fish undertake the reverse migration from rivers to offshore spawning grounds at an age of approximately 4-8 years, where they remain. There are distinct habitat preferences for different age classes of fish. Newly recruited juvenile fish prefer rock habitat structure, while sub-adult fish are commonly associated with fallen timber.

Aging of fish throughout Australia has revealed that this is a slow growing species, where sexual maturation does not occur until they are at least 6 years old, and have migrated offshore.

Recreational fishing of this species primarily targets juvenile and sub-adult fish that have not yet contributed to a spawning, while commercial fishing targets mature fish. Wetland reclamation, riparian vegetation clearing and stream barriers all have an effect of limiting access to new habitat for this species. State fisheries regulations and fisher effort differs dramatically for this species throughout Australia. Fish stocking groups, community catchment groups, landowners, fishers, fisheries managers and other government bodies all have a role to play to facilitate the conservation of this species.

Theme 2

Research methodologies

RECREATIONAL ANGLER SURVEYS: THE INTERACTION OF SCALE AND OPTIMAL CONTACT METHODS FOR EFFORT AND CATCH ESTIMATION

Kenneth H. Pollock

North Carolina State University, Raleigh, NC 27695-8203, USA

Abstract

Recreational fishing catch and effort are more difficult to assess than commercial effort and catch because of the large numbers of individual anglers involved. However, there is a growing body of literature on angler surveys that I review. Complemented angler surveys are defined in terms of the methods used to calculate total angler effort and total angler catch and these methods are often different in large complex surveys. For example, a marine recreational angler survey in the United States (US) uses a telephone-access survey whereas a recreational angler survey on the Delaware River, in the eastern US is an aerial-access survey. This survey uses aerial flights to estimate angler effort by expanding aerial counts of boats fishing. It also uses clerks stationed at access points to record catch rates of individual anglers that can be combined with the effort estimate to estimate total catch. Special problems of the Aerial-Access survey are considered. A traditional unequal probability sampling design and a maximum count model-based approach both have advantages and disadvantages.

Some recreational angler surveys to estimate effort and catch are run at small scales like an individual lake. Others, however, are run at very large scales to the level of states or even countries. In boat based fisheries, a "bus route" access-access survey may be possible at a moderate scale like a large lake but at a larger level, one may need to use an aerial-access survey or even a telephone-access survey. When the scale moves to a national fishing survey, like the Australian survey, then a telephone-telephone design with multiple contacts may be necessary, even though there are drawbacks in having the catch data depend on angler recollection rather than direct observation by trained clerks. I suggest the need for some field validation of catch rates by comparing telephone catch rate estimates with access point catch rate estimates in the same time periods. There is also the need for rotation out after a reasonable time so that respondents don't suffer burnout and drop out. I discuss the issues to be considered to arrive at a scientifically defensible and yet practical design in a time of limited resources for fisheries agencies. Other operational issues such as the value of license files as sampling frames and the use of rewards to increase response rate in recreational angler surveys are also discussed.

Introduction

Recreational angler surveys have received a lot of attention in recent years (Guthrie et al., 1991; Pollock et al., 1994). This is because they are so important for providing sound information on which to base fisheries management decisions. In addition, there is growing recognition of the complexity involved in designing surveys to estimate catch and effort for large regional fisheries. The traditional access and roving surveys developed in the 50s and 60s are not suitable for large-scale surveys. Many regional surveys require a design that uses a separate survey for effort and another for catch. Examples are aerial-access and telephone-roving and these are known as complemented surveys (Pollock et al., 1994).

One example of a large regional survey that uses a complemented design (aerial-access) is the marine survey in British Columbia run by Canada Fisheries and Oceans for the Georgia Strait, near Vancouver. This survey uses aerial flights to estimate angler effort (E) by expanding aerial counts of boats fishing. Also it uses clerks stationed at access points to record catch rates of individual anglers (catch per unit effort - CPUE) that can be combined with the effort estimate to estimate total catch. (C = E x CPUE). The Georgia Strait Recreational Angler Survey has been in continuous operation since 1980. Catch and effort statistics for this tidal sport fishery are calculated for each month, statistical area, and for individual species. Catch of salmon species has shown very serious declines since 1980. This survey is clearly a very valuable source of long-term information. (English, 1983; English et al., 1986; Hardie et al., 1998).

Another example of an even larger complemented survey (telephone-access) is the National Marine Fisheries, USA, Marine Recreational Fisheries Statistics Survey (MRFSS) (Essig and Holliday, 1991). This survey is designed to provide effort and catch estimates for segments of the marine recreational fishery. A general population telephone survey using random digit dialing is administered in coastal counties to determine effort (E). After establishing if respondents had fished at all, anglers are asked to recall their fishing

effort in days, fished over the previous two months. In addition, an on-site access point survey to determine catch rates (CPUE) and collect biological data is carried out. Catch is then estimated as the product of effort and catch rate (C = E x CPUE) as before.

There are a variety of contact methods that can be used for either component of the survey: for effort (access, roving, aerial, mail, telephone); and for catch rate (access, roving, mail, telephone). Aerial surveys can only be used to estimate fishing effort. Traditionally it has been recommended that catch rates only be estimated using on-site methods (Pollock et al., 1994). However, a new approach from Australia that deserves serious attention uses a telephone-telephone diary panel survey (Coleman, 1998; Lyle et al., 2002). This survey uses multiple contact telephone interviews to get both catch rate and fishing effort over time.

Here I discuss some special design issues involved in aerial-access designs and illustrate these with reference to the Georgia Strait Recreational Angler Survey mentioned above, and a survey planned on the Delaware River in the eastern United States in 2002. (Volstad, 2002). I also discuss the challenges that arise in choosing the optimal contact methods as one moves from a small scale to increasingly larger scales. For example, in a marine system the survey could refer to a small saltwater lake, a large estuary, all of a particular state's coastal waters, or even all national coastal waters. The contact methods change from traditional access-access and roving-roving surveys to aerial-access surveys up to telephone-access and telephone-telephone surveys. I refer to recent completed and ongoing research and make general recommendations for sound design choices.

Small scale surveys: access and roving surveys

Small-scale angler surveys that typically use access-access and roving-roving methods have a long history going back at least 50 years and are described in detail in Malvestuto (1983) and Pollock et al. (1994). A more recent important modification suitable for a slightly larger scale is the "bus route survey" for access points developed by Robson and Jones (1989) and also described in detail in Pollock et al. (1994).

Larger scale surveys: aerial surveys

Georgia Strait aerial – access survey

Aerial survey component. Aerial surveys are often used in surveying fisheries resources (Gunderson, 1993; Pollock et al., 1994). Here, the aerial survey component is used as part of the estimation of fishing effort in boat trips (obviously another survey method always has to be used to estimate catch rate). However, it does not use the standard method of randomized instantaneous counts (Malvestuto, 1983; Pollock et al., 1994). A form of model-based sampling is used (Hoenig et al., 1989; Hoenig and Heywood, 1991). Here a boat count is taken at a peak period of the day. This boat count is adjusted by the proportion of boats active in that period of the day, which is estimated from the angler interviews obtained in the access-point survey. The proportion of boats active in the period is estimated from the angler interviews taken over a particular month. This method has been used in other studies (Parker, 1956; Fraidenburg and Bargmann, 1982; McNeish and Trial, 1991; Dauk, 2000; Dauk and Schwarz, 2001; Lockwood et al., 2001). It makes the assumption that the activity pattern is consistent across days in the month. This approach was used to increase the precision by having the counts at the busiest time of day and using all of the interviews in a month. The price of this increased precision may be the introduction of bias, because activity pattern may differ among days, depending on the weather or other factors.

Other important issues that need to be considered in use of aerial surveys are sighting of boats from the air and recognition of which boats are actually fishing. Violations of these assumptions are forms of visibility bias (see Pollock and Kendall, 1987). There may be some poor weather days where fishing still occurs and the plane doesn't fly or if it does fly, visibility is not perfect.

Access point survey component. The access-point survey is used to obtain completed boat-party interviews. It would not make practical sense to use roving interviews in such a large fishery. These interviews are used to estimate the catch per unit effort in various strata and the proportion of boats fishing during particular time blocks.

In this survey, the access points (boat landing sites) are not chosen randomly. The most active sites appear to have been chosen so that the most data could be obtained. Clearly there are implicit assumptions that catch rates, and proportion of boats fishing in time periods, are the same across all landing sites (I do not recommend this be followed in other surveys). A related issue is that there is a substantial number of boats launching from private docks. The assumption is that these sites also have the same catch per unit effort and proportion of boats fishing, as the sampled landing sites.

Estimation equations. The estimation of fishing effort within a stratum (measured in boat trips) is obtained from:

Effort = boat count/proportion of boats fishing.

Recall that proportion of boats fishing comes from the interviews at the access points.

The estimation of catch per unit effort (CPUE) within a stratum is obtained from:

CPUE = mean CPUE.

CPUE is measured as catch/trip. It is also divided into "kept" and "released". Kept fish are based on inspection, whereas released fish come from angler-supplied information that is assumed to be without error.

The estimation of catch within a stratum is obtained from:

Catch = Effort x CPUE.

It is measured in numbers of fish by species for both kept and released fish. Overall effort and catch are estimated by summing the stratum values.

Aerial survey design - ongoing research. The timing of the aerial counts during the day involves some interesting design issues. A traditional probability sampling design with non-uniform probability (Pollock et al., 1994) is one approach, but an alternative is to use the time of maximum count method that was described for the Georgia Strait survey. Here the count is taken at the time of day when the most anglers will be seen and the access interviews are used to estimate what fraction of the daily fishing activity is covered during the count period. Lockwood et al. (2001) compared these two approaches and found that the results were similar in terms of estimates and precision. We are also implementing a field test comparison of these two methods as part of the Delaware River 2002 Angler Survey (Volstad, 2002; Volstad et al., 2002a). This is also an aerial-access survey. It is still not clear which of these two modifications should be used.

Another aspect of the analysis of aerial-access surveys will also be addressed in the Delaware River 2002 Angler survey. If access points are chosen using probability sampling within time strata, using unequal probability to allow for expected use, effort can then be estimated by direct expansion from the access interviews. In addition effort can also be estimated by expanding the aerial counts using the two modifications described earlier. Although it has not been presented in the literature, we believe these two estimates could be combined, weighted by the inverse of their variances (Volstad et al., 2002b). The only proviso to consider before combining is if there is any fishing not covered by the access points (ie bank fishing, small unlisted access points or private inaccessible access points). The difference between the aerial survey estimate and the access estimate is then a measure of the under coverage of the listed access points. Catch estimates can also be computed two ways and combined in a weighted manner if appropriate.

Very large scale surveys: telephone surveys

Telephone – access survey

The National Marine Fisheries, USA, Marine Recreational Fisheries Statistics Survey (MRFSS) (Essig and Holliday, 1991) is a Telephone-Access design to provide effort and catch estimates for various segments of the total marine recreational fishery around the coast of the United States. Only a brief description is given here based on Essig and Holliday (1991) and Pollock et al. (1994).

Telephone component. A general population telephone survey using random digit dialing is administered in coastal counties to determine effort. Random digit dialing (RDD) is used because there is no list frame for recreational anglers in the US. RDD involves obtaining a list of all the telephone prefixes and first two digits of the suffixes within each area code. A particular number consists of 10 digits say 919-821-1495. Consider the block 919-821-14XX. Random digits are chosen to pick numbers for the last two digits. This saves reaching so many non-working numbers. Unlisted numbers are included under this method whereas they would not be if a telephone directory frame was used. There are many refinements to RDD that will not be discussed here. After establishing if the contacted person has fished at all, anglers are asked to recall their fishing effort in days fished over the previous two months and the mode of fishing (shore, private or rental boat, charter or party boat).

Access component. An on-site access point survey to determine catch rates, fishing location (ocean more than three miles from shore, ocean less than three miles from shore and inland waters) and collect biological data is carried out. This was due to concerns with collecting catch rate data from the telephone component. (Essig and Holliday, 1991). Access sites are public only and sampled in proportion to their expected use. A lot of flexibility is given to the interviewer as to when they can sample within the two-month time block.

Catch is then estimated as the product of an effort estimate (E) based on the telephone survey and catch rate (CPUE) from the access on-site interviews. (C = E x CPUE). There are special adjustments for dealing with non-residents that are not considered here.

Telephone – telephone survey with diaries

A telephone-telephone survey design with anglers contacted repeatedly using a diary approach has been used in some recent Australian surveys. Lyle et al. (2002) provides a description of the methodological approach applied to the Northern Territory and Australian National Surveys and I summarise here. The

objectives were to: describe the characteristics of recreational fishers (participation rates, socio-demographics); evaluate effort and catch by species, method and region; assess economic impacts in terms of investment and expenditure associated with fishing and evaluate awareness and attitudes to fishing-related matters. All saltwater and freshwater fishing activities were within the scope of these surveys.

The survey design for general population sampling has been based on single-stage cluster sampling (Thompson, 1992), where the primary sampling unit was the household (chosen by random sampling) and the secondary unit was the recreational fisher within the household, with all fishers in the household included in the sample. Since a listing of recreational fishers was not available in Australia, random sampling of households has been adopted as a feasible means of screening the resident population. The basis for sampling residents was the "white pages" telephone directory (electronic version), which was used as a proxy for private dwelling listings at state and national levels. (98% of the resident population resided in private dwellings). The use of directory lists enabled obvious business numbers and multiple household listings to be filtered out and the sample population stratified into regions. There were special problems with sampling non residents that are not discussed here.

The surveys comprised three components: (i) a screening survey, designed to identify fishing households and invite anglers to participate in the follow-up diary survey; (ii) the diary survey, in which fishing and expenditure activity was monitored over a period of time through regular telephone contact by survey interviewers and (iii) an attitudinal survey, administered as a final telephone interview at the completion of the diary survey.

Screening survey. The household screening survey was administered as a structured interview in which demographic data (age, gender, education, ethnicity, boat ownership, past and likely future fishing activity) of all household members were established. All household members identified as intending fishers (likely to go recreational fishing in the following 12 months) were invited to participate in the diary survey. Respondents who agreed to participate received a diary kit, comprising a covering letter (to establish survey legitimacy), a show card of the most common fish species/species groups relevant to their region and a diary for each intending fisher.

Diary survey. After receiving the diary kit, data requirements were explained to respondents in a brief interview and the next contact arranged. Unlike mail-back diary surveys, the diary was employed more as a "memory jogger" than a logbook, and significantly, responsibility for data collection rested with the telephone interviewers. The level of fishing activity determined the frequency of such interviews but, as a general rule, respondents were contacted at least once a month, even if no fishing was planned. A conservative diary period of just 4 months was employed in the Northern Territory Survey because of concern over possible effects of non-response arising from respondent fatigue. Lyle et al. (2002) state that other studies plus a pilot test, justified a 12-month diary wave for the National Survey.

Attitudinal survey. The attitudinal survey comprised a telephone interview at the end of the diary survey in which respondents were asked a range of questions aimed at assessing awareness and attitudes in relation to resource and management issues.

Trade offs. An advantage of use of telephone surveys in general is one can obtain information on effort and catch rates for anglers not easily reachable in an on-site survey (typically an access survey). These could include shore-based fishing, night fishing, and fishing from private docks and jetties.

A key point in evaluating the Australian telephone diary surveys is that effort and catch rate data that are self-reported may contain very large measurement errors. These may be due to willful deception, recall bias, prestige bias or just lack of knowledge (eg species identifications). Lyle et al. (2002) in their excellent paper discuss all these potential problems and discuss methods they used to reduce these errors to a low level. For example, they had a short recall period and used the diary approach to reduce memory problems. They also checked catch rates from onsite and telephone interviews were similar in some test sites around Australia.

Clearly it is not feasible in the Australian context to use a telephone-access design due to cost. It is widely known that there are trade offs between cost of a survey and precision of the estimates, but it is also true although perhaps less well known, that methods which reduce bias in the estimates may be much more expensive. On site catch rate estimates will be much more expensive than off site self-reported catch rate estimates.

The National MRFSS telephone-access survey in the US which has been run continuously in two-month waves for many years has a different purpose and early on decided not to rely on telephone estimates of catch rates (Essig and Holliday, 1991). (In fact various pilot tests found that there were species identification errors and a tendency to overestimate both the numbers and sizes of the fish caught.) At present I also believe that intentional deception in angler supplied catch data in some highly regulated US recreational

and mixed recreational and commercial fisheries subject to severe restrictions is a distinct possibility. This is probably not a problem in Australia right now, but may be later on if catch in specific recreational fisheries is ever severely restricted due to over-fishing or habitat degradation.

Summary of some general design issues

1. Think very clearly about survey objectives.
2. Use pilot studies to refine methodologies and find potential problems that would compromise the final survey's success.
3. Clearly document all aspects of the final survey design including a list of all assumptions.
4. Consider carefully the number of strata and the variables used to define the strata.
5. Avoid non-random sampling of access points, anglers etc, use stratification or non-uniform probability sampling to increase precision.
6. Devise a sound statistical analysis plan before the data is collected.
7. Establish the level of precision (and hence sample sizes) that you believe is adequate and decide which variables you want it to apply to (i.e. total effort and catch estimates over the whole survey period or for individual time periods and area estimates as well).
8. Make sure that all variance (and standard error) estimates are based on sound statistical theory and that appropriate covariance terms are added if quantities are not independent.
9. Aerial surveys can be very cost effective for obtaining reliable fishing effort at the intermediate spatial scale of an individual estuary or river system.
10. Effort and catch rate data that are self-reported may contain very large measurement errors. These may be due to willful deception, recall bias, prestige bias or just lack of knowledge (e.g. species identifications). Develop methods to reduce these errors or serious bias can result. This could involve refining the protocol using the same contact method or abandoning that contact method and using one that uses on-site interviews
11. It is widely known that there are trade offs between cost of a survey and precision of the estimates, but it is also true that methods which reduce bias in the estimates may be much more expensive (for example, on site catch rate estimates will be much more expensive than off site self reported catch rate estimates).
12. The advent of no-fishing zones and other restrictions are now becoming common in recreational fisheries in the United States. Also some fisheries have recreational and commercial components that are both subject to restrictions. There will be more incentive for anglers to lie about the location and extent of their fishing effort and catch in these fisheries where highly adversarial relationships between the agency and anglers may develop. Therefore I recommend the avoidance of reliance on angler reported data in these fisheries where possible.
13. Complete license file frames can be a very powerful tool in improving the quality and cost effectiveness of angler surveys. For example, telephone surveys are much easier to implement and much more cost effective in such circumstances. Of course, there are substantial administrative and political problems to be overcome in getting them in place.
14. Response burden and the decline in response rate in all surveys is a serious issue for the future that concerns many survey researchers. This is exacerbated by tele-marketing techniques in many western countries. Some important surveys with serious response burden are offering rewards for participation to try and increase response rates. This may be become more common in recreational fishing surveys in the future.

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REGIONAL PATTERNS IN SWEDISH RECREATIONAL FISHERIES

Håkan Appelblad[1], Bo Bengtsson[2] and Gösta Weissglas[1]

[1] Umeå University, Department of Social and Economic Geography, SE-901 87 Umeå, Sweden
[2] National Board of Fisheries, Sweden, P.O. Box 423, SE-401 26 Göteborg, Sweden

Abstract

Interest in Sweden, as in the other Nordic countries, for recreational fishing is widespread. About 35 % of adult Swedes fish for recreation. However, different regional patterns are evident concerning participation, attitudes towards the use of national resources and willingness-to-pay (WTP) for access to recreational fishing. One factor is to be found in the regional differences within Sweden: the population found in rural areas is generally more interested in fishing than people in urban areas. The recreational fishermen in the peripheral areas have, on the other hand, lower relative WTP for their current fishing.

Swedish recreational fisheries is based on roughly 10-20 % of the overall Swedish catch, while the yearly expenditure by recreational fishermen is about three times larger than the value derived from the commercial fisheries in Sweden. In a recent public survey, preservation and environmental issues concerning the overall fish stock was stressed, with the proposition of a general fishing fee in Sweden (long present in the other Nordic countries). The paper is based mainly on analysis of the Swedish component of a large Nordic survey. A comparison is also made with contemporary material from the official Swedish survey on recreational fisheries.

Introduction

Recreational fishing in Sweden is one of the most popular and widespread outdoor leisure activities. About 35 % of Swedish adults fish. Sweden and the other Nordic countries show similar features in terms of low population densities[1] and rich supplies of fishing waters, i.e. a long coastline, many lakes and thousands of kilometres of running waters. The high participation rate in recreational fishing found in Sweden as in other Nordic countries may be seen as a reflection of inherited traditions of subsistence fishing, very common in pre-industrial societies.

This paper is mainly based on analysis of the Swedish component of a large Nordic survey [2]. *The Nordic Survey* was carried out simultaneously in Denmark, Finland, Iceland, Norway and Sweden, from October 1999 to January 2000. The age limits for the sample were 18 and 69 years of age. The main area of the survey was willingness-to-pay (WTP), and hence the estimation of the economic value of recreational fishing.

Participation, typologies and behaviour in recreational fishery

Participation in recreational fishing in Sweden, as in the other Nordic countries, is widespread. About 35 % or 2.3 million adult Swedes fish recreationally at least once a year. Within Europe, only the Nordic countries, Norway (50%), Finland (40%) and Iceland (32%) match this level. With reservations for different interpretation and definitions of a recreational fishery, the overall European level of partition in recreational fishing is approximately 5% (Hickley and Tompkins, 1998). In total, the Swedish recreational fishermen fish for 35 million days annually. As shown in the official Swedish survey on recreational fisheries, *Fiske 2000*[3], the interest in fishing in Sweden is even higher (55%) than the participation rate suggests. The most important motives for fishing are in (ranked) order: contact with nature, relaxation, personal catch opportunities and social companionship.

Within the population of recreational fishermen, *sports fishermen*[4] or anglers, are the largest group, compris-

[1] The overall population density in Sweden is 20 inhabitants per square kilometre. Sweden had 8.9 million inhabitants in 2001.

[2] The Nordic survey derives from the joint Nordic project, Economic valuation of the recreational fishery in the Nordic countries. The Nordic Council of Ministers and participating institutions have financed the Project. The true sample included 24 900 Nordic citizens, and the number of replies was 11 404 (45.8 %). Toivonen et al. (2000).

[3] *Fiske 2000* is carried out by Statistics Sweden on commission of the National Board of Fisheries (Fiskeriverket, 2000).

[4] According to the Swedish definition those who fish with rod and line only.

ing 75% of all recreational fishermen. *Subsistence fishermen* (those who fish with static gear, like gillnets and traps) comprise 9 % and *generalists* (those who use both hand gear and static gear) 16%.

The total annual expenditure on recreational fishing by Swedish citizens is approximately 280 million US$[5]. Investments, like long lasting equipment are excluded from this figure. The average individual annual expenditure on recreational fishing is 150 US$.

Willingness-to-pay (WTP), in addition to the annual expenditure, for the same fishing experience is 38% or over 50 US$. This is the average consumer surplus among recreational fishermen. Compared to the other Nordic countries, Sweden as a whole, shows low consumer surplus, low additional willingness to pay and a high percentage of fishermen rejecting any increase in expenses.

According to *Fiske 2000,* the total catch by recreational fishing was 58 000 tonnes. Sports fishermen (using only rod and line) caught 31 000 tonnes (on average 18kg per fisherman), subsistence fishermen caught 16 000 tonnes (67 kg) and generalists around 11 000 tonnes (31kg) (Fiskeriverket, 2000). By combining these catch figures with the activity rate and WTP among the major categories of fishermen, it is possible to arrive at a preliminary use value (consumer surplus) for the catch. The overall consumer surplus among sports fishermen would be 2.70 US$ /kg of caught fish, contrasted with only ten cents (US$) for subsistence fishing . Thus the marginal utility of the fish caught by an angler is many times higher than the fish caught by a subsistence fisherman.

Regional patterns

The regional patterns show distinct differences in participation, expenses and WTP for access to recreational fishing. One explanatory factor is to be found in the regional differences within Sweden, which has a more densely populated south and a more sparsely populated north.

The population found in rural areas generally shows more interest in fishing than those people in urban areas. In rural areas almost every second person is a recreational fishermen (44 %) and fishes for 17 days annually. The corresponding share of fishermen in urban areas is 31% and in semi-urban areas 35% and they fish on average 11 and 13 days respectively.

The peripheral parts of Sweden, i.e. Upper and Central Norrland, have the highest level of participation (close to 60 % of the total population) and those who fish do so relatively often. The same feature is also seen in the other Nordic countries. All Danish regions have a participation rate under 15%, lower than any other Nordic region. In the Copenhagen region, less than 10% fish for recreation. Besides Denmark, South Sweden has the lowest participation rate, of 25 %.

Eastern Finland has the highest frquency of fishing avtivity with, on average, almost 25 fishing days per recreational fisherman. The Swedish and Norwegian capital regions and Iceland show the lowest average of around 10 days per person per year.

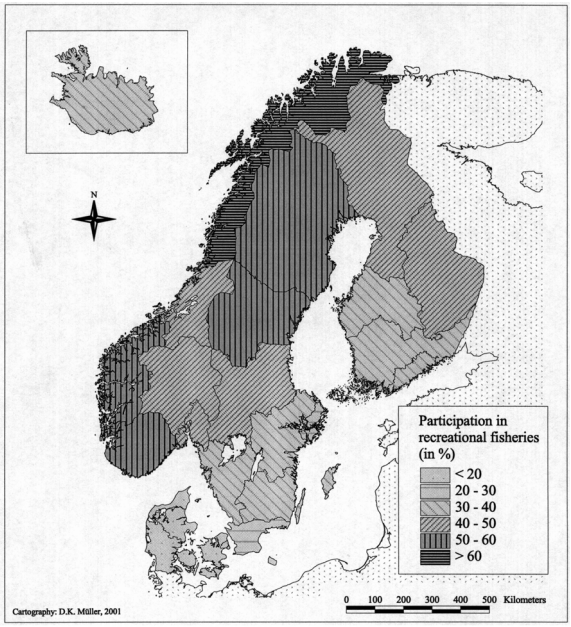

Figure 1. Percent participation in recreational fishery among the whole population (18-69) in Sweden and other Nordic regions (Appelblad, 2001a)

The absolute use value (by equalised PPP values[6]), being the additional WTP for the current experience of fishing, is by far the highest among recreational fishermen in Iceland. However, the relative additional WTP (as percentage of total fishing expenses) is also high in the Stockholm[7] region at 70%. Sweden as a whole has the second lowest relative additional WTP after Iceland. The relative WTP figures seem to indicate that the marginal utility of fishing corresponds with fishing frequencies and thus probably the opportunities for fishing. A smaller number of fishing days gives a higher relative WTP and vice versa.

There are a high percentage of Swedish fishermen who do not wish to pay any more than they already do for their fishing experience. It can be noted that on a regional level, all eight Swedish regions have more zero

[5] The conversion from Swedish SEK to US$ is made by using the Purchasing Power Parities (PPP) for GDP in 1999. At that time 1.00 US$ equalized to 9.70 SEK (OECD homepage; http://oecd.org/).

[6] The conversion from Swedish SEK to US$ is made by using the Purchasing Power Parities (PPP) for GDP in 1999. At that time 1.00 US$ equaled 9.70 SEK (OECD homepage; http://oecd.org)

[7] Stockholm is the capital of Sweden

WTP's (between 38 and 56%) than any other Nordic region. Somewhat surprising is the fact that the Stockholm region has the highest relative WTP and at the same time, the highest share of zero WTP (56 %). The fishermen in the capital region thus express a polarised attitude towards the benefits of recreational fishing, unlike the other regions, which show a less contradictory pattern.

Recreational fishing and commercial fishing

Recreational fishing in Sweden is characterised by large figures, in terms of interest, number of fishermen, number of fishing days and consequently the total amount of money spent on fishing (even though the money spent by individual fishermen may be rather modest). As mentioned above, the total catch in recreational fishing is estimated to 58 000 tonnes of which 48,000 tonnes (or 82 %) was used for human consumption and 10 % was released. (Fiske, 2000).

The Swedish commercial fishery is one of the smaller national industries, compared to forestry, mining and agriculture. Official statistics indicate catch figures between 250 000 and 400 000 tonnes during the last decade. Lately up to approximately 70% of the overall catch is taken as 'industrial fish' (or fodder), i.e. not for human consumption.

The average annual value of sea fisheries in Sweden is approximately US$100 million. This figure can be compared with the total annual expenditure by Swedish citizens on recreational fishing, approximately US$280 million. These figures can be used as a basis for a discussion on the different uses and benefits of a natural resource. There may also be some questions to be answered i.e. which use of a natural resource, like fish, is most beneficial to society? Some of the differences between the commercial and recreational fishery indicate an ongoing process where the number of professional fishermen are decreasing while the catch and the yield has only varied slightly over the last ten years. Between 1990 and 2000 the number of commercial fishermen has decreased by 26%. The workforce is now less than 3 000 people (Fiskeriverket, 2001).

Legislation and resource management

The features of Swedish recreational fisheries described here reflect some of the conditions present in Sweden. The "Allemansrätt" - the Right of Public Access (RPA) - is perhaps the most important of them all. In practise, this unwritten law, gives free access to any land and water for recreational activities such as hiking, canoeing, berry picking or swimming. Therefore people are not used to paying for outdoor recreational activities. In addition, in most Swedish waters, as in the other Nordic countries, only a moderate fee is charged for most types of recreational fishing. The fishing right belongs to the landowner and is not included in the RPA.

For a long time, the recreational fishery along most of the Swedish coastline has been free of charge for the public. In 1985, recreational fishing along the last part of the coastline and in the five largest lakes were included within recreational fishing laws. For fishing in all other areas, a fishing permit has to be obtained from the landowner. Landowners or a Fishery Management Unit decides on the fishing rules for a particular area. The National Board of Fisheries sets the national rules for fishing in the coastal zone and the five largest lakes (inclusive of upstream rivers to a definitive fish migration obstacle). The local fishing rules can be made more rigorous than the national rules but not more open.

Recently, a governmental review suggested the introduction of a general fishing fee (for fishing in the waters where fishing today is free) and a bag limit of four fish per day. Both these two proposals are in the light of growing public attention on fish resources and the high costs of effective and biological sound management of the recreational fishery. This method for solving an economical problem and a biological problem (over-fishing) has been used in the other Nordic countries.

Concluding remarks and future trends

Within Sweden the regional pattern of recreational fishing shows significant differences. The Stockholm region differs from the rest of Sweden with relatively low participation in recreational fishing, but at the same time having a relative high economic benefit (in terms of WTP). In the northern part of Sweden and in rural areas there is a relatively high fishing activity.

The perceived economic benefit of fishing is relatively low in Sweden as a whole. This condition might reflect the idea (more pronounced in Sweden) that fishing should be free. The Swedish Right of Public Access may be one of the explanatory factors in this idea. The free fishing right along the Swedish coast and in the larger lakes may be another factor explaining the relatively low perceived economic benefit of fishing.

The following points are the authors' keynotes on what might be the trends and/or future for the Swedish/Nordic fisheries

- The number of recreational fishermen and the number of fishing days will increase.
- There will be fewer commercial fishermen.

- There will be increased public and political will to take steps in order to restore and/or preserve biodiversity and to act towards the sustainable use of the resources.
- A general fishing fee or license will be introduced in the waters (coastal water and the five largest lakes) in complement or parallel to the owners' fishing permits.
- The income from this general fee will be used for enhancement of the fishing conditions, surveillance, large-scale national projects, research and development. The fee register can be used, among other things, as a tool for collecting the statistics necessary for any decision making, such as on catch limits, bag limits, restricted or closed areas and seasons.
- As a result of all this, there will be better, more economic and sustainable use of the fish resources.

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ADDING VALUE TO RECREATIONAL TAGGING: COMBINED GENETIC AND CONVENTIONAL TAGGING TO ESTIMATE FISHING MORTALITY RATES

Rik C. Buckworth[1] and Steve J. D. Martell[2]

[1] Fisheries Group, Department of Business, Industry & Resource Development, GPO Box 3000, Darwin, NT 0810, Australia;
[2] The Fisheries Centre, University of British Columbia, 2204 Main Mall, Vancouver, BC V6T1Z4, Canada

Abstract

We propose the combined use of genetic and conventional mark-recapture approaches for measuring fishing mortality rates (***F***), for monitoring the impact of fishing, particularly in fisheries where there are both recreational and commercial sectors. Teaming the two approaches provides a means by which the value for management of recreational catch and release and marking programs can be increased substantially.

Few tagged animals are necessary for effective monitoring of a fishery, under the assumptions that tag-shedding and tag-induced mortality are well quantified, and the total catch is well-estimated. If unaccounted for, these problems lead to under-estimates of fishing mortality rates, as does under-reporting of recaptures. These basic problems hamper estimation of ***F*** with mark-recapture techniques in recreational fisheries. Teaming conventional tagging with genetic mark-recapture approaches might overcome some of these problems. In genetic mark-recapture, individuals are firstly "tagged" by microsatellite DNA techniques (msDNA), then a sample of the known total catch is screened for recaptures. Biopsies can be taken without it being necessary to land the fish for tagging. Sampling a known fraction of the catch can be more tractable analytically, than estimating a reporting fraction.

If a program of *in situ* genetic marking is concurrent with conventional tagging, and tissue samples are also taken at release from conventionally-tagged fish, then screening will indicate: fish marked *in situ*; recaptures with intact, conventional tags; and recaptured fish that have shed tags before recapture. Information is thus provided on the relative rates of mortality between the *in situ* and conventional approaches, as well as the rates of shedding and reporting for conventional tagging. Defining these rates with precision usually requires very large tagging programs, but the information might still be useful for separating components of mortality and identifying development directions for conventional techniques. If applied in a monitoring context, precision is evolved over time. We investigate, using closed loop simulation of a small fishery, the use of a combined *in situ* / recreational conventional tagging approach where the information from both sources is used to manage a commercial fishery.

Introduction

The most fundamental question asked by fishery managers and researchers must be: "what *is* the impact of this fishery?" To measure this impact, often expressed as the fishing mortality rate (F), fisheries scientists and technicians go to considerable effort, sampling fish, running surveys and conducting various other forms of information gathering. But, unfortunately, information is typically inadequate for good definition of F. Consequently, there are many examples of fishery failure in which, despite considerable investment in monitoring and assessment programs, fisheries have failed (e.g. Walters and Maguire, 1996).

Mark-recapture is potentially very informative: relatively few tagged animals are necessary for effective monitoring of F in a fishery (Martell and Walters 2002), but there is a set of stringent assumptions that must be met. These are that tag-shedding and tag-induced mortality are well quantified, that the tagging is representative over the exploitable population, and that the reporting rate is known exactly. If unaccounted for, these errors can lead to bad bias in F estimates, and are major reasons why information produced from recreational tagging has largely been restricted to growth and movements.

The precision of F estimation, within a fishery, improves with the number of tags released. In most fishery management contexts, the precision will largely be determined by the number of tags that the management of the fishery can afford i.e., the costs of tagging will largely limit the precision with which □F is determined. We have proposed routine genetic mark-recapture as an additional approach for monitoring F, overcoming some of the limitations in conventional tagging listed above (Buckworth et al., 2002). We investigate here the combination of genetic and conventional tagging, providing the opportunity for relatively inexpensive conventional tagging by anglers to contribute to estimation of F, and indicating tag shedding and mortality rates in conventional tagging.

The Genetag approach teamed with conventional tagging

In theory, the genetic mark-recapture approach differs from other tagging approaches simply in the way individuals are identified. However, there is a very significant practical difference: fish may be tagged remotely, and thus the tag shedding and mortality problems may be avoided. This is because there is very little tissue necessary for genetic identification by microsatellite DNA techniques (msDNA), so that biopsies can be taken without boating fish for tagging. Identified by their "DNA finger print", the fish are 'marked' *in situ*. Matches to these individuals in subsequent screening of the landed catch are "recaptures". Depending upon the fishery in question, this may provide some real economies in the tagging operation. More fish can be tagged within a restricted seatime, compared to conventional (hard) tags, as there is no time lost landing fish, or landing fish that are unsuitable for tagging. Sampling a known fraction of the catch can be more tractable operationally than estimating a reporting fraction.

If a program of *in situ* genetic marking is concurrent with conventional tagging and tissue samples (for DNA fingerprinting) are also taken at release from hard-tagged fish, then screening will provide:

1. fish that were marked i*n situ*;
2. recaptures with intact, conventional tags; and,
3. recaptured fish, detected genetically, that have shed hard tags before recapture.

Information is thus provided on the relative rates of mortality between the *in situ* and conventional approaches, as well as the rates of shedding and reporting for conventional tagging.

The Northern Territory fishery for narrow-barred Spanish mackerel

Widely distributed and supporting valuable fisheries throughout the Indo-West Pacific, the narrow-barred Spanish mackerel, *Scomberomorus commerson*, is fished in the NT by a commercial troll fishery landing nearly 500 t (2001 estimated catch: NT Fisheries Group logbook data), divided among twenty licensed operators. Small catches are also landed incidentally in gill net and trawl fisheries. The commercial fishery is managed by input controls (a limited numbers of licences, with a licence reduction program in place to reduce capacity, and gear controls). Anglers also target the species, and are permitted a possession limit of 5 Spanish mackerel per person but numbers caught and subsequently released are not controlled. Numbers caught are around half that of the commercial fishery (Coleman, 1998).

A fast swimming pelagic predator, *S. commerson* is principally found in schools near reefs and shoals, and is not amenable to survey by trawl, gill net or by air: catch per unit effort is a poor index of abundance. Their vigorous attack and fight, yet relative fragility, mean that Spanish mackerel are difficult to economically catch and tag in sufficient numbers for a one-off, or monitoring, estimation of F. There are also concerns about mortality arising from tagging operations. Consequently, stock status and F have been poorly defined in assessments of the fishery (Buckworth and Clarke, 2001). Nevertheless, mark-recapture has been successfully used in description of growth in the species (McPherson, 1992) and recreational tagging programs in northern Australia include *S. commerson*.

Simulations

We conducted simulations of a small fishery for *S. commerson*, with an unfished population biomass of 1000 t, over a 20 year time horizon. We used an age-structured reference population model, parameterised using information from McPherson (1992), a moderately-productive stock-recruitment relationship and log-normally varying recruitment (CV = 0.6). Catchability was inversely related to population biomass. Management control of the fishery followed an optimum harvest rate rule (F_{opt} (= 0.174; Figure 1) which was calculated from an equilibrium model (Walters and Parma, 1996) and fishing effort in any year t was controlled to an annual target of

$$E_t = F_{opt} / \hat{q}_{t-1},$$

where the catchability $\hat{q}_{t-1}$ was estimated from the time series of tagging information up to and including the previous year. During the first 5 years of simulation, E_t was reduced by multiplying by t / 5, to represent contained development of the fishery. Natural mortality was imposed annually before the fishing season and it was considered that the tag releases were conducted at the beginning of the fishing year. These consisted of genetic tagging of 500 or 1 000 fish, with the total catch subject to levels of 20% or 50% screening. Additionally, hard tags were applied to none, 200 or 500 fish. It was considered that all hard tags, if recaptured unshed, were reported.

Recaptures from genetic and conventional tagging were generated by sampling from binomial distributions, the number of tags specified being the number of trials. It was necessary to calculate separate sample probabilities of recapture for the different groups of recaptures. For genetic tags, this was the harvest rate, U_t (= catch / biomass vulnerable to fishing) $*$ p_s (the proportion screened).

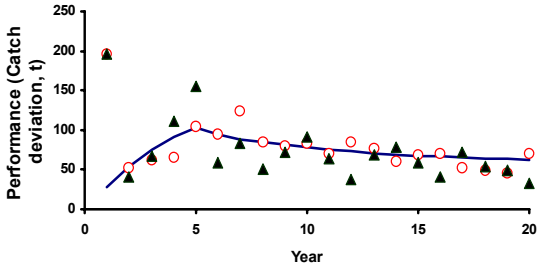

Figure 1. Trajectory of optimum catches (solid line) from a sm fishery compared with typical series of catches when monitoring w based on low (triangles: 500 genetags, 20% catch screening) and moderate (circles: 1000 genetags, 50% screening, 200 hard tags:) tagging effort.

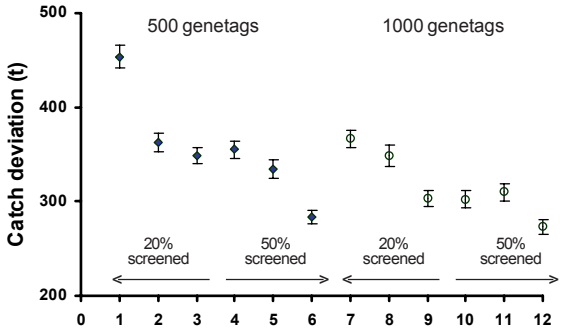

Figure 2. Performance Indices (sums over 20 years of absolute deviations from optimum trajectory) for simulated fisheries with different combinations of genetic and conventional tagging. Symbols represent means of 100 simulations, error bars are standard errors. **Triangles**, 500 genetags released; **Open circles**, 1000 genetags. The first 3 results in each series represent 20% screening, the second set of 3 in each series have 50% screening. Genetic tagging was augmented with none, 200, or 500 hard tags as shown on horizontal

For conventional tags, it was necessary to allow for mortality due to tagging ((TM) and for tag shedding (TS); these were imposed immediately after tagging and the probability of recapturing a tagged fish, with tag retained, was $U_t * (1 - TS) * (1 - TM)$ i.e. the harvest rate reduced by tag shedding and tag mortality rates. For conventional tags for which the tag had been lost but which were detected in genetic screening, the probability of detection was $Ut * TS * (1 - TM)$. The rates TM and TS were constant at 0.10 for all trials.

The annual harvest rate was simply estimated from genetic tagging as the recapture rate (tags recaptured / tags released, for genetic tagging) Rg , raised by the proportion of the catch screened, ie

$$\hat{U}_g = R_g p_s$$

Given the number of conventionally tagged fish detected in genetic screening Ncg and detected with tags (ie unshed), Nc, the tag shedding rate was initially estimated annually as

$$\hat{T}_{S,t} = (N_{cq} / p_s) / [(N_{cq} / p_s) + N_c]$$

then updated as the mean over the years of simulation, $\overline{T}_S$. With the recapture rate of conventional tags being R_c, the annual estimate of the tag mortality rate was

$$\hat{T}_{M,t} = [1 - R_c / (1 - \overline{T}_S)] / \hat{U}_g$$

with $\overline{T}_M$ as the mean of $\hat{T}_{M,t}$ over the years of the simulation. The estimate of the harvest rate derived principally from conventional tagging information as

$$\hat{U}_c = R_c / (1 - \overline{T}_S) / (1 - \overline{T}_M)$$

Note that this estimate depends also on the harvest rate estimate from genetic tagging. Where both genetic and conventional tagging were employed, we estimated the harvest rate for further calculations within each year simply as a weighted mean of the harvest rate estimates from genetic and conventional tagging.

The estimated fishing mortality rate in year t, ($\hat{F}_t$) and annual catchability estimate ($\hat{q}_t$) were each calculated from this harvest rate. A Kalman filter approach was then applied to provide an estimate of catchability, $\hat{q}_t$, that incorporated information from previous years. As noted above this catchability estimate was used with F_{opt} to decide the annual effort to be applied in the following year.

Under the optimum management regime, the time series of catches would be, after initial building, a trajectory of annual values of the product of the optimum fishing mortality rate and the population biomass in year t (ie $C_{opt} = F_{opt} B_t$) (Figure 1). We measured management performance in the simulated fisheries relative to this optimum trajectory, simply as the sum, over the course of the fishery, of the absolute deviations from this trajectory:

$$P = \sum_{t=1}^{20} | C_t - C_{opt} | \text{ (Walters, 1998)}$$

For each combination of genetic tag numbers, screening and conventional tags, 100 simulations provided information on management performance. Additionally, estimation performance was examined by recording the actual F (= -ln(1– U_t) imposed by the fishery at 10 years, as well as recording the estimated tag mortality and shedding rates.

Results

Trajectories for simulated fisheries, even those with minimal monitoring, typically tracked the optimum series, illustrating the main effect that more information from tags reduces variation from the optimum (Figure 1). More explicitly, increasing the number of genetags, the proportion screened or the number of

hard tags released each improved performance (Figure 2) The effect of more information from each of these was to reduce the mean performance index (P) – indicating lower average deviation from the optimum as tag information increased. Thus, the minimal case of 500 genetags and 20% screening achieved a P of 454 t, indicating a mean deviation of 22.6 t from the optimum. Adding a program of 200 hard tag releases to that scenario reduced the P to 362 t (mean = 18.1 t), both compared to the mean optimum catch of 72.7 t. This was similar to the result achieved by doubling the number of genetags, with 1000 genetags and 20% screening, producing a P of 367 t (mean =18.1t). The most effective monitoring, achieving P = 273 t (mean =13.7 t) was with 100 genetags, 50% screening and 500 hard tags.

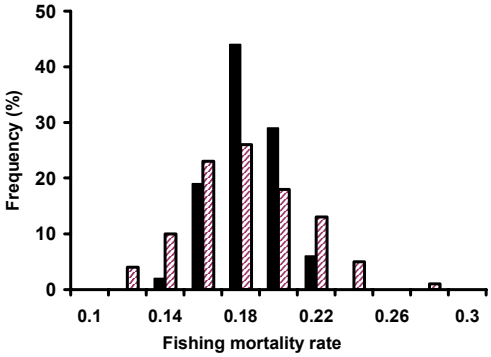

Figure 3. Distribution of the fishing mortality rate in the 10th year of the simulated fisheries. **Solid bars** indicate fisheries with annual releases of 1000 genetags and 500 hard tags, with 50% catch screening; **hatched bars** indicate annual 500 genetag and 200 hard tag releases, with 20% screening. The optimum value of F was 0.174.

The estimation performance, driving the fishery performance, also improved as more information was available from tags. The distribution of F in the simulated fisheries at the tenth year (Figure 3), centred around the Fopt value of 0.174. The spread around this optimum decreased as tagging commitment increased. Both mean tag shedding and tag mortality rates at the 10th year were poorly estimated when commitment to tagging was low, but improved substantially as tag numbers and screening were increased (Figure4). These were nevertheless centred around the input value of 0.1.

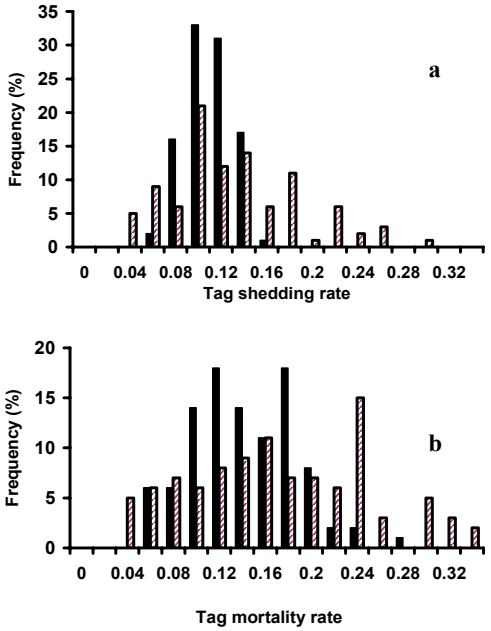

Figure 4. Distribution of estimates of **a**, mean tag shedding; and **b**, tag mortality rates in the 10th year of the simulated fisheries. **Solid bars** indicate fisheries with annual releases of 1000 genetags and 500 hard tags, with 50% catch screening; **hatched bars** indicate annual 500 genetag and 200 hard tag releases, with 20% screening. The real value of each rate was 0.1.

Discussion

We have illustrated here that, when combined with genetic tagging, conventional tagging can contribute to estimates of the fishing mortality rate, thereby improving fishery management performance. The simple analysis we present quite clearly demonstrates the simple principle that more tags, providing more information produce more precise estimates of F, can improve fishery performance. In any fishery the amount of commitment (effort put into information gathering for monitoring, often indicated by funding) determines the precision with which management can be implemented. A primary cost in a monitoring program based on tagging, is the release of the capture animals for tagging. Scenarios in which the principal cost of monitoring a small fishery might be a genetic tagging program, can be substantially improved when even a small conventional tagging program is also conducted. Although F was reasonably well determined, tag shedding rates and tag mortality rates were highly variable, particularly for low tagging commitment. This is not surprising as the number of recaptures dealt with were very low and these rates were determined by calculation from the two tagging recapture rates (ie genetags and hard tags). If these became objectives of research, with the intention of improving methodologies, these would be improved with larger tagging programs or by using additional information (eg double tagging programs, other mortality data) to refine the rate estimates. We have also found that in spreadsheet simulations that estimation improves substantially if rates are higher. We also assumed that distribution of tags and implementation of the effort control each year were without significant error. In development of a fishery management strategy these problems would need to be addressed.

Clearly, this simple illustration could not accommodate all possible mark-recapture models, estimation methods for the different rates, or sets of fishery control rules that might be developed. It is conceivable that performance could be improved with alternative rules for calculating catchability levels and weighting the relative input of information from genetic and conventional tagging. This should be a fruitful area of future research.

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MEASURING ANGLER EFFORT WITH REMOTE SURVEILLANCE EQUIPMENT

John Douglas

Department of Primary Industries, Marine and Freshwater Resources Institue, Private Bag 20 Alexandra, Victoria 3714, Australia

Abstract

Creel surveys of angler catch and effort are presently being used to monitor and/or determine the success of recreational fishing in Victoria. Such surveys are costly and time consuming to carry out and it is difficult to maintain this effort over a long time period. Fisheries Victoria is currently trialing two forms of remote sensing initially in conjunction with creel surveys, ie traffic loggers and pedestrian counters on access tracks. The results of these trials show that in certain situations remote sensors offer a relatively low cost, reliable, non-intrusive monitoring method that can operate in remote areas and work twenty four hours a day, seven days a week. Remote surveillance has the potential to effectively and efficiently monitor angler effort and represent a useful tool to assist in the monitoring of angler usage and effort trends.

Introduction

Fisheries managers need to be aware of trends in angler numbers to effectively manage the recreational fisheries. However, such data is required to be collected over long time scales so that any changes or trends in the angler effort can be detected. Changes in angler effort may relate to changes in fish stocks, habitat, and other more general demographic trends (Connelly et al., 1999). Therefore early detection of effort trends can allow the formulation and implementation of appropriate management actions. Also, in combination with angler expenditure and biological information, angler effort data can assist administrators to effectively assign personnel and resources toward specific management objectives (Gordon et al., 1973).

A common method of monitoring recreational fishing pressure is by the use of angler interviews or creel surveys. Such studies obtain estimates of angler effort and catch and also other sociological aspects of the fishery. For example, how satisfied anglers are with the fishery. However, creel surveys are demanding to run. They require the employment of a creel clerk to ask the questions and depend on an appropriate sampling design that adequately samples across the whole spectrum of angling activities in the fishery. Indeed, sample size determination in creel surveys is a very important consideration as the amount of sampling effort has a direct effect on both the accuracy of the estimates and the overall cost of the survey. The funds and staff commitment required to maintain ongoing creel surveys are restrictive to many organisations and therefore often the surveys are restricted to one off events. Whilst such samples give snap shot estimations of catch and effort, it is the long term data sets of these attributes of the fishery may yield considerably more information, particularly in assessing trends in angler effort.

Given the high cost of monitoring angler effort, other methodologies have been explored to obtain the required information on a more cost-effective basis. Modern people counting devices such as traffic and trail counters may have some uses in fisheries management. The counters offer fisheries managers a relatively cheap, reliable and non-intrusive data collecting system to monitor angler activities. The devices have the ability to operate in remote areas and work twenty-four hours a day, seven days a week. Remote surveillance therefore has the potential to be a useful tool to assist in the long-term monitoring of angler usage and effort. Victorian Fisheries is trialing two types of remote surveillance equipment to assess the suitability to monitor long term trends in selected fisheries. A traffic counter was trialed at Lake Dartmouth and pedestrian counters are currently being trialed along pedestrian access tracks of the Rubicon River.

Types of counters

Several technologies are available "off the shelf" for counting both traffic and pedestrians. Traffic counters are devices used to count vehicles and are routinely used by councils and road authorities to monitor traffic flow and volume. The devices can be loggers or

counters and can be programmed to recognise an assortment of vehicles such as cars, trucks and cars with trailers. Depending on the installation, the devices can give speed, direction and time information. The typical traffic counter has a tube across the road and when a passing car compresses the tube, the compressed air operates the counter. Such tube counters are a relatively common sight along roads. The units are quite portable and can operate on sealed and unsealed roads. Sometimes an inductive loop, optic fibre or piezoelectric sensors operate the counters. Such counters can detect vehicles at slower speeds than tube counters and can be deployed in either permanent or temporary placement.

Pedestrian counters are often set on walking trails to monitor use. The counters are portable, usually battery powered and easy to conceal and install. There are two common forms of pedestrian counters, mechanical and electronic. Mechanical counters or loggers require some form of pressure or switch to be triggered to operate. Electronic counters commonly employ either active or passive infra red technology. Active infra red units use a reflected beam of infra red light and operate when the beam is broken by a pedestrian. Passive units are triggered by close movement and operate without the beam.

Case study #1 Lake Dartmouth

Lake Dartmouth is an impoundment in the foothills of the Great Dividing Range in north eastern Victoria (36°35'S.,147°31'E.). The lake was formed in 1979 when a 180m high embankment was constructed across the Mitta Mitta River (Hume, 1991). At full capacity it stores 4,000,000 ML of water and covers 6,400 Ha (Tunbridge et al., 1999). Lake Dartmouth provides a carry-over storage for drought security, supplementing Lake Hume (DWR, 1989). The surrounding catchment is predominantly vegetated with natural bush, and the water quality is generally excellent. Brown trout (Salmo trutta Linnaeus), rainbow trout (Oncorhynchus mykiss Walbaum), and Macquarie perch (Macquaria australasica Cuvier) thrived in the newly formed lake during the early 1980s, producing significant populations and very good angling. The lake currently supports an important recreational fishery. Lake Dartmouth is principally a boat-based fishery with a single, concrete, boat ramp located at the end of a single access road.

During the late 1990s, local angling groups raised concerns that the Lake Dartmouth trout fishery had declined and required stocking (North East Angler, 1998). In response to these concerns, Fisheries Victoria instigated a study of the fishery to determine whether trout catch rates were low and if stocking was warranted. An integral component of this study was to undertake a creel survey designed to emulate a previous creel survey of the fishery conducted during the mid 1980s (Hume, 1991) and compare the results. To verify the creel design was sampling the population of anglers, a traffic counter was installed on the main Dartmouth access road. The traffic counter was deployed on the access road to trial the ability of the device to detect angler usage patterns. Such information could be used to check if the creel design was intercepting most anglers. Because the device would also count the number of boat trailers, we could obtain a baseline measure of use for the future monitoring of angler numbers.

The traffic counter chosen was a TCS instruments (Australia) "Trafficorder". This model utilises two rubber tubes spread across the road to detect vehicles. The counter has a suite of inbuilt programs which allows the device to be programmed to record data on traffic volume, classification of vehicle, speed, time of day and direction. We chose the mode that classified vehicles into a series of categories or bins based on length (distance between axles) and number of axles (one bin was cars with trailers). As recreational boating activities such as water skiing are prohibited, the majority of cars with trailers represent boat fisherman. The remoteness of the water storage and lack of bank access limit bank angling. Therefore, the monitoring of cars with trailers was seen as a suitable approach to monitor angler pressure.

The situation at Lake Dartmouth was ideal to deploy a traffic counter and the counter was set up to log traffic in both directions hourly.

Apart from providing the number of boat trailers using the Dartmouth boat ramp over a year, and thus presenting a measure of annual effort, the results from the traffic monitoring could also be viewed several ways. It provided information on angler usage patterns by clearly indicating vehicle movement on several temporal scales. On a daily basis, boat users completed their trips in daylight with a spread of return throughout the day but more in the afternoon/evening (Figure 1a). On a monthly time scale, the counter clearly showed increased activity on the weekends (Figure 1b), and on a longer scale, highlighted the increased activity on events such as holidays (Christmas, New Year and Easter) and fishing contests (Figure 1c). The counter also counted the total number of cars for the year.

Case study #2 Rubicon River

The Rubicon River is a relatively small stream near Thornton, Victoria (37° 15'S., 145° 48'E.) which flows

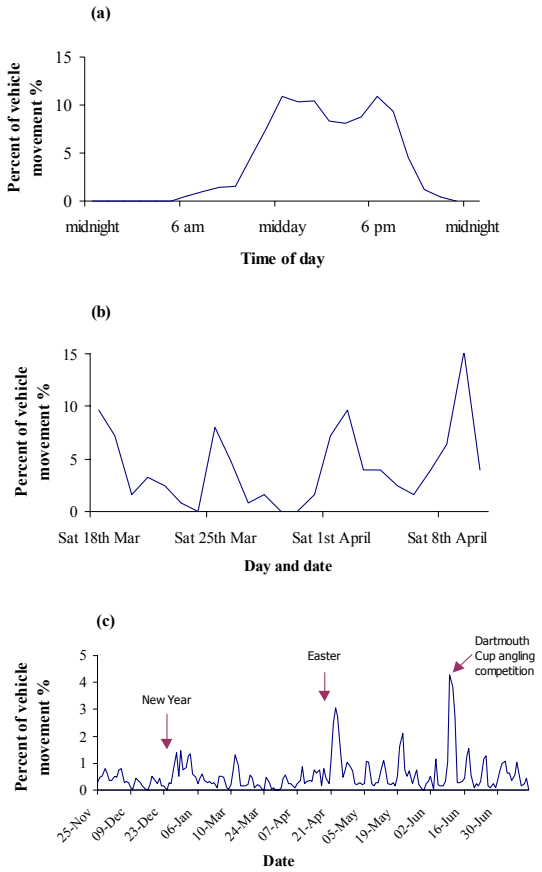

Figure 1. Examples of traffic counter results from Lake Dartmouth boat ramp road (Douglas and Giles, 2001)

through forested country in the upper reaches before crossing a cleared floodplain to join the Goulburn River. In general, the stream has a boulder and cobble substrate and typically a run pool riffle morphology across much of its length. The Rubicon River supports a significant self-sustaining population of brown trout (Tunbridge et al., 1999). While much of the upper forested reaches are inaccessible to angling due to hydro-electric power generation, the mid to lower section of the stream are popular fishing venues. Anglers raised concerns that the stream does not maintain an acceptable catch rate over the entire trout season and the falling catch rates possibly reflect over-harvest from too much angling pressure. On behalf of Fisheries Victoria, a study was undertaken to investigate this issue. The study included a creel survey to establish the angler take, as well as population estimates across the angling season. Pedestrian counters (Ballinger Technology, Melbourne) were also installed at selected angler access tracks to trial the effectiveness of such devices to detect and record angler usage. Knowledge of such information would support the creel survey design and to would obtain some baseline relative use estimates that may serve useful to monitor effort over a long time scale.

The type of trail counter used was activated when a pedestrian walked across a buried pressure pad. The

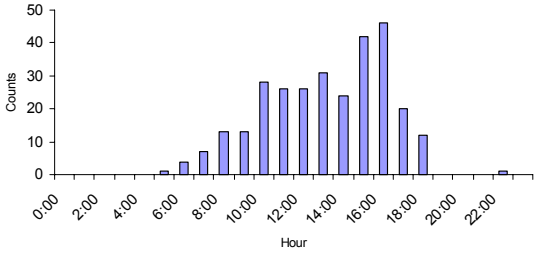

Figure 2. Example of pedestrian counter results based on several months data pooled on an hourly basis from an access track on the Rubicon River. The results indicate that angling is primarily undertaken during the day.

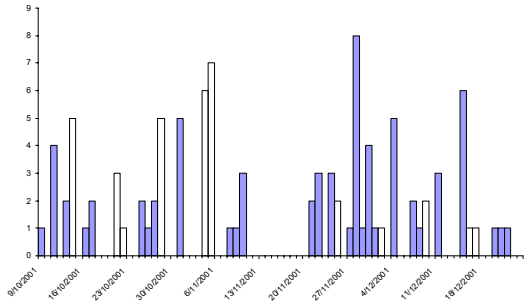

Figure 3. Example of pedestrian counter on Rubicon River access track over three months. Clear columns represent weekends. Chart indicates importance of mid week visits.

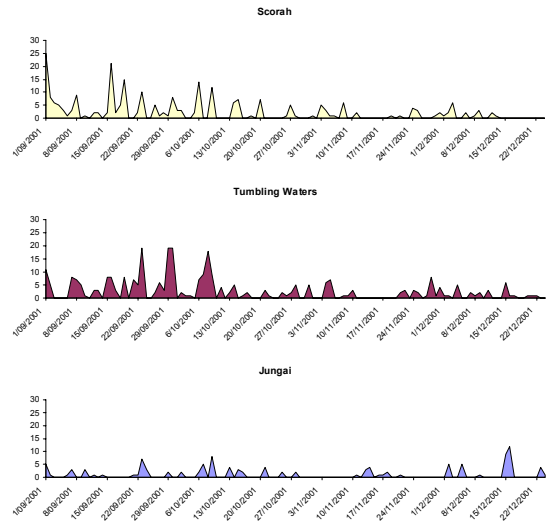

Figure 4. Comparison of pedestrian counter results for three access tracks on the Rubicon River for three months at the start of the trout angling season. Results also indicate a trend of decreasing activity after the first month.

information was logged hourly. The counters were placed to log angler use on an hourly basis at three main access tracks along the river.

Similarly to the traffic counter, the pedestrian counters give an estimate of activity on the access tracks. The results from the pedestrian monitoring could also be viewed several ways to investigate angler usage patterns. Like the traffic counter, the pedestrian counters

clearly indicated people activity on several temporal scales. On a daily basis, most activity was confined to daylight with a spread of return throughout the day (Figure 2). On a monthly time scale, the counter clearly showed activity did not necessarily increase on the weekends, but was relatively constant across the whole week (Figure 3). On a longer scale, increased activity in the first month of the season was highlighted (Figure 4).

Discussion and conclusions

Remote surveillance equipment such as traffic and people counters have the potential to obtain high quality data very cost-effectively and as such they offer a useful tool to fisheries managers. However they may not be suitable in all fisheries monitoring applications.

We found the traffic counter on the Lake Dartmouth boat ramp road to be a most useful device to record cars with trailers. The counter had a built in accuracy check that binned unknown vehicles. A large number of counts in this bin would indicate a malfunction with the counter. Routine checking of the device ensured minimal data loss if such an event occurred. Ongoing monitoring of the access road via a traffic counter will serve as a useful activity to monitor angler use in Dartmouth in the future. Any changes in counts will indicate changes in the angler effort of the fishery and therefore might indicate some change in the fishery that requires further investigation.

The pedestrian counters were not as successful as the traffic counter due to some early set up problems. Indeed, pressure pads may not be the most suitable detection devices for these counters. The main problem with the pads was non-recording. The initial set up of the counters included using a light gravel/clay mixture over the counter pad. However, in summer this topping baked hard in the sun and formed a tough shield. This appeared to dramatically decrease the sensitivity of the pad and therefore pedestrians were not recorded. The devices were routinely checked. The person downloading the information would walk across the counter ten times and check to see how many of the passes were recorded. If the accuracy was low some remedial action was undertaken to remove some of the mixture on the pad. Physical disturbance of the pads by wombats was also encountered. Wombats were sometimes attracted to the fresh soil and would dig up the pad. Also, being heavy, a wombat could trigger a pad to count. Indeed, during the initial set up prior to the trout season, a large number of counts at one counter was thought to be due to wombat activity due to the number of tracks and scratchings on the track and around the pad. Another problem with the Rubicon River counters is the inability to monitor direction and to distinguish anglers from non-anglers. The stream is popular for other activities such as picnics and walks.

Despite these problems, the pedestrian counters still have merit and have provided some useful information. For example, the results to date reveal differences in angler use at various sites and some overall trends. Comparisons of the three sites on the Rubicon indicate less relative usage in the Jungai area (figure 4). The stream in this area is difficult to wade at all times due to the presence of larger boulders (greater than a metre in diameter) and is particularly hard to fish in times of higher flows early in the trout season. Consequently, the area is not as popular with anglers. The counters also indicated a change in fishing activity after the first month of the trout season (figure 4). It appears angling levels have subsided after an initial burst of higher activity immediately after the season opened. Anglers appear to fish the Rubicon on any day. A snapshot of angler counts over three months on an access track does not indicate any more effort on weekends than on weekdays. This is in contrast to the Lake Dartmouth fishery, that has definite peaks of angler activity on weekends (figure 1b). Such angler usage information may be useful to fisheries managers to understand high use periods and annual angling trends for enforcement activities, creel surveys and general knowledge of the fishery.

Other pedestrian detection devices are available that may be more suitable than the pressure pad to detect pedestrians. For example, some counters use either active or passive infra red devices to detect and count people. Whilst the various new counting and technologies require further investigation to determine their suitability under various situations, the range of technologies presents the fisheries managers with several possible options. Permanent or semi permanent counters could be set up at boat ramps on some fisheries, or at popular access points for anglers along streams. Infra red beam counters could even be deployed across the smaller streams to count anglers as they walk upstream.

The extensive range of modern counting devices offer the fisheries managers and researchers a relatively cheap, reliable and non-intrusive data collecting system to monitor angler activities in a range of locations. The devices can operate in remote areas and operate for twenty-four hours a day, seven days a week. Remote surveillance has the potential to be a useful cost effective tool to assist in the long-term monitoring of angler effort in selected fisheries.

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THE USE OF CREEL SURVEYS TO ANSWER FISHERIES MANAGEMENT QUESTIONS IN VICTORIA, AUSTRALIA

Kylie Hall and John Douglas

Department of Primary Industries, Marine and Freshwater Resources Institute, Private Bag 20, Alexandra, Victoria 3714, Australia

Abstract

It is becoming more apparent that managers often need to know more than just catch and effort in a fishery: at times they also need to know what anglers think and do regarding fishery resources and why. In Victoria, recreational catch and effort data is collected by creel surveys. These surveys are designed to answer specific management questions and range from simple catch and effort data collections to more complex assessments incorporating angler opinions. The inclusion of angler opinions, such as satisfaction information, enables a more holistic view of a fishery, allowing for integration of angler preferences into the fisheries management process. Creel survey programmes implemented on inland waters in Victoria are reviewed, and the differences in objectives, design and complexity are reported. The surveys provide information on the profile of anglers, fish species caught, targeted species, an estimation of total catch and harvest, angler preferences with regard to regulations, seasonal frequency of fishing trips, and resource usage patterns. The results recommend improved communication and feedback between users plus mechanisms for future regional development and management of recreational fisheries.

Introduction

Future management of our fisheries, both wild and stocked, will depend on our ability to give people what they want, to the extent that the resource can support it. Few recreational activities create the emotional commitment and intensity found in fishing and it is thus imperative that management initiatives are supported by quality data. Using various methods, data must be collected to describe, understand and predict angler behaviour.

There is a long tradition of using on-site studies (i.e. creel intercept surveys) for capturing fisheries-dependent data from anglers to estimate their effort and catch, and of using off-site studies (i.e. mail surveys) to collect attitude and opinion data. Although these two types of angler studies appear mutually exclusive, this need not be the case, so questions about angler attitudes, economic expenditures, and demographics (among others) may be asked (in a creel survey) if they serve the objectives of the survey.

Fisheries agencies have only three tools to manage recreational fisheries: regulation of harvest, stocking and habitat enhancement. To use all of these three tools effectively, angler surveys of sound design and implementation are necessary. At a time of major advances in the science of stock definition, habitat restoration and life history recognition, a stronger conceptual framework for management is evolving with increased involvement and support from anglers for scientifically based resource management strategies.

We need to strike a politically, socially and biologically acceptable balance between quantity and quality of recreation, maintaining benefits from stronger wild stocks and hatchery programs. It is not enough just to know what the resource is doing; we need to know how anglers are impacting on the resource. The inclusion of angler satisfaction information with recreational catch and effort data into stock assessments, enables a more holistic view of a fishery. It provides feed-back to management and allows for integration of angler preferences into the fisheries management process.

Research programs in Victoria are based on real management questions arising from an annual consultation process and more recently, the development of localised fisheries management plans.

Research is designed to address objectives common to all fisheries managers, such as the protection and enhancement of wild populations, resource sharing and value for money of stocked populations.

Five recent angler survey case studies are detailed, varying in size and complexity.

Victorian Creel Survey Case Studies

Lake Purrumbete

Lake Purrumbete is a deep lake (maximum depth 45 m and mean depth 22 m) in an old volcanic crater. At full capacity the lake has a surface area of 570 ha and holds 120 000 ML. Surrounded by grazing land, the lake has good water quality. The lake has restricted public access and a boat is necessary for best results. Traditionally it has been stocked with yearling brown and rainbow trout and chinook salmon (all finclipped). Wild populations of redfin and eels are also present. A closed season for boat fishing of salmonids (June to September) was introduced at the request of local and regional angling groups to provide an 'opening day'. Angling regulations include bag and possession limits for salmonids, but no minimum size limits.

Perceived issue. Anglers propose that stocking of fingerlings instead of yearlings will provide better returns to anglers.

Research. A boat ramp creel survey was previously undertaken on the lake from 1984 to 1987, and a similar survey has been running since 1992. From 1992 to 2000 this survey was undertaken and reported on by regional fisheries officers. Although the survey is still undertaken by the officers, analysis is now focussed on monitoring the return of finclipped yearling rainbow trout and unclipped fingerling rainbow trout.

Findings. Netting surveys have found that the most abundant fish in Lake Purrumbete are redfin. Brown trout are the second most abundant. Recent years have seen an increase in shore based angling (since the introduction of brown trout) and an increase in angler pressure. A five year decline in the estimated catch of redfin ended in 1999 with a 10 fold increase, which was suggested to be the result of a prolonged period of warm weather and declining water levels. Preliminary recent findings suggest very poor returns from rainbow trout fingerling stocking, with predation thought to be responsible.

Lake Dartmouth

Lake Dartmouth is a high altitude, deep, large lake (180 m wall). At full capacity the lake has a surface area of 6 800 ha and holds 4 000 000 ML. Lake Dartmouth is in a forested catchment, with excellent water quality. Wild populations of brown and rainbow trout and the endangered Macquarie perch are present. No closed season for salmonids is in place for this lake. A closed season is in place for Macquarie perch. Regulations include bag and possession limits for salmonids and Macquarie perch plus a minimum size limit for only Macquarie perch.

Perceived issue. Anglers are concerned that increased angling effort has affected the fishery and stocking may be required.

Research. As most fishing at the reservoir occurs from boats, a creel survey was designed to intercept boat anglers at a single boatramp access-point over a one year period. A creel officer was employed for the duration of the survey. Fishery independent netting surveys were also undertaken.

Findings. A creel survey had been undertaken in the 1980s to establish angler take and effort. Valuable information on fishery trends, such as catch composition, annual yield, and catch per day was gained by comparison with this early data. The brown trout fishery showed little change over 15 years, with no change in overall angler effort and similar total catches providing no justification for stocking. The rainbow trout fishery appears more variable than the brown trout fishery, and may have declined slightly, however, this could only reflect variability in the population. A dramatic collapse of the Macquarie perch fishery has occurred, from around 4 000 fish in 1984 to 1986 to 161fish in 1999 to 2000. In general, most anglers are satisfied with the fishery, troll lures as the main angling method, fish the lower section of the lake near the boat ramp and are mainly Victorian residents (Melbourne 38% or local 35%).

Lake Mokoan

Lake Mokoan is an impounded swamp, initially dammed to provide a backup water supply for the nearby township of Benalla. It is shallow (maximum depth 7 m) with tracts of dead standing trees. At full capacity the lake has a surface area of 7 800 ha and holds 365 000 ML. Surrounded by scattered forest and flat grazing country, the lake is turbid and warm with poor water quality (algal blooms occur most summers). An initial population of redfin was present, but the lake has been stocked since 1988-89 with Murray cod and golden perch and few redfin persist. Carp are also present. Regulations include a closed season for Murray cod, but not for golden perch. Recently bag and possession limits and minimum size limits for golden perch were introduced.

Perceived issue. Anglers were concerned that although catches of stocked golden perch are relatively high, the average size of golden perch has decreased over time. Anglers suggest that increased stocking will compensate.

Research. Roving creel surveys (boat and shore) by regional fisheries officers intercepted anglers to estimate effort and catch from both incomplete and complete fishing trips. Fishery independent netting surveys were also undertaken.

Findings. Golden perch stockings have produced a productive, well patronised fishery. Evidence suggests a possible decline in the average size of golden perch. Many golden perch are being caught, with high catch rates of 2.4 fish/angling hour. The estimated harvest of golden perch in 2000 was higher than the number annually stocked. Golden perch are showing slower than normal growth, which is likely to be a symptom of high stock density. The study recommends that stocking should only occur in alternate years to minimise inter-year class competition.

The survey was undertaken before size limits for golden perch were introduced. However, based on current size limits, 41% of the measured (i.e. kept) golden perch were under the size limit of 30 cm (the average length was 30 cm). Most anglers (70%) would have taken home fewer than the current bag limit of 10 golden perch with 20% of anglers taking no fish home . The maximum individual harvest could have been up to 60 golden perch. Imposition of current size and bag limits will effectively provide an additional number of golden perch (in the order of 20 to 55% of the current annual stocking). The study recommends that stocking be decreased by at least 20% to compensate.

Lake Mokoan is to be decommissioned to create water savings for environmental flows – the fishery will be negatively impacted.

Rubicon River

The Rubicon River is a stream trout fishery in north east Victoria. A tributary of the Goulburn River, it is touted as Victoria's premier wild trout fishery. Wild populations of brown and rainbow trout and black fish are present. Regulations include a closed season and bag and possession limits for salmonids. No minimum size limits apply for salmonids.

Perceived issue. Anglers were concerned about the effect of increasing effort on fish stocks, acceptable catch rates not being maintained over the trout season, and that the reported low catch rates reflect high angling pressure. Anglers requested lower bag limits.

Research. A roving creel survey sampling anglers (to obtain near completed trip data) to estimate effort and catch is being used. Subjective assessments of satisfaction are quantified by relating satisfaction to catch rates. Fishery independent electrofishing surveys are also being undertaken to determine population size, and trends over time, and movement. Environmental variables are also being monitored.

Findings. The survey is still in progress. Early indications are that angler harvest rates are relatively low, with very few fish measured by the creel survey clerk. Many anglers practice catch and release (undersize fish or sportfishing). Catch rates don't appear to have fallen dramatically over the season and may be more related to angler skill than to the number of fish present. The original angler perceptions may therefore not be correct.

Lake Wendouree

Lake Wendouree is a highly developed urban lake at Ballarat. The lake is circular in shape and shallow (maximum depth of 2 m). At full capacity the lake has a surface area of 2 15 ha and holds 3 860 ML. The lake is multi-use with a 2km Olympic rowing course, yachting and boat and shore anglers. A road and walking track surround the lake (6 km), making it a popular haven for runners, bike riders and drivers. Brown and rainbow trout are stocked. Redfin and carp are also present. The local angling club is vocal and passionate and has long historical connections with trout in Victoria (Ballarat fish acclimatisation society). A weed problem occurs, but the lake is clear in patches and weed is cut in places by the council's weed cutter. The weed does however, provide fish and invertebrate habitat. Regulations include a closed season and bag and possession limits for salmonids. No minimum size limits apply. Trout do not breed in the lake and the trout fishery relies on stocking.

Perceived issue. Anglers are concerned that despite bag limit regulations and a closed season, an overharvest of trout is occurring. Anglers suggest the bag limit should be reduced.

Research. A roving creel survey (boat and shore) to estimate effort and catch from mainly incomplete fishing trips is being used. Sociological questions also assess angler awareness of current regulations and support for tighter restrictions.

Findings. The survey is still in progress. Early indications are that the fishery is well patronised, and large numbers of fish are being caught. The rainbow trout fishery is fairly consistent during the season, but as the weather warms the catches decline. Brown trout catches are mainly related to hatch events of mayfly or mudeye (in spring) or cool water periods in the mornings or evenings. Anglers fishing from the shore mainly catch rainbow trout whilst boat anglers mainly catch brown trout.

Conclusions

Creel surveys have the potential to monitor catch and effort over long periods and to compare usage over long time scales and identify trends. Creel surveys are also a potential tool to assess the popularity of fisheries and monitor angler response to altered fishery management arrangements.

Systematic planning, in response to specified questions, problems or issues, is imperative for meaningful creel survey results. The best surveys are designed when the managers are able to communicate the decisions that need to be made and the information needed to make them.

The inclusion of angler satisfaction information with recreational catch and effort data into stock assessments enables a more holistic view of a fishery. It provides feed-back to management and allows for integration of angler preferences into the fisheries management process.

The results recommend improved communication and feedback between users plus mechanisms for future regional development and management of recreational fisheries.

Fisheries Agencies also have a responsibility to provide sufficient information to assure angler expectations are consistent with the productivity and potential of the waters under consideration.

THE NATIONAL RECREATIONAL AND INDIGENOUS FISHING SURVEY

Gary W. Henry

NSW Fisheries, PO Box 21, Cronulla, NSW 2230, Australia

Abstract

A national survey of recreational fishing was conducted in Australia during 2000 to 2001. The objective of the survey was to collect nationally consistent and comparable fishery statistics for the non-commercial components of Australian fisheries. The survey was the first large-scale detailed examination of recreational catches in Australian waters. The project was a joint initiative of Commonwealth and State/Territory fisheries agencies, recreational and commercial fishing advisory bodies indigenous and environmental groups. A team of scientists from State/Territory fishery agencies and specialist consultants implemented the survey.

Telephone/ diary survey techniques were used to gather information on the major (angler) component of the non-commercial sector. Modified on-site (face-to-face) techniques were used to collect data from indigenous and international visiting fishers and to validate diary information. Secondary data sources and a number of calibration experiments were developed to improve the stability and accuracy of the data. These innovative techniques were considered to be significant improvements in angler survey methodology.

Approximately 44 000 Australian households, 46 indigenous communities and several thousand visiting fishers were selected for the survey. Detailed information was acquired on approximately 100 000 fishing events. These data were expanded to provide national catch estimates for recreational, indigenous and visiting fishers. The project has resulted in one of the most comprehensive data sets yet to be collected on recreational fishing in Australia. These data may be combined with commercial fishing data sets to provide a complete representation of aquatic resource use and to support conservation and management.

Introduction

A national recreational fishing survey was conducted in Australia during 2000 to 2001. The survey was the first large-scale examination of recreational catches in Australian waters. It was the largest survey in terms of the people involved, anglers surveyed and cost plus the most comprehensive in terms of the range and detail of information collected. The scope of the survey included the catch of all aquatic animals in Australian waters, by all resident and visiting fishers (5 years of age and older), using all recreational fishing methods.

The project was a collaborative effort of Commonwealth and State fisheries agencies, recreational and commercial fishing advisory bodies, indigenous and environmental groups. All these government, industry and community groups were involved in discussions regarding the objectives, scope of the survey and the data to be collected. The project was funded by grants from the Fisheries Research and Development Corporation, Natural Heritage Trust and the States/Territory and implemented by a team of scientists from State/Territory fishery agencies and two specialist consultants.

The enumeration (data collection) phase was completed in December 200. Data entry, editing and checking was completed in March 2002 and the survey team is now completing the analyses and expanding catch estimates to national figures. Therefore, the project is a work-in-progress with the expected completion within the next few months. This paper will provide an overview of the survey, the process and methodology and the preliminary outcomes. It will also serve as a link to other papers that will present more specific aspects of the survey.

Goals

The objective of the survey was to collect nationally consistent and comparable fishery statistics for the non-commercial components of Australian fisheries. In particular, the survey sought to obtain estimates of the level of participation in recreational fishing, the demographic profile of anglers, estimates of the fish catch and fishing effort, the species composition of the recreational catch, the economic activity associated with recreational fishing and the attitude and awareness of anglers to the prominent recreational fishing management issues. This information will be

used to support the management of recreational fishing in Australia and the conservation of fishery resources.

Methods

A multi-dimensional survey instrument was developed to accommodate the diverse nature of Australian fisheries. Telephone screening and diary survey techniques were used to gather information on the major (angler) component of the recreational fishery. Modified on-site (face-to-face) techniques were used to collect data from indigenous and international visiting fishers and to validate diary information. Secondary data sources (Australian Bureau of Statistics - ABS - 2001 census) were used to benchmark the sample. Follow-up surveys (refusals, non-contact, non-intending fisher) were used to correction for non-response bias and behavioural changes. The methods used to gather data for the major components of the survey are presented in separate papers. This paper will discuss the major (recreational) component of the national survey.

A sample of Australian households was selected from the electronic white pages telephone directories, according to the population distribution. These households were contacted and residents were asked a series of questions about their fishing and boating activities and the demographic profile of the household. Fisher households were encouraged to participate in a diary survey for the ensuing 12 months. These cooperating households were provided with a number of documents to assist the accuracy of their reporting. These included a letter of appreciation from the relevant fisheries agency, a fish identification booklet, regional maps and a diary (or memory jogger). About 100 interviewers were employed to maintain contact with fishers and these interview staff were provided with several weeks formal training and a comprehensive set of manuals to ensure the consistency of the data collection. Each month, whether fishing was expected or not, interview staff contacted their fishers to gather any fishing or expenditure information. The research team maintained close control of process through a monthly activity report generated by interview staff.

Results

Response profile

A stratified random sample of 43 945 households was drawn from telephone directories (electronic white pages) of the national population according to statistical divisions published by the ABS. Survey interview staff rang each of these households during March-April 2000. Interviewers received a positive response to the initial contact with high rates of cooperation being experienced. Discounting sample loss (disconnected numbers, business numbers, other sample loss) contact was made with the residents of approximately 37 248 households. A respondent in each household was asked a series of questions about the demographic profile of residents and their fishing and boating activities. A response to all primary fishing, boating and demographic questions (usable data) was obtained from 29 800 (80%) households. No contact was made with 5% of households despite more than 20 calls and a relatively small number of respondents 1 351 (4%) refused to answer any questions. The response to the initial contact was relatively consistent among all States/Territory.

Diary acceptance and completion rates

Each respondent who indicated that at least one resident (of his or her household) was likely to fish during the coming year, was invited to participate in a diary survey. Approximately 21 500 anglers from 10 400 fishing households were identified in the initial telephone screening. About 18 250 anglers from 9 220 households agreed to participate in the diary survey. This diary acceptance rate was exceptional with (nationally), 84% of eligible fishers from 88% of eligible households agreeing to participate in the survey. The collection of fisheries statistics commenced in May 2000 and continued for a 12 month period until April 2001. Fishing households were contacted at least each month (whether fishing was likely or not) to obtain details of their fishing activity and expenditure on fishing related items. The Australian fishing community responded well to the diary survey with (nationally) about 16 900 (92%) of the initial participants remaining in the survey for the full 12-month period. The sample fraction represented about one in every 200 Australian anglers. Again, similar diary acceptance and completion rates were recorded among States/Territory.

Participation

National census figures and the initial telephone screening indicated that 3 351 643 Australian residents fished in the 12 months prior to the commencement of the national survey. These figures indicate that about 19% of the Australian population participated in fishing. Participation rates varied across the nation according to the degree of urbanisation. High levels of participation in fishing were recorded in the sparsely populated States of Northern Territory, Tasmania and Western Australia while relatively low levels of participation in fishing were recorded in the populated eastern States of Victoria and New South Wales. Despite the relatively low fishing participation rate, New South Wales had the highest number of anglers by

virtue of its large population size. Queensland, Victoria and Western Australia followed in order of the size of their angling communities. The distribution of anglers within each State also showed patterns related to population spread. Relatively high levels of fishing participation occurred in country regions while low rates of participation were found in the cities. This pattern was particularly evident in New South Wales and Victoria where the capital cities (Sydney and Melbourne) recorded the lowest levels of fishing participation in the nation.

Catch, effort and expenditure

The survey team has completed the flat expansions of the data to obtain estimates of the national fish catch, fishing effort and the economic activity associated with fishing. That is, the information provided by diarists has been expanded by the sample fraction of anglers taken from each Australian statistical division. In previous large-scale angling surveys, it has been common practice to report these flat expansions of catch and effort without consideration of the range of biases associated with these estimates. The Australian national survey team has developed correction factors for non-response errors (refusals, non-contacts, intending non-fishers, non-intending fishers) and other behavioural biases that have been the subject of assumption in previous studies. This application of correction factors for non-response and behavioural biases was considered to be the real innovation in the advancement of angling survey methodology. Preliminary analyses of the national survey data suggest that the application of non-response correction factors may have a significant effect on the estimates of catch and effort from flat expansions. The survey team, therefore, considered it necessary to complete these analyses before publishing the final corrected estimates of national catch, effort and expenditure figures.

Conclusions

While the national angling survey is still a work-in-progress, the survey team is pleased with the outcomes to date. A significant proportion of the Australian population was polled and a large number of anglers were identified. A high proportion of these anglers accepted a diary and participated in the survey for its duration. The ABS confirmed that the initial screening sample was representative of the broader national population. Anglers participating in the diary survey provided detailed fishing information, on at least a monthly basis, for a complete year. Approximately 95 000 fishing trips were recorded. The database contains fishing information on 350 aquatic species or family groups taken throughout Australia by 18 different fishing methods, from all fishing platforms, by residents 5 years of age and greater. The data from the survey were expanded to national estimates of participation and harvest and corrected for potential biases in the survey design. The information resulting from the national survey is considered to be the most comprehensive and representative body of fishery statistics yet obtained for the recreational sector. It will allow Australian recreational fishing effort and catch to be described spatially, temporally and by method for the first time.

LARGE SCALE SURVEYS: HOW SMALL CAN YOU GO?

James B. Higgs

Queensland Fisheries Service, GPO Box 2764, Brisbane, Queensland 4001, Australia

Abstract

Queensland has developed an extensive recreational fisheries monitoring program based on random telephone surveys and angler diary programs conducted on a biennial basis. The program was developed primarily to collect catch and effort information on Statewide and Statistical Division scales. Subsequently the data collected is now frequently called upon to provide "indicative" information in the absence of fine scale site based surveys.

Information from the telephone surveys is used to calculate estimates of the statewide annual angling population and their demographic characteristics. They also provide estimates of the importance of intrastate visitation, that is useful in regional development programs. Classification of the demographic characteristics of anglers and their fishing preferences also allows the development of fishing profiles for each of the 15 statistical divisions that cover the state. This information is incorporated into the fisheries management planning process and compliance and education strategies.

Catch estimates from the diary program have been widely accepted by the recreational and commercial fishing sectors, partly because of the involvement by these sectors in the development and ongoing monitoring of the surveys. Comparison of access site estimates with diary program information suggests that the diary program can adequately predict the relative importance of fishing effort usage from major boat ramps. Consequently, in the absence of suitably designed site based surveys, the large scale diary information is becoming increasingly important in resolving localized issues. Uses to date have included resource allocation debates for tailor (Pomatomus saltatrix) and stock assessment on a regional scale for a variety of Scombrids.

The use of a program that was specifically designed to monitor trends in catch, catch rates and fishing effort over large spatial and temporal patterns to answer specific small scale management issues is debatable. However, the absence of site based surveys means the use of any information that is accepted by both fishing sectors is a reality in a fisheries management situation.

Introduction

Unlike the census nature of monitoring programs developed for most commercial fisheries, the sampling approaches taken to monitor recreational fisheries are often complicated procedures, that are not well understood by many clients of the agencies responsible for conducting the research. The diverse nature of recreational fishing activities also means that sampling programs developed without extensive knowledge of the fishery, or direct input from fishers, are often less than optimal. In addition, the open access of most recreational fisheries provides additional requirements for fisheries managers, who are often focused on the management of input and output controlled commercial fisheries.

A committee approach to the development of Queensland's recreational fishery monitoring program (RFISH) was adopted as the most appropriate means of addressing the unique features associated with the development of a statewide sampling program. Members of the Recreational Fishing Information Coordination Committee (RFICC) were selected on their expertise in fisheries research, fisheries management or practical experience in the Queensland recreational or commercial fisheries. Based on extensive consultation with a range of groups throughout Queensland, and in consultation with international researchers in the field of recreational fishing surveys, RFICC recommended the core of RFISH should be a biennial two stage survey that employed a telephone survey to collect participation details and a diary program to collect catch and effort information. In addition, the committee recommended other sources of information such as fishing club records, charter vessel logbooks, and creel surveys should be integrated where possible with the biennial surveys to maximize the value of existing sources of recreational fisheries information. RFICC has been maintained past the development phase of RFISH and now functions to monitor the implementation of the biennial surveys and to collate and disseminate ancillary sources of recreational fishing information.

This paper uses recent changes in Queensland management arrangements for tailor (Pomatomus saltatrix) to highlight the benefits associated with the inclu-

sion of industry input in the development and implementation phases of large scale surveys.

Tailor - a case study

Concerns based primarily on public perceptions of a decrease in the abundance of Queensland tailor stocks lead to an investigation by the Sub Tropical Finfish Scientific Advisory Group (SAG). The SAG advised that the current commercial and recreational fishing effort was leading to a "high probability of moderate to high risk of unsustainable fishing" (QFS, 2002). Information collected as part of the RFISH statewide biennial surveys and the census information collected through the daily commercial logbook program (CFISH) were used by the SAG in their assessment of tailor stocks. Higgs (2001, 1999) and Roy Morgan Research (1999) provide full details of the RFISH methodology and results.

Results from the RFISH telephone surveys highlighted the importance of tailor to the Queensland recreational fishery with between 31 000 and 39 000 anglers having targeted the species in the 12 months prior to the surveys. This makes the species the fourth most commonly targeted species in Queensland behind whiting, flathead and bream (Higgs and McInnes, 2002). Higgs (2001) suggested that the harvest of tailor by Queensland residents had decreased significantly between the 1997 and 1999 RFISH surveys from 1.2 million to 0.6 million fish. This represents an estimated decrease from 500 tonnes to 250 tonnes (Williams, 2002). Catch estimates and catch rates from the commercial sector were also lower in 1999 than 1997. However, there were no clear trends when considering the available history of catch information that ranged from 111 tonnes to 240 tonnes between 1988 and 2000 (Williams, 2002).

Table 1. Theoretical effect that the implementation of bags limits, with a range of multipliers for Fraser Island limits, would have had on the total harvest of tailor reported in diary trips provided by anglers in the 1997 and 1999 RFISH diary program.

Proposed Bag	Multiplier applied to Fraser Island bag limit				
Limit (fish)	1	0.5	1.5	2.0	3.0
No limit	100.0	100.0	100.0	100.0	100.0
25	86.6	76.8	90.1	93.1	94.6
20	82.8	72.1	86.7	90.5	92.4
18	80.9	68.2	84.6	88.6	91.3
16	78.5	64.4	82.1	86.3	89.8
14	75.7	62.0	79.3	83.6	87.8
12	72.6	58.8	76.2	80.3	84.9
10	68.7	53.9	72.3	76.4	80.9
9	66.2	49.6	70.2	73.8	78.3
8	63.3	46.8	66.7	70.8	75.4
7	59.9	42.3	63.6	67.3	71.9
6	55.9	39.1	59.4	63.1	67.7
5	51.1	33.6	54.9	58.0	62.4
4	45.4	30.1	48.4	51.7	56.0
3	38.2	23.6	41.4	43.6	47.6
2	29.3	20.5	31.3	33.6	37.0
1	17.3	14.6	19.6	19.9	22.2

Anecdotal information from the recreational fishing sector suggested that there needed to be regional specific management arrangements for the recreational fishery. This would accommodate a significant recreational fishery for tailor that has developed on Fraser Island, an area of approximately 200 000 hectares which is predominantly a terrestrial national park.. Results from the RFISH telephone survey indicated that between 13 000 and 14 000 Queensland residents did most of their saltwater fishing at Fraser Island (Higgs and McInnes, 2002), Further investigation of the data provided by diary participants in the 1997 and 1999 RFISH diary programs suggested that, respectively, approximately 35% and 40% of the total recreational harvest was taken from the Fraser Island region. Harvest rates were also found to be two to three times higher for trips at Fraser Island than for the remainder of Queensland.

The concerns regarding the sustainability of Queensland's tailor stocks caused new legislative measures for both the commercial and recreational fishery. These legislative requirements included an annual quota for the commercial fishery of 120 tonnes, for catches of tailor in excess of 100 kg in any 24-hour period and a 20 fish recreational limit on the taking and possession of tailor. A specific exception, allowing the possession of 30 tailor, applies to fishers who take tailor from waters around Fraser Island and who stay on the island for 72 hours or more. In addition, the annual tailor closure for foreshore waters between Waddy Point and Indian Head on Fraser Island has been extended a month to include 1 August to 30 September each year. These legislative requirements are aimed to reduce and cap the total tailor harvest to approximately 90% of the historical levels.

Table 1 shows the results from a series of scenarios that were used to evaluate a range of bag limits for Fraser Island and the rest of the Queensland recreational tailor fishery. This modeling process was conducted on the raw catch information provided by the 1997 and 1999 RFISH diary program participants. It was used to determine the theoretical net reduction in

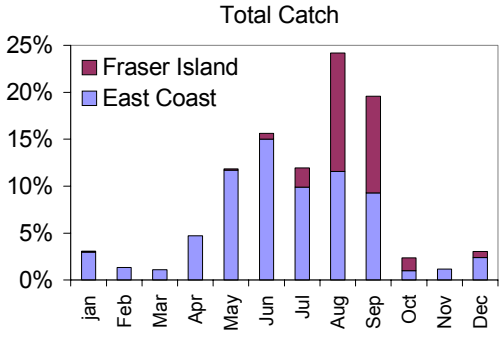

Figure 1. Seasonal distribution of total catch of tailor reported in the 1997 and 1999 RFISH diary programs for Fraser Island and the remainder of the Queensland recreational fishery.

total harvest that would result from the application of bag limits on "unrestricted" catches reported in the diary program. The range of scenarios used included a bag limit on Fraser Island of between half to three times the bag limit for the remainder of the fishery. These scenarios were used to cover a range of expectations from restricting the catches on Fraser Island (because of the island's conservation status), to enhancing the fishing opportunities on the island (because of the extended nature of trips to the area and associated costs).

Anecdotal information from the recreational fishery plus logbook information from the compulsory CFISH program shows the majority of tailor catches occur between May and September. A review of the raw logbook information from the 1997 and 1999 RFISH diary programs supports the anecdotal information from the recreational fishery (Figure 1). A review of the data for Fraser Island found the catches for this area occur predominantly in August and September, which coincides with the extended seasonal closure implemented from 2002.

Discussion

Queensland is very different to other Australian states. Brisbane, the capital city, is located in the extreme south-eastern corner of the state. There are also several large regional centers of population distributed along over 2 000 kilometers of coastline. In addition, the Queensland population is growing at a faster rate than any other state, with population growth occurring equally between the capital city and regional areas. The vast expanse of the state and disperse large regional population centers also provide a number of recreational fisheries opportunities ranging from fishing for stocked native freshwater fish species in dams and impoundments to deepwater heavy game-fishing for marlin. All of these features make the collection of recreational fishing information for the development of appropriate fisheries management regimes a difficult process in Queensland.

The recommendation by RFICC to establish a statewide biennial survey reflects the difficulties associated with the collection of recreational fisheries information with a limited budget and a diverse, dispersed, recreational fishery. The benefits of having an established statewide recreational fishery data program are becoming more evident with the collection of additional years of information and the inclusion of results into the fisheries management planning process. The committee process used in the development and implementation phases of the RFISH program has also provided the confidence to accept inclusion of data, at a finer scale than was originally anticipated in the development of the program, into a range of fisheries management arrangements. This confidence stems from the ownership of the RFISH program, that has developed over the past eight years of committee member involvement in all areas, including data collection, analysis and extension of results to clients.

The committee process has also provided researchers, managers and fishing industry representatives with an opportunity to be exposed to the issues that are faced by each representative. This exposure has lead to an enhanced understanding of the issues associated with the collection and analysis of recreational fisheries information, plus the process involved in the development of fisheries management regimes related to the management of the recreational fishing sector. The confidence that industry has in the RFISH results has meant use of the RFISH information to address issues such as those identified in the tailor case study can be conducted in a relatively fast time frame without the need to conduct specific surveys and their associated costs to the department. This "value adding" to the statewide survey results helps strengthen the argument to maintain an ongoing recreational fishing survey to provide comparable results to the existing compulsory census of commercial fishing operations in Queensland.

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ANALYSIS OF RECREATIONAL FISH CATCHES – DEALING WITH HIGHLY SKEWED DISTRIBUTIONS WITH MANY ZEROS

Michael F. O'Neill[1] and Malcolm J. Faddy[2]

[1] Southern Fisheries Centre, Department of Primary Industries, Deception Bay, Queensland 4508, Australia
[2] School of Mathematics and Statistics, The University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

Abstract

Data from surveys of recreational anglers fishing on three estuaries in eastern Australia reveal highly skewed distributions of catches with many zeros. Such data may be analysed using a two component approach involving a binary (zero/non-zero catch) response and the non-zero catches. A truncated regression model was effective in analysing the non-zero catches. Covariates were incorporated in the modelling, and their critical assessment has led to improved measures of fishing effort for this recreational fishery.

Introduction

Analysis of recreational catch data can present problems because many fishing trips fail to catch any fish (e.g. Figure 1). The resulting data are generally highly skewed and even after various transformations may not meet the assumptions required for many standard statistical techniques. For example, the use of a log transformation and normal residual distribution (Robins et al., 1998) fails to take account of the discrete nature of catch data and this becomes more problematic when the catches are small which is fairly typical in recreational fishing surveys (e.g. Figure 1). Models based on discrete distributions such as the Poisson and negative binomial fit into the generalised linear modelling framework (McCullaugh and Nelder, 1989) and use appropriate residual distributions. However, the factors influencing zero catches may well be different from those that influence non-zero catches; for example, recreational fishers may be less enthusiastic while they are not catching fish and if no fish are caught in a relatively short period of time they may go elsewhere.

Welsh et al. (1996) presented models for dealing with discrete species abundance data that contain many zeros. The models represent extensions of the Poisson and negative binomial distributions to allow for extra zeros. Such models are essential for hypothesis testing given the properties of recreational survey data with many zero values: the importance of factors affecting the recreational catch may be under- or overstated if models of this type are not used, leading to unreliable inferences. The model used here has a separate component for the zeros; this allows possibly different factors to influence this component of the model, and also allows the zero and non-zero catch data to be analysed separately.

Data on recreational catches of yellowfin bream (*Acanthopagrus australis*) from three estuaries in south-east Queensland, Australia, are used in this paper. A truncated regression model that allows for extra zeros is presented along with an account of the results.

Modelling

There are two components to the modelling and data analysis. The first component refers to the binary response of zero or non-zero catch, with the capture of fish of a species by a fishing group occurring according to the probabilities

$$P_{(\text{non-zero catch})} = p \text{ and } P_{(\text{zero catch})} = 1 - p$$

The logit of the probability p was modelled as a linear function of the covariates: estuary, season, day type, fishing platform, number of anglers in the group, fishing time and number of fishing lines in the group (the first four of these being factors).

The second component was for only those catches where a non-zero number of fish was caught. Truncating discrete distributions by conditioning on the catch being greater than zero will provide appropriate distributions to analyse these data. The Poisson and negative binomial distributions are special cases from general discrete distribution modelling described in Faddy (1997) and referred to as extended Poisson process

modelling (EPPM) with transition rates:

$$\lambda_n = \log(1+\delta\mu)\left(\frac{1}{\delta} + n + \frac{c}{d+n}\right)$$

for $n = 0, 1, 2, \ldots$ (1)

where the parameter μ can be modelled as a linear function of any covariates using a log link. Here the limit as $\delta \to 0$ results in the Poisson distribution with mean μ and $c = 0$ gives negative binomial distributions with mean μ, with other values of c giving more general dispersion properties. Faddy (1997) and O'Neill (2002) describe how the transition rates (1) are used to calculate the corresponding discrete probability distribution $p_0, p_1, p_2, \ldots$. These probabilities can then be truncated to give an appropriate distribution on 1, 2, 3, … :

$$\frac{p_i}{1-p_0}, \text{ for i} = 1, 2, 3, \ldots \quad (2).$$

Data

Recreational fish catch data from roving creel surveys were collected between June 1997 and August 1998 from the Burnett River, Maroochy River and Pumicestone Passage in south-east Queensland, Australia. Overall, a minimum of five weekdays and five weekend days or public holidays, selected at random, were surveyed each month in each estuary. These days were surveyed either in a morning shift (6 am to 12 noon) or afternoon shift (12 noon to 6 pm).

The three estuaries were stratified into smaller areas to enable angler numbers to be counted. Counts were recorded on each survey shift in each area at random times. During a shift, staff would drive their boat to an area and count the number of boats and people actively fishing (with a line in the water). Once the count was complete, boat/shore fishing groups were randomly interviewed for a one-hour period. The number of persons fishing, actual fishing time (hours), number of fishing lines used, number and species of fish released, and number and size (total length in centimetres) of each fish retained were recorded for each fishing group.

Anglers from five to eight randomly selected areas were interviewed in each shift. If no anglers were present in a scheduled interview area, a zero count was recorded and another nearby area was surveyed.

Results

Data

Shown in Figure 1 is the histogram of the observed yellowfin bream catches per fishing group. High frequencies of zero catches are apparent along with considerable skewness in the upper tail of the non-zero catches.

Logistic regression of binary (zero/non - zero catch) response

Catches of yellowfin bream showed a low proportion of fishing groups actually catching fish. These proportions changed significantly with the estuary fished, the time of year and fishing platform. Also, they were dependent on the number of people in the fishing group, the time spent fishing and the number of fishing lines used. The probability of a fishing group catching yellowfin bream increased the longer they fished and the more fishing lines used. However, the probability of boat and shore groups catching yellowfin bream decreased with the number of anglers in the group, although this effect for shore groups was the least significant (p-value ≈ 0.03).

EPPM regression of non-zero catches

Both the Poisson and negative binomial based models tended to underestimate the residual variation, with the EPPM (1) and (2) doing better with an estimate of the parameter c of 0.12. In each estuary the average catch of yellowfin bream was generally less than one fish per group hour. There were significant differences in average yellowfin bream catches due to some of the variables. Catches of yellowfin bream in the Maroochy River and Pumicestone Passage were significantly higher than in the Burnett River. Average catches of yellowfin bream were highest during the winter

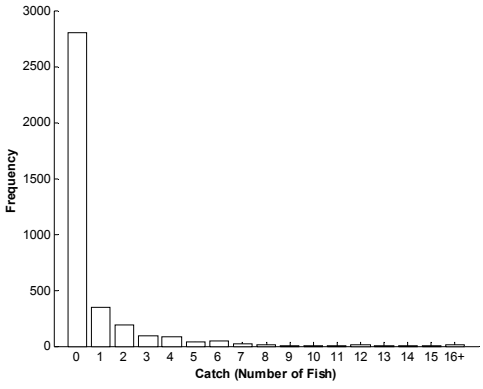

Figure 1. Observed distribution of yellowfin bream catches.

months. There were no significant differences in average yellowfin bream catches between boat and shore fishing groups, and between weekend and weekdays. There was a significant positive effect of the time spent fishing on the average catch. For shore based fishing, there was a negative relationship between average catch and the number of anglers per group, but this was the least significant effect (p-value ≈ 0.03). There was also no significant effect of the number of fishing lines in the group on average catches.

Discussion

In this paper models generalising those described in Welsh et al. (1996) have been used to analyse data on recreational fish catches. The methodology was particularly applicable to these data which exhibited many zero values and low non-zero catch sizes, as the models used more accurately reflected these properties of the data than more standard modelling options available in most statistical packages. The truncated EPPM component has adequately allowed for the considerable dispersion shown in the data (Figure 1), and the overall analysis facilitated critical assessment of important effects on recreational catches, thereby making more effective use of the survey data.

The analyses identified important factors affecting the recreational catch. Total catch for yellowfin bream should be estimated separately in each estuary, season and fishing platform. However, the catch data could be grouped across weekend and weekdays to estimate total catch. The models also indicated some interesting relationships between catch and fishing effort. As expected, for both boat and shore fishing groups, the average catch increased as the time fished increased. However, larger boat fishing groups were less likely to catch yellowfin bream than similar sized shore groups. This negative relationship probably indicated that the more serious and experienced boat anglers tended to fish by themselves or in small groups. Larger sized groups fishing from a boat may have fished more as a social activity and were therefore less likely to catch fish. Also, more fishing lines used by a given number of anglers tended to increase the likelihood of catching fish. This latter positive influence had a counteracting effect on the negative influence of larger numbers of boat anglers reducing the chances of catching fish. Overall, the results indicate that number of hours fished per group is a fair representation of boat-fishing effort, while the number of hours fished per line or angler (since these will be correlated) represents shore-fishing effort. With these measures of fishing effort and the above stratification by estuary, season and fishing platform, more reliable estimates of recreational catch rates and hence total catch can be made (O'Neill, 2000), thus providing better information for management of the fishery.

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IS RESEARCH DESTROYING RECREATIONAL FISHERIES MANAGEMENT?

Frank B. Prokop

Recfishwest, PO Box 57, Claremont, WA 6010, Australia

Abstract

When management reforms are proposed, there is a tendency, particularly from those most directly affected, to question the scientific basis by which the decisions are made. The need for bullet proof science is often given as a rationale for delaying implementation of new management measures, including on occasions, by researchers who wish to access funding sources to study declining populations.

While contestability of research findings poses a significant problem for many commercial fisheries, it represents a much more difficult and complex task for recreational fisheries. There are greater difficulties in obtaining reliable catch estimates, there is a tendency to measure effort of inefficient anglers when undertaking biological studies and catch efficiencies are significantly skewed.

Many research programs are poorly planed to answer important management questions and often ignore the importance of catch expectation, strike rates, perceptions of angling quality and changing attitudes that drive recreational fisheries management. Many researchers are afraid of engaging recreational fishers and continue to apply inappropriate paradigms to the management of recreational fishers. There is also ongoing debate about the relative importance of biological, economic and social factors in the management of our fisheries.

This paper will explore some of the difficulties that confront traditional research ideologies and funding practices for recreational fisheries management from a design and implementation perspective. More effective methods will be proposed.

The difficulty of fisheries management

Many of the best managed fisheries in the world have collapsed. This has confounded managers and scientists, destroyed political careers and affected fishermen, their families and their communities for many years.

There is a greater need for definitive science which is becoming more difficult to obtain, due to decreasing funding for research, greater demands for real time advice and a desire by some vested interests to challenge the methodology, the results or the error measurements.

There are many political pressures brought to bear throughout the management process which has the capacity to alter the recommendations, change the level of critical risk or gamble that the stocks are more robust than they are. In some jurisdictions, it is infinitely easier to increase quotas than it is to decrease them and the threat of civil action and compensation claims are no longer being made idly.

Management requires input from a variety of stakeholders, including: research, compliance, politicians, other public servants within and outside of the management agency, commercial and recreational fishers, community groups and the managers perspective and philosophy. In many instances, personal views get confused with professional advice and even so, the capacity for agreement with such diverse perspectives for a cryptic animal like a fish, is almost nil.

Where possible, management needs to be based on as much fact as possible, but obtaining definitive information is expensive and time consuming. It requires good time series information and patience. However, where a stock is declining time is at a premium and political pressures very strong.

The time lapse research project

While good science is extremely important, the lack of information isn't necessarily a reason to delay action. The 'best available information' can form the basis of real and conservative management if all stakeholders recognise the penalties if the fishery collapses. While this requires a more facilitative approach to management, it can pay strong social dividends if participants

feel that they are actively engaged in making management decisions.

What is inexcusable, is to use the lack of science as a lever to gain large grants or to delay the implementation of management. In 1993, in Western Australia, recognising a decline in Tailor numbers *(Pomotomus saltatrix),* the recreational fishing community was pushing for a bag limit reduction and a closed season when the fish were considered most vulnerable. Incredibly, the scientific advice was that a closed season should not be implemented as it might affect the PhD project of a student currently undertaking a study of this species.

While this is an extreme example, the following graphs illustrate the importance of acting as soon as practicable and the importance of shortening as much as possible the time frame from the commencement of study to implementation of management reforms.

The example presented below is based upon a high quality and real data set for Australian salmon *(Arripis truttacea)* in Western Australia. It is also a particularly useful example as quality research in the 1990s has clearly identified environmental factors as the key determinant of abundance and commercial fishing has little influence on stocks, except with respect to local depletions.

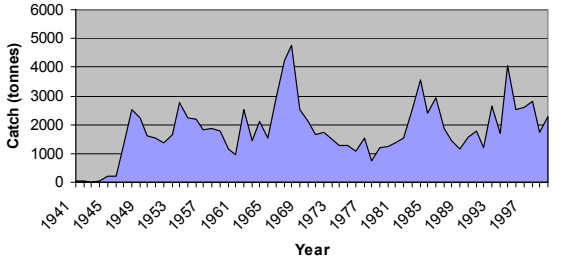
It is valuable to be able to work with long time-series data (Figure 1).

If we snip the data from 1962 to 1969, we see a classical boom fishery (Figure 2).

The boom is followed by a decline (1967 – 1972) (Figure 3), but is it a correction caused by the fishing of relatively unexploited stocks or does it represent growth overfishing?

A small recovery can cause a relatively minor fishery like this to drop down the priority list (Figure 4). Recreational fishers might well be saying that this is 'just a blip' in the commercial plunder of the stocks. Commercial fishers, concerned about potential cuts to effort or catch might well postulate that this represents a recovery and 'there have never been so many fish around!!' In real life a study was undertaken at this time.

The decline in year 13 would cause political ramifications and calls for fisheries to explain why they didn't listen to the doomsayers who thought the increase in year 12 was just a blip (Figure 5). A small decline like this would ensure research funding which would start the following year. Many projects are funded for three years.



Australia. Real data used for this example.

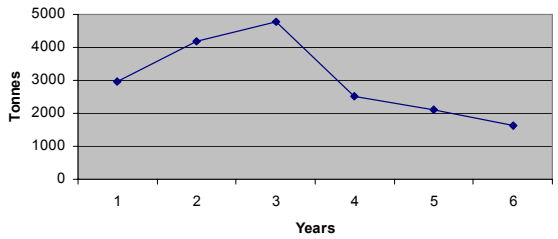


Figure 2. Commercial Australian Salmon Catches During an 8 Year Period. Boom time for fishery.

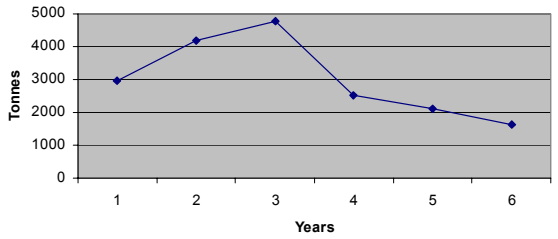


Figure 3. Commercial Australian salmon catches in WA during a six year period following boom. Bust or correction?

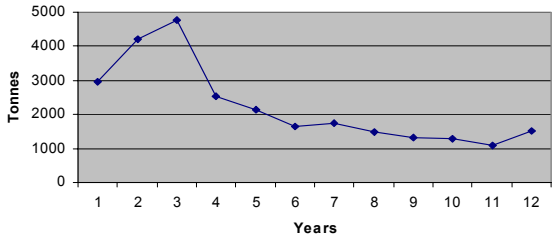


Figure 4. Commercial Australian Salmon catches with more data - Recovery or Not? Should we commit funds?

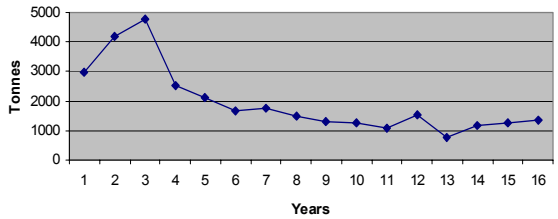


Figure 5. Commercial salmon catches. Decline year 13 ensures study. The three year study is undertaken in years 14-16.

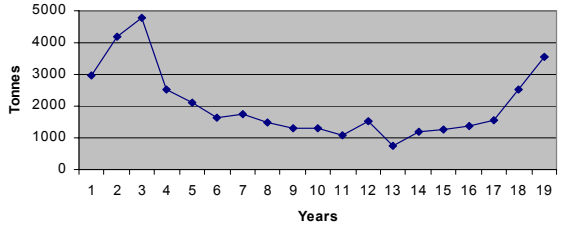


Figure 6. Commercial catches while the study is analysed, peer reviewed and published for study on years 14-16.

For some projects the results cannot be released until they are peer reviewed or in some cases published in refereed journals. The analysis takes time but this is the time for managers and researchers to work together to get the community ready for the implications of the research. Unfortunately in this case, catches are recovering dramatically after being repressed during the study period (Figure 6).

The consultative processes are becoming increasingly lengthy and in some cases unwieldy. Given the extent of the recovery following the study, the methods and results would probably be vigorously challenged by those who may lose out under management proposals. Ministers would be lobbied very hard as they look for a magic fix. If the study was allowed, ongoing work may help to identify the causes for the recovery but for a low value fish like the Australian salmon this might not be the case (Figure 7).

By the time the legal people get through with it (and potentially the legislature), it could be eight years from the time the study was agreed to, until the implementation of management reforms that used that information. The situation can be complicated if a further study is being analysed and the results will be available 'shortly', especially if it gets out that the results are 'different' or suggest that the recommendations aren't appropriate (Figure 8).

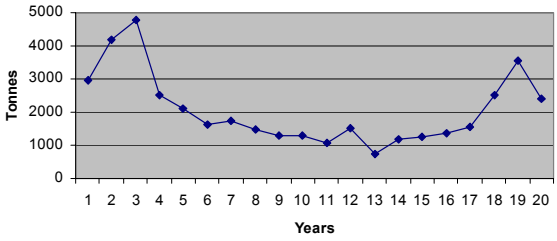


Figure 7. Commercial catches while committees meet and Ministers consider for study in Years 14-16

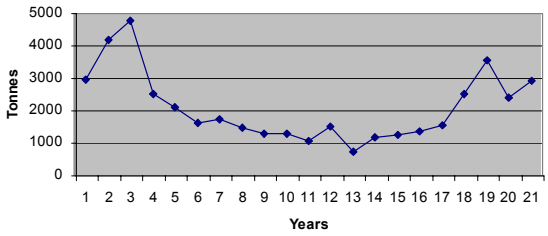


Figure 8. New Rules Implemented in Year 21 on Scientific Information for years 14-16

Making things work better

Clearly the system has to be streamlined. Implementation of management and its assessment is a superior system if there is any background information against which new data can be compared. This will shorten the period considerably but requires several fundamental changes:

1 Industry must accept the need for change proactively. If industry understands that they are the greatest losers from a stock decline there is a strong incentive to maximise profits rather than catch. This has worked extremely well with the Voluntary Resource Sharing process where recreational and commercial fishers have cooperatively negotiated management reforms.

2 Research must meet clearly identified management needs and frequently be reactive to management rather than driving it. Given the time delays highlighted in this paper this is becoming essential.

3 Longer term research projects must become the norm rather than the exception.

4 Research that does not have a primary focus of refereed papers in international journals, must be recognised, for the management which results and the community benefit. This should include joint papers written by researchers and managers and better rewards for research of an applied nature.

5 The lack of information should never be used as an excuse for not proceeding with management. Management can and should be modified as information becomes available.

6 Assumptions, especially in areas like average catch rates for recreational fishers through creel surveys must be assessed objectively by managers and stakeholders. This will avoid criticism that rubbish figures are based upon unrealistic assumptions.

No-one ever questions the need for research on which to base fisheries management. However, there is an opportunity to cater research to the needs of resource management and the future sustainability of the fisheries and the industries which depend upon them.

STATISTICAL ASPECTS OF THE AUSTRALIAN NATIONAL RECREATIONAL - FISHING SURVEY

Dennis D. Reid[1] and Laurie West[2]

[1] New South Wales Fisheries, PO Box 21, Cronulla, NSW 2230, Australia
[2] Kewagama Research, 70 Foxtail Rise, Noosa Valley, QLD 4560, Australia

Abstract

A survey to examine recreational and indigenous fishing in Australia was implemented in 2000 to 2001. This paper describes the main statistical features of the design and the analysis of the recreational fishing segment of the project. The survey involved two phases – a screening survey of 44 200 households in all Australian States and Territories to identify fishing households, followed by a longitudinal survey of respondents identified as intending fishers in the screening survey. The design of the screening survey was a stratified cluster sample, with 49 strata based on Statistical Divisions used for the Australian Census by the Australian Bureau of Statistics (ABS). The cluster was defined as the household, and all fishers within a participating household were included in the longitudinal study. This is a different approach to previous studies, which used only one randomly chosen fisher from each identified fishing household. Use of the cluster sample design overcomes the biases towards single person households inherent in previous studies. Comparisons of the screening sample against ABS population benchmarks, and the development of sample expansion factors are described.

Introduction

A survey to provide estimates of recreational and indigenous fishing in Australia was implemented in 2000 /2001 financial year. General features of the survey are described in Henry (2002) and Coleman et al. (2002). This study addresses only the statistical methods used in the estimation recreational fishing component of the project. Data from the screening phase were used to provide estimates of participation rates at 1 May 2000. These data together with those from the 12-month longitudinal study and follow-up surveys of non-response at screening and of non-intending fishers (Lyle et al., 2002) allowed the estimation of participation rates, catch, effort and expenditure over the period 1 May 2000 to 30 April 2001 by State/Territory and nationally. Detailed results of the survey will be reported by the survey working group later in 2002.

Statistical design

At the time of writing, the final analysis of the data for the National Recreational Fishing Survey is approaching completion. The novel features of the analysis are briefly described in the following.

Telephone surveys of anglers have generally adopted the approach of selecting a single angler from each household, and then using this fisher as a proxy for all fishers in the household (for example: New Zealand (Teirney et al., 1997), Quebec and Newfoundland provinces of Canada (www.dfo-po.gc.ca/communic/statistics/recfsh95) and Queensland, Australia (Morgan Research, 1998)). One problem with this approach is there is an over-representation of single fisher households, and an under-representation of multiple-fisher households. In the present study, the first phase of the survey provided data for estimation of participation rates. For the second phase of the design, all anglers in a household were taken into a longitudinal study of one year's duration. In the diary study, information on catch, effort and expenditure was collected for each trip made by the respondent over the diary period.

The sampling procedure consisted of two phases: the screening sample and the longitudinal study. The statistical design was based on a single-stage cluster sample, with the randomly selected household as the primary sampling unit, and individual fishers (5-years and older) within the household as the secondary unit.

Cluster sampling is recommended where there is no frame listing (Schaeffer et al., 1996). A listing of all fishers in the Australian population is not available, hence no list exists from which a simple random sample may be obtained. A frame listing of households exists in the form of telephone listings, thus a random sample of households can be chosen, and from each of these primary sampling units, the set of all eligible fishers was selected for the longitudinal phase of the survey.

The major advantages of the cluster sampling design in this situation are that it provides the correct weightings to both single and multiple-angler households and it provides multiple-fisher data through a single (initial survey) contact, thus substantially increasing the sample size for a given sample expenditure. The statistical efficiency of cluster sampling compared to simple random sampling depends on the correlation between anglers within households. The proposed sampling procedure will allow the estimation of the dependence between fishers within households.

Feasibility study of sample sizes.

In the feasibility stage of the project, a guide to the likely sample size required at screening to give the required number of diarists was needed. Simple analyses were carried out to provide this estimate; to give an idea of the magnitude of the relative error estimates for participation rate, effort and harvest; and the error terms expected using a range of possible values for the initial gross sample size. Some brief details of these initial calculations follow.

Participation rate

For each stratum (i.e. region or group of regions), the sampling error of the estimate of participation rate is well approximated by the binomial estimator (details given below).

P_h is the estimator of the proportion of the population who have fished at least once during the survey period. The formula for the variance of the estimator P_h is:

$$P_h = \frac{N_h - n_h}{N_h} \bullet \frac{p_h \bullet q_h}{n_h - 1}$$

where N_h = number of persons ≥ 5 years old in the population for stratum h; n_h = number of persons in sample for stratum h; p_h = number of fishers in sample from stratum h, divided by n_h; q_h = 1- p_h;

The standard error (SE) of the estimated participation rate is the square root of the above variance estimator. The relative standard error (RSE, expressed as a proportion or % is SE deided by the mean).

To obtain results for the total of all regions, the usual stratified random sampling estimators for p_h and V(p_h) were used (Cochran, 1977). These are:

$$p_{tot} = \sum \frac{N_h \bullet p_h}{N_{tot}}$$

(i.e. the sum over all strata, weighted by the population proportion in each stratum).

$$V(p_{tot}) = \sum \left(\frac{W_h^2 \bullet p_h q_h}{n_h - 1} \right)$$

where W_h is the stratum weight (N_h / N_{tot}).

To estimate total annual harvest, H = number of fishers x mean catch-rate (fish/hr) x mean effort (hours) per fisher.

Variance for the estimator of number of fishers is estimated from binomial error (above).

Catch rates

A guide to the variance for catch rates may be provided by a simple mathematical expression, tested on the results of a wide range of previously published creel surveys.

From some of the published results of creel surveys which quote standard errors, a reasonably robust estimator for the variance of the cpue estimator is provided by taking 2 x Poisson variance (= 2 x mean cpue). This gives estimates of variance which are quite close to the eight values for variance(cpue) for various New South Wales studies described in West & Gordon (1994) and the three values for West Australian studies described by Caputi (1976). This estimator was used as an approximate general guide to the level of RSE to be expected.

Using this simple estimator, the $SE_{(cpue)}$ for a sample size of 5 000 (anglers) with a mean cpue of 0.5 fish/hr would then be 0.014, which is equivalent to a RSE of 2.8%.

A previous study which attempted to provide a generalisation for determining appropriate sample sizes (for creel surveys) is Lester et al. (1991), which proposed a power law relating variance(cpue) to cpue. This was of the form Var(cpue) = 1.41· (cpue)$^{1.24}$, and applied to walleye and trout in Canada. The variance estimates using this estimator for the Australian studies are a little higher but broadly similar to those using the 2xPoisson variance assumption described above.

Effort

The mean effort assumed was 28 hours over the one- year diary period. For recent NSW creel surveys, the value of the standard deviation was very close to the value of the mean, so as a working hypothesis, we assumed that the variance to be approximately equal to the square of the mean. For example, in the above study, for a mean of 28 hours as the mean annual effort (hrs) per fisher and a sample of 5 000, SE (effort) = 0.4, with RSE = 1.4%.

Table 1. Gross screening sample size, estimated number of diarists from screening, realised sample of fully-responding diarists, relative standard errors (RSE) for estimates of total harvest and for components of catch forming 10% of total harvest, based on feasibility analysis.

	Initial gross sample of households	Feasibility est. Number of Diarists	Final fully-responding Diarists	Feasibility Est. RSE for total harvest %	Feasibility Est. RSE for 10% of harvest %
NSW/ACT	10 300	3 761	3 365	3.8	10.5
Victoria	9 055	2 745	2 232	4.2	10.5
Queensland	7 900	2 988	3 309	4.4	11.9
South Aust	5 090	1 915	2 428	4.2	9.2
West Aust	5 400	2 227	2 982	3.9	8.5
Tasmania	4 022	1 218	1 696	4.9	11.0
NT	2 178	1 080	1 079	7.1	19.6
Australia	43 945	15 934	17 091		

Harvest

The variance for the estimator of total harvest can be obtained by using the approximate result for the coefficient of variation (CV) of a product, i.e.

$$CV_{tot.harvest} = CV(PCI) = \sqrt{CV^2(P) + CV^2(C) + CV^2(T)}$$

where CV is SE/mean (= RSE expressed as a proportion), P is number of fishers, C is cpue (fish/angler hour), T = total effort (hours).

The above equation is a simplification of the formula for variance of a product (Goodman, 1960), but was adequate for the purposes of the feasibility study.

Sensitivity of the total harvest estimate to variation of the assumptions for the error terms for effort and cpue can be easily considered, by varying the RSE terms for cpue and effort in the above calculation. For example, if the assumption of twice the Poisson variance is considered as an underestimate of the possible error for cpue, then doubling this (to 4 x Poisson variance) changes the RSE of the total harvest estimate for NSW from 3.8% to 5.0%.

Sample allocation

Allocation of the final target sample of 43 945 households to the six states and two territories was based on the general principle of obtaining estimates of harvest and effort at roughly comparable levels of precision for the lowest level of geographical aggregation for each state. This level is either Statistical Division (SD), as specified for the Australian Census by the Australian Bureau of Statistics (ABS), or where population size is too small at this level, a combination of Statistical Divisions. The sample allocation depended on assumed and/or derived estimates of participation rates, harvest rates and average effort, for which comprehensive data were available for some components for one or two states, but were generally quite sparse. The sample allocation resulting from this procedure was generally quite similar to allocation based on the square root of the population of a state divided by the sum of the square roots of each of the states. The latter procedure is used to allocate interviews between counties for the National Marine Fisheries Service surveys of recreational anglers in the marine waters of the United States (Van Voorhees et al., 2000). This method of allocation ensures an adequate level of sampling for geographical areas with relatively small populations.

The final sample sizes for each State/Territory are given in Table 1.

Representation checks, population benchmarks and expansion of sample

The data obtained from the screening sample were compared to population data for persons in private dwellings at 30 June 2000. The household benchmarks for age/gender classes were confined to persons in private dwellings, as we considered that residents of non-private dwellings are likely to have very different fishing characteristics to those of private-dwelling households. ABS Consulting provided estimates of the number of private households by Statistical Division, and the number of persons associated with these. Chi-squared tests indicated that a number of cells in the SD/sex/age matrix were not representative of the corresponding population cells. The most common anomalies between the sample and population benchmarks were for households comprising only one person. Collaborative work with ABS Consulting suggested the possible use of an integrated weighting approach to apply the population benchmarks to the survey sample. This method (Lemaitre and Dufour, 1987; Bethlehem and Keller, 1987; Deville et al., 1993) is an iterative method for obtaining a single uniquely defined weight per household which is appropriate for both estimates of persons and households. The alternative is using heterogeneous weights for members of the household according to gender/age characteristics, and a separately determined weight for the household. Given the cluster design of the survey, and the fact that some estimates are estimated at the person level (effort, catch, etc) and some are based on the household level (expenditure, boat ownership, etc), integrated weighting seemed preferable to the standard post-stratification approach.

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COLLABORATIVE TAGGING PROGRAMS: A COMPARISON

Jill StJohn[1], Gary Jackson[1] and Patrick Coutin[2]

[1] Department of Fisheries WA , Marine Research Laboratories, PO Box 20, North Beach WA, 6920, Australia
[2] Marine and Freshwater Resource Institute, PO Box 114, Queenscliff, Victoria, 3225, Australia

Abstract

Tagging programs are one of the most common types of collaborative research involving fisheries scientists and recreational fishing groups. Such programs, however, can differ greatly in both their objectives and the way in which they are conducted.

We explore the most effective use of recreational fishers in tagging programs by evaluating the results of three collaborative tagging studies that have varying levels of involvement of researchers and volunteer anglers. Although all three programs tagged snapper (*Pagrus auratus*) in different locations within Australia, both the research objectives of the programs and the level of involvement by researchers varied. We compared the quantity and quality of the tag data among the three programs, Westag, Victag and SBTag.

The most accurate data resulted from the research based tagging in Shark Bay (SBTag). SBTag tagged relatively few fish (n = 2168) but, as data quality and rates of recapture (10%) were high, the objectives of this study were met.

There were two key conclusions of the study. Firstly, research outcomes of the tagging improved as the level of involvement by research increased. Secondly, the quality of data was more important than quantity. The quality of tag data for research depends on the accuracy of the information recorded about tag and recapture events and the reporting of all tag and recapture data. Under-reporting of tag data occurred when the protocols of recording the data were not fully implemented. Under-reporting of recapture data, however, depended on the awareness of the general community about the tagging program. Finally, the best research outcomes are achieved when researchers are involved in the design, quality control and implementation of volunteer-based tagging programs.

Introduction

Collaborative research between fisheries scientists and recreational fishing groups is increasingly becoming viewed as an alternative to traditional scientific research. Proponents of such collaborative studies consider that the benefits, lower costs and community participation, outweigh the costs of reduced scientific rigor. At their best, community based tagging projects use the fishing knowledge and expertise of recreational anglers to increase the number of tagged fish in a research project. What is the most effective use of recreational fishers in tagging research? We present the results of three collaborative tagging studies on snapper in Australia that have varying levels of involvement of researchers with volunteer anglers. We compare these collaborative tagging studies using three criteria: 1. whether research objectives were met 2. quantity of tag data and 3. the quality of the data.

The three tagging projects focused on snapper (*Pagrus auratus*), one of the most important recreational and commercial fish species nationally, and were done in different geographical locations throughout Australia. "*Maximising survival of released undersize west coast reef fish*", is a Fisheries Research and Development Coorporation (FRDC) funded collaborative research project between the Deptartment of Fisheries, Western Australia (DFWA) and Westag (Australian National Sportsfishing Association - Western Australia branch (ANSA-WA)). Snapper is just one of four demersal species targeted by Westag for this study. "*Assessment of the snapper fishery in Victoria*", is an FRDC-funded collaborative research project between the Marine and Freshwater Resource Institute (MAFRI), and Victag (ANSA-Vic.). "*Movement of snapper in Shark Bay*", is funded by the National Heritage Trust and is a collaborative tagging project run by the DFWA using individual Shark Bay fishers. For convenience, these research programs will be referred to as Westag, Victag and SBTag respectively.

Although all tagging studies were collaborative, the level of involvement by researchers varied between the three programs (Table 1). Essentially, Westag is being run entirely by ANSA-WA with the DFWA playing a supportive role only. Victag, however, was supervised by MAFRI scientists who provided advice on tagging techniques, release data quality (maps for

spatial precision, length measuring, recording of all releases), database management support and actively assisted with collection of recapture data. In contrast, SBTag used volunteer anglers to catch fish with researchers doing all the tagging and associated data collection. Thus, these three snapper tagging projects represent three different models of varying involvement between recreational anglers and researchers (Figure 1).

Research objectives

Research objectives of the three tagging programs reflect the wide application of tagging studies and included: measuring the survival of released fish using three methods (Westag); estimating tag retention and providing data on growth (Victag); describing movement (Victag, SBTag); and age validation (SBTag), The research objectives were met for both the Victag and SBTag, while Westag is not yet completed.

Quantitative results

All tagging programs over-estimated the number of fish they expected to tag within the time frame of the study (Table 2). To date, Victag was the only program to reach its expected tag number, but this took twice as long as expected. Despite tagging the same species, the recapture rates varied between tagging programs and can be explained by either differing mortality or the quality of the tag data. Mortality in fish populations is influenced by biological and environmental factors. For example, recapture rates of tagged snapper are high in Shark Bay because the bay is enclosed and snapper populations are relatively localised.

In both Victag and SBTag relatively few taggers, respectively, 30 of the 170 taggers and approximately 15 of the 51 volunteers and 27 staff, tagged most of the fish.

The effect of funded research programs on established tagging programs varied. Compared to the years prior to 2000, when funding began (see Table 1), ANSA-WA members tagged less snapper in 2001 and charter boats did most tagging (Figure 2). In contrast, the number of snapper tagged by ANSA-Vic increased markedly after the research study commenced (see Table 1, Fig. 3).

Table 1. A general outline of the three tagging programs including year began, areas of responsibility for each group in the collaboration between Volunteer Anglers (VA) and Researchers (Res) and whether or not the research objectives of the program were accomplished.

	Westag*	Victag	SBTag
Year began	2000	1995	1998
Recruitment	VA	both	Res
Tag training	VA	both	Res
Tagging and datasheets	VA	VA	Res
Database entry	VA	VA	Res
Recaptures	VA	both	Res
Community awareness and extension	VA	both	Res
Objectives met	Not yet	Yes	Yes

*nb. the Westag study is incomplete

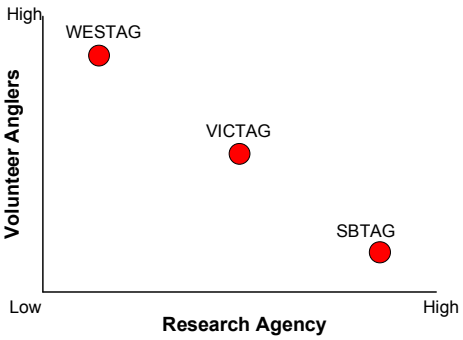

Figure 1. Varying involvement of both recreational anglers and the research agency in the three snapper tagging programs.

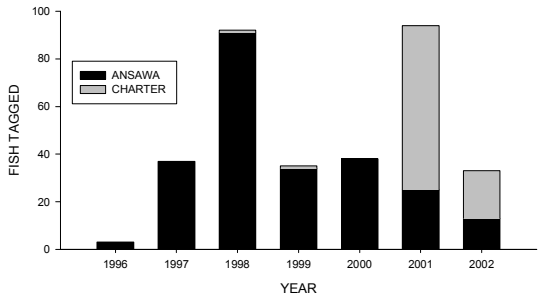

Figure 2. The number of snapper tagged by Westag (ANSA-WA) and by charter boats (charter) from 1996 to the present (2002 data is up to April 30).

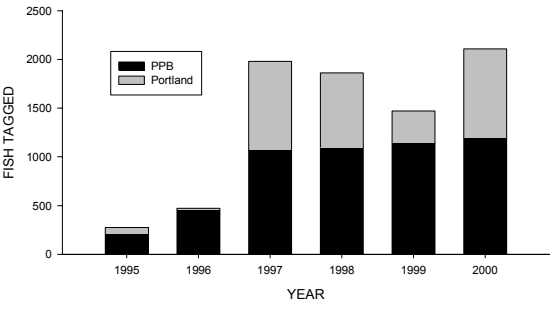

Figure 3. The number of snapper tagged by Victag with Hallprint Tbar anchor tags from 1995 to 2000 at two locations: Port Phillip Bay (PPB) and Portland.

Table 2. The quantitative results of the three collaborative tagging studies.

	Westag*	Victag	SBTag
Expected number tagged (time frame)	3000 (5 yrs)	10000 (2 yrs)	4000 (3 yrs)
Actual number tagged (time frame)	203 (1.5 yrs)	12700 (4 yrs)	2168 (4 yrs)
Number recaptured	24	274	224
% recaptured	12	2.1	10.3
Number of anglers tagging	40	170	78
# fish tagged per angler per year	5	19	7

* nb the Westag program is ongoing (incomplete).

Data quality

The quality of tag data for research depends on:

1. accuracy of the information recorded about tag and recapture events; and
2. the reporting of all tag and recapture data.

Differences in the methods to ensure the accuracy of data varied between the three studies. Researchers recorded all tag data in SBTag. For Victag, tag data was double checked firstly by ANSA-Vic's tagging co-ordinator and subsequently by the scientist. Data sheets recorded both FL and TL for quality control. Scientists often verified recapture data. Currently, in Westag there are no data checks. In the total number of recaptures in the Westag database (n = 302), we found errors in length measurements (39%, n = 118), days at liberty (7%, n = 21) and species identification (1%, n = 4). Errors included missing data as well as zero and negative values.

Under-reporting of tag data leads to the over-estimation of recapture rates in tagging programs. In SBTag all tagged data was entered into the database. In Victag, a strict process was implemented to ensure all tag data was returned to the ANSA tag co-ordinator. New tags were not issued to members until their tag data sheets for previous tags were submitted. Similarly, new tags were withheld from clubs until tag sheets were returned. In Westag there is no clear process to ensure all tag data sheets are returned. As under-reporting of tagged fish is evident when tag data is absent from recaptured fish, we compared the proportion of recaptured snapper that had no tag data. For Westag, Victag and SBTag respectively 8.3%, 3.6% and 0.0% of the recaptured snapper did not have their associated tag data. Thus, under-reporting of tagged fish decreased as involvement of researchers with the tag programs increased.

Under-reporting of recaptured fish is difficult to detect and depends on community awareness of the tagging program. Community involvement in tagging should increase public awareness of the program thus improving reporting of recaptures. Other factors, however, affect public awareness and reporting of recaptures as seen in Shark Bay. Public awareness of SBTag was high because management policies required recreational fishers to visit fishery offices before going fishing. Despite good public awareness, there was a lower recapture rate in one location adjacent to a closed area. One explanation for this is that recreational fishers are unwilling to report tag recaptures near closed areas. Both Victag and Westag launched public awareness campaigns to improve tag recapture and rewards were offered for VICTAG recapture data.

Summary

In summary, quality data, rather than quantity, is imperative for successful research outcomes of tag studies. In Shark Bay a small tagging study with a high rate of recapture can achieve its research objectives. When recapture rates are low, large tagging studies are required to meet research objectives and volunteer anglers may be used to boost numbers of tagged fish. The success of the Victag collaborative tagging program conducted by MAFRI and ANSA lies in MAFRI's involvement with recruitment and training of taggers, strict protocols for provision of tags and follow-up of recaptures with public education and awareness. The collaborative-tagging research programs with high levels of involvement by research agencies have the best outcomes for research. In conclusion, researchers need to be involved in the design, quality control and implementation of volunteer-based tagging programs.

ESTIMATION OF CATCH AND RELEASE FISHING MORTALITY AND ITS SAMPLING VARIANCE

Gene R. Wilde

Fish and Wildlife Management Institute, Mail Stop 2125, Texas Tech University, Lubbock, Texas 79409 USA

Abstract

The quality of many recreational fisheries depends on high survival rates of fishes that are captured and released by anglers. Catch and release of fishes may be voluntary or required by regulation (e.g. bag limits and minimum length limits). A considerable number of studies have examined the mortality of angler caught-and-released fishes. Most studies provide estimates of catch and release mortality that are presented without estimates of their sampling variability. Further, most studies fail to include control fish, which allow measurement of mortality attributable to experimental and observation conditions. Herein, I present methods for estimating catch and release mortality when control fish are included in the study design.

Introduction

Catch and release fishing has been practiced for over 100 years (Wydoski, 1976), but has increased in popularity in recent years (Barnhart, 1989; Muoneke and Childress, 1994). The increase in catch and release fishing has occurred for two primary reasons. First, many anglers practice catch and release as a conservation effort, to maintain fishery quality. Second, because fishery resources are finite, yet angler effort continues to increase, fishery managers are increasingly using restrictive length and bag (creel) limits to protect the viability of fish stocks. These regulations may require anglers to release fish of certain sizes or those in excess of a bag or possession limit. The success of catch and release in achieving various angler or management goals requires that a substantial proportion of fish that are captured and released survive (Muoneke and Childress, 1994).

A large number of studies, most recently reviewed by Muoneke and Childress (1994), have examined the mortality of fishes captured and released by anglers. These studies have examined the magnitude of catch and release mortality and its relationship to gear type, environmental conditions and handling, among others. These studies have been successful in providing fishery managers with insight into potential fishery effects and ways to reduce mortality. However, many studies have been limited in their usefulness due to inadequacies in study design and failure to assess the quality of the estimates obtained. Among the most common design shortcomings are inadequate sample size and absence of controls. Additionally, most studies fail to present variance estimates for catch and release mortality and those that do, have not included control fish (e.g. Persons and Hirsch, 1984; Muoneke, 1992).

Three basic study designs are currently used to assess catch and release mortality:

i fish are captured and then released into pens, cages, or small ponds where they are observed for mortality over a fixed, generally short, period (e.g. Diggles and Ernst, 1997);

ii fish are captured, released, and observed for mortality as in (i), but control fish, not subjected to angling, are also released into the holding facility to allow an assessment of mortality that might be attributable to transport to, or conditions within, the holding facility (e.g. Clapp and Clark, 1989);

iii fish are captured, released, and observed, with or without control fish, but only a sample of the captured fish is observed for mortality (e.g. Bettoli et al., 2000). The first two designs are those most commonly used to assess catch and release mortality in recreational fisheries. The third design is commonly used to assess mortality associated with fishing tournaments in which hundreds or thousands of fish may be captured (Wilde, 1998).

Methods for calculating the mean and sampling variance of catch and release mortality are well known where control fish are not included in the study design; however, methods for estimating these quantities when control fish are included have not been described. Herein, I describe the calculation of the mean and sampling variance of catch and release mortality

for both designs. I also comment on two representative studies of catch and release mortality, used here as case histories: control fish were included in one study, but not in the other.

Estimating the mean and sampling variance of hooking mortality

Catch and release mortality is a Poisson process: individual hooked fish experience one of two fates, they survive or die. If control fish are not included in the study design (a design to be avoided), the sum of N of trials is a binomial variable MT, with mean:

$$MT = nR / NR, \quad (1)$$

and sampling variance:

$$Var(MT) = (MT \times (1 - MT))/ NR, \quad (2)$$

where MT is the catch and release mortality, nR is the number of captured fish that dies, and NR is the total number of fish captured (and released). Note that Var(MT) can be reduced only by increasing the number of fish captured and released (NR). The standard error for catch and release mortality SE(MT) can be estimated as the square root of Var(MT) and a 95% confidence interval about MT is approximated by:

$$MT \pm 2 \times SE(MT). \quad (3)$$

A confidence interval about MT based on the binomial distribution provides a more exact confidence interval (Sokal and Rohlf, 1981).

If control fish are included in the study design, basic probability theory (Mood et al., 1974; Larson, 1982) provides guidance for calculation of the mean and sampling variance of catch and release mortality. The mean is estimated as:

$$MT = MR - MC, \quad (4)$$

where MR is the mortality of caught and released fish and MC is the mortality of control fish. MC is calculated as:

$$MC = nC / NC, \quad (5)$$

where nC is the number of control fish that dies and NC is the total number of control fish. MT is a binomial variable if NR = NC, otherwise MT is best treated as a normal variate.

With control fish included in the design, the sampling variance of MT can be calculated as:

$$Var(MT) = Var(MR) + Var(MC) - 2 \times Cov(MR, MC). \quad (6)$$

If we assume mortality of released fish (MR) and control fish (MC) are independent, a conservative assumption, then Cov(MR, MC) = 0 and:

$$Var(MT) = Var(MR) + Var(MC), \quad (7)$$

where $$Var(MC) = (MC \times (1 - MC))/ NC. \quad (8)$$

Var(MT) can be reduced by decreasing either Var(MR) or Var(MC), which is accomplished by increasing NR or NC, respectively. Correcting for mortality of control fish generally will reduce Var(MT) because it is the combination of two smaller variances (i.e. equation 6) rather than one larger variance (i.e. equation 2). Most studies of catch and release mortality under sample both angled and, especially, control fish. As before, the standard error of catch and release mortality SE(MT) can be estimated as the square root of Var(MT) and a 95% confidence interval about MT is approximated by:

$$MT \pm 2 \times SE(MT). \quad (9)$$

Case histories

Catch and release mortality of two reef fishes, wire netting cod (*Epinephelus quoyanus*) and yellow stripey (*Lutjanus carponotatus*), captured from the Great Barrier Reef, Australia, was studied by Diggles and Ernst (1997). Fish were captured with lures or bait, held in aerated 60 L containers for no longer than one hour, and transported to a holding facility where they were observed for mortality over a two-day period. No control fish were included in their study design. Mortality was low in both species, ranging from zero to 6.7% (Table 1). In three of the four species-bait combinations, observed mortality was not different from zero (approximate 95% confidence intervals include zero). Precision (100 × SE(MT) / MT) of the estimates of

Table 1. Catch and release mortality of wire netting cod *Epinephelus quoyanus* and yellow stripey *Lutjanus carponotatus* captured with lures and bait. Catch and release mortality MT and its variance Var(MT) calculated as described equations (1) and (2) in text. Data were obtained from Diggles and Ernst (1997).

	Wire netting cod		Yellow stripey	
	Lure	Bait	Lure	Bait
Number of fish angled	120	38	122	60
Number dead	1	1	0	4
Mortality MT (%)	0.8	2.6	0.0	6.7
Var(MT)	0.69	6.74	0.00	10.37
Approximate 95% confidence interval	0.8±1.66	2.6± 5.19	0.0±0.00	6.7±6.44

Table 2. Catch and release mortality of smallmouth bass *Micropterus dolemieu* captured in four test periods. Catch and release mortality MT, corrected for control fish, and its variance Var(MT) calculated as described equations (4) and (7) in text. Data were obtained from Clapp and Clark (1989).

	Test period			
	1	2	3	4
Number of fish angled	17	7	9	3
Number dead	1	1	2	0
Mortality MR (%)	5.9	14.3	22.2	0.0
Control fish	33	32	35	38
Number dead	0	2	3	0
Mortality MC (%)	0.0	6.3	8.6	0.0
Corrected mortality MT (%)	5.9	8.0	13.7	0.0
Var(MT)	32.60	193.20	214.40	0.00
Approximate 95% confidence interval	5.9±11.41	8.0±27.80	13.7±29.29	0.0±0.00

catch and release mortality were poor, ranging from 48 to 103%. Further, without control fish it is impossible to definitively attribute the observed mortality to hooking or subsequent handling, transport and confinement of fish. Diggles and Ernst (1997) presented analyses of differences in mortality attributable to bait type (bait versus lure) and the part of the body in which fish were hooked. These analyses are vitiated by the limitations in the study design. The observed mortality generally was not different from zero, nor could it be definitively assigned to hooking effects.

Catch and release mortality of smallmouth bass *Micropterus dolomieu* was studied by Clapp and Clark (1989). Study fish were captured and transported to two experimental streams. Fish were tagged with numbered floy tags prior to release. Four two-week fishing trials were conducted. In the first, one experimental stream was fished with live bait, whereas the other was fished with spinners. Fishing was conducted over a two-week period, after which the experimental streams were drained and numbers of live and dead angled and non-angled (control) fish were counted. The streams then were re-filled; fish were returned to their respective streams and the next two-week trial was begun. Terminal tackle used was switched between experimental streams after each trial so that each stream was fished twice with bait and twice with spinners. Mortality of captured smallmouth bass ranged from zero to 22.2% and mortality of control fish ranged from zero to 8.6% (Table 2). Catch and release mortality of smallmouth bass, corrected for mortality of control fish, ranged from zero to 13.7%. Excluding results from the single trial in which no angled fish died, approximate 95% confidence intervals about all estimates of catch and release mortality included 0. Precision of the estimates of catch and release mortality were poor, ranging from 97 to 174%.

Discussion

Studies of catch and release mortality should present estimates of the sampling variance of all estimates. This allows an assessment of the precision of the estimates, their robustness, and, in fact, whether there is actual evidence that mortality exceeds zero or differs among treatments. Many estimates of catch and release mortality have low precision, with a standard error SE(MT) greater than the mean (MT). Increasing sample size can increase precision of catch and release mortality estimates. Most studies can be improved by including control fish, which unfortunately are infrequently included in studies of catch and release mortality. Beyond allowing an assessment of whether experimental conditions beyond the treatment (hooking) explain study results, inclusion of control fish allows more accurate estimation of catch and release mortality and reduces the variance of such estimates.

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INDIGENOUS FISHING SURVEY IN NORTHERN AUSTRALIA - A METHODOLOGICAL CHALLENGE

Anne Coleman[1], Laurie West[2] and Gary Henry[3]

[1] Fisheries Group, Department of Business, Industry & Resource Development, GPO Box 3000, Darwin NT 0810, Australia
[2] Kewagama Research, 70 Foxtail Rise, Noosa Valley QLD 4562, Australia
[3] New South Wales Fisheries, PO Box 21, Cronulla NSW 2230, Australia

The primary focus of the National Survey is estimates of catch and effort for all 'non-commercial' fishing activity in all areas of Australia. The vast majority of this information will be obtained from the telephone/diary survey of recreational fishing, which provides excellent coverage of the resident population. However, in areas of coastal northern Australia, Indigenous people are also an important, if not the major non-commercial user of fisheries resources. A telephone/diary survey would not provide adequate coverage of these residents, so a survey module was designed to examine the fishing activity of Indigenous fishers in Northern Australia.

An innovative approach was needed to design a survey which had never been attempted before on such a large scale. Ultimately, the design needed to balance logistic and financial constraints whilst maintaining the focus on optimal data quality. The survey was based on general population sampling. Communities were stratified by location, with a random selection of 46 communities chosen. Within each community, dwellings were selected randomly and an initial face to face interview was used to collect household profiling information. All respondents from selected dwellings were then invited to participate in a twelve-month catch and effort survey. Respondents were visited regularly throughout the survey period and details of fishing activity for the week prior to the contact recorded.

While the recreational and indigenous components have different values to each State and Territory, the combination will provide a comprehensive picture of non-commercial fishing, and allow a more comprehensive description of the extractive sectors of Australia's fishing resources.

PREDICTING THE EFFECT OF LEGAL MINIMUM LENGTH CHANGES ON FISHING MORTALITY USING DATA FROM AN ANGLER FISHING DIARY IN AN AGE-STRUCTURED MODEL

Simon Conron

Marine and Freshwater Resources Institute, PO Box 114, Queenscliff, Vic 3225, Australia

Experienced anglers were used as a fishery-independent sampling method for black bream (Acanthopagrus butcheri) in Victorian estuaries. They fished at specific times and locations using hooks and baits which were likely to catch fish above and below the legal minimum length. The anglers kept detailed records of catch, effort and fish size. They also removed otoliths from a sample of fish. Results indicate that black bream stocks from these estuaries have different year-class profiles and growth rates, that varied both within and between estuaries. Catch rate data were used as an index of relative abundance in an age-structured model. This model was used to forecast the potential impacts of changes to legal minimum lengths on the fishery. The involvement of anglers in this project has been expanded to other smaller fisheries for which creel surveys or other conventional data collection tools are impractical.

Incorporating recreational catch into fishery assessments: a case study with the Tasmanian southern rock lobster fishery

Stewart. D. Frusher, Caleb Gardner, Malcolm Haddon, Jeremy Lyle and Jane Forward.

Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, GPO Box 252-49, Hobart, Tas 7001, Australia

In Tasmania, the southern rock lobster (SRL) commercial fishery is managed by quota. A total allowable commercial catch (TACC) is set each year. The SRL resource also supports an active recreational fishery which has seen a 50% increase in the number of recreational licenses issued since 1996.

The annual fishery assessment utilizes a size-structured, spatially explicit model. This model allows recreational catch to be incorporated spatially and has been recently modified to include estimates of each year's recreational catch as a proportion of the commercial catch. This talk will demonstrate the importance of incorporating spatial recreational data into fishery assessments by considering the following scenarios: no recreational catch (control); total recreational catch apportioned to all regions equally; recreational catch apportioned to different regions on the basis of area; and, finally, annual recreational catches estimates separately for each region. Results are based on recent recreational surveys and are presented in the form of comparisons in legal sized biomass and egg production estimates over the last ten years against the control scenario.

The biology of the SRL varies substantially from southern to northern regions in Tasmania, with growth increments being up to eight times larger in the north. While the Tasmanian commercial catch is only taken using pots, the recreational catch is primarily obtained by potting and diving. Both methods are restricted to inshore regions (depths < 15m) and are considered to target different size classes of lobsters. Divers are more capable of reaching their bag limit and can therefore target larger lobsters. The talk will also demonstrate the need for assessments to account for biological variability between regions and fishing methods.

Characterising response and nonresponse in the Australian National Recreational Fishing Survey: implications for general population angling surveys

Jeremy M. Lyle[1], Laurie West[2] and Dennis D. Reid[3]

[1] Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, GPO Box 252-49, Hobart, Tas 7001, Australia
[2] Kewagama Research, 70 Foxtail Rise, Noosa Valley, QLD 4560, Australia
[3] New South Wales Fisheries, PO Box 21, Cronulla, NSW 2230, Australia

The 2000/01 national survey of recreational fishing in Australia involved a multi-faceted survey design, the primary elements being a general population telephone survey to identify anglers, followed by a telephone/diary survey in which fishing activity was monitored over a 12-month period. Overall response rates to all facets of the survey were high, with over 80% response to the screening survey (all primary data provided) and, of respondents who agreed to participate in the diary survey, about a 95% response over the full diary period. Data quality and sample representation were important considerations in the development of the survey instrument. These issues were addressed through a number of approaches, including benchmarking against population census data and specifically designed components within the survey itself to characterise non-response groups and provide adjustment factors where necessary.

In the screening survey, non-response arose as a result of refusals (partial or full) and non-contacts. Sub-samples of these two groups were successfully followed up by telephone and categorised in terms of substantive data, including age, gender and previous fishing participation. Comparisons with the response group were undertaken to determine whether adjustments were necessary for data expansion. There was a non-angler bias in households that initially refused the screening interview. In terms of diary acceptance, previous fishing participation and avidity were found to correlate with the rates of diary uptake and there was a strong correlation between these profiling characteristics and fishing participation and days fished during the survey period. This analysis demonstrated that the least avid groups were generally under-represented and, if this was not taken into account, would result in over-estimates of harvest and effort. The impact of persons 'unexpectedly' moving into the recreational fishery was evaluated through interviews conducted at the end of the diary phase with a sample of respondents who expressed no intention to go fishing during the diary period. These non-intending anglers indicated whether or not they had fished during the diary period. These data were set against observed participation rates amongst the intending anglers (diarists) to determine actual participation rates. This approach avoids a simplistic equilibrium assumption, where the number of anglers 'leaving' the fishery equals that 'entering' the fishery.

Through the range of data quality control measures developed for the national survey we demonstrate the impact of non-response and provide a framework for addressing this issue in other large-scale angling surveys.

PREDICTING WESTERN ROCK LOBSTER (*PANULIRUS CYGNUS*) RECREATIONAL LICENCE SALES, USAGE AND CATCH IN WESTERN AUSTRALIA

Roy Melville-Smith, Adrian W. Thomson and Nick Caputi

Western Australian Marine Research Laboratories, P.O. Box 20, North Beach, WA 6920, Australia

Recreational rock lobster fishers in Western Australia are required to purchase a licence. Information from the licence database is used to generate a mailing list for a survey on fishing activity, that is sent out to between 3 000 and 4 000 fishers randomly selected at the end of each season. Data from the survey is used to estimate annual western rock lobster (Panulirus cygnus) recreational catch and fishing effort. Catch is significantly correlated with licence usage rates and abundance of puerulus (the post-larval settling stage of rock lobster) settlement three to four years earlier (r^2 = 0.91), and these variables are used to predict future western rock lobster recreational catches. In this study, a multiple-regression incorporating long term trends (1986/87 to 2000/01 seasons) and puerulus settlement indices (at Alkimos three to four years earlier) has been shown to be highly correlated with licence usage (r^2 = 0.90) and licence sales (r^2 = 0.82). Based on this relationship it is predicted that licence usages will be approximately 26 000 in 2001/02, 31 000 in 2002/03 and 34 000 in 2003/04 and licence sales approximately 34 000 in 2001/02, 39 000 in 2002/03 and 42 000 in 2003/04. Assuming these numbers of licences will be used, it is predicted that the recreational catch will decrease from 560 tonnes in 2000/01 to 470 tonnes in 2001/02, but increase to 720 tonnes in 2002/03 and 910 tonnes in 2003/04.

COMPARISONS OF LOGBOOK CENSUS AND TELEPHONE SURVEY METHODS OF MONITORING RECREATIONAL FISHING EFFORT ON CHARTER BOATS AND PARTYBOATS

David A. Van Voorhees and Thomas R. Sminkey

U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Fisheries Statistics and Economics Division, F/ST1, 1315 East-West Hwy, Silver Spring, MD, USA 20910

The U. S. National Marine Fisheries Service conducted pilot studies in South Carolina (2000) and California (2001) to compare logbook census and telephone survey methods of monitoring marine recreational fishing effort on charter boats and partyboats. The primary objective was to determine whether a more timely, less burdensome sampling survey approach would provide measures of fishing effort similar to those obtained from existing mandatory logbook reporting programs. The secondary objective was to evaluate potential sources of error in the alternative reporting methods. Logbook counts of boat trips and angler trips were compared with estimates obtained from a weekly telephone survey that sampled from a comprehensive directory of boat representatives. With a 10% sampling rate and 70-90% response rates, annual telephone survey estimates for both Federal and State waters were not significantly different from the logbook counts in South Carolina. Monthly telephone survey estimates also closely matched logbook counts. Comparisons of logbook reports by telephone survey respondents and non-respondents indicated a negative non-response bias during the most active fishing months. However, paired comparisons of telephone and logbook reports for the same boats showed that significantly more effort was reported in telephone interviews. Under-reporting errors estimated from a coordinated, independent dockside survey of boats were higher for logbooks than for telephone interviews, and they were generally lower for partyboats than for charter boats. Preliminary comparisons in California are showing similar results. The telephone survey approach appears to be a very effective, and potentially more accurate, method for monitoring charter boat and partyboat fishing effort.

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AFMA'S FISHERY DATA COLLECTION AND VERIFICATION PROGRAMS

Wade Whitelaw

Australian Fisheries Management Authority, Box 7051, Canberra Mail Centre, ACT 2610, Australia

To sustainably manage any fishery, especially where there are a number of resource users, scientists and managers firstly need catch, effort and bycatch information. Secondly they need to have confidence in the data they are using.

AFMA, who have responsibility for managing Australia's Commonwealth fisheries, have in place a number of data acquisition and verification processes. These include vessel logbooks, catch disposal records, season landing returns, VMS and observer programs.

Examples of information collected through logbooks and verified by season landing returns and observers include the Northern Prawn fishery and the eastern tuna and billfish fishery. Both these fisheries have interactions with recreational fisheries.

Observer programs, besides providing independent catch and effort information, also obtain biological information on target and bycatch species. These may be both commercial and recreational species. Observers are able to collect a myriad of biological information and samples that assist scientists and managers to better understand the biology of the species as well as ecological interactions.

Verification processes are required for any type of fisheries data. This includes commercial, recreational and artisinal data.

Theme 3

The values of recreational fishing

SHARING/ALLOCATION OF WILD FISH RESOURCES AMONG COMPETING INTEREST/USER GROUPS – POLICY OPTIONS AND A DECISION FRAMEWORK

C. Murray MacDonald

Fisheries Victoria, Department of Natural Resources & Environment, P.O. Box 103, Geelong, Victoria, 3220, Australia

Abstract

Perhaps the most controversial and challenging issue in fisheries management, after stock conservation and fish habitat protection, is how to determine appropriate sharing/allocation of common pool wild fish resources among competing recreational, commercial, traditional and non-extractive interest groups.

This paper describes alternative 'economic' and 'community interest' models or policy options for determining appropriate allocations of fish resources. The 'economic' model assumes no prior rights of access to fish resources, and requires comparable estimates of the net economic value of competing uses. Fish resources are re-allocated from low net value to high net value uses in order to maximise net economic benefits across all uses.

The 'community interest' model assumes all community sectors have an intrinsic right of access to a share of fish resources, and requires surveys of community preferences for alternative uses of/benefits from the fish resource. Proportional allocations are made according to community preferences in order to maximise social equity in the use of fish resources.

The paper also describes a decision making process for translating broad fish resource allocation goals into specific allocation targets for particular fish resources; for implementing re-allocations where necessary; for monitoring compliance with allocation targets; and for periodically reviewing allocation goals and targets in light of possible changes in community values attached to the fish resources in question.

Identification of clear fish resource allocation policy options and application of a transparent decision making framework for determining allocation targets is intended to de-mystify the resource allocation issue and to promote broader public understanding and acceptance of allocation decisions.

Introduction

There is an increasing public expectation in Australia and worldwide, that utilisation of fish resources will be managed according to the principles of Ecologically Sustainable Development (ESD). The broad application of these principles to Australian fisheries was first described during the development of a national Fisheries ESD Strategy in the early 1990s. More recently the national Standing Committee on Fisheries and Aquaculture (SCFA) has been co-ordinating the development of a Fisheries ESD Reporting Framework which provides more detailed guidelines on how to translate the broad ESD principles into operational management objectives and performance indicators for individual fisheries in order to demonstrate sustainability (Fletcher et al., 2002).

The Fisheries ESD Reporting Framework requires (amongst other things) that specific and measurable management objectives and performance indicators be identified and implemented for the biological sustainability, resource sharing, economic, social and governance dimensions of each individual fishery. This paper focuses on the resource sharing (allocation) aspect of the management of utilisation of wild fish resources. It discusses some of the policy issues surrounding fish resource allocation, identifies allocation policy options available to Government, and provides a decision and implementation framework for translating a chosen policy option into specific allocation objectives or targets for a given fish resource. The policy options and decision framework allow for the inclusion of non-extractive as well as extractive uses of fish resources in allocation decisions.

When are resource allocation decisions needed?

Resource allocation decisions are needed when a particular fish stock is subject to two or more significant competing uses, and there is a need to determine how best to share the resource among all legitimate users/interest groups. Competition can occur between different groups interested in the catching/harvest of the fish resources (e.g. recreational fishers, fish consumers, commercial fishers, traditional/customary fishers, participants/dependents of industries supporting commercial or recreational fishing) or between

these groups and those interested in non-extractive uses of the resources and their habitats (e.g. divers, ecotourists, people wishing to maintain 'existence' values of resources, participants/dependents of industries supporting non-extractive use/appreciation of fish resources and their habitats).

It should be noted that separate allocation decisions are likely to be needed for different fish resources because of differences in community values attached to each fish resource.

Resource sharing versus resource conservation

It is very common when dealing with complex and controversial fisheries management problems to find people confusing fish stock conservation and habitat protection issues with fish resource allocation/sharing issues, and in particular trying to justify proposed changes in resource sharing arrangements by using resource conservation arguments. These two issues should be dealt with separately, and management measures designed to conserve fish stocks should be clearly distinguished from those designed to achieve resource allocation objectives.

To use a well worn metaphor, stock conservation and habitat/environment protection is about trying to maintain or increase the size of the fish resource 'cake' for the benefit of all users. Any activity (including particular fishing methods) which threatens to diminish the size of the fish resource 'cake' must be controlled or even prohibited, otherwise all users (including future generations) will be worse off. On the other hand resource allocation/sharing is about how to most appropriately 'slice up' the available fish resource 'cake' among competing user groups, regardless of the size of the 'cake'. In other words, fish stock conservation is largely a biological/ecological issue, whereas fish resource allocation/sharing is primarily a socio-economic issue.

Policy options for making resource allocation decisions

There are three alternative approaches or models for arriving at decisions on the most appropriate allocation of access to or benefits from wild common pool fish resources:

1 the 'Economic' Model - an approach designed to maximise net economic benefits from the use of fish resources,
2 the 'Community Interest' Model - an approach designed to maximise social equity in the use of fish resources,
3 the 'Compromise' Model - an approach designed to achieve a mixture of net economic benefit and social equity in the use of fish resources.

The economic model

If maximisation of net economic benefit is chosen as the desired allocation outcome (policy) for a particular fish resource, then a market-based economic model is applied. This involves generation of comparable estimates of the net or marginal economic value (in dollar terms) of all competing uses of the fish resource in question. This information is then used to set allocation targets for each use which results in maximum net economic benefit across all uses (Hundloe, 1997; 2001). Comparisons of recreational fishing expenditure and wholesale market value of commercial catches are not an appropriate basis for making fish resource allocation decisions. These measures are not directly comparable and neither is a comprehensive measure of the net economic value (benefits less costs) to society of commercial or recreational use of fish stocks (Hundloe, 1997; 2001; Kearney, 2002).

Implicit in this market-based economic approach to fish resource allocation are the assumptions that:

1 no individuals or groups start off with any intrinsic right of access to or benefit from a share of the fish resources in question;
2 comparable net or marginal economic value ($) estimates can be made for all competing uses of the fish stock; and
3 the best interests of the whole community are served by maximising net economic benefit.

The economic model is likely to generate maximum net economic benefits, but it may not deliver equitable outcomes to those sectors of the community who are unable or unwilling to place premium economic value on their particular use in order to obtain a fair share of the available fish resources.

The 'community interest' model

If maximisation of social equity is chosen as the desired allocation outcome (policy) for a particular fish resource then the 'community interest' model is applied. This involves ascertaining community preferences for alternative means of access to or benefit from the fish resource in question, and setting allocation targets according to the proportion of the entire community favoring each particular use/benefit.

Implicit in this 'community interest' approach to fish resource allocation are the assumptions that:

1 members of the community that collectively 'own' the fish resource in question do have an intrinsic right of access to or benefit from a fair share of the common pool fish resource in a manner of their choosing,
2 all legitimate uses of the fish stock (whether they can be assigned a net economic value or not) are equally valuable in determining allocation outcomes,
3 the best interests of the whole community are served by sharing access to or benefits from the fish resource in a way that maximises social equity.

The 'community interest' model is likely to result in the most socially equitable allocation of fish resources, but it may not produce maximum net economic (dollar) benefits from the use of these resources.

The compromise model

If a mixture of net economic benefit and social equity goals is chosen as the desired allocation outcome (policy) for a particular fish resource then the compromise model is applied.

The compromise model might involve setting jurisdiction-wide allocation targets for a particular fish resource using the net economic benefit approach, but modifying these targets in local or regional areas in recognition of social equity issues (e.g. accommodation of indigenous fishing rights/interests or the interests of fishing-dependent local communities).

Conversely, the compromise model might involve setting jurisdiction-wide allocation targets for a particular fish resource using the 'community interest' approach, but modifying these targets in local or regional areas in recognition of regional economic issues.

Steps in the allocation decision-making and implementation process

Step 1. Identify fish resource for which an allocation decision is needed - including identification of the community whose interests will be affected by an allocation decision.

Step 2. Select preferred allocation policy for the fish resource in question - the governing body of the community decides whether community interests are best served by allocating the fish resource to maximise net economic benefits (i.e. using the economic model), or to maximise social equity (i.e. using the 'community interest' model), or to achieve a mixture of both net economic benefits and social equity (i.e. using the compromise model). Different policy options may be chosen for different fish resources to reflect different community values attached to each resource.

Step 3. Collect appropriate information to facilitate a decision on target allocations for the fish resource in question - information is obtained on the net or marginal economic value of identified competing uses (if the economic model is to be used) or on community preferences for alternative uses/benefits (if the 'community interest' model is to be used) or on both (if the compromise model is to be used).

Step 4. Compare current allocations of the fish resource with desired target allocations - current information on catch shares and other non-extractive uses of the fish resource will be required for this purpose.

Step 5. If re-allocation is needed, use appropriate management or structural adjustment tools to achieve allocation targets - fishery management tools may include output (catch) controls, input (effort) controls or a mixture of the two, depending on the characteristics of the fishery. Non-extractive uses/interests can be catered for by establishing aquatic protected areas in some locations, and by ensuring that all uses of the fish resource are sustainable into the future.

Step 6. On-going monitoring of competing uses to ensure that they remain aligned with allocation targets - in the case of non-commercial fishery uses, this will require monitoring methods which permit estimates of total catch of the fish resource in question.

Step 7. Periodic review of the appropriateness of the allocation policy and allocation targets for the fish resource in question (back to Step 2) - such reviews will be necessary because government economic and social policies may change, and because community values regarding use of a fish resource may change over time.

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INFLUENCE OF RECREATIONAL FISHERMEN ON REGIONAL ECONOMIES

Ian Murphy

PO Box 8, Grange, Queensland, 4051, Australia.

Abstract

Recreational fishing has been an intrinsic part of growing up, leisure time and a primary activity for holidaymakers for several generations. Regional centres that have evolved as ports for commercial fishermen have gradually developed as holiday destinations and growth in recent times has generally been attributed to tourism. In many cases those opting for lifestyles that include access to fishing have populated such regions.

As the world demand for quality seafood has increased, these desirable areas, which grew because of good fishing, have become over-fished or are dangerously close to it. Management plans and strategies are being implemented to control the fishing effort of commercial and to a lesser extent, recreational fishermen. Many of the stakeholders are calling for total closures of regions to all types of fishing.

What many regional authorities don't understand is that their economies are dependent on tourism and that a high percentage of visitors to their areas come for the recreational fishing. Numerous studies have established the numbers of recreational fishermen and many of these studies have tried to ascertain the value of the fish taken by these fishermen. But the amount of money spent by recreational fishermen was, at best, a guess. The Northern Territory Government is the only state or territory government to realise the value of recreational fishing and develop management strategies to maximise economic gain while sustaining that fishery.

Sunfish Queensland has published a series of survey-based reports on the amount recreational fishermen spend to go fishing. The results are eye-opening in their enormity and uniformity and highlight that many regional economies rely, if not survive, on recreational fishing for income. Recreational fishermen who visit or live in any given region contribute to its economy in every aspect and if the fishery collapsed, they would either not visit or move away, leaving the region struggling – much like a mining town does when the mine that supports it closes.

For this reason, recreational fishing and the sustainability of fish stocks for this purpose must become a high priority for local, state and federal governments when planning for the future.

Introduction

Australia is a large island nation with a total length of coastline second only to Canada. 85% of the nation's modest population (around 20 million) live on or near the coast with the highest density on the eastern seaboard. The generally good climate allows Australians to enjoy a wide range of outdoor sports and leisure activities, many of which involve being on or near the water. Recreational fishing is one of these sports and leisure activities and around 20% of Australians participate at least once a year. It can be undertaken as an organised activity or serious sport or as a leisurely day out with the family where catching a fish is a secondary objective.

Families going on holidays often go to smaller coastal centres to enjoy the comparatively cleaner, quieter, and less spoiled environment. These same areas usually provide better fishing opportunities and the desire to catch a fish is a big reason for people to visit the region. There are many holiday regions on Australia's vast coast, many within a days drive from the major capitals and a few remote places only accessible by 4WD, helicopter or boat. Many of the regions offer several attractions including surfing, bushwalking, ecotourism and diving. They also offer recreational fishing and many tourists visiting a region for another reason consider the fishing when making their final decision on where to go.

Regional towns were settled and established for many reasons: mining, logging, farming (both horticulture and agriculture) and as ports. Fishing fleets often grew within the ports and the towns established a 'seafood flavour' as the local produce was harvested from the ocean. The relaxed lifestyle, excellent fishing and the enjoyment received from holidaying in these regions induced many people to return and take up permanent residence. The growth of the permanent population and the influx of visitors every holiday season helped these regions grow and survive. As the twen-

tieth century drew to a close many of the natural resources that helped establish the regions were exhausted and the regions relied on tourism and the 'seafood flavour' to maintain the economy.

The perceived decline in fish stocks prompted fisheries management to improve. Research and monitoring increased during the 80's and 90's resulting in changes and restrictions on fishing activities. However the research was focused on commercial fishing activities with very little attention afforded to the recreational sector. The main reason for this was economic. The commercial fishermen were perceived to be making a living and creating employment for the region through their activities. Recreational fishermen were considered inefficient users of the resource and, in effect, wasting the resource and contributing little to the economy.

One point that is always overlooked: How much does the recreational fisherman contribute to the economy and would he/she continue to live or holiday in the region if there were no fish to catch?

The answer has never really been known although many estimates have been made based on single questions in wide ranging surveys. For this reason Sunfish Queensland Inc. and the Queensland Industry of Recreational Fishing commissioned a series of reports into the spending habits of recreational fishermen and their contribution to the economy. The surveys targeted four regions on the Queensland coast that were believed to have a high percentage of recreational fishermen, fishing grounds that were showing signs of overfishing from both commercial and recreational fishermen, and environmental degradation from bad land management and urban development. It was considered that if these fisheries were to decline or collapse the economies would also collapse. Even the decline of the inshore fisheries would be sufficient for the majority of recreational fishermen to move elsewhere, adversely affecting the economy. One region, Pumicestone Passage, had already been closed to commercial fishermen due to public pressure.

Methods

This paper is a summary of four reports based on the results of written surveys in four selected regions on the Queensland coast: Pumicestone Passage (1999), Hervey Bay and the Great Sandy Strait (2000), Townsville/ Thuringowa (2001) and Mackay/ Whitsunday (2001).

Table 1. Value of Capital Equipment (in A$)

	PumicestonePassage		Hervey Bay		Townsville/Thuringowa		Mackay/Whitsunday	
Population	82,000		60,000		110,000		58,000	
Total (A$)	97,377,059*		101,911,279		167,929,493		152,234,275	
Boats as % of total	91		88		70		79	
	region	**capita**	**region**	**capita**	**region**	**capita**	**region**	**capita**
Boats ($K)**	88,834	9.697	89,992	11.382	117,740	14.369	121,312	12.958
Fishing Equipment ($K)**	5,849	0.546	10,008	0.495	24,763	0.750	12,241	0.610
Electronic Accessories ($K)**	N/A*	N/A*	7,488	1.184	13,037	1.768	11,015	1.400

* Pumicestone Passage report was the first in the series and several items were overlooked when writing the survey resulting in a lower capital investment figure and a higher percentage of boats as part of the total capital investment.
** Total amount of dollars spent by region and capita

Table 2. Yearly Expenditure (in A$)

	PumicestonePassage	Hervey Bay	Townsville/Thuringowa	Mackay/Whitsunday
Visitation Rate	48 000*	300 000	430 000	222 000
Total	8 212 616*	38 345 904	69 851 006	42 617 436
$ per capita per year**	1 711	1 278	1 624	1 919
Car and boat fuel	1 090 185*	13 127 820	25 326 226	13 392 678
Terminal tackle and lures	389 880*	3 708 900	5 960 230	3 321 835
Fish and crab bait	429 537*	3 982 776	7 512 662	4 190 560
Maintenance	3 062 430	2 624 792	3 989 300	4 156 050
Takeaway food	326 553*	3 154 896	4 945 860	3 139 318
Insurance	1 562 220	1 117 339	1 714 840	1 487 588

* Pumicestone report visitation rate appears to be extremely conservative and reflects the low expenditure totals. Average amounts spent per trip were more uniform (see Table 3).
** Based on average of 10 trips per year.

Table 3. Fishing Trip Expenditure per capita (in A$)

	Pumicestone Passage	Hervey Bay	Townsville/Thuringowa	Mackay/Whitsunday
Bait	8.55	12.68	16.70	17.14
Terminal Tackle	6.47	9.90	12.22	12.20
Lures	3.81	18.78	16.32	16.86
Car fuel	11.18	20.96	20.76	20.75
Boat fuel	15.00	29.70	46.70	46.32
Takeaway food	10.63	17.44	17.75	22.13
Accommodation (per night)	27.00	39.62	54.00	60.90

Results

The results of the four surveys are outstanding in their magnitude and uniformity. The results compare with expenditure from other States/Territories (Coleman, 1998 (NT); Dominion Consulting, 2001(NSW)).

Capital equipment

Recreational fishermen usually require a certain amount of equipment such as boats, fishing equipment (rod and reels), electronic accessories, crab pots and specialised clothing. These items generally last for an extended period of time and although they can be upgraded regularly (depending on the fisherman's requirements and budget), are classified as a capital expense. The capital expenditure across the four regions varied but in all cases boat ownership made up a high percentage of capital expense (see Table 1). Fishing equipment and electronic accessories such as depth sounders and GPS receivers made up the other two significant capital expense items (Table 1). All of these items are readily available from marine dealerships and tackle stores within the region and generate significant local economic activity.

Yearly expenditure

Recreational fishermen also spend a significant amount per year to maintain and insure equipment, travel to and from fishing destinations and to buy terminal tackle, bait and take away food. This economic activity is continuous although the amounts can vary depending on seasons, weather patterns and fish abundance. The yearly expenditure of recreational fishermen in the four regions would contribute considerably to the cash flow of many small businesses including fuel outlets, takeaway food shops, bait and tackle shops and marine repairers (Table 2).

Trip expenditure: average per trip

The surveys showed inconsistent results for the amount spent per trip on consumables (Table 3), although these variations reflect the difference in fishing conditions, fish targeted and distances traveled.

Pumicestone passage is a shallow estuary, with fishermen targeting small fish within close proximity of accommodation or boat ramps. Often the target fish are non-predatory so lures are not required and fishing trips are often short in duration requiring less food and drink.

The other three regions offer several different fishing conditions from inshore and estuarine, to offshore reef and sport fishing. The distances traveled by boat or car are often far greater and trip duration longer. The fish targeted are usually predatory and quite large requiring large lures, bait and terminal tackle.

Conclusion

Recreational fishermen make a large contribution to regional economies.

Recreational fishing is obviously a great attraction for people coming to a region either on holidays or to live. Approximately 70% of people surveyed claiming fishing access as one of the reasons for living in the region and around 15% of those citing it as the sole reason (Murphy, 2002). Recreational fishermen indirectly contribute economically to other industries in the region, including real estate and automotive industries because of their specialised needs. Note should also be made of the steel garage (building) industry as many of these are built to house fishermen's boats.

Results show that more than 46% of economic activity generated by recreational fishermen comes from fishing done within two nautical miles of the shore, predominantly off the nearby beaches and rivers of the populated area (Murphy, 2002). These areas are also the most environmentally sensitive, but in many cases, are still open to both commercial and recreational fishing activities.

This series of reports highlights that the economic activity generated by recreational fishermen that live and holiday in regional areas is significant and reinforces the need to sustain the fishery, actively encourage recreational fishing and (in many cases) improve facilities for the wellbeing of those regions.

It has been suggested that recreational fishermen are inefficient at catching fish and the results of the surveys could support this suggestion. However, recreational fishermen fish mainly for pleasure and recreation with only a small percentage fishing solely for food. The reports findings cannot put a value on the pleasure aspect of recreational fishing but it can assert that a fish in the water is worth much more to the economy if it is pursued by recreational fishermen, than if it is caught commercially.

Recreational fishing is a major reason for holidaying and living in these regions. The recreational fishery needs research funding in order to be understood, socially, environmentally and economically, so that in conjunction with the commercial fishing industry and environmental agencies, it can be managed to maintain sustainability of fish stocks and the maximum economic benefit for the local community.

Governments, both State and Federal, need to look seriously at the value of the recreational fishery and its enormous contribution to the wellbeing of many regional economies. A portion of the GST (Goods and Services Tax) raised by the spending habits of recreational fishermen (conceivably in excess of A$100mil-

lion p/a in Queensland) should be directed into research, management and enforcement of the recreational fishery as a separate entity, possibly as a major component of Tourism or Recreation/Leisure portfolios.

All state governments should follow the example of the Northern Territory, Tasmania and more recently New South Wales and create recreational only fishing areas with strict bag and size limits to help maintain fish stocks for the future, encourage tourism and promote economic growth.

With the average recreational fisherman spending in excess of A$1200 per year, it is realistic to say that by increasing recreational fishing opportunities, one new job will be created for every 30 people encouraged to participate in recreational fishing.

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ANGLING POLICY AND PROPERTY RIGHTS IN FRANCE: AN ECONOMIC APPROACH

Julien Salanié and Philippe Le Goffe

Pôle d'Enseignement Supérieur et de Recherche Agronomique de Rennes, Département Économie Rurale et Gestion, 65 rue de St-Brieuc – CS 84215, 35042 Rennes Cédex, France.

Abstract

Ronald Coase has shown that well-defined property rights and the absence of transaction costs ensure that bargaining can lead to efficient environment allocation. In France, as in most developed countries, fishing rights are well-defined and belong to land-owners. However in many cases these rights are traditionally given for free to anglers associations (AAPPMA). AAPPMA are the basic institutions in charge of angling management in France. In a first part we describe how private fishing rights are institutionally turned into public goods. This is the basis of the French democratic angling rule : fishing "everywhere, for everyone and at low cost".

In a second part we analyze the economic drawbacks of foregone property rights. Two main external effects arise from the public nature of recreational fishing in France. First we deal with externalities between anglers, known as the "tragedy of the commons". Then we describe the external effects between land owners (mostly farmers) and anglers. This leads to pollution and loss of environmental services.

At present in France, the management system in place relies only on public policy to solve the externality problem because property rights are given up. Public intervention is necessary in many cases. In the last part we explore the compatibility between the French egalitarian angling system and better economic efficiency and anglers' welfare. For specific externalities we suggest the possibility of fishing rights bargaining between AAPPMA and land-owners. Efficient pricing by AAPPMA could simultaneously cope with congestion, if any, and environmental management.

In conclusion we suggest how economic research could contribute to quantify these externalities and clarify the policy debate by quantifying the demand for angling.

Introduction

This paper looks at the efficiency of recreational fishing management in France. We argue that angling policy is not leading to efficient resource allocation. Because we believe that this inefficiency can be explained by the structure of property rights, the paper is organized as follows. Firstly we present fishing right management in France. Secondly, we explain how economic theory provides analytic tools for the interpretation of external effects by focusing on property rights. Finally, we show that property-right enforcement could regulate some of the negative externalities affecting angler's welfare.

How angling policy has led to the loss of fishing rights in France: historical and institutional reasons

In France, fishing rights belong to landowners, as in many countries. We will refer in the following text to this fishing right as a property right, but it is indeed a right to use the resource. Property rights include the right to fish and the duty to maintain the environmental quality at the site where the right does apply. The rights and duties associated with fishing rights are defined by the law — Article L.230–L.235 in the Rural Code (Anon, 2002).

In the Middle-Ages, fishing rights belonged to the Lord. Fishing rights were viewed as privileges and were abolished by the French revolution of 1789. At this stage, anyone could go fishing anywhere (Breton, 1993). Soon after, in 1794, fishing rights were re-established. In the early 20th century, sport fishermen achieved the recognition of angling in comparisson to commercial fishing (Thibault, 1992). Recreational fishing was free, until a law was introduced on July the 12th, 1941. This law abolished free recreational fishing by obliging every angler to paying a fee to an anglers association (AAPPMA[1]). This situation is still true today. Even a property right owner has to acquire a fishing license to fish, even where he owns the right.

[1] In French : Associations Agréées de Pêche et de Protection des Milieux Aquatiques.

In France, the agencies in charge of recreational fishing management are the AAPPMAs. They are aggregated into departmental and regional federations. AAPPMAs are concerned with the management of recreational fishing as well as the environmental quality of waterways. The application of the law concerning angling is assumed by the government agency responsible for inland fishing (CSP[2]).

Adequate property rights must be specified completely, transferable and enforced. In France, fishing rights have these properties. In theory, all the elements are present to reach economic efficiency in resource allocation. However, the history and institutional organization of recreational fishing in France leads to some problems: property rights are traditionally attenuated, which can be viewed as a heritage from the French revolution; the angler's lobbying proved efficient in leading to a very low level of fee implementation; the 1941 law was modified in 1984 to provide better protection of rivers and a democratization of recreational fishing. From these follows, that in France angling is quasi-open-access. The fishing fee is very low and there are multiple forms of exemption. Indeed, 20% of anglers are exempted. The national federation of AAPPMAs (UNPF[3]) is making the democratic rule of recreational fishing a priority. The rule enforced by the UNPF is "*fishing everywhere for everyone at low cost*". The government, via the CSP, encourage the democratization of recreational fishing and made it a goal in the law change of 1984. Owners of fishing rights are encouraged to give-up their rights. It is unusual that the rights are sold to the AAPPMA. In 2000, the government provided a legal framework for giving-up property right in a decree that specifies the way rights can be given free of charge to AAPPMAs. AAPPMAs also set agreements between regional federation. By paying a low additional fee, an angler can fish in all the department or the entire region. Recently, national agreements have arisen. They are reciprocal agreements which allows a recreational fisherman who pays the reciprocal fee to fish almost everywhere in France. However, a few AAPPMAs are opposed to this system, which they find incompatible with an "environmentally friendly and responsible recreational fishing". This institutional framework leads to a non-optimal situation from an economist's point of view.

The economic problem associated with property rights attenuation

In France, fishing is accessible to everybody, with almost no restrictions, at a very modest price. Thus, recreational fishing has become a quasi-public-good in most regions of France. The attenuation of property rights is the source of three types of externalities that negatively affect the angler's welfare. An acceptable definition of an externality is given by Pigou (1920) as an effect imposed by an individual A on the welfare of an individual B, without compensation. For recreational fishing, the three main externalities that can be identified are the following :

- two externalities among anglers taking the form of stock externality and congestion,
- externality between anglers and farmers taking the form of pollution and loss of environmental services.

Externalities among anglers arise because a private good (recreational fishing) is institutionally turned into a public good. As there is almost no cost for recreational fishing, it becomes an open-access resource. Since Hardin (1968) we know that open-access resources are subject to "the tragedy of the commons". Because fishing is free, anglers enter the fishery until marginal welfare per angler is zero. This phenomenon has been modeled by Fisher and Krutilla (1972) for recreational activities in general and more recently, for recreational fishing by Anderson (1993).

The stock externality should be limited by imposing limitations on the number of anglers. Economic efficiency is attained when the marginal willingness to pay for an additional fish equals the marginal stock externality. There is such a point, associated with a number of anglers. Efficient policy would tend to reach this point.

Congestion problems are very similar to stock externalities. These are also related to the high number of anglers on the rivers. There is little information on the impact of congestion in France. If we consider that recreational fishing is an activity where anglers look for calm and solitude, then we expect congestion to be present. Congestion affects anglers in the same way as stock externality.

It is likely that recreational fishing does not affect the stock levels in France. However we know that for some stocks (e.g. spring salmon) recreational fishing represents a real threat. Surveys made by AAPPMAs tend to show the absence of congestion on French rivers, at least locally. A national survey conducted in 1990 revealed that for 10% of the anglers congestion was a reason to limit their visits (ISL, 1990). Moreover it is noted that for some periods like opening-day, public holidays or weekends, congestion is evident.

[2] In French: Conseil Supérieur de la Pêche (National Fishing Council).
[3] In French: Union Nationale pour la Pêche Française.

Anglers can be considered as free riders. Because anglers are not paying for the property rights, landowners (mostly farmers) are not incited to account for them. If landowners could trade their rights, they would be encouraged to improve fishing quality and to preserve the environment. Anglers are not the only users, by far, of rivers and the associated amenities. Anglers alone cannot manage the issues of drinkable water, loss of biodiversity, floods, coastal pollution, etc. Because transaction costs are too high and water is a public good, these external effects deserve specific public policies. In France and especially in Brittany[4] agriculture is very intensive. Briton agriculture is mostly intensive animal growing which releases to the environment, and then directly to the rivers[5], huge quantities of nitrates, phosphates and heavy metals. However, in some areas these effects are local. For these we believe that anglers action can have an effect because transaction costs are low. Agriculture areas along the rivers is a problem to recreational fishing in terms of access and scenic nature of the rivers. The cropping of corn for cattle feeding is threat to the rivers, in terms of pesticide release into the rivers and bank erosion.

Property rights enforcement could reduce the externalities associated with the open-access situation. It works if transaction costs are low, which is the case for the latter external effects.

Ideas to conciliate the AAPPMAs system and economic efficiency

We have seen that property rights do exist but are attenuated. Recreational fishing is therefore a common pool resource subject to Hardin's tragedy of the commons. Then, anglers can be viewed as free riders and this leads to a non optimal situation with negative externalities that lower anglers' welfare.This situation can be solved by simply enforcing well-defined property rights. Economic literature has largely shown the close relationship between property rights and externalities (Demsetz, 1967).

Coase (1960) has shown that well-defined property rights are a sufficient condition to reach economic efficiency if there are no transaction costs. This result is valid whatever the initial distribution of property rights. Coase suggestion's is that bargaining for property rights will lead to the efficient allocation of resources. The hypothesis of no transaction costs limits the application of Coase's solution.

In France everything concerning rivers and recreational fishing, relies on public policy. Environmental policy is based on two major policies. Firstly, the water policy to deal with pollution. A public policy is necessary, due to high transaction costs at the scale of the water basin and the public nature of water. Secondly, agricultural policy uses many specific tools. Agri-environmental measures (European common agricultural policy) and territorial farm contracts (French policy) are policies that can affect the riparian agricultural parcels. They take the form of grassland premiums, subsidies to conserve wetlands and to clean river banks. Since market transaction-costs are low for these amenities, coasian bargaining could be more efficient than a costly public policy.

Recreational fishing policies are based on many measures. The most important measures are closure periods, size limits, daily bag limits, technical restrictions on bait and hooks, a TAC for salmon and stock enhancement. These measures do not affect the level of congestion on the French rivers. Worse, these measures are probably useless to preserve stocks (Thibault, 1992) and are radical regarding angler's welfare. Restrictions imposed on fishing periods are necessary during spawning periods but sometimes they are extended widely into traditional fishing periods.

However, we think the system can be maintained and improved. At present, anglers are paying a fee for the entire year. Instead they might be paying at the margin i.e. for each additional visit. In this way, fishermen will limit their visits, which will have positive effects on congestion and probably stocks. It is also possible to imagine a system to restrict trips during high congestion periods like public holidays or the opening day. This could take the form of quotas of anglers or lotteries like in Spain. Indeed, lotteries match the AAPPMAs democratic system. For several types of local external effects where transaction costs are low (bank cleaning, creation of environmental buffers, conservation of wetlands, etc), we suggest property right bargaining between AAPPMAs and farmers.

It is noted that the transition period between the actual system and a more sustainable one is a problem. At this stage, anglers will pay for property rights but rivers will only improve in the longer term. For this reason, we think that anglers will be reluctant to pay.

Finally, we need to control income effects. Indeed strong income effects are not compatible with the democratic rules of AAPPMAs. The implementation of social pricing looks like an appropriated solution.

[4] Brittany is the western part of France. It has reputation for its beautiful rivers in which one can fish trout or salmon.
[5] There is no phreatic in Brittany due to the granitic susbstrate.

Conclusion

We have shown fishing rights are traditionally released for free in France. The institutions in charge of recreational fishing management organize the attenuation of property rights. The results is that recreational fishing is institutionally turned into a public good. Three types of externalities arise from this situation : stock externalities, congestion and pollution. Property rights bargaining could improve the situation. Anglers would pay more for good quality fishing and environmental improvements. Moreover, by reducing the number of anglers, it will cope simultaneously with congestion and stock externality.

Economic research can contribute to the policy debate by quantifying the welfare losses linked to these externalities. This can be done by measuring the demand functions using contingent valuation method, travel cost method and random utility models. Indexing demand functions on indicators of environmental quality (agriculture), congestion and stock level allows for the calculation of welfare variations linked to the improvements. In this way, economic research can give arguments for the implementation of new policies.

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MAKING THE PROBLEM THE SOLUTION: USING PROFESSIONAL FISHING EVENTS TO SET LIVE-RELEASE STANDARDS

Eugene R. Gilliland[1], Harold L. Schramm, Jr.[2] and Bruce D. Shupp[3]

[1] Oklahoma Department of Wildlife Conservation, 500 E. Constellation, Norman, Oklahoma 73072, USA
[2] U.S. Geological Survey, Mississippi Cooperative Fish & Wildlife Research Unit, Mississippi State, Mississippi 39759, USA
[3] B.A.S.S., Post Office Box 17900, Montgomery, Alabama 36141, USA

Abstract

Although release of live angled fish is as old as recreational fishing, the adoption of a catch-and-release ethic in the United States is strongly linked to the incorporation of this practice into black bass (Micropterus spp.) fishing tournaments in the early 1970s. Pioneer tournament organizations recognized the biological and social importance of minimizing mortality of tournament-caught fish and actively promoted live-release tournaments. Although many anglers and fishing organizations now strongly support catch-and-release, and information on improved fish-care procedures and equipment has been made widely available, average total mortality of black bass released after competitive events has remained at 26-28% for the last two decades. We integrated widely accepted procedures for handling and transporting hatchery-reared fish with constraints imposed by bass boat livewell and tournament weigh-in procedures into a suite of recommendations that can increase survival of released fish. We discuss the process of working with an organization that sponsors professional bass tournaments to incorporate these state-of-the-art procedures into their events, and utilize that visibility to promote the concepts to other anglers and tournament organizers.

Introduction

Professional competitive fishing for black bass (bass tournaments) began in 1967. The number and size of tournaments increased rapidly, and forward-thinking tournament organizers began encouraging live release of fish caught in tournaments. Mortality of black bass released after tournaments was studied extensively in the 1970s (May, 1973; Wellborn and Barkley, 1974; Archer and Loyacano, 1975; Plumb et al., 1975; Seidensticker, 1975). This early research showed total mortalities as high as 60%. By the late 1980s, bass boat livewells and weigh-in procedures had been improved and mortality rates had declined to less than 20% in some tournaments (Chapman and Fish, 1985; Schramm et al., 1987; Plumb et al., 1988). Schramm et al. (1985) suggested that this decreased mortality was due to a now-pervasive, catch-and-release ethic among anglers and tournament organizers, and an increased knowledge of proper fish care.

Tournaments organized by the Bass Anglers Sportsmans Society (B.A.S.S.) had an excellent record, with delayed mortality rates generally less than 10% due to strict fish handling guidelines and weigh-in procedures (Bryan, 1988). An important factor contributing to this low mortality was the scheduling of B.A.S.S. tournaments in the cooler months of the year when lower water temperatures were less stressful on tournament-caught fish (Holbrook, 1975; Wilde, 1998).

Several studies documented increased tournament participation in many states, with some reservoirs hosting more than 200 events per year (Shupp, 1979; Schramm et al., 1991; Gilliland, 1998; Wilde et al., 1998). Growth in the popularity of black bass tournaments has fueled a corresponding growth in the fishing tackle and boating industries that has spilled over to other countries around the world. B.A.S.S has played a key role in the promotion of bass angling and tournament competition. Over 600 000 members receive Bassmaster magazine each month, and the number of organizations conducting professional tournaments and communicating with anglers through print and electronic media continues to grow. Print and television coverage of tournament competition has created professional anglers that are the icons of their sport, not unlike professional athletes from baseball, basketball or football, and thus opinion leaders. Rank-and-file bass anglers and tournament participants emulate their favorite professionals by using the same equipment and techniques; holding the same opinions about conservation and following the same principles of conduct in their own tournament fishing. These professional anglers can be a powerful educational resource for fisheries managers.

In the 1990s, published reports of high delayed mortalities following summer tournaments (Steeger et al., 1994; Weathers and Newman, 1997), evidence that larger black bass suffered higher post-release mortality rates (Meals and Miranda, 1994) and uncertainties about the biological impacts of tournaments at the population level (Kwak and Henry, 1995; Hayes et al., 1995) raised new questions and concern among fishery managers. Wilde (1998) suggested that the decline in mortality rates observed between the 1970s and the 1980s had plateaued in the 1990s at around 28% and was not likely to fall further unless tournament anglers and organizers made substantial changes in operational procedures. This revelation and the results of research showing that mortality could indeed be lowered using state-of-the-art livewell aeration and weigh-in procedures (Gilliland, in press) rekindled an interest in educational efforts.

Procedures

Presentations and panel discussions on tournament-related mortality at the "Black Bass 2000" symposium, held in conjunction with the American Fisheries Society Annual meeting in St. Louis, Missouri, set the process in motion. It was understood that to improve the survival of released fish following tournaments, an educational process must take place that removes the denial anglers have of post-release mortality and instills a stronger conservation ethic. Then, increased knowledge and changes in attitude must translate into changes in behavior. Teaching anglers and tournament organizers the right way to do things would not be enough. The recommendations must be something they can easily do to be universally accepted.

The booklet "Live Release of Bass, A Guide for Tournament Anglers and Organizers" (Schramm and Heidinger, 1988) had been recommended by most state fishery management agencies for many years. With the revelation that tournament-related mortality rates had gone unchanged during the 1990s, it was evident that a revision of this publication, updating it to include the currently accepted best practices in fish care, was in order.

B.A.S.S. offered to publish a new booklet that incorporated the latest knowledge about stress factors, livewell water quality management and fish-friendly weigh-in procedures. Initial meetings with the B.A.S.S. staff centered around which procedures could be used successfully at large professional events versus those that could be more easily accomplished at smaller tournaments. A suite of recommendations was eventually settled upon that were a compromise between the best science and the nature of the sport. After several rounds of editing and wordsmithing, "Keeping Bass Alive, A Guidebook for Anglers and Tournament Organizers" (Gilliland et al., 2002) became a reality. With printing costs paid for by two bass boat and two outboard motor manufacturers, the booklet is being distributed free of charge to U.S. state fisheries management agencies, members of the B.A.S.S. State Federations, tackle and boating industry representatives and outdoor writers. Other interested parties may download the booklet via the ESPN/B.A.S.S. website (http://espn.go.com/outdoors/bassmaster/).

The booklet first discusses why bass die – the stress factors that can cause initial and delayed mortality – and then discusses least stressful hooking, playing and landing techniques.

The second portion of the booklet teaches the angler what to do once the fish is in the livewell. Information is provided about water temperature control (especially vital in warmer months) and techniques to maintain adequate dissolved oxygen levels and remove waste products. Tournament contestants are encouraged to be more conscientious and not make assumptions about the efficiency of their boat's livewell and aeration system. Recommended procedures include continuous recirculating aeration or oxygen injection, using ice for water temperature control, and adding non-iodized salt to the livewell water. Specific details of aerator operation, recipes for the correct amounts of ice and salt to add to livewell water and even instructions on updating older boat livewell systems are included.

The third section of the booklet provides tournament organizers a detailed description of proper weigh-in protocol. Organization is critical. The weigh-in must be efficient so that handling of fish is reduced to a minimum and fish are out of water for a minimum amount of time. The release method and location are other factors that organizers must consider to minimize delayed mortality. Detailed information is provided on why each step in the weigh-in process is important in reducing mortality, as are descriptions of the recommended equipment.

Challenges

With the educational materials developed, two major challenges remain. First, we must convince other tournament organizations to adopt the recommended fish-care and weigh-in procedures. They must understand that these procedures are good for the resource on which their sport is built. They must also be shown that these procedures will be good for tournament fishing, will reduce the likelihood of dead fish at weigh-in and the public relations problem that surround this aspect of the sport.

The second, and perhaps greater, challenge will be to convince individual anglers the worth of these procedures. For many anglers that have not seen dead fish floating to the surface several days after a weigh-in, there is a denial that a problem exists and therefore, there is no need to change their current fish-care methods. Our future outreach plan includes convincing professional anglers to adopt and follow the recommended fish-care protocol. If these opinion-leaders become more conscientious about the task of keeping their catch healthy, become more conservation-minded, and become more outspoken about the need for improved fish care, the rank-and-file bass anglers and tournament participants will follow.

In addition to distribution of the booklet and articles in the popular fishing press about its availability, word-of-mouth testimonials will be vital in spreading this new doctrine. Perhaps the greatest potential for educating anglers will be through the expanded coverage that black bass tournament fishing is receiving on television. The opportunity for exposure at B.A.S.S. and FLW Outdoors events on television networks (ESPN2 and PAX) will help showcase the recommendations in action as they are used by the stars of the sport on their premier "stages" across the U.S. Our goal is that all tournament anglers and even non-tournament anglers will take notice, and these new procedures will become the norm, thereby improving the survival of released fish throughout the tournament industry.

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BASS FISHING IN THE UNITED STATES: A SOCIAL AND ECONOMIC IMPACT ASSESSMENT

Hobson Bryan

Department of Geography, Regional and Urban Planning, University of Alabama, Box 870322, Tuscaloosa, Alabama 35487-0322, USA

This reports the results and implications of a series of studies on the social and economic impacts of "professional-level" freshwater bass tournaments in the United States, sponsored by Bass Anglers Sportsman Society and Operation Bass.

Most qualifying tournaments have direct and indirect economic impacts of approximately one million dollars (US) on local economies, with the most prestigious end-of-year tournament generating impacts of over twenty-five million dollars (US). The value of this latter event in terms of media coverage alone, approaches a similar figure. These tournaments, their marketing and media generation, are the lynchpins of a multi-billion dollar (US) recreational fishing economy in the United States.

During the past thirty years, professional bass fishing tournaments have been the impetus for a boom in interest in the sport, that sees over 100,000 local and club-level events a year, coverage of major events by major television networks, and thirty million anglers who report that they fish for bass. Interest and participation in tournament bass fishing has spread to a number of areas of the world, including Japan, Spain, Zimbabwe, and South Africa.

In spite of these developments, interest and participation in angling in general, in the United States and elsewhere has levelled off and has actually declined in some areas. This seems to be due to a range of factors in the freshwater arena, including fish mortality from viruses, poor water quality, high fishing pressure and poor catch-and-release practices, particularly at local and club levels of bass fishing competition.

The argument is made that the future of bass fishing specifically, and recreational angling generally, in the United States will depend on the industry taking more steps to "grow the sport" than simply marketing interest in tournament competition. These steps include: providing greater opportunities for people to have successful fishing experiences,especially children; marketing the sport to women and other underrepresented minorities who have not traditionally participated and taking steps to reverse the decline in quantity and quality of public fisheries.

Fish and game agencies must become more diligent to serve the needs of diverse constituencies, including minimizing conflicts between tournament and non-tournament anglers, adherence to strict uniform standards of fish handling for catch-and-release competitions and protecting public waters from take-over by private interests.

Acknowledgements: These studies were funded by a series of cooperative agreements and consulting contracts among the author, Bass Anglers Sportsman Society, Operation Bass, and The University of Alabama.

JUNIOR CODE OF CONDUCT "GET HOOKED . . IT'S FUN TO FISH" EDUCATION KIT

John D. Elliott

Department of Primary Industries, PO Box 500, East Melbourne Vic 3002, Australia

The 'Get Hooked' kit is based on Australia's National Code of Practice for Recreational and Sport fishing, a code which aims to provide guiding principles to ensure that fishing gets better over the years.

The kit is centred around a junior code of conduct developed for children in years three through to six, which can be delivered in schools by teachers, often assisted by Fishcare volunteers or Fisheries Officers. It is written to comply with the state Curriculum Standards Frameworks.

Although the 'Get Hooked' kit is centred around a fishing code of practice, the concepts covered move well beyond simply fishing; introducing students to basic ecological ideas such as food webs and ecological sustainability whilst raising their awareness of aquatic life and encouraging safe and responsible behaviour.

The education kit covers six modules covering basic safety and environmental messages, including take only what you need, fish with friends, you're the solution to the water problem, throw the little ones back, don't leave your tackle behind and quality catchments equal quality fish.

The fact that many students have a keen interest in fishing and the aquatic environment, together with the variety of learning areas which the materials in 'Get Hooked' cover, means that teachers find presentation of the material from this kit most worthwhile.

The education kit was initiated and developed by the Department of Natural Resources and Environment and its production was funded by the National Heritage Trust and Fisheries Management Agencies around Australia. The kit is endorsed by Recfish Australia (The Australian Recreational and Sport Fishing Confederation Inc.).

THE VALUES OF RECREATIONAL FISHING

Rex Hunt

Rex Hunt Enterprises, PO Box 31, Sandringham, Vic 3191, Australia

The presentation will include how recreational fishing impacts on the social, cultural and economic aspects of the world. Specifically, it will cover the following topics:

• personnal childhood fishing experiences and the positive effect it had on personal development.

• the value of kids fishing - social groups, outdoor activity, teaching reponsibility, cultural, environmental and family.

• the value to the world economy of the recreational fishing industry - retail trade, torism and travel.

Theme 4

Management of recreational fishing

SHOULD RECREATIONAL FISHING EFFORT BE ACTIVELY MANAGED VIA LIMITED-ENTRY PROGRAMS?

Carl Walters

Fisheries Centre, University of British Columbia, Vancouver, B.C. V6T1Z4, Canada

Abstract

Recreational fishers have now become the dominant users of many coastal fish stocks and there is very limited room for further expansion of fishing opportunities, by capturing commercial allocations, rebuilding historically depleted stocks, and marine habitat and enhancement programs. With huge fleet capacities, open-access recreational fisheries now respond to fish abundance increases with strong effort responses that wipe out any potential gains in quality of fishing for individual fishers. We need to start looking very seriously at direct effort control, via limited entry/lottery access systems, to provide quality rather than quantity of fishing opportunity for at least some fishing areas. Many fishers would prefer to fish less often but with better success, some businesses like lodges and guides would benefit as well, and unless we do start to manage effort we will be subject to strong public criticism and perhaps even more severe conservation measures like large marine protected area closures.

Introduction

Recreational fisheries are now firmly established as the dominant or sole users of many coastal and most interior fish stocks in North America and the Antipodes. A parade of economic studies has demonstrated unequivocally that allocation of harvest opportunities to recreational users is generally the "best use" of publicly owned fish resources, in terms of economic activity and value of each fish landed, and recreational fishers represent a nearly unbeatable force in those situations where allocations between commercial and recreational fishers are decided through political processes. Where commercial and recreational fishers do still compete for available fish, commercial fishing entitlements are gradually being eroded or reduced through buy-back or license retirement programs.

So recreational fishers have won the day, and it is no longer a serious issue whether recreational fishing interests will have the lion's share of whatever fish resources they choose to pursue. The real question today is not how to justify recreational fishing rights, but rather how to use these rights wisely. That is, now that we have the fish, what are we going to do with them?

Our major ocean recreational fisheries now sit at about the same point in terms of development of effective fisheries management as did the coastal commercial fisheries at the turn of the 20th century. Fishing fleets are growing, technology is rapidly improving, and there is open access without prospect of control on fishing effort. Recreational fishing is beginning to cause visible and obvious depletion of at least some local concentrations and stocks of fish, and can do particularly severe damage to stocks of "incidental" or "bycatch" species for which there is no automatic reduction in fishing effort when stock sizes are lower due to reduced numbers of fishers attracted out. There are widespread and bitter complaints about "too many fishers chasing too few fish", meaning not that stocks are necessarily being depleted but at least that the available and vulnerable fish are being shared across too many fishers. The really major and popular fisheries are at "bionomic equilibrium" where potential fishing effort measured by the number of fishing boats at docks and on trailers is much, much higher than realized effort, and realized effort has stopped growing because the quality of fishing (catch rates and fish sizes) has been driven down too low to attract more activity (Johnson and Carpenter, 1994; Walters and Cox, 1999). There are now strong calls for "active management" of recreational fisheries so as to improve the quality of these bionomic equilibira (see review in Post et al., 2002).

This paper addresses three questions about where recreational fisheries management can and should go over the next decade. Can we solve emerging problems of poor fishing quality and overfishing by supplying more fish? Can we insure sustainability through traditional harvest regulations, like catch-and-release? Is it time to confront the open-access problem through direct controls on fishing effort, i.e. limited-entry licensing and lotteries? I believe that we have just about

used up the supply-side options, that traditional regulations will soon fail us, and that we need to immediately begin the same programs of effort control that have been necessary to insure sustainability of commercial fishing. These are bitter pills to swallow, but at least we have a century of experience with failed commercial fisheries management to draw on in developing innovative approaches to sustainability.

Can we meet future growth in demand through supply-side management?

We are rapidly running out of options for making more fish available to recreational fishers by taking fish away from commercial fishers, improving habitats, and stocking more fish through hatchery programs. Reductions in commercial fisheries have led to rapid responses in sport fishing effort, but no improvement in quality (catch per angler) of fishing (see Figure 1, Florida pompano example). Coastal habitat restoration is hugely expensive, and will likely not be particularly effective. Recreational fishing now threatens rebuilding of some stocks that were historically depleted by commercial fishing, so restoration of historical abundances of fish will likely involve reduced fishing opportunities, not improvements in supply. A favorite of sports fishers everywhere is hatchery stocking. There have been some spectacular advances in marine fish enhancement technology (thanks largely to the aquaculture industry), but there is every sign from experience so far with large-scale marine fish stocking that most enhancement programs will fail as miserably as the salmonid stocking programs in the Pacific Northwest of North America (Hilborn, 1992).

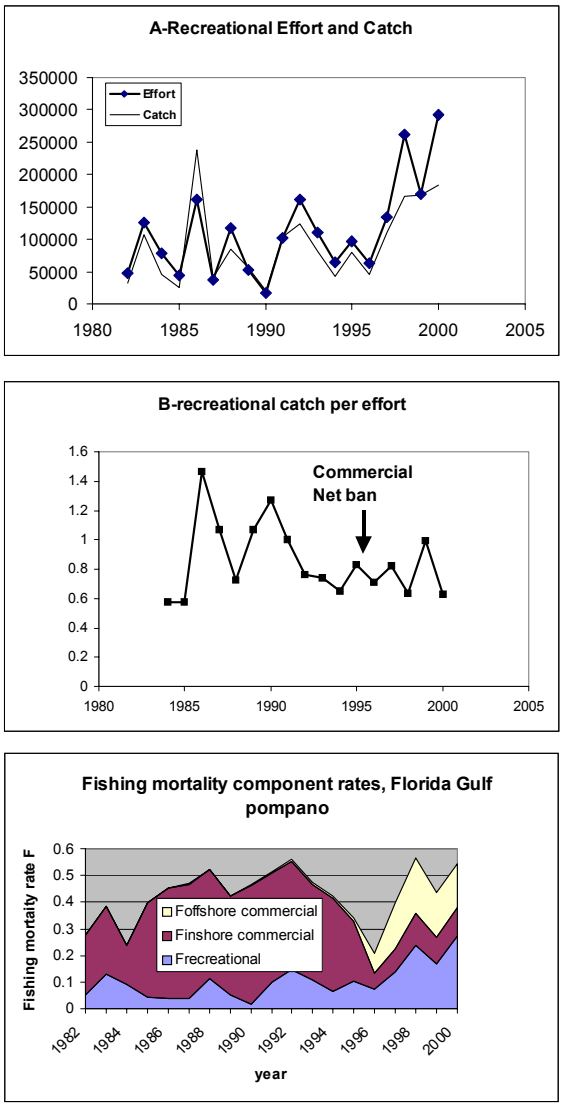

Figure 1. Sport effort, catch per effort, and fishing mortality rate changes in the west coast of Florida pompano fishery, following a ban on inshore commercial gill-netting. Note that effort responses in both the recreational and offshore commercial fishery contributed to return fishing mortality rates to high (and unsafe) levels following the closure, and that there was no long-term improvement in the quality of sport fishing as measured by catch-per-effort.

Can we at least insure sustainability through traditional harvest regulation methods, mainly bag and size limits and catch-and-release angling?

Some recreational fisheries are now causing high enough fishing mortality rates to trigger conservation concerns and even legal requirements for reducing harvests to meet spawning stock conservation objectives (see e.g. Radonski et al. 2001; Cox 2000). Management responses to such requirements have mainly been through a series of traditional restrictions on allowable takes by individual anglers. So we see restrictive bag limits (or even catch-and-release), ever more complex size limit schemes (usually with "slot limits" to prevent taking fish that are both too small and too large), and closed seasons. There is little evidence from stock assessments and back-calculations of historical exploitation rates that such regulations have been particularly effective. Poor performance of individual take regulations is due at least in part to unregulated sport effort responses: if/when a regulation does have some beneficial effect on abundance, it also improves catch per efforts and fish sizes, and these improvements in turn attract more anglers until the improvements are destroyed or dissipated.

Even in cases where we have moved all the way to pure catch-and-release angling, there are suspicions that sport fishing can cause high cumulative mortality rates and both growth and recruitment overfishing. Even if each capture event involves only a low probability (e.g. 10%) of mortality, in some cases fish may be subject to multiple capture events before having a chance to spawn. This is especially a problem in some major coastal marine fisheries that target juvenile fish in "nursery areas" (e.g. barramundi, snook, red drum, chinook and coho salmon). Estimates of these mortality rates are just starting to become available through acoustic tagging studies.

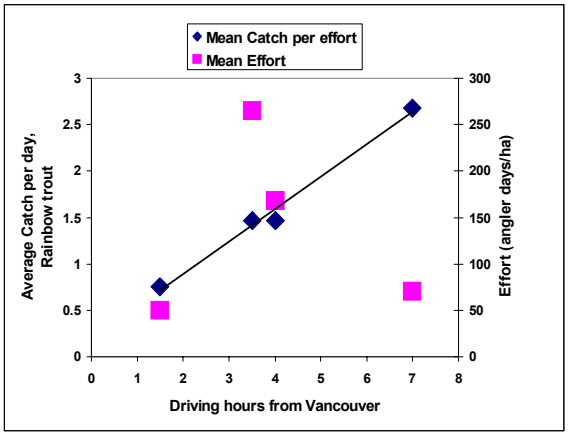

Figure 2. Apparent effects of travel time cost on sport fishing effort and catch per effort in British Columbia rainbow trout lakes. Travel times on order 5-7 hours represent the difference between practical weekend fishing trips and more major vacation commitments. Low efforts near Vancouver likely represent effect of very low biological productivity (much less effort needed to reduce fish density than in more productive interior lakes). Data points represent statistical reporting regions (Vancouver, Kamloops, Okanagon, and Cariboo).

Is it time for limited entry (effort limitation) programs?

There are at least six reasons for management agencies to begin implementing limited entry programs on the most popular and crowded fishing grounds.

1. At least some anglers express clear preference for good quality fishing (high catch per effort and fish size) over quantity of fishing opportunities.
   These preferences show up most clearly where there are spatial gradients in access cost, like the British Columbia rainbow trout fishery (Fig. 2). Most anglers fish close to home, and competition among them drives catch per effort to painfully low levels. But a few anglers are willing to invest the time and cost to access less crowded (or privately controlled, access-limited) areas, and they are rewarded by higher catch rates. Probably many of the anglers who only fish close to home would go further afield to find better fishing, but are constrained by economic factors (time, money) from doing so. These "clients" of management are not well served by open-access management.
2. Measurable economic benefits of fishing may be maximized at lower effort levels than occur under open access.
   In figure 2, some anglers are telling us that the "price" that they are willing to pay for higher catch per effort is whatever it costs to drive for at least seven hours. If total value is measured by the product (effort)x(price), and if travel time investment is taken as the price measure, it is easy to show that total value may often be increased by deliberately reducing effort in at least some crowded areas to achieve quality of fishing equivalent to the high "price" distant options. How many areas to treat this way is an open question, that would have to be settled through adaptive management experiments where we allow anglers to "vote" (by trying to access limited entry options) on how much restriction they would prefer.
3. Protection of businesses that depend on seasonal fishing.
   Most recreational fishing is seasonal, and much of the economic value that we attribute to it derives from businesses like resorts and boat rentals that must achieve minimum total bookings per season to be viable. Open access fishing often creates a rush for the fish early in the season, which can depress catch rates so rapidly that too many anglers are unwilling to even try later in the season. Businesses can then fail even when total fishing effort (and apparent economic activity) is very high.
4. Prevention of sustainable overfishing.
   In at least a few places like California and Florida, there is a threat of draconian conservation measures, in the form of large-scale, permanent closures (marine parks and protected areas). Public demands for such measures arise largely from the perception that fisheries management agencies have been unsuccessful at regulating both commercial and sport fishing activity.
5. Erosion of available cost-quality gradients.
   A simplistic economic answer to demands for low effort/high quality angling is to let the market take care of the problem: if you really want good fishing, then spend the money to access a private or more distant site, i.e. make a higher-cost choice along the gradient shown in Fig. 2. Unfortunately, in places like British Columbia (and Darwin), these opportunity gradients are disappearing fast, with very rapid growth in human populations of outlying communities. This growth is spurred in part by better opportunities for outdoor recreation like fishing. Put vividly, the "locals" are now getting the fish before we urbanites even have a chance to choose high cost options.
6 Prevention of "unfair" opportunity capture by wealthy anglers.
   Wealthy anglers are now using a variety of property rights devices, such as buying all the land along a stream or around a lake, to prevent public access and deterioration of fishing quality even when the waters and fish are technically "public resources". So limited entry is becoming a reality in some areas, without access opportunity being "fairly" distributed among all public stakeholders via some system like lotteries.

Taken together, these arguments form a very compelling case for development of limited entry programs along the same lines that are now widely accepted (and much appreciated) in big-game management. Just

as in the big-game case, limited entry should not be imposed wholesale over all recreational fisheries, but should instead involve a relatively small number of "test" places along with places of greatest conservation concern. Such limited entry programs will (at least initially) be costly to develop and to enforce, and will doubtless create much complaint from some sport fishers.

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CHARACTERISTICS OF ANGLERS LIVING IN THE METROPOLITAN AREA OF BERLIN (GERMANY): IMPLICATIONS FOR URBAN FISHERIES MANAGEMENT AND RESEARCH

Robert Arlinghaus and Thomas Mehner

Leibniz-Institut of Freshwater Ecology and Inland Fisheries, Department of Ecology and Biology of Fishes, Müggelseedamm 310, PO Box 850119, 12561 Berlin, Germany

Abstract

Increasing urbanization of the human population has focused attention on the development of recreational fishing opportunities in metropolitean areas. Urban recreational fisheries can provide numerous benefits and may substitute for decreasing numbers of commercial fishermen. Inland fisheries management programs must consider not only fish but also the human component of the fishery. However, no information is available on the main characteristics of anglers living in the reunified Berlin (Germany) since the last survey was conducted several decades ago (1977 in Western Berlin). Therefore, a self-administered mail survey was sent (simple random sampling) to 3500 angling licence holders living within the metropolitan area of Berlin. The aim was to identify characteristics of the angling population to allow for the establishment of appropriate management policies. Based on an adjusted response rate of 37% (n=1061), this paper describes selected characteristics of the Berlin angling population and provides implications for management. Responses were analysed, *inter alia*, for demographics, activity, experience, behaviour, preferences, motivations, catch and expenditure. An outstanding feature was that the majority of "Berlin anglers" fished exclusively (39.6% of the respondents), or predominantly (31.6%) outside Berlin in the adjacent German Länder (States), although fishing taxes and fees were paid in Berlin. Consequently, in the urban fisheries of Berlin, a marketing and management outreach program is needed to satisfy the users, increase participation and strengthen local fisheries-related economies.

Introduction

Increasing urbanization has focused attention on the development of recreational fishing opportunities in metropolitan areas. Urban recreational fisheries can provide numerous benefits to society (Peirson et al., 2001) and may substitute for decreasing commercial fishing activity in industrialised countries. In addition, metropolitan areas can be major suppliers of angler days to adjacent (rural) states (Ditton et al., 2002). This has implications for fisheries management and the promotion of tourism (Ditton et al., 2002). Irrespectively, one objective of urban fisheries management should be to provide and enhance urban angling opportunities: to allow people to fish where they live (Schramm and Edwards, 1994). Against this background, inland fisheries management and marketing programs must consider not only fish and the aquatic ecosystem but also the human component of the fishery.

No current information is available on the main characteristics of anglers living in the reunified Berlin. The last survey was conducted several decades ago, in Western Berlin (Grosch et al., 1977). Thus, this paper aims: (a) to describe selected characteristics of the Berlin angler population; (b) to outline recent trends of the fishery in Berlin; and (c) to provide management implications.

Materials and Methods

To gather data on characteristics of anglers living in Berlin (Berlin anglers), a simple random sample was drawn from an official list of angler licence holders held by the Berlin Fishery Board (BFB). In total, there were 36 456 addresses as of 31 December 2000 (corrected for duplicates). A self-administered, 6-page mail survey was sent to 3500 anglers in April 2001. Questionnaires were sent in BFB envelopes, with a personalized cover letter and a postage paid envelope. The questionnaire was designed after Dillman (1978) and pre-tested with 70 anglers. It included mostly closed-ended questions with ordered choices. This was done to facilitate completion of the questionnaire by the respondents and encourage participation.

Due to financial and legal constraints, follow-up mailings and non-response checks were not conducted. Instead, to increase participation, the survey was publicized in the media and difficult questions (e.g. income, willingness-to-pay) were deliberately avoided .

Based on an adjusted response rate of 37% (n=1061), responses were analysed for demographics, activity, experience, behaviour, species preferences, catch and expenditure by anglers. As most data were on an ordinal scale, the median was calculated as a measure of

central tendency. Results were compared with angler surveys of two German federal States (Länder) where data were available from similar surveys using mail procedures and the same 12 months recall time frame (Bavaria: Lederer, 1997 and Saxony-Anhalt: Wedekind, 2000). Although comparison of data was possible because of similar survey procedures, caution was encouraged in generalizing results to all anglers because of probable non-response and coverage error.

Results

The majority of the respondents in Berlin were married males (Table 1). Compared with the anglers of Bavaria and Saxony-Anhalt, anglers in Berlin were: older; more experienced; travelled longer distances to the waterside; undertook specific angling holidays to a greater extent; and spent more money in total on their leisure activity.

Most Berlin anglers fished exclusively (39.6%) or predominantly (31.6%) outside the federal state boarders of Berlin (Figure 1), although angling tax and licences were paid and issued inside the state. Anglers in Berlin preferred to catch piscivorous fish species such as pike (*Esox lucius*) and pike-perch (*Sander lucioperca*) over coarse fish. Piscivorous species and eel (*Anguilla anguilla*) were also regularly taken home for consumption (Figure 2). From the response pattern of the anglers who fished at least partly in Berlin (60.4%), it was estimated that 2.3 kg fish were harvested annually per angler from water bodies in Berlin. Thus, by assuming 40 000 anglers live in Berlin, the yield from Berlin's waters by recreational fishers was estimated at 55.5 t in 2000.

Discussion

Generally, the angler population in Berlin was characterised by a high activity and experience level (Table 1). This probably reflects the needs of an urban population to escape from daily stress and relax in pleasant surroundings. It also indicates the importance of angling for part of the urban population. In addition, the money flow created by Berlin anglers can be important for local economies, e.g. angling shops in Berlin or tourism-related businesses outside Berlin. Part of the annual expenditure is due to the official fishing tax, which has been paid by anglers in Berlin since 1995. Thus, angler expenditure finance (at least partly) public fisheries management authorities. However, the number of angling licenses issued has decreased in recent years. This reduction is probably due to the implementation of the fishing tax and the requirement to undertake an official angler examination (Figure 3). Due to the declinimg numbers of licence holders, the examination was discontinued for all anglers who could demonstrate they held an angling licence before April 30th 1995 (Figure 3). This may increase angling participation in future.

Most of the responding Berlin angling licence holders fished exclusively, or predominantly outside the urban setting (Figure 1). Two of the most water-rich federal states of Germany (Brandenburg and West-Pommerania) are located near Berlin, which may explain this pattern. Apparently, fishing sites outside Berlin offered more attractive angling opportunities for Berlin anglers. The benefits offered outweighed the increased travel time and cost to reach the sites.

Table 1. Demographic and participation characteristics of the angler population in Berlin compared with anglers in Saxony-Anhalt and Bavaria.

Demographic characteristic	Participation characteristic		Berlin: Group median or % of total (n=1061)	Saxony-Anhalt: Group mode, mean or % of total (n=442)	Bavaria: Group mean or % of total (n=1259)
Age (years)			51.4	45.2	45
Gender (% males)			96.5	96.6	-
Singles (%)			27.5	19.1	-
	Angling experience	(years)	27.2	24.5	20
	Angling days	(day a^{-1})	34.8	10 – 30	44
	Hours per angling day	(h day^{-1})	8.6	3 – 5	-
	Estimated effort	(h a^{-1})	299	120	-
	Harvest / Catch	(kg a^{-1})	10.1 (harvest)	21.2	17
	HPUE / CPUE	(kg day^{-1})	0.29 (HPUE)	0.71	0.39
	Travel distance	(km)	43.7	10-50	17
	Angler using cars	(%)	82.8	-	-
	Membership in angling clubs	(%)	58.3	-	-
	Boat anglers	(%)	41.5	-	-
	Boat ownership	(%)	35	-	-
	and replacement value of boat	(DM)	3191	-	-
	Replacement value of tackle	(DM)	1212	-	-
	Specific angling holidays	(%)	57.5	20	31
	and associated costs	(DM a^{-1})	1642 (445 based on all anglers)	-	463
	Fix expenditure	(DM a^{-1})	424	<200[1]	641
	Variable expenditure	(DM day^{-1})	58.1	26.7	-
	Estimated total expenditure	(DM a^{-1})	2890	1110[1]	1104[1]

[1] not fully comparable due to different question format
- data not available

Although recreational fishermen numerically and economically dominate in Berlin, commercial fishers are still present. However, the long term trend is decreasing numbers (Figure 4). This does not imply that recreational fishing will immediately substitute commercial fisheries in Berlin. In fact, commercial fisheries today are owners of most of the fishing rights and sell angling tickets for their water bodies. As long as commercial fishing enterprises are able to operate in self sustaining ways (see Grosch et al., 2000), this situation is not likely to change from the view of property rights. Furthermore, both fisheries target similar species, e.g. eel and pike-perch (Figure 2), which are marketable species for fishers and consumable fish for anglers. Anglers and commercial fishers harvest about the same amount of these fish per year (50-70 t). This may not only cause intrasectoral conflicts, but also be detrimental to water quality due to "negative" biomanipulation. For example, anglers and fishers usually remove piscivorous fish from within the food web. This, in turn, reduces the predation pressure on zooplanktivorous fish and consequently the abundance of herbivorous zooplankton (in particular *Daphnia* sp.), which in turn, may increase the probability of algal blooms.

Management Implications

At the *higher management level* (of public authorities), it is recommended that there is increased interstate cooperation in fisheries management, due to the substantial amount of fishing outside Berlin by the Berlin angling licence holders. Their fishing activity affects fish stocks, fishing communities and economies outside Berlin (compare for example expenditure in Table 1). However, increased interstate cooperation may be difficult to achieve because of the federal system in Germany. In this respect, it would be desirable to discover the reasons why anglers are fishing outside Berlin. This knowledge may also help prevent the decline in numbers of angling licenses being issued in Berlin.

As most anglers selectively fish for piscivorous fish species, an education program is also recommended to inform anglers about their potential contribution to water quality deterioration through "negative" biomanipulation. However, reaching anglers may be difficult because only approximately half of the anglers are members of fishing organisations (Table 1).

Public authorities should also address the potential intra-sectoral conflicts between commercial and recreational fisheries in Berlin. This can be achieved by information, education or even specific regulations. The utilization of fish stocks by both commercial and recreational fishers in Berlin challenges the system's ability to provide satisfactory allocation between the sectors. However, as in many other highly industrialised regions and societies, the numbers of commercial fishers in Berlin is decreasing (Figure 4). Man-

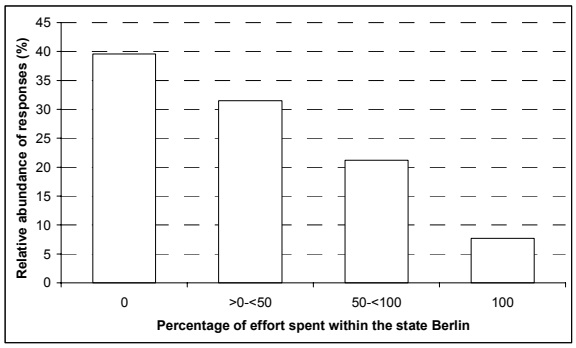

Figure 1. Distribution of angling effort spent in the state of Berlin by Berlin angling license holders.

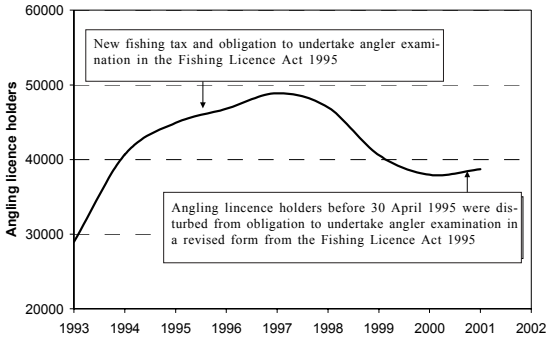

Figure 3. Post reunification development of number of angling license holders in Berlin.

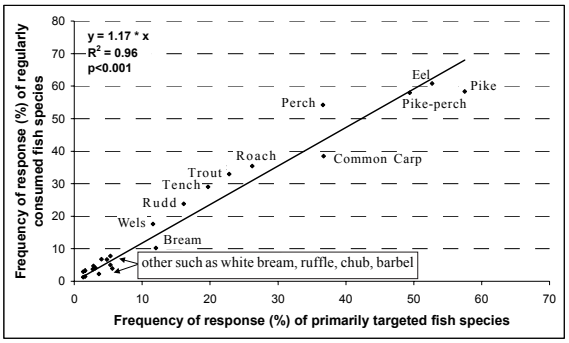

Figure 2. Linear correlation between frequency of response (%) or primarily targeted and regularly consumed fish species by Berlin angling licence holders (multiple responses were possible).

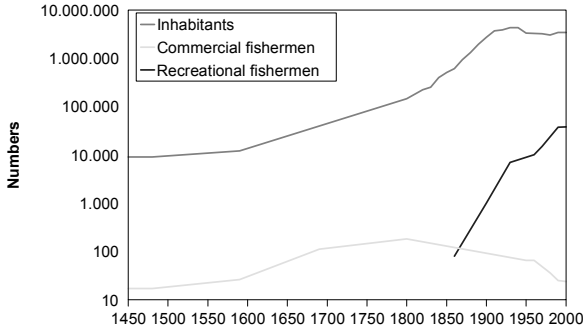

Figure 4. Population development and number of fishermen in Berlin 1450 to 2000.

agement agencies should be aware of this trend and develop angler-tailored fishing opportunities in the metropolitan setting in the case of decreasing level of commercial fishing activity. In future, commercial fisheries could be further engaged as a tool for water quality and fish stock management (e.g. fishing for abundant stocks of zooplankivorous fish, Grosch et al., 2000).

At the *lower management level* (of individual commercial enterprises or angling clubs), the challenge ahead is to enhance angler satisfaction and benefits and to market the angling experience. This should increase revenue and/or club membership. Under certain circumstances it may be more profitable for selected commercial fishers (inside and outside of Berlin) to act as service industries for anglers and manage fish stocks for the recreational benefit. In the case of degraded aquatic ecosystems and problems in recruitment, some stocking of piscivorous fish may still be needed to satisfy anglers requirements. Partnerships with tourism promotion organizations could also help in attracting anglers.

Further human dimension research is also required to tailor fisheries management programmes to the requirements of recreational fishers.

Acknowledgements

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A FRAMEWORK FOR COMMUNITY BASED MANAGEMENT OF RECREATIONAL FISHERIES

Stephen A. Chase[1] and David Dunn[2]

[1] Atlantic Salmon Federation, P.O. Box 429, St. Andrews, New Brunswick, Canada, E0G 2X0
[2] Department of Fisheries and Oceans, P.O. Box 5030, Moncton, New Brunswick, Canada, E1C 9B6

Abstract

Recreational Fisheries often define the social, economic, and cultural characteristics within the regions where they occur. As individual as both the fish and the fishery, community environmental values are the essential bridge linking the past and the future of the recreational fishery. This longstanding relationship between community and fishery has fostered the relatively recent emergence of trends linking science and regulation through precautionary principles and adaptive management. Associations or groups that bind individual interests toward healthy and vibrant eco-systems are an essential and fundamental component of many recreational fisheries. With regulatory and research agencies reducing budgets and withdrawing from some fields of activity, strengthening management systems by increasing participation of user groups is fundamental to the future of many recreational fisheries, many of which require immediate action to avert ecological and/or economic disaster. Community values continue to transcend both science and regulation toward a level of stewardship beyond the capacity of even the most advanced regulatory agencies. In eastern Canada, user groups are banding together like never before offer significant roles in cooperation with regulatory agencies.

This paper will elaborate on the environmental and fiscal challanges confronting community-based stewardship groups in Eastern Canada in the areas of protection, restoration, assessment, research, allocation, and public education of the wild Atlantic salmon and its habitat. Based on long-term experience in community stewardship of fish habitat in Eastern canada, the paper outlines key factors that would contribute to the success of stewardship initiatives anywhere in the world. The paper also presents fundemental objectives and principles to guide establishment of an effective community stewardship framework.

The paper is intended to be interest to those with a responsibility for managing and regulating fisheries and fish habitat. It will aslo be of intrest to all community groups with a shared vision for the future of their recreational fishery, fisheries resources and the ecosystem on which they depend.

Introduction

In Atlantic Canada and Quebec, the wild Atlantic salmon is a measure of our environmental health and well-being. It serves as food for First Nations and is a source of the cultural identity of both Aboriginal and non-Aboriginal people; it provides recreation and enhances our quality of life; it also provides jobs and income for Canadian individuals, businesses and rural communities. The wild Atlantic salmon helps define who we are and where we live. It is our heritage and our responsibility; it must also be our legacy.

The wild Atlantic salmon is facing increasingly difficult challenges. A number of stocks are low or at risk. Some stocks have been lost. Rebuilding efforts are constrained by low ocean productivity, habitat damage and non-selective harvesting practices.

It is clear that fundamental changes in government priorities and direction are required to meet these challenges and to protect this valuable public resource. This paper outlines some basic concepts and principles experience has demonstrated are necessary, in establishing a new direction for the wild Atlantic salmon fishery – a direction that will secure our legacy for future generations.

Context

North American populations of wild Atlantic salmon have been declining for 20 years. Many factors contribute to the survival of wild salmon, including: industrial and municipal pollution, land use practices, predation, dams and impoundments, global warming, Acid precipitation, aquaculture, and various harvesting practices. Closures and/or catch reductions of salmon fisheries have, by themselves, failed to reverse the slide.

In the Bay of Fundy region of Canada, for example, wild salmon populations are in imminent danger of biological extinction. Some wild Atlantic salmon

populations in the adjacent New England area of Maine in the United States have been extirpated, while others have been listed as endangered. Given the trends that have emerged so far, rivers to the north of these areas may be at risk unless action is established through effective partnerships between federal, provincial/state and Aboriginal governments and conservation organizations. Time appears to be the enemy; there is precious little of it left if we are to put these populations on the road to recovery.

The survival of the wild Atlantic salmon depends significantly on eliminating the loss of fish in the marine environment, and on the availability of a healthy and productive freshwater habitat, as free as possible from the adverse impacts of humans and other causes.

In addition, many parts of Eastern Canada's economic, social and environmental well- being depend heavily on the sustainability of these diverse and rich aquatic ecosystems, including its fisheries resources. In Atlantic Canada and Quebec, it is estimated that the extended benefit of the recreational fishery stands at well over $200 million annually.

A Department of Fisheries and Oceans (DFO) survey of Community groups addressing watersheds in the southern Gulf of St Lawrence concluded that the contribution of all community projects in the Gulf Region in 1998 exceeded 140 person years of volunteer labour, and $2 million in direct expenditures. The volunteer contribution, however, needs to be recognized, strengthened and supported by governments to be sustainable.

In Canada, the *Constitution Act (1982)* assigns the federal government (DFO) jurisdiction for "seacoast and inland fisheries" and the provinces jurisdiction over all water within their boundaries and the rights of ownership to the public lands within the province. The federal government fulfils this responsibility through the Fisheries Act, whereas the provinces carry out their responsibilities through various environmental or wildlife management legislation.

The *Fisheries Act* allows the DFO to make decisions for the conservation and protection of fish habitat. The provinces, for their part exercise responsibility for aquatic habitat. Both the federal and provincial governments play significant roles in the regulating the inland recreational fishery. The respective jurisdictions are somewhat complex and subject to overlap, duplication and gaps in responsibility, but major efforts are being made to make them as complementary.

Working together, both orders of government are enabled to establish the basis of partnerships between themselves and to facilitate the involvement of conservation organizations. However, while governments (federal and provincial/territorial) have expressed broad support for community watershed management (CWM) processes, but only limited efforts to stimulate their formation have been taken in Atlantic Canada. Quebec, however, has been more proactive in establishing the zone d'exploitation controlée (ZEC) system of community stewardship for the same reasons.

More recently, as a result of decisions of the Supreme Court of Canada, it is clear that First Nations should also have an important role to play in this area. Native rights of access to fisheries resources and the attendant responsibilities have led many First Nations governments in Atlantic Canada and Quebec to develop management plans and to establish constructive working arrangements with the federal and provincial governments and with conservation organizations.

Notwithstanding those holding responsibility, non-government conservation organizations have assumed a leadership role in ensuring that conservation activity actually takes place in rivers and streams.

The Atlantic Salmon life-cycle

The life-cycle of the wild Atlantic salmon alternates between the freshwater and marine environments. Atlantic salmon adults spawn in brooks and rivers where, as juveniles, they may spend up to three years in the nursery area before migrating out to sea. These small salmon (smolt), leave the bays and estuaries for their feeding grounds located off the southwest coast of Greenland, where most North American and European fish congregate before moving back to their natal rivers. The "homing" capability of the Atlantic salmon is one of its many remarkable characteristics. It is among relatively few fish that find their way back to specific rivers and brooks from which they originated.

Changes in the ocean and freshwater environment and greatly increased uncertainty make it increasingly difficult to predict future returns of salmon with confidence. Thus, a conservation-based, precautionary approach to fisheries management is mandatory in the face of increased uncertainty regarding changing ocean conditions and resultant impacts on salmon stocks.

Fundamentally, for the wild Atlantic salmon fishery to be sustainable, a sufficient number of eggs must survive to replace the spawning adults that produced those eggs. Survival from egg to spawning adult depends on the productivity of freshwater and ocean salmon habitats, natural mortality and harvests by the fisheries. It is well understood that cleanfreshwater habitat in our rivers and streams is the best way to propagate the species. It is essential, therefore, that we establish a process and plan to maximize quality

freshwater habitat for the Atlantic salmon and other native aquatic species.

Freshwater habitat issues

Of the two aquatic habitats on which the salmon depends, the freshwater environment presents the greatest immediate opportunity to effect best management practices and remediation. Many of the rivers and estuaries of Atlantic Canada and Quebec salmon rivers have been subjected to harmful human activities. There is, however, no up-to-date inventory of the extent to which salmon habitat has been degraded, nor is the nature and extent of the measures required to correct the problems known.

To effectively address the freshwater environmental conditions affecting survival of the wild Atlantic salmon it will be necessary to develop river-specific plans to address the several known factors impacting survival of salmon populations, including:

Land use practices Poor land use practices in watersheds supporting salmon populations alter watercourses and degrade water quality through contamination from chemicals, sediment, and other materials, or through elevated water temperatures and unnatural fluctuation in temperature or water flow. Any of these factors can result in significant degradation or destruction of habitat.

Obstructions Dams, impoundments and obstructions can either eliminate or reduce access of fish to spawning areas or passage of fish between the freshwater and marine environments. Dams have been the most damaging cause of loss of Atlantic salmon habitat in North America and Europe. In addition, natural obstructions can, even on a temporary basis, reduce passage and limit propagation

Predators There are many natural predators – birds, mammals and fish that affect salmon populations. Birds (mergansers, cormorants and kingfishers), mammals (otter, mink and others) and fish (trout, bass and pike) are natural predators of juvenile salmon. The key factor in the case of predators lies in maximizing the opportunity for the natural balance to be maintained. This may mean action ranging from preventing the introduction of exotic species to initiating selective elimination of predators where the balance may have been upset as a result of other factors.

Aquaculture Aquaculture, in both estuaries and freshwater environments, represents major problems for salmon populations. Escapees from marine cages can migrate up rivers to compete for food and habitat, mate with wild salmon to reduce the genetic quality of offspring to survive in the wild conditions, and spread disease and parasites.

Harvest There are several forms of harvest that can be managed to ensure the viability of salmon populations. The commercial harvest of Atlantic salmon has, to a large extent, been significantly reduced in North America, although there are major commercial harvests in Greenland and St. Pierre-Miquelon. The Aboriginal subsistence or food fisheries extant in Canada harvests large numbers of salmon through various methods ranging from off-shore interceptory fisheries to in-river gill net fisheries. Anglers also account for the harvest of large numbers of large *multi-sea winter* salmon (MSW, i.e. a salmon that has overwintered at sea more than one once) and small adult salmon. There is also the persistent problem of illegal harvest or from by-catch of salmon in other fisheries.

Marine habitat issues

There has been a drastic decline recently in rate of survival of salmon at sea. Furthermore, while we know salmon are disappearing, we do not know where or when their death occurs. This makes its impossible to identify the causes of the mortality. The causes are uncertain, but they may be driven by a combination of factors, both natural and anthropogenic.

The present hypotheses for the factors causing salmon mortalities at sea are:

- Predation by seals or birds
- Capture as by-catch in fisheries targeted at other species
- Poor oceanographic conditions, leading to death
- Lack of food
- Changes in marine migration routes which lead the fish to inappropriate areas
- Exposure to diseases or parasites, possibly from the aquaculture industry
- Ecosystem changes in the marine environment

The only way to identify potential causes, is to track salmon out to sea, and correlate the site and time of their death with environmental factors such as predators, food supply. While this is conceptually simple, it is extremely challenging and expensive from a technological perspective. The smolts are small when they leave for the ocean. This limits the size, power and longevity of the tags that they can be marked with. Atlantic Salmon Federation (ASF) has been supporting groundbreaking research into tag technologies, and has developed a tag that will permit the tracking of smolt movement in the salmon for a six-month period.

Identification of the causes of decline and finding solutions to address them, requires coordinated international action. Fortunately, the groundwork for such

action has been laid by the North Atlantic Salmon Conservation Organization (NASCO), and the key scientific priorities identified. What is missing, however, is the commitment from governments to begin to fund this necessary research and to provide leadership that would lead others to contribute to it.

Stewardship of the Atlantic Salmon

In recent years, with the decline in salmon populations and river closures, the volunteer forces are shrinking. This is occurring at a time when they are most needed to meet the challenges facing salmon populations. The loss of volunteers has also coincided with a significant reduction in available funding to government programs that provide for conservation, management and protection of fisheries resources.

Because of the serious situation facing the wild salmon and the significant social, cultural and economic dependencies on the wild stocks there is a clear need to put in place a comprehensive and sustainable program that strengthens the resource, as well as other native fish species.

It is also clear that this will occur best, under a clear policy framework that enables development of river-specific conservation, management and protection plans through a partnership between the respective government and non-government conservation organizations. It is also essential to understand that an effective delivery of such a program, in terms of public support (buy-in) and at an advantageous cost, requires engaging and sustaining volunteer stewardship resources at the local level.

Fortunately, various models of community stewardship have been developed that can address this situation. CWM initiatives, involving volunteers, have emerged throughout the range of the Atlantic salmon in North America and elsewhere. The drive to establish community stewardship can emerge for either economic or social reasons. It will also differ from place to place, according to local needs and conditions. Irrespective of reasons, however, the best models share essential attributes that contribute to their success.

It is proposed that the success of a community watershed management process will be improved if provision is made for each key element. It is also recognized that these key elements will be adapted to each situation in ways that make sense at the local level.

The key elements of community watershed management processes have been identified through a careful review of the successes and failures of many community watershed management initiatives in Canada and elsewhere.

Key elements affecting the success of community watershed management processes

One decision-making process The community watershed management process should be the only process in the watershed through which advice and decisions respecting management of resources in a watershed are taken.

Legitimacy The community watershed management process must be recognized by all parties (governments and stakeholders) as a legitimate process through which decisions affecting the watershed and resources are taken.

Broad participation All stakeholders, both Aboriginal and non-Aboriginal, should participate in the process.

First nation representation There should be significant representation by First Nations in the overall direction and management of the community watershed management process.

Decision support Advice and decisions provided by community watershed management process should be based on the best possible research and information.

Adequate resources to sustain CWM process The community watershed management process needs to have adequate resources to do its work properly.

Decision-making capacity The community watershed management process needs to have an important role in affecting and/or making decisions

Clear roles and responsibilities The respective roles and responsibilities of the all parties need to be established and understood by everyone.

Dispute resolution There must be an effective dispute resolution mechanism in place to resolve issues among stakeholders.

Objectives and principles of community stewardship for the Atlantic Salmon

In the current environment of fish population declines and fiscal cutbacks, stewardship of native fish populations, including salmon, is much more likely to result in sustained conservation, management, and protection of wild Atlantic salmon resources through effective initiatives.

The key elements of community watershed management processes together with the accumulated experience of government agencies and non-government conservation organizations point to the need for adoption of a stewardship framework with clearly stated objective and principles.

The objectives and principles of community stewardship for the salmon presented below, have been developed through experience in implementing various models of community stewardship across Atlantic Canada and Quebec, and elsewhere. This experience has enabled identification of the fundamental objectives of community stewardship and the principles through which the objectives can be best attained.

The two overriding objectives of effective stewardship initiatives should be conservation and improved decision-making. Firstly, the conservation objective would conserve and protect existing salmon stocks and habitat, in-river and at-sea. Secondly, improved decision-making would ensure that all stakeholders (Governments, Aboriginal and non-Aboriginal) be involved in decision making affecting conservation, management, and protection of the resource as well as opportunities of access to the resource. Each objective has attending principles that guide the stewardship of the salmon and other native fish species through community watershed management structures.

Objective 1 – Conservation

The need for a conservation ethic for our salmon resources and their habitat is widely accepted.

It is important to recognize that salmon management is also an international issue due to the highly migratory nature of the resource. To achieve the resource conservation and sustainable use objectives outlined in this paper, cooperative international management will be required.

Principle 1. *Conservation of wild Atlantic salmon stocks is the primary objective and should take precedence in managing the resource*. The new conservation ethic involves ensuring that adequate numbers of Atlantic salmon spawn each year, that successful reproduction takes place and that genetic diversity is maintained. Effective conservation of salmon also requires that access (including harvest) management be integrated with production management on a watershed basis. Habitat and enhancement planning should complement access management and ensure escapement goals are consistent with the productive capacity of the habitat.

Ultimately, conservation goals must be established at levels that optimize productive capacity and benefits to everyone, especially those dependent on wild salmon for social or economic reasons. To accomplish these goals, integrated watershed plans will be prepared in consultation with public stakeholders.

Principle 2. *A precautionary approach to fisheries management should be adopted.* Given uncertainties in predicting fish population levels and survival levels, a precautionary, risk-averse approach to fisheries management is essential. Salmon populations need to be maintained at sufficient levels of abundance to provide a buffer against marine survival and other conditions which threaten the spawning success of the next generation. Therefore, operational guidelines for implementing the precautionary approach will be developed.

Principle 3. *There is a need to work toward a net gain in productive capacity for salmon habitat in Atlantic Canada.* Since salmon depend on the unique characteristics of the freshwater and saltwater habitat in which they live and spawn, specific habitat conservation and development goals should be achieved through the protection, management and restoration of fish habitat. Strategic, short-term enhancement of threatened stocks can, where necessary, also be used to assist their survival and accelerate rebuilding. The goal is to ensure that natural salmon habitat is maintained to support naturally reproducing populations of salmon.

Development and enhancement of cooperative arrangements with other levels of government and the public, necessary to achieve these goals, is a high priority. In particular, it is important that the federal, provincial/state and Aboriginal governments work together to maximize benefits for salmon habitat. These jurisdictions have the regulatory authority over various complementary activities affecting marine and freshwater habitat.

Principle 4. *An ecological approach should guide fisheries and oceans management in the future*. The definition and practical implementation of an ecological approach to fisheries and oceans management is complex, and work needs to be done to clarify how it should apply. However, it is clear that an ecosystem approach involves understanding and providing for the complex interactions between the different species and requires a move away from single species management. The transition to an ecological approach to fisheries and oceans management will require a phased, step-wise approach, building on knowledge as it becomes available.

Ecological integrity is defined as a condition where the structure and function of an ecosystem are unimpaired by stresses induced by human activity and is likely to persist. It is recognized that, like the net gain in the productive capacity of salmon habitat, this overall objective needs to be looked at on a broad level and the operational applications fully discussed.

Objective 2 – Improved decision making

Governments, First Nations, conservationists, recreational anglers and the public generally have valid and

diverse interests in the resource, which must be treated fairly, in the spirit of cooperation and mutual respect.

Principle 5. *Clear, objective and relevant information on major issues requiring decisions should be provided to the public with sufficient time and opportunity for review, comment and feedback. Periodic review of progress and achievements would be initiated to facilitate accountability for the sound management of the salmon resource and its habitat.* The environment in which stakeholders are involved in fisheries activities has changed over time; however, the institutional structure used to solicit stakeholder input has not kept pace and is outdated. While governments may solicit advice from the various stakeholder groups, there is a need for mechanisms to better involve all stakeholders in the decision-making process. Increased public involvement in planning and management is essential to ensure sound decision-making and to build public understanding and support for necessary management actions.

Principle 6. *Government and stakeholders can together be responsible and accountable for sustainable fisheries.* Resource managers and stakeholders need to share joint responsibility for sustainable fisheries including management costs, decisions, and accountability. Effective community stewardship models need to be based on strong, working partnerships among all stakeholders.

These partnerships need to provide for specific rights and roles, as well as accountability for well-defined responsibilities and commitments. Stakeholders should be given more say in the decisions that affect the resource, including development of management plans, increased control over expenditures associated with implementing the plan and greater security of access to the resource. As management organizations mature, and confidence develops, more decision-making can be turned over to community stakeholders. In turn, stakeholders should also be held accountable for decisions they make.

Principle 7. *Enhanced community, regional and sector wide input to decision making could be pursued through a structured management and advisory board system*.

In the future, many of the decisions related to fisheries resources and their habitat could be made through a series of regional boards, covering a geographic area containing one or more watersheds. The scope of these boards would be intended to cover a variety of issues of common interest.

The regional boards could support many activities including, but not limited to, watershed production, integrated coastal zone planning, fishery enforcement and compliance, and habitat protection, enhancement and restoration. Many communities are already actively involved in stream and habitat restoration and stewardship. Hhowever, there is enormous potential for local groups to combine resources to maximize the benefits and enable an even greater roles in fisheries resource and oceans management activities.

Conclusion

Our collective experience in Atlantic Canada and Quebec has helped us learn many of the contributing factors underlying the success or failure of community stewardship initiatives.

At the heart of a successful wild Atlantic salmon restoration program are effective community stewardship organizations. Their success depends on being recognized and supported as legitimate and necessary partners of governments in the formulation and delivery of management plans for habitat and fisheries resources.

The wild Atlantic salmon is important enough in these regions of Canada from any of several perspectives, as a measure of our environmental health and well-being; as food for First Nations and a source of the cultural identity of both Aboriginal and non-Aboriginal people; as a source of recreation; or providing jobs and economic support to rural parts of the country.

All of these factors, taken in combination, point to a clear need to do whatever we can, through strong partnerships, to sustain and strengthen wild Atlantic salmon populations.

The basic concepts of community stewardship, the objectives and principles derived from experience, and outlined in this paper, demonstrate that it is possible to secure a secure future for the wild Atlantic salmon. The task is to build on what we have learned and move forward together.

AN ASSESSMENT OF ANGLER EFFORT AND CATCH RATE IN RELATION TO ABUNDANCE OF BARRAMUNDI (*LATES CALCARIFER*) IN THE MARY RIVER, NT, AUSTRALIA

Roland K. Griffin

Fisheries Group, Department of Business, Industry and Resource Development. GPO Box 3000, Darwin,NT 0801, Australia

Abstract

Between 1989 and 1995, estimates of barramundi fishing catch and effort by anglers in the Mary River were obtained by creel surveys. In each of those years, a fishery-independent estimate of the barramundi population at Corroboree billabong, a popular fishing location in the middle section of the Mary River, was obtained by closed area depletion methods. This paper examines the relationship between the abundance of barramundi and the effort and catch rate each year. A strong relationship between abundance and catch rate was not apparent for general anglers, but a weak relationship existed for guided anglers. The relationship between effort and abundance was somewhat atypical, with effort generally related to abundance in the previous year, rather than the same year. Possible explanations for these relationships are discussed.

Introduction

Barramundi (*Lates calcarifer*) is a very significant species in the Northern Territory (NT), indeed throughout northern Australia. In the NT it is the target of a significant commercial gillnet fishery in coastal waters, yielding up to 900 tonnes per year, valued at over A$4 million. The commercial fishery is very tightly managed and has largely recovered from over-exploitation in some areas in the 1970s.

The species is also an extremely important, almost totemic, icon species for recreational anglers in the NT. It also draws anglers from throughout Australia and overseas. The recreational harvest in 1995 was estimated to be over 100 000 fish weighing an estimated 3-400 tonnes (Coleman, 1998). A substantial fishing guide industry has developed in the last 10 years, with barramundi mostly the main target. Professional guides (known in NT as Fishing Tour Operators or FTOs), are required to provide daily logbooks of fishing activity and catch. In 2001, guided anglers caught 45 000 fish of which, 40 000 were released. The general rate of release of fish is very high, with around 60% of barramundi released, including many which could be legally harvested.

With the rise in significance of the recreational fishing sector in the 1980s a major focus of barramundi management has been the allocation of the resource between the competing sectors. One outcome has been that commercial fishing has been excluded from some areas, most notably, Darwin Harbour, Kakadu National Park, and the Daly, Mary and Roper rivers.

Historically, assessment of the barramundi fishery has been based on the time series of catch and effort from the commercial fishery. This time series is based on monthly summary data provided by the licensees. Commercial catch per unit of effort is regarded for this purpose as a reasonably reliable estimator of barramundi abundance. With removal and reduction of the commercial effort from many areas, this easily obtained abundance data is either degraded or is simply not available. The challenge faced by the managers of the barramundi resource is to find another way to provide data on the status of the stocks. One possible source is the catch and effort data from the recreational sector, provided either through diaries, creel surveys or the FTO logbooks. This paper aims to provide an assessment of the utility of available recreational catch per unit effort estimates as proxies for fish abundance or as determinants of fishing effort.

Data sources and study area

Since the mid 1980s barramundi research effort in the NT has been focused to a great extent on the Mary River (some 100 km east of Darwin), and on Corroboree Billabong in particular, within the river. The Corroboree Billabong is a section of the Mary River which only flows during the wet or monsoon season from December to April or May. Corroboree is a very popular

recreational fishing destination with fishing guides and tourists because it is also a very picturesque location with abundant wildlife. The data examined is of three types:

- roving creel surveys conducted annually from 1989 to 1995 providing annual estimates of catch, effort and catch per unit effort (CPUE);
- annual estimate of barramundi abundance in a part of the billabong from 1989 to 2001, obtained by depletion methods; and,
- daily log book data provided by FTOs from 1994 to 2001.

Roving creel surveys

Stratified, randomised, roving creel surveys, using standard methodologies (Pollock et al., 1994), were conducted and estimates of angler effort, catch and CPUE derived (Figure 1) (Griffin, 1995).

In the course of the roving creel surveys some parties using the services of a fishing guide were encountered. Data from those parties has been examined separately, providing for comparison with "normal" parties.

Population estimation

Each year since 1989, the population of a 450 m section of Corroboree Billabong has been estimated by depletion methods (Griffin and Walters, in press). A standard set of gill gillnets was used inside an enclosure, formed by heavy, small mesh nets, to deplete the enclosed population over a period of four or five sampling days in September each year. From the time series of declining catch, over the sampling period, the population of barramundi was estimated. The estimated population of barramundi in the enclosed area has been found to be quite variable, with most of the extreme variation attributable to marked variability in the abundance of recruits. Estimates of total barramundi abundance and abundance of legal sized fish are shown below (Figure 2).

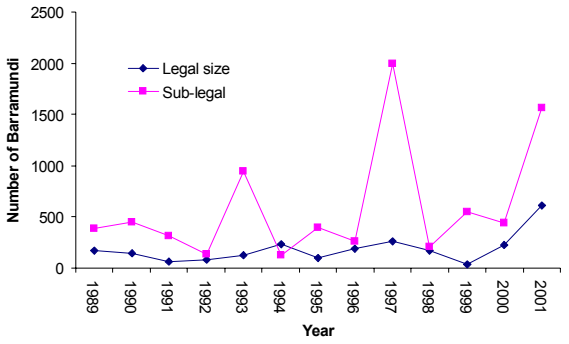

Figure 2. Estimated population of legal and sub-legal barramundi at Corroboree Billabong sampling area, 1989 to 2001.

Fishing tour operator daily logs

Since 1994, FTOs have been required, as a condition of licensing, to provide a daily summary of fishing activity by clients. The time series of total catch rate (fish/angler hr), including released fish, is used in this analysis because guided anglers release over 80% of fish caught, including many which could legally have been harvested (Figure 3). The total catch rate of guided parties interviewed during creel surveys from 1989 to 1995 is also shown in Figure 3. The FTO logbook total CPUE shows a marked rise in recent years.

CPUE and abundance relationship

The relationship between angler CPUE and barramundi abundance was examined by linear regression (Figure 4), the relationship was clearly not significant and in reality, was non-existent.

Relationships between known abundance and angler catch rates were further investigated to examine possible effects of factors, such as skill and experience or seasonal effects, which might mask underlying relationships between abundance and catch rate. For example, the catch rate of guided parties encountered during creel surveys was examined to investigate the possibility that anglers with the benefit of the guide's knowledge and experience, might have catch rates

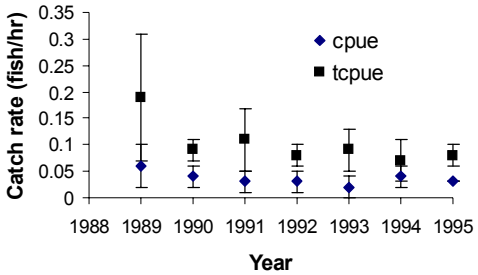

Figure 1. Angler harvest rate (CPUE, fish kept per angler hour) and total angler catch rate (tCPUE) at Corroboree Billabong, 1989 to 1995. Error bars are 95% confidence intervals.

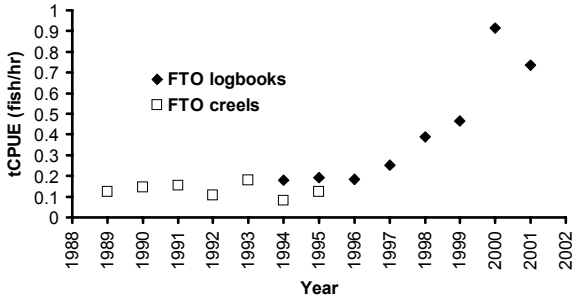

Figure 3. Total catch rate of guided fishing parties at Corroboree Billabong. 1989-1995 from creel surveys; 1994-2001 from FTO log books.

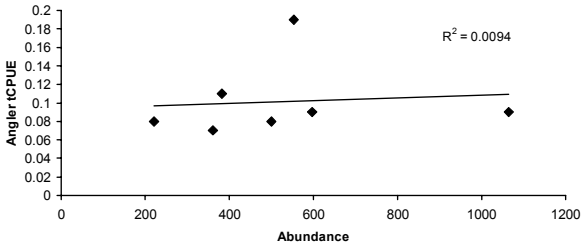

Figure 4. Plot of angler total CPUE (fish/hr) against barramundi abundance at Corroboree Billabong, 1989 to 1995.

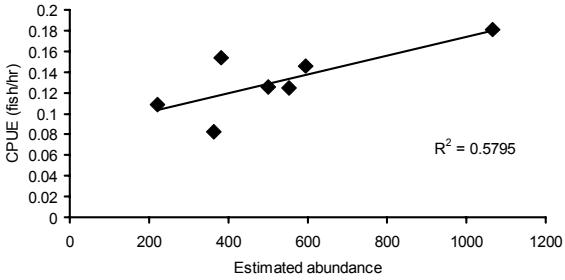

Figure 5. Plot of guided angler total CPUE (fish/hr) against barramundi abundance at Corroboree Billabong, 1989 to 1995.

more in proportion to abundance (Figure 5). In this case the relationship is stronger, but is not statistically significant and is driven largely by only one data point. Without this point, there is no clear relationship.

Further, a plot of total CPUE versus abundance for guided parties (from FTO logbooks) at Corroboree Billabong shows virtually no relationship (Figure 6).

Given the high skill and experience level of many of the guides this result is a little surprising. If the two years of very high abundance (primarily of new recruits which are not targeted by anglers at Corroboree) are excluded, a relationship is likely. Further examination of this type of data would be warranted.

Effort and abundance relationship

It is frequently assumed that recreational fishing effort at a particular location will depend on the quality of fishing at that location, which is dependent on abundance of fish (Walters and Cox, 2002). To test this assumption, the relationship between the estimated level of fishing effort at Corroboree Billabong and the estimated population of barramundi was examined (Figure 7).

Quite clearly the relationship is not significant statistically, when all data is included, but it is very strongly influenced by the high abundance in 1993. In 1993, the population was enhanced by a very high number of recruits which are not particularly targeted or catchable at Corroboree Billabong, as they are at other locations and other times. Exclusion of the 1993 data would substantially improve the relationship. However, while the relationship between effort and abundance of legal sized barramundi is somewhat clearer (R^2=0.22), it is not significant.

Other factors, independent of fish abundance at Corroboree Billabong have probably had a major influence on recreational fishing effort. Boat launching facilities at the site were primitive and became progressively worse until a proper boat ramp was constructed in 1994. Favourable conditions for growth of lotus lilies resulted in almost complete coverage of much of the billabong surface during the dry season from 1991 to 1993. The consequence was much reduced efficiency of the commonly used fishing methods (casting or trolling of artificial lures) and general difficulty of access to water. These two factors were probably the main cause of reduced catch rate and reduced effort, despite generally moderate to high abundance of barramundi. Griffin and Walters (1997) described how overall angler effort in the Mary River declined from 1989 to 1993, despite evidence that the stock was increasing following closure of the commercial fishery in the river. They suggested that poor economic conditions over that period might have contributed to the reduction. These observations clearly indicate that many factors other than abundance of fish can influence angler catch rate and effort.

Further examination of effort/abundance relationships revealed a significant correlation between angler effort and abundance of legal size fish in the previous

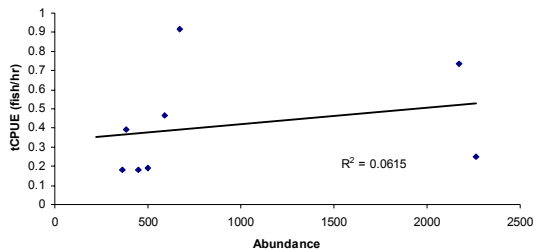

Figure 6. Plot of guided angler total CPUE (fish/hr) versus barramundi abundance at Corroboree Billabong, 1994 to 2001.

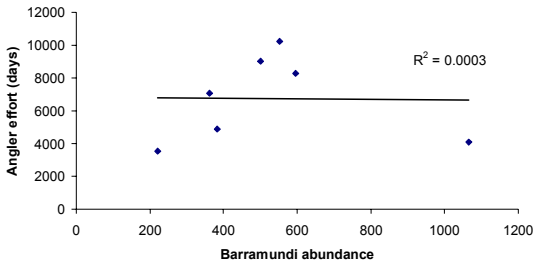

Figure 7. Plot of angler effort (days) verus barramundi abundance at Corroboree Billabong, 1989 to 1995.

year (R^2=0.78). A similar significant correlation is evident (R^2 = 0.63) between angler CPUE in the latter part of the fishing season (September to November - when catch rates are seasonally high and participation is high among local, experienced anglers) and effort in the following year. These correlations suggest the possibility that reports of good catches in the latter months of a fishing season before the wet season essentially closes the area (even if only a minority of anglers is making those catches) can lead to increased effort in the next year. It is unfortunate that the catadromous nature of barramundi means that many of the fish present late in the year, particularly the larger, more memorable ones, will migrate to sea and will therefore not be present when the effort burst comes the following year. This may be another factor complicating any relationship between abundance and effort.

Conclusion

This analysis has shown that in the case of Corroboree Billabong, in the time period examined, angler derived catch and effort data would be of limited use as an indicator of barramundi abundance. It also shows that knowledge of the abundance of barramundi is not a good determinant of fishing effort, with any underlying relationship obscured by interference from a range of other factors, such as access, fishing conditions and possibly even economic conditions. From this conclusion two inferences of significance to fishery management can be derived. The first is that angler derived data should be used as a stock monitoring tool only if the various confounding factors are understood. The second is that the apparent lack of a strong direct relationship between fish abundance and angler CPUE in this case does not support the common assumption that poor catch rates are due to low fish abundance, or conversely, that stocking could be used to boost abundance and improve perceived "poor" catch rates.

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THE FUTURE DIRECTIONS AND CHALLENGES FOR RECREATIONAL FISHERIES MANAGEMENT IN WESTERN AUSTRALIA – REGIONALISATION AND INTEGRATION

Nathan J. Harrison and Andrew C. Cribb

Department of Fisheries, 168 St George's Terrace, Perth, WA 6000, Australia

Abstract

Western Australia's (WA) marine finfish stocks are distributed over a vast 12 000 km coastline, ranging from tropical waters in the far north of the state, through sub-tropical and temperate zones to the cooler waters of the south coast.

These four broad regions support a diversity of marine life and habitats and the level and impacts of human use also varies widely between each area.

The WA Department of Fisheries is currently developing four broad bio-regional recreational fishing management strategies as a more effective framework for linking the distribution and abundance of fish stocks with the levels of fishing activity.

A bio-regional management approach is consistent with the approach adopted on a national level by the Commonwealth agency Environment Australia, and is a key element in both Commonwealth's Ocean Policy, and in the National Representative System of Marine Protected Areas.

Importantly, regional management plans will provide a spatial framework for integrating the management of recreational and charter fishing with commercial fishing and other uses in each region, such as indigenous fishing, conservation and eco-tourism.

Background

Western Australia's (WA) marine finfish stocks are distributed over a vast 12 000 km coastline, ranging from tropical waters in the far north of the State, through sub-tropical and temperate zones to the cooler waters of the south coast.

These four broad regions support a diversity of marine life and habitats and the level and impacts of human use also varies widely between each area.

In WA over 640 000 people participate in recreational fishing, generating an estimated 10 million angler days. This represents a 300% increase in effort over the last 10 years (Baharthah and Sumner, 2000).

The increase in effort primarily relates to population growth. However, in Western Australia participation rates have also increased. In 2001, 34% of the population participated in recreational fishing (Baharthah and Sumner, 2000).

The high participation rate in recreational fishing is in part due to the fact that Western Australia's population is heavily centred around coastal areas.

In total recreational fishing in believed to contribute over A$570 million to the State's economy and generates 7000 full-time jobs (Linder and McLeod, 1991).

Issues for management

Population growth has resulted in the construction of new roads, marinas and industry, making population growth one of the prime drivers for most of the issues that threaten the future quality of recreational fishing in WA.

Increased coastal development, while improving recreational fishing access, has led to the disappearance of fish refuges with many fish stocks now exploited over their entire habitat range.

Dramatic improvements in technology have also had impacts on the way people fish: particularly from boats. The use of quality eco-sounders and global positioning systems (GPS) has now become widespread. In effect anglers equipped with high-tech gear to locate key fishing areas no longer require extensive fishing experience or as high navigational and fishing skills.

Competition in time and space among competing user groups for available fish stocks has also become a focus for community debate. As resource sharing issues have intensified there have been a reluctance for

anglers to accept community stewardship for the resource.

With more pressure on our fish resources, regional specific issues have arisen in different parts of WA, which have required the development and implementation of modified management arrangements for specific areas and species.

In the mid 1990s recreational fisheries management in WA became increasingly reactive with resources focused on dealing with problems as they arose.

The State-wide management approach was proving to be inflexible, primarily because it was not based on bio-geographic zones or patterns of fishing activity.

Responding to isolated management problems has resulted in over regulation from a "band-aid" approach to management

The choice for managing our recreational fisheries resources was either to continue with the same management approach and see a gradual decline in the quality of recreational fishing or to pro-actively manage for the future.

The regional management approach

A solution to protecting the future quality of recreational fishing was developed by the Recreational Fishing Advisory Committee and the Department of Fisheries WA. The solution revolves around the development of four regional management strategies for the State, which incorporates a detailed planning process capable of developing better targeted and more flexible responses to key management issues.

The basis for a more regional approach to recreational fisheries management was an acknowledgment of the natural complexity and diversity of WA's marine life and environments, and a clear need to better link management to the biology and distribution of both fish stocks and fishing activity. In other words building effective management from the biological characteristics of resource upwards, rather than simply imposing human social values on fish.

A key element in the regionalised approach is to simplify legislation where possible and provide a more uniform set of rules across each region. However, this does not preclude establishing smaller management zones.

It is the view of the Department, that Western Australia's inshore fisheries are reaching a critical stage in their exploitation status, and that further unconstrained growth in either the commercial or recreational fisheries sectors is not sustainable.

Creel surveys demonstrate that recreational bag limits and other management settings for many species are, for the majority of recreational fishers, not achievable, and consequently not effective in constraining either individual or total catches by the sector – and offered little protection to aggregating fish.

More significantly, the existing management framework and settings have limited ability to contain further expansion in both catch and effort by the recreational sector.

Integrating management

The regional recreational fisheries strategies will complement the new management arrangements for the charter industry and provide the necessary framework for recreational fishing to be incorporated into an integrated management framework with the commercial finfish sector.

Before catch allocations can be managed under an integrated management framework, it is first necessary that effective sectoral management arrangements are in place. Some fisheries are not highly managed (e.g. finfish) and a move to a higher level of management is essential for both the commercial and recreational sectors.

Complimenting the regional recreational fishing strategies a corresponding review of the unmanaged components of the commercial finfish sector is also planned to ensure the effective management of the commercial catch.

Importantly, regional management plans will provide a spatial framework for integrating the management of recreational and charter fishing with commercial fishing and other uses in each region, such as indigenous, conservation and eco-tourism.

The implementation of the regional recreational fishing strategies will achieve two critical steps in the development of integrated management:

1. they will clearly establish a framework within which recreational fisheries can be integrated with the management of commercial finfish and charter fishing.
2. they will adjust recreational sector catch management to compensate for the escalation in recreational fishing pressure and efficiency over the last decade. It is unlikely that the total recreational catch will be significantly affected – a more likely out-

come is there will be some redistribution at the margins away from "high catch" fishers who maximise their catch on each trip, making more fish available to other less efficient or less well equipped anglers and going some way to providing greater equity of opportunity.

To assist with the integration of fisheries management, an independent review committee is examining alternative management frameworks and principles for the future allocation of fish stocks to ensure maximum benefit to the community.

The Department believes an integrated management approach is essential to meet growing pressures on our fish resources and the requirements of Ecological Sustainable Development.

Issues surrounding the allocation of resources are complex and it may take a further five to ten years to implement the new framework across the majority of fisheries.

In the interim, it is important that each sector continues to be managed effectively within current catch ranges.

In WA the spatial boundaries for the different regions reflects the distribution of fish stocks, and will permit the determination of sustainable catch levels and the allocation of catch shares to the various user groups on an appropriate spatial scale.

Integration on a regional basis may also provide a spatial framework for data collection that will assist in the proportional management of catch and access shares.

Challenges ahead

The sustainable management of fish stocks requires a holistic approach to management – in other words recreational fishing can't be managed in isolation. The implementation of the regional recreational fishing management strategies, the review of commercial wetline fishing and ultimately, the establishment of an integrated management framework will require community, industry and political support.

Generating community and industry support that can lead to political support will require extensive community consultation and stakeholders involvement.

Under an integrated management framework where catch shares are assigned to the recreational sector there will be a need to implement management strategies which effectively manage the recreational catch. Currently there is a reliance on management tools such a bag limits which do little to restrict the recreational catch.

Effectively managing the recreational catch will require greater use of tools such as closed seasons, closed areas, licensing and no take areas. Support for the use of these strategies especially if differential controls are in place for the commercial sector will require extensive community consultation and education.

Once an integrated management framework is established the collection of fisheries research data needs to be comparable and meaningful if catch shares assigned to each sector are to be effectively managed.

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LONGITUDINAL SURVEY SUGGESTS DECLINING INTEREST IN RECREATIONAL FISHING

James B. Higgs

Queensland Fisheries Service, GPO Box 2764, Brisbane, Queensland 400,1 Australia

Abstract

Results from random telephone surveys contacting in excess of 22 000 Queensland households suggest that 28.1% and 26.1% of the Queensland population aged 5 years and above had been fishing in the 12 months periods prior to surveys conducted in 1996 and 1998. This corresponds to a recreational fishing population of 882 000 and 848 000 anglers (aged 5 years and above). Preliminary information from the third biennial survey, which was delayed 12 months to enable Queensland to be involved in the National Recreational and Indigenous Fishing Survey, suggest a continued decline in participation rates by recreational anglers. Declining participation rates raise significant issues for both management agencies and the recreational fishing industry.

Queensland has Australia's highest rate of population growth and fisheries managers and some scientists have assumed that this will correspond with a proportional increase in the number of anglers, associated fishing impacts and demand for recreational fisheries infrastructure. The information collected as part of the longitudinal studies suggests however, this may not be the case. Projections of the Queensland population and the associated recreational fishery have been conducted and have highlighted what the Queensland recreational fishery may look like in the short (10 years) to medium (50 years) term.

Declining participation rates are often attributed by the recreational fishing industry to be associated with declines in fish stocks and increasing competition with the commercial fishing sector. General declines in sport and outdoor activity, and increases in time spent associated with new recreational activities such as the internet could suggest that competition by other forms of "recreational entertainment" for finite leisure time may be an important factor in the declining participation rates.

Fisheries managers and enforcement officers need to include these trends into their forward planning programs to help develop the best distribution of resources to deliver sustainable fisheries management arrangements.

Introduction

Recreational fishing in Queensland, as with other areas around the world, is going through a period of rapid change in response to competing recreational activities, increased environmental awareness and increased urbanisation of the population. In Queensland, this change is further compounded by the quasi commercial nature of some sections of the recreational fishery that, up until 1990, were able to sell part of their catch under a government run permit scheme.

In a review of the Queensland recreational fishery conducted in the early 1990s, lack of accurate estimates of the size of the recreational fishery and its associated harvest were identified as key pieces of information that were missing from the management of Queensland fish stocks. In response to this finding, the Recreational Fishing Information Coordination Committee (RFICC) was established in 1995, with representatives from research, fisheries management and conservation agencies, as well as the recreational and commercial fishing industries. The RFICC recommended that the core of the Queensland recreational fishery monitoring program should be a biennial two stage survey that employed a telephone survey to collect participation details and a diary program to collect catch and effort information. The first telephone survey was conducted in 1996, with the third survey delayed until 2001 to enable Queensland's involvement in the National Recreational and Indigenous Fishing Survey.

Findings from the third statewide telephone survey have clarified observed differences between the first two telephone surveys and have identified clear trends that will need to be included in the development of future fisheries management regimes.

Methods and results

Each of the telephone surveys employed the same questionnaire that was extensively field tested in 1996 in association with the Australian Bureau of Statistics and Roy Morgan Research (a market research company that has been successful in tendering for each

of the surveys conducted to date). A market research company was identified as the most appropriate means of conducting the initial screening survey for a number of reasons including: 1, ability to monitor and code responses at the time of interview using a Bellview Computer Aided Telephone Interview (CATI) system; 2, fast processing and analysis of information; 3, public recognition of the company conducting the interview; and 4, a quality assurance scheme and proven ability in similar types of surveys.

In additional to collecting information to characterise the Queensland recreational fishing population, the telephone survey is designed to obtain between 300 and 350 angling diary participants in each of 15 statistical regions that cover the State. The survey should not, however, be confused with a quota type survey, as the primary sample of phone number is "exhausted" prior to new numbers being included in the sample (QFS, 2002).

Key characteristics of the Queensland recreational fishery identified during the surveys conducted in 1996, 1998 and 2001 are included in Table 1. Full results are available on request from the Queensland Fisheries Service, with major findings also published as a technical report (QFS, 2002)

Figure 1 shows the age composition of the Queensland recreational fisher population that has been identified in the three Statewide recreational telephone surveys. Results clearly highlight the major changes to the age composition that have occurred in the 15-19 and 20-29 age classes, arguably the demographic groups most targeted by new forms of recreational activities.

Estimates of population growth by the Australian Bureau of Statistics indicate the Queensland population will reach almost 6 million residents by 2051, with the number of residents aged 50 years and older almost equal to the entire current population (Figure 2) (ABS, 2000). Demographic information obtained from the telephone surveys was combined with estimated population growth figures (ABS, 2000) to forecast predicted angling populations using a series of scenarios: 1, 1996 participation rates maintained; 2, 1998 participation rate maintained; 3, 2001 participation rate maintained; 4, the linear decline from 1996-2001 continues; 5, the linear decline restricted to 75% of 1996 figure; and 6, the linear decline restricted to 50% of the 1996 levels.

Scenario 1 to 3 forecast the recreational fishery to reach a million anglers between 2005 and 2016. Continuation

Table 1. Comparison of key elements of the Queensland statewide recreational fishing telephone surveys[1].

	Feature	1996 (%)	1998 (%)	2001 (%)
Queensland population aged 5 years and older	Fished in the 12 months prior to the interview	28.1	26.1*	24.6$#
	Fished, but not in the past 12 months	45.2	48.1	48.8
Recreational fishing population aged 15 years and above	Proportion of total fishers aged 20–29	24.3	22.0	19.7
	Fishers fishing less often than once a month	60.4	60.0	56.0$#
	Fishers fishing once a month	21.9	22.2	24.2$#
	Fishers fishing fortnightly	10.0	9.9	11.5$#
	Fishers fishing weekly or more often	7.7	6.8	8.1
	Fishers fishing in saltwater	92.3	92.4	91.2
	Saltwater fishers fishing from a boat only	27.2	28.2	30.5$#
	Fishers fishing in freshwater	28.8	30.4	33.2$#
	Freshwater fishers fishing in dams and impoundments	29.1	36.2*	39.2$#
	Reason for recreational fishing – food	49.1	42.1	34.0$#

* Indicates significant difference between 1996 and 1998;
$ Indicates significant difference between 2001 and 1996;
# Indicates significant difference between 1998 and 2001.

* A fisher is defined in the survey as a resident aged 5 years and above that had been recreationally fishing, prawning or crabbing in the 12 months prior to the telephone interview.

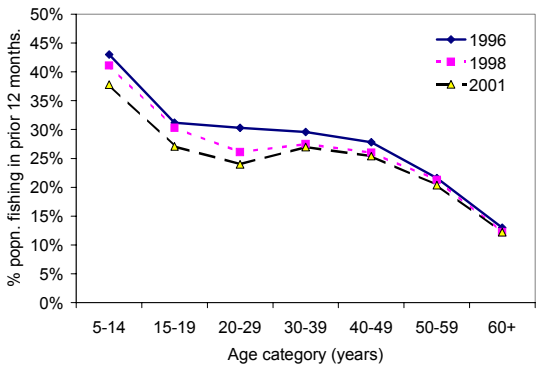

Figure 1. Age composition of the Queensland angling population identified during the 1996, 1998 and 2001 statewide telephone surveys conducted as part of the RFISH program.

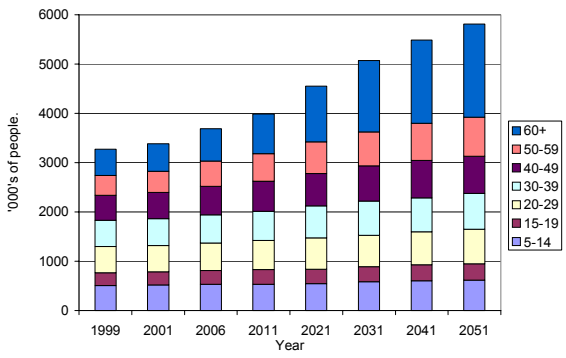

Figure 2. Forecast population size for Queensland and associated estimated size of the recreational fishery

Table 2. Estimated size of the Queensland angling population ('000's of anglers) from 6 scenarios developed from RFISH participation estimates and the estimated population growth for Queensland produced by the Australian Bureau of Statistics.

Scenario		a Million anglers by	Anglers in 2005	2011	2031	2050
1	1996 participation rates	2005	1,011	1,070	1,280	1,422
2	1998 participation rates	2011	945	1,001	1,198	1,331
3	2001 participation rates	2016	896	950	1,142	1,270
4	1996-2001 linear decline	Not reached	808	769	641	500
5	scenario 4 with decline capped at 75% of 1996 participation	2038	824	829	960	1,066
6	scenario 4 with decline capped at 50% of 1996 participation	Not reached	808	769	717	722

of the rate of decline observed in Scenario 4 to 6 suggests that only scenario 5 will reach a million anglers in Queensland in 2038 (Table 2). Even in the short term, the use of each of the scenarios highlights the importance of incorporating these estimates into the development of management plans that influence the recreational fishery. Using the range of scenarios, the estimated recreational fishing population for 2005 ranges from 808 000 anglers to 1 011 000 anglers, a difference of approximately 20%. By 2011, the difference in estimates produced by the scenarios increases to approximately 28%, and by 2050, the difference will be 65% (Table 2).

Discussion

The information collected as part of the statewide RFISH telephone surveys highlight how rapidly changes are occurring within the Queensland recreational fishery and foreshadow what the recreational fishery in the future will look like (Figure 3). This visualization of the future should be incorporated into the development of the Queensland recreational fishery by both industry and government agencies alike to maximize the effectiveness of policy development to meet the needs of a changing fisher population.

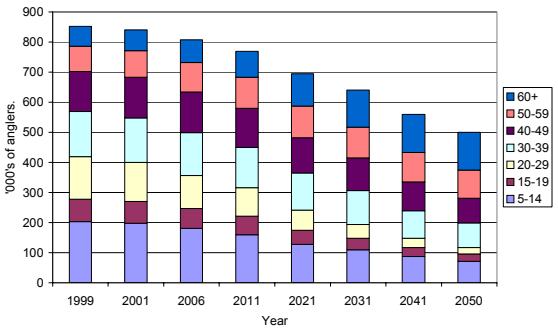

Figure 3. Demographic breakdown of the Queensland recreational fishery based on 1996 and 2001 telephone surveys and forecast demographic characteristics based on scenario 4 and projected population growth.

Rapid changes in angler motivation to fish have several clear policy implications. Obviously, the issue of stricter bag limits for the recreational fishery may be more readily accepted as anglers become less likely to want to fish for food. At the same time, the issue of increasing pressure from commercial fisheries without limits on their catches will become a more debated issue. This is even more likely with the observed trends of increasing boat ownership and representation of more avid anglers in the recreational fishery suggesting the average fisher is becoming increasingly committed to recreational fishing. The increased levels of commitment to the fishery is likely to see a corresponding level of involvement in the management planning process and pressure to implement controls on the output of the commercial sector through the implementation of catch quotas, area closures or reduction in fishing effort.

Results from the telephone survey also track the development of the recreational fishery in stocked dams and impoundments that has increased dramatically in recent years. This increase can be attributed to an extension campaign directed largely through industry magazines and television programs. There are a number of features of a stocked dam fishery that have particular interest to many anglers. These features include: 1, easy access to the fishing sites; 2, relatively inexpensive gear requirements; 3, perceived sustainability as a put and take fishery; and 4, perceived enhanced fishing success and variety of targets through stocking programs. The benefits of this expanding fishery to regional communities will be a focus of future economic components of the Queensland recreational fishing program

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INNOVATIONS IN PARTICIPATORY APPROACHES FOR SUSTAINABLE RECREATIONAL FISHERIES MANAGEMENT

Michelle Hollaway[1] and Derek Foster[2]

[1] Queensland Fisheries Service, Department of Primary Industries, PO Box 46, Brisbane, QLD 4001, Australia
[2] Department of Primary Industries, PO Box 5165, SCMC, Nambour, QLD 4560, Australia

Abstract

Community-based fish stocking groups have established in Queensland. These groups contribute to the management of local freshwater fisheries. Management of these recreational fisheries is facilitated on a co-operative basis between fish stocking groups and the Queensland Fisheries Service (QFS) of the Department of Primary Industries, under the fish stocking program. Officially known as the Recreational Fishing Enhancement Program, the program has been operating for approximately 15 years. The Queensland Government introduced the program in 1986, with input and support from recreational fishing groups such as Sunfish Queensland, Australian National Sportfishing Association and the Anglers Fish Stocking Association of Queensland. The initial aims were to stock and restock inland water storages (dams and weirs) with native fish species, create an inland recreational fishing resource and tourism attraction, and remove pressure on saltwater estuary fishing. The first twelve years of the program saw the Department take a major role in decision-making and priority setting.

Negative feedback from fish stocking groups indicated a need to implement change in the approach to the program. QFS responded to these needs and innovations were implemented over a three-year period to provide mechanisms for change. Varying degrees of community participation occur within many of the activities that contribute to the management of Queensland's freshwater recreational fishery. These types of participation are interpreted through a Typology of Participation model specifically designed for fisheries management. Originating from work of rural extension theorists and modified to suit a fisheries context, this model is presented as a guide for describing examples of Queensland management initiatives.

Extension theories are presented together with specific case studies to demonstrate how these innovative approaches have been applied and the resulting shift in community attitude. These innovations have fostered a positive community atmosphere, constructive dialogue, and recognition that Queensland Fisheries Service and community groups can work together in partnership to sustainably manage freshwater recreational fisheries.

Introduction

In recent years there has been a significant international move in community-government relationships with regard to natural resource management. This move has seen a shift from paternalistic government policy and administration to community-government consultation, cooperation and partnership. Suzuki and Knudson (1992) describe the validity of cultural perspectives when considering the management of natural systems. The move towards community-based resource management indicates government recognition of this validity. This acknowledges that communities can provide significant contributions to policy, management, labour and resources that are relevant and locally acceptable.

Many programs throughout the world illustrate that local communities and individuals have been active participants in the management of natural systems within catchments (Hinchcliffe et al., 1999; Stapp et al., 1998). In Australia, national community-based programs such as Landcare (Chamala and Keith, 1995) and Waterwatch (Foster, 1995) encourage community participation in catchment management. These programs illustrate that government, non-government organisations, local communities and individuals can sponsor and be partners in catchment management.

Initiatives of the International Centre for Living Aquatic Resources, Network of Aquaculture Centres in Asia-Pacific (NACA), Southeast Asian Fisheries Development Centre and International Institute for Rural Reconstruction (IIRR) have generated community based fisheries management programs (IIRR, 2001; Subasinghe et al., 2001). The Samoan Fisheries Project (Kallie, 1999; King and Faasili, 1999) is an example where each village in Independent Samoa generates their own fisheries management plan that may include a restocking program for giant clams.

There are numerous fisheries management programs where local community groups produce and release fingerlings for conservation and 'put, grow and take' purposes. In the United States some of these programs are driven by non-profit organisations such as

Table 1. A model for community participation in recreational fisheries management

Level of participation	Characteristics of level
1. Passive participation	The community is presented information on what is going to happen (or has happened) in a project, how and when it will happen. The community has no input into fisheries management.
2. Participation through provision of data	The community provides data by answering a set of pre-determined questions. Often the data is not validated through further contact with the data provider. The community queries how the information will contribute to fisheries management.
3. Participation for emotional reward	The community provides resources, such as money, people or time, in return for emotional comfort. They feel their contribution will help to sustain the fishery resource. The community feels there is no need for continuous involvement in fisheries management.
4. Participation by consultation	The community provides feedback on proposed changes to policy. The issues and solutions are pre-defined within a government document. Solutions may be modified in light of the community response. The community has no role in decision-making for fisheries management.
5. Functional participation	The community is represented on a committee to provide advice to fishery managers. The committee has been formed with pre-determined objectives to meet a pre-determined purpose. The committee tends to be dependent on the initiators. The community provides expert advice for consideration in fisheries management.
6. Interactive participation	The community is represented on a committee that jointly provides input, analyses information, and develops strategies and actions. Objectives of the committee are determined by its members. Results in the strengthening of local groups through information exchange. The community takes a lead role in local decisions that contribute to fisheries management.
7. Self-mobilisation	The community takes the initiative to form groups to meet their own objectives. They develop contacts within government departments, source funding to achieve their objectives and have control over the use of the funds. Their success strengthens the community. The community provides the resources to accomplish fisheries management objectives.

Trout Unlimited (www.tu.org). In other cases the United States Environmental Protection Authority (www.epa.gov/OWOW/fish) supports community groups. The Salmonid Enhancement Program established in Canada (Department of Fisheries and Oceans, 1996) has a strong community base for the fish-stocking program.

In Queensland, programs such as Fishcare Volunteers, Seagrass Watch and the Recreational Fishing Enhancement Program involve community groups and individuals in varying ways.

Due to variations in the style of interaction between communities and government, confusion arose about the meaning of the term 'participation'. A Typology of Participation (Pretty et al. 1995) was developed to guide extension professionals in interpreting community participation. This typology describes different types of participation for agricultural communities and is drafted in a hierarchy of levels. It has been modified to suit recreational fisheries management (Hollaway, 2001) (Table 1). When used in conjunction with a design framework (Foster, 2002), it is possible to develop effective processes to assist community groups to be self-directing participants in fisheries management programs. 'Participative' processes for communities in fisheries management are well accepted and successful throughout the world. A broad range of groups that can participate in these processes include government, non-government organisations, local communities and individuals.

Participatory processes have been developed for the Recreational Fishing Enhancement Program, through the use of a design framework and the above typol-

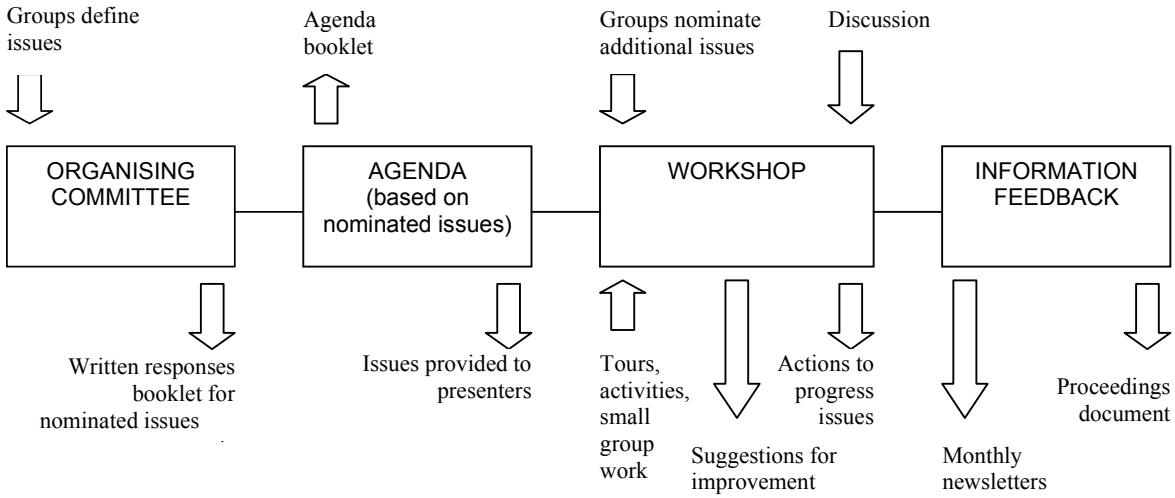

Figure 1. Process used to increase participation in workshops with recreational fishers

ogy. Two case studies, the Freshwater Recreational Fishing and Stocking Workshop and the Future Directions Group, demonstrate the results of community participation in recreational fisheries management.

Case study one - freshwater recreational fishing and stocking workshop

This is an annual workshop attended by members of Queensland's fish stocking groups, recreational fishing bodies and government staff it occurs on a weekend in different locations each year. It was initiated to provide a forum for stocking groups to raise issues and concerns related to the fish stocking program (Hamlyn, pers comm).

At workshops pre-1999 participants were told either what was going to happen or what had already happened with projects and issues related to the program. These workshops developed into a forum of conflict and anger, with a widely held view of scepticism for the government. This generated dissatisfaction amongst stocking groups and lowered morale of government staff. Why did this develop? Community views, ideas and responses were being ignored and the participants were not given an opportunity to provide input into projects and issues associated with the program. This can be considered passive participation-level 1 (Table 1). Understandably, the participants came to the workshop with a preset attitude of mistrust. Low levels of participation in the workshop design contributed to these reactions.

Consequently, the workshop format was reviewed in 1999. A structured process (Figure 1) with an organising committee consisting of government, non-government and community has been established. The committee achieves functional participation-level 5 (Table 1) by providing advice on the workshop design. Continuous interaction with stocking groups is a key feature of the process and allows groups to participate by consultation-level 4 (Table 1) through defining issues and providing feedback.

The result of the new process is significant with a substantial change in participant's attitudes. The workshop now fosters a positive atmosphere with constructive and logical discussion. It is now recognised that all participants can solve issues and develop policies together. The process is reviewed after each workshop to incorporate feedback and ensure continuous improvement.

Case study two - future directions group

Structured interviewing of sectors involved in the fish-stocking program revealed a need to examine, discuss and plan the best approach to the future of the program. To service these needs, a group representing recreational fishing bodies, hatchery operators, charter operators, bait and tackle operators and government agencies was formed in 2001 to set future directions for the Queensland fish stocking program and freshwater recreational fishery.

Encouraged by the success of increased community participation in the fish stocking workshops, similar processes were encouraged by all parties for this strategic planning exercise.

The planning process (Figure 2) encouraged interactive participation-level 6 (Table 1). The group participated in joint analysis of issues that lead to the development of actions to ensure a sustainable future for the program. Group members frequently sourced feedback from their sectors to allow participation through

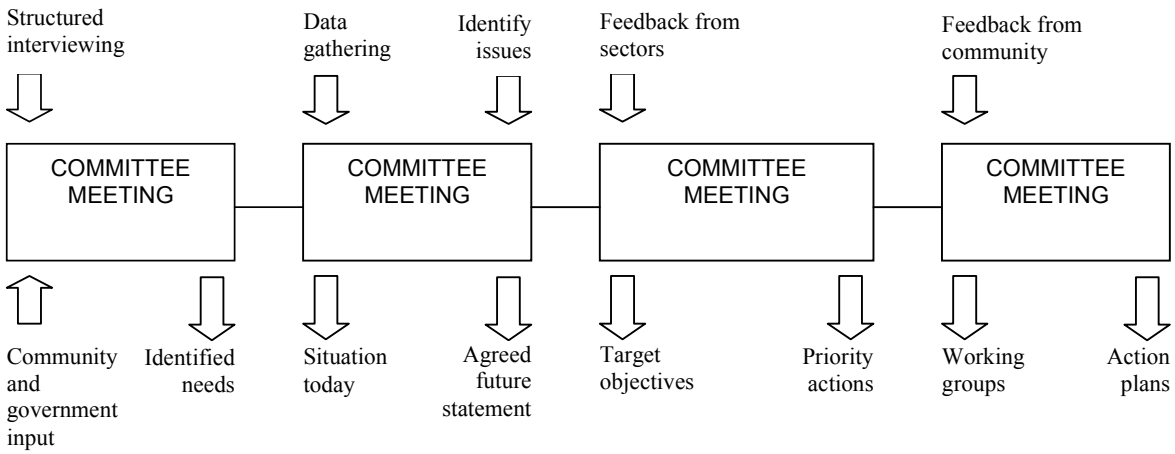

Figure 2. Process used to increase participation in strategic planning

consultation-level 4 (Table 1). Each member was responsible for meaningful contribution to ensure the quality of the outcomes.

This high-level participation process has fostered a progressive development of group dynamics. This has resulted in a positive working atmosphere, constructive discussion and progression of issues through community-government joint working groups.

Conclusion

1. Effective processes use a structured framework for design
2. Participation is consciously considered and decisions are made about levels to be achieved
3. High level participatory processes result in satisfied clients and practical output.
4 High level participatory processes complement fisheries management arrangements

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RESEARCH AND MANAGEMENT OF SNAPPER, *PAGRUS AURATUS*, STOCKS IN THE INNER GULFS OF SHARK BAY, WESTERN AUSTRALIA

G. Jackson, R. Lenanton, N. Sumner and A. Cribb

Department of Fisheries, Marine Research Laboratories, PO Box 20, North Beach, WA 6920, Australia

Abstract.

The sheltered inner gulf waters of Shark Bay have long been a popular destination for visiting recreational fishers, particularly during the winter months when snapper (*Pagrus auratus*), the key target species, aggregate to spawn. Such reproductive behaviour has made spawning snapper highly vulnerable to over-exploitation in the past, particularly with improvements in affordable fishing technology, e.g. GPS and colour sounders. Previous research showed little or no mixing between snapper in oceanic waters adjacent to Shark Bay ('oceanic stock'), and those inhabiting the two inner gulfs ('eastern' and 'western' stocks). More recent evidence suggests that the 'western 'stock is comprised of isolated spawning populations in Denham Sound and the Freycinet Estuary.

Community concern that the exploitation of snapper in the Gulfs was unsustainable had been expressed since the 1970s.Events became critical during the mid-1990s with particular concern surrounding high catches of larger spawning snapper in the Eastern Gulf. At that time, limited biological and fishery information on inner gulf snapper stocks was available for management. Since then, significant research, involving annual stock assessment surveys using the daily egg production method and recreational fishing surveys using the bus-route method, has been undertaken to provide essential information on stock size and recreational catch. Following extensive community consultation in 1997–98, various management measures aimed at rebuilding adult biomass in both Gulfs have been introduced. The 'eastern' stock has been fully protected by a total snapper fishery closure since June 1998. Significant stock rebuilding has occurred and there is now considerable community pressure to reopen the fishery. In contrast, over the same period, adult biomass in the Freycinet Estuary appears to have sharply declined and there is concern that the current management measures are inadequate to maintain the breeding stock.

The current situation with these high profile snapper stocks, each at markedly different levels of biomass, provides an excellent research opportunity, prior to re-opening the Eastern Gulf; 1, to develop an alternative management approach capable of constraining the recreational snapper catch within sustainable limits; and 2, to evaluate the effectiveness of recreational fishery management by comparing outcomes of both traditional and alternative management strategies.

Background

Shark Bay, located on the central coast of Western Australia (Figure 1), received World Heritage status in 1991. It has also been a popular recreational fishing destination since at least the 1970s. Snapper (*Pagrus auratus*, Sparidae), represent 50% of the recreational catch from the sheltered inner gulfs (Sumner et al., 2002) where snapper spawning aggregations are targeted during winter months (June – August). Earlier extensive research (genetics, morphometrics, otolith chemistry, tagging) revealed little or no mixing between the oceanic, and Eastern and Western Gulf stocks of snapper (Johnson et al., 1986; Moran et al., 1998; Edmonds et al., 1989; 1999). More recent evidence tends to supports this view, further suggesting that the Western Gulf stock is comprised of separate spawning populations in Freycinet Estuary and Denham Sound (Whitaker and Johnson, 1998; Nahas et al., in press). However some questions were raised about the links between the Denham Sound and oceanic stocks. These are currently under investigation.

Although snapper have been taken commercially in the gulfs in the past, present catches are extremely low. Currently, most concern is related to the level of exploitation by recreational fishers. Recreational effort was low in the 1970s, but increased through the 1980s to the early 1990s (Jackson, unpubl.), when improved technology enabled fishers to more effectively locate snapper spawning aggregations. By the mid 1990s, there were numerous allegations of over-exploitation of snapper in the Eastern Gulf. Proposals to introduce more stringent management measures were unpopular, and in the absence of quantitative evidence of serious stock depletion, were not supported politically. High levels of recreational fishing pressure continued during the mid 1990s, resulting in more widespread concern about serious stock depletion. This fishery was typical of many recreational marine fisheries, with little or no quantitative information available as a basis for management. This paper briefly describes research into the biology and stock size, and the estimation of recreational catch. Comparisons are also made of the effectiveness of different man-

agement responses implemented to date in the Eastern Gulf and Freycinet Estuary, with a view to identifying the most efficient, cost-effective management strategy for the future.

Stock size, biology, and recreational catch.

Stock assessment methods based on catch per unit effort (CPUE) time-series traditionally used in established commercial fisheries, were not possible due to lack of adequate data. Mark-recapture techniques were also discounted. In June 1997, an evaluation of the daily egg production method (DEPM, Lasker, 1985), to estimate spawning biomass of inner gulf snapper stocks commenced. Annual estimates have been made each year between 1997 and 2001 for the Eastern Gulf, Denham Sound and Freycinet Estuary populations. Snapper samples taken in conjunction with these surveys were used to study age, growth and reproduction. Trawl and trap surveys were also undertaken to investigate recruitment variability. The first estimate of the recreational snapper catch for Shark Bay, which included the catch from the oceanic fishery, was undertaken in 1983 using aerial and boat ramp surveys. Subsequent surveys undertaken in 1998–1999, 2000–2001, and 2001–2002, were based on a modified bus-route method (Robson and Jones, 1989). The current best estimates of spawning biomass and recreational catch from the Eastern gulf and Freycinet Estuary (Figure 1) are presented in Figure 2 and Table 1 respectively.

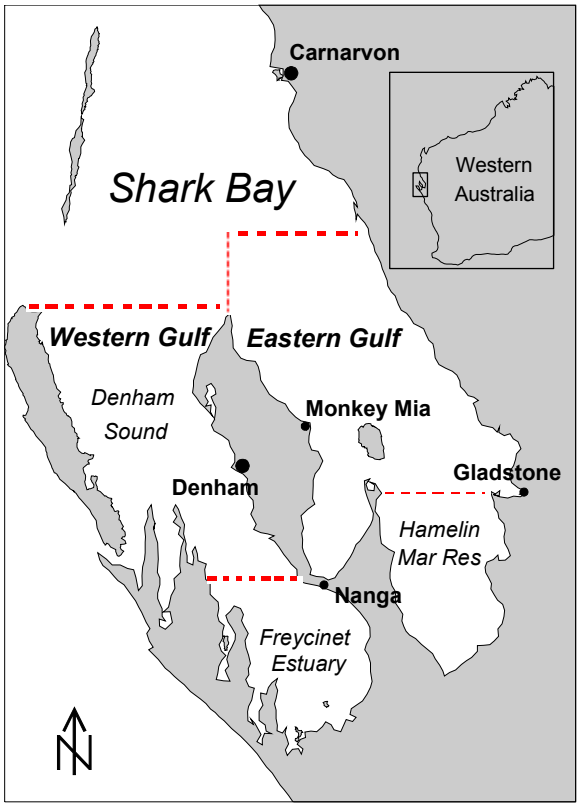

Figure 1. Map of Shark Bay, Western Australia, with key locations referred to in text.

Management responses

Low recreational catch rates of adult eastern gulf snapper in 1996 (Sumner and Steckis, 1999), together with very low estimates of 0+ recuitment in the Eastern Gulf supported the hypothesis that the Eastern Gulf spawning stock was seriously depleted. The Eastern Gulf , bag limit was reduced from eight to four, and the minimum legal size (MLS) increased from 41 to 45cm total length (TL). During 1997, continuing poor 0+ recruitment resulted in further restrictions. In the Eastern Gulf, the MLS was increased to 50cm (TL), while the bag limit was reduced to two. The Western Gulf bag limit was reduced from eight to four, while the MLS increased from 41 to 45cm (TL). During 1998, outcomes from the pilot DEPM survey (Jackson and Cheng, 2001), and extensive consultation with various community groups, resulted in the closure of the Eastern Gulf to the take of snapper that is currently still in place. During the period of closure spawning biomass data (Table 1, Figure 2) indicate that significant stock rebuilding has occurred. There is now considerable community pressure to re-open the fishery. In contrast, over the same period, the spawning biomass in the Freycinet Estuary appears to have declined (Table 1, Figure 2). There is now concern that current manage-

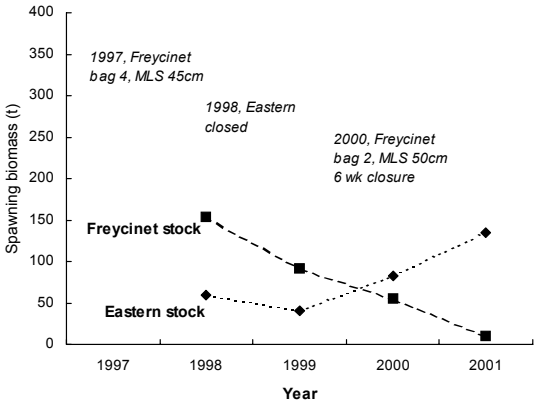

Figure 2. Spawning biomass of eastern and Freycinet Estuary (Western Gulf) snapper stocks 1998 – 2001 estimated using DEPM. **MLS**, minimum legal size.

Table 1. Recreational snapper catch (tonnes) and total effort (fisher days) 1983 – 2000, inner Gulfs of Shark Bay, Western Australia (Department of Fisheries WA, unpublished).

	Eastern Gulf		Western Gulf			
			Denham Sound		Freycinet Estuary	
Year	Catch	Effort	Catch	Effort	Catch	Effort
1983	7	6 500	12	3 500	17	4 500
1995*	~60	1 100	na	na	na	na
1998	~3	11 100	12	21 000	~30	17 000+
2000	0	9 500	10	16 000	~20	10 000+
2001	*0*	*7 000*	*8*	*12 000*	*22*	*15 000*

* May - July

ment measures are inadequate to maintain the breeding stock, despite the bag limit being further reduced to two (with only one fish over 70cm TL), the MLS being increased to 50cm TL, and the introduction of a six week spawning closure between mid-August and the end of September .

Where to now?

Currently there is mounting pressure to re-open the Eastern Gulf to recreational fishing. Experience in the Western Gulf has shown that despite the imposition of draconian restrictions, the spawning biomass has continued to decline. This is primarily related to the inability of such measures to effectively restrict recreational fishers access to the stock. The harvest strategy and associated monitoring and evaluation program ultimately chosen must have the capacity to achieve this in a cost-effective manner. It must also have broad community acceptance.

Acknowledgements

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ALLOCATING FISHERIES RESOURCES: WHO DESERVES WHAT?

Bob Kearney

Applied Ecology Research Group, University of Canberra, Canberra, ACT 2601, Australia

Abstract

Attempts to avoid the tragedy of the commons in the management of the world's fisheries have led to increased allocation of these resources to those who would, presumably, ensure their sustainability and wise use. Allocation of wealth, in whatever form, inevitably leads to disputes and often conflict. The allocation of fisheries resources, whether through increased ownership, preferential access or geographic and temporal restrictions, is no exception.

There are many competing primary claimants for fisheries resources, recreational, commercial, indigenous and non-consumptive and numerous other parties who claim access to water and/or waterways, such as developers, agriculturists, aquaculturists, riparian land-holders and polluters. Claims are made on many different grounds, such as historical precedent, birthright, cultural heritage, value to tourism and decentralisation, promotion of exports, social justice, community wellbeing, environmental protection and political expediency, but seldom are the principles, which should underpin allocation, clearly enunciated. Even less often are the comparative benefits of these principles debated openly between claimants.

The range of principles is great and varies with circumstance. Alternatives, which might impact allocation of fisheries resources, are presented.

Introduction

Until very recently, world capture fisheries production closely paralleled human population growth (Figure 1). Current, more detailed analyses suggest that fisheries production from the great majority of the world's nations has actually begun to decline, following virtually continuous growth up to the late 1980s (Figure 2). Australia's production (Figure 3) is in line with the view that supply has been decoupled from demand.

Against this background of fully-exploited or over-exploited fisheries resources, fisheries managers are increasingly immersed in problems of resource allocation. Increased acceptance of the theory that increased property rights to resource users will engender greater responsibility for resource husbandry and sustainability intensifies the allocation debate.

Resource use (allocation?) in Australia in 2002

Most debate on fisheries resource allocation in Australia has centred on competing claims of commercial and recreational fishers, with indigenous and conservation interests becoming increasingly prominent in the last few years. However, there are many other users of our aquatic resources and some of the more prominent of those to which an allocation, deliberate or otherwise, is made are listed in Table 1. Comments, on how the allocations to each of the sectors have been estimated, follow.

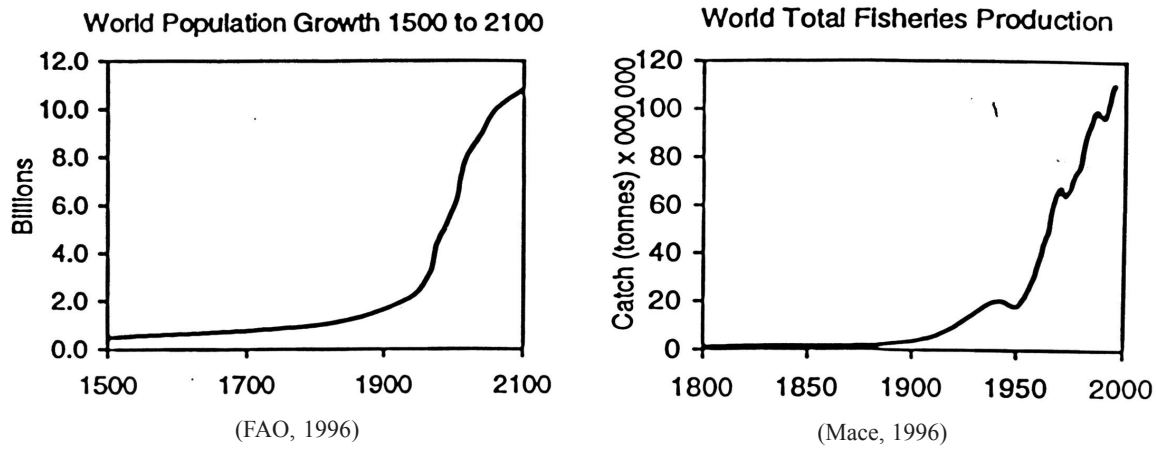
The current total Australian recreational catch is based on an earlier estimate of 50 000 tonnes per annum (Kearney, 1995a) corrected for current estimates of the number of anglers in Australia (19% of the 2001 population; G. Henry, pers.comm., compared to the estimate of 33% current in 1994.)

The commercial catch is well documented at about 200 000 tonnes per year (Figure 3).

Shamefully, there do not appear to be any official figures on total indigenous catches. The '< 5 thousand' tonne figure is a guess, based on the limited available data.

The 400 000 tonne allocation to seals is the estimate of food consumption of Australia's sea populations made by Goldsworthy et al. (2002). It should be noted that these same authors estimate that the sea populations will double in size in the next 9 years.

Japanese researchers have estimated the world's whales and dolphins consume more than 400 million tonnes of marine organisms a year. Species eaten by



(FAO, 1996) (Mace, 1996)

Figure 1. World population growth and fisheries production bfore and after the industrial revolution.

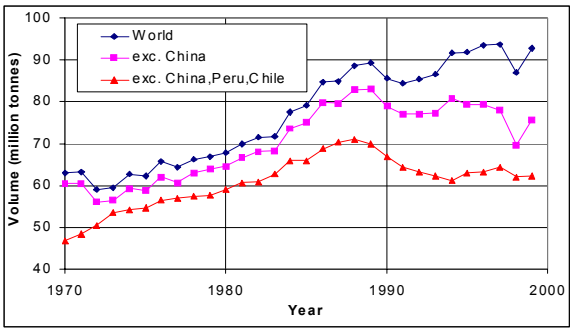


Figure 2. World - Capture Fisheries Production (from Lowe, Kearney and Foran, in prep)

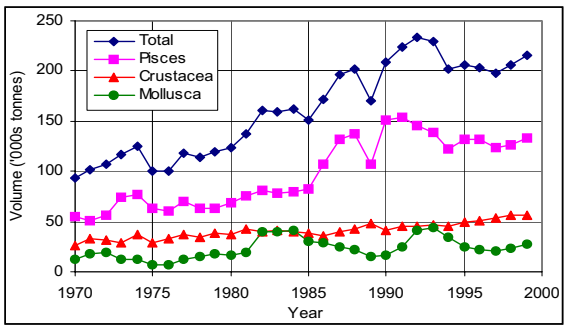


Figure 3. Australia – Capture Fisheries Production (from Lowe, Kearney and Foran, in prep)

Table 1. Allocated Between Groups (Deliberately or condoned)

Sector		Allocation (000 tonnes)
Recreational fishing		30
Commercial fishers		200
Indigenous users		<5 ?
Marine mammals	- seals	400
	- whales and dolphins	>180?
Birds		>200 ?
Aquaculture		10 ?
Biodiversity (endangered species, MPAs)		<5 ?
Animal rights		>0 ?
Land holders		5 ?
Total		>1,000 (approx)

Table 2. Used (or abused), but not deliberately allocated

Sector	Allocation (000 tonnes)	
Habitat degradation	?	(10)
Pollution (urban, industrial, agricultural)	?	(5)
Introduced species	?	(5)
Urban/coastal development	?	(5)
Water allocation	?	(5)
Total		(30)

whales are often not the same as those pursued by humans. More often, there is direct competition between humans and dolphins. It is not known what fraction of cetacean's food is sourced from Australian waters. However, as our 200 mile zone encompasses 16 million km^2 or 4.5% of the world's total ocean area, a similar proportion (4.5%) of the Japanese world estimate would be a staggering 18 million tonnes per year. Even acknowledging that Australia's waters are relatively unproductive and taking a conservative figure of 1% of the world's average would give consumption by cetaceans of 180 000 tonnes per year, approximately equal to our annual commercial catch. It must also be noted that most whale species are recovering from historically low levels.

Consumption by sea birds is guessed. However one species of shearwater alone is estimated to consume more than 80 000 tonnes per year (> 10 million birds x 80 g per day x 100 days) so an estimate of a total of 200 000 tonnes appears conservative. Most of this consumption is of organisms not directly targeted by humans, but for some bird species, such as cormorants, competition is more direct.

Other figures are guesses, but are most likely conservative.

Table 2 lists a number of other resource "consumers" and gives guesses on the minimal amounts of such consumption. More realistic estimates for these fac-

tors would probably be an order of magnitude higher, for example the 10 000 tones due to habitat degradation may not even account for damage to our freshwater fisheries production, which is a very small percentage of the total from our Exclusive Economic Zone. However, even the minimal figures given, account for the same total as the national angling catch and exceed the commercial catch from our freshwater and estuarine areas where habitat degradation is greatest. It is also most significant that the negative impact of the factors listed continues to increase.

Why the allocation to each group

Recreational fishers argue it a birthright to be able to fish. Indeed it has been, but recent introduction of license fees in several Australian states now restricts access to those who pay.

High levels of expenditure on recreational fishing are frequently quoted as representing the value of the activity. I have previously supported Hundloe's (1997) argument that expenditure does not represent value (Hundloe, 1997), particularly in Australia where the majority of expenditure is on imported goods (Kearney, 1999). There are economic benefits from recreational fisheries (Kearney, 2002) and I have argued those associated with tourism and decentralisation are most valuable.

The number of people who fish, is a big factor in favour of angling. But, one can't help but wonder if the decline in the estimate of participation from 33% in 1994 to 19% in 2001 is merely due to now having a more accurate estimate!

I continue to contend that the real values of recreational fishing in Australia are social: reasons are given in Kearney (1999; 2002).

Arguments that anglers are more conservation conscious than commercial fishers are not always supported by the limited available data (see for example WBM, 1997).

Table 3. Why the allocation? Who deserves what?

Recreational fishers	Commercial fishers	Indigenous
Birthright	Food for all	Birthright
Expenditure	Quality food	Food
Economy	Health benefits	Social
Decentralisation	Exports	Cultural
Number of participants	Economy	Heritage
Social	Decentralisation	Tradition
Resource conservation		Historical
Conflict resolution		Self esteem
Lobbying		Development (jobs, etc)
		Ethical

Allocating all of the resource to one user group does reduce conflict between groups, but does not necessarily address conservation imperatives.

Commercial fishers present many valid reasons why they deserve allocation (Table 3) . However not all these reasons apply to all fishers. For example, the southern bluefin tuna industry does not provide food for all Australians as virtually 100% of the catch is exported. The $300 million export earnings tend to justify this strategy.

The reasons for indigenous allocation all appear worthy and valid. The case will strengthen.

Why do we allocate to marine mammals and sea birds. Probably because we don't realise we do! Seals are totally protected but they are not endangered. Some species of albatross definitely need special protection but recent studies suggest populations of many sea birds have thrived on man's help to catch or scrounge food. Sea gulls in Sydney are but one obvious example.

Aquaculture receives an allocation because many senior Australian fisheries managers believe it represents the future of our fish supplies: we already import more than 70% of the fish we consume. Unfortunately Australian aquaculture currently consumes much more fish, and other sources of protein, than it produces.

It is only right that Australia should be making an allocation of resources to biodiversity conservation, however it is a pity we have no data on what this allocation is, or should be.

Animal rights issues have not, as yet, had major impact on fisheries resource allocation in Australia. However arguments against such practices as the use of live bait, targeting spawning aggregations of fish and catch and release are certain to increase and progressively impact allocation.

The reasons why we make an "allocation" to sectors, or issues, such as habitat degradation, pollution and coastal development (Table 2) are similar across the sectors and largely reflect high, short-term, economic returns from the activity and the great cost of eliminating or even changing the activity.

Allocation within groups

Allocation within groups is a much bigger, but often overlooked, issue than can not be dealt with thoroughly in this brief presentation. Accordingly I will outline only the major issues that relate to the two

categories of fisheries resource issues most relevant to this conference; these are commercial and, of course, recreational fishers.

Allocation within the commercial sector traditionally gives priority to those currently active in the fishery and with a well established history. Those who explore may also receive acknowledgement. More recent management strategies, in particular the use of individual transferable quotas (ITQs) have facilitated the transfer of the allocation to those with money (expenditure).

Allocation within the recreational sector in Australia has historically been little considered. The belief that there is equity, in that all citizens have equal rights to the same catch, is challenged by the implementation of licenses and by statistics which show that a very small percentage of anglers take most of the total catch. A competitive edge remains in that skill and knowledge are reflected in catches, as is expenditure on equipment in the form of better boats, four wheel drive vehicles and higher quality tackle and bait, and the employment of guides. With the current move in numerous Australian states to increase the areas available for the exclusive use of anglers, or at least the exclusion of commercial fishing, it would be good to see more restrictive bag limits which give the majority of anglers, who catch very little, a greater chance of success. What about considering total bag limit of two kilos in such areas? After all, the average angler only catches one kilo a day, and therefore, will not be restricted.

Conclusions

In 2002 we have:

- human population growth at the highest ever levels;
- marine mammal population explosions;
- stable, at best, commercial fisheries production;
- increasing environmental degradation which is huge, but largely not quantified;
- increasing use of allocation and property rights management closely tied to increased user-pays;
- allocation in preference to conservation (the recent closing of all commercial fisheries for Murray cod in the Murray-Darling Basin is a good example. Fishing for cod in all forms ranks sixth on the causes of declines in the species after habitat destruction, pollution etc (Davis et al., 2000) and the commercial fishery took less than 5% of the targeted catch, with angling and illegal poaching taking about half each of the other 95%, and the commercial fishery provided the only data set which documented the plight of the species. With the banning of commercial fishing, the narrow interests of short-term conflict resolution have been served by shooting the messenger who was telling us about the real problem);
- Australia's policy direction to increase ecosystem based management;
- the gaps in our information base that remain as wide as ever; and
- growing pressure on ethical grounds to reconsider how and why fisheries resources are allocated.

Against this background, who does deserve a greater allocation? Has Australian society decided? Or have Australians even been given the facts? Who should get more? Is it the anglers, the seals, the developers or the preservationists? The commercial capture fisheries share is unlikely to increase, even with improved management. The recreational share is nominally going up in inland, estuarine and inshore areas, but on examination this is only in comparison with the commercial share, which was declining anyway. What good is a marginally increased share of a rapidly shrinking pie.

Do we even know what is happening? Have we really identified the problem? Is the real issue environmental and habitat degradation? Is increasing exclusive extractive use to anglers alienating this group from the rest of the 94% of Australians who eat fish and could provide support for the real battle? One thing is certain, unless a problem is properly identified it cannot be solved, except by chance. I am prepared to hold all bets on the problems of resource conservation and allocation being resolved by luck.

Finally, even in 2002, I believe it is still appropriate to conclude the same way as I concluded in an address to the 1994 Australian National Conference on Recreational Fishing (Kearney, 1995b): of all groups and interests competing for our natural resources , the only ones who share the goal of long-term maximum sustainable direct human benefit from the extractive use of our living aquatic resources are, of course, recreational, indigenous and commercial fishers.

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POPULATION LEVEL CONSEQUENCES OF NOT LIMITING EFFORT IN A SPORT FISHERY

Eric A. Parkinson[1], John Post[2] and Sean P. Cox[3]

[1] BC Fisheries Branch, 2204 Main Mall, UBC, Vancouver BC, Canada, V6T 1Z4
[2] Deptartment of Biological Sciences, University of Calgary, 2500 University Drive NW, Calgary, Alta. Canada T2N 1N4
[3] Resource Management and Environmental Studies, UBC, Vancouver, BC, Canada V6T 1Z4

Abstract

In a previous sportfish symposium, Cox and Walters argued that an extreme degradation of quality is an inevitable consequence of open-access management of recreational fisheries. We have extended their arguments by linking a size-structured harvest model to a size-structured population for rainbow trout in small lakes. The population model is based on empirical survival and growth data derived from whole lake manipulations of density and size structure involving over 50 lake-years of data. The harvest model is based on intensive surveys of 5 lakes and angling quality data from another 32 lakes. We use the model to simulate the impacts of open access effort management on stocks that vary in habitat quality and capacity. We modeled population status under a pristine state and a state that produced maximum angling value (MAV = effort X value per unit effort). We compared a variety of indicator of status under these states with the same indicators under conditions that correspond to the currently observed angling quality on 32 British C olumbian lakes. Maximum depression in angling quality (relative to pristine) under the MAV state was <50% but the observed angling quality was often less than 10% of that expected under pristine conditions. Depression in population status was even more pronounced. Although average length of spawners often changed very little, age distribution of modeled spawner populations typically changed from two to four age classes to one where >80% of spawners were from a single age class. Population densities that correspond to observed angling quality were almost always <10% and, in some cases, <0.1% of the population density expected under pristine conditions. Depression of population density from the MAV state to the observed state was less severe, ranging from 50% to <2%. These studies suggest that lakes that support good angling quality under pristine conditions are at high risk of severe overfishing under the open-access policy of effort management that is typical in most North American sportfisheries.

Introduction

The role of fishers in driving the population dynamics of fish has been the subject of intense theoretical and empirical study. The two main approaches to this problem have been the biological theory of stock-recruitment relationships (Ricker, 1975) and the economic theory of exploitation of a common property resource (Gordon, 1954). The literature in each of these areas is extensive, but they have rarely been linked in a single analysis. In this paper, we link a simple model of angler behavior to a simple numerical model that is based on the biology of population regulation for rainbow trout in lakes.

The biological theory of population regulation suggests that there are optimum conditions that will achieve the desired balance between the conflicting goals of maximum sustained yield (MSY) or economic value while minimizing risk of collapse. In sport fisheries, MSY can be replaced by a maximum sustainable benefit, which can be defined as angler effort multiplied by a measure of angling quality. In keeping with the precautionary principle, MSY is typically viewed as a lower bound rather than a target for management. Quantitative models range from simple 2 parameter analytic models to complex age-structured, stochastically driven models.

Economic theory predicts that exploitation will be driven by fishers' expectations of economic returns. The distribution of effort will be determined by the relative economic returns in alternative fisheries (Holland and Sutinen, 1999). For commercial fisheries with open access (i.e. effort is not restricted), many authors have recognized that economic forces often results in the severe over harvest of most common property resources (Ludwig et al., 1993; Hilborn, 1985). An economic equilibrium results when boats stop entering a fishery because exploitation has driven catch per unit effort (CPUE) down to the point where revenue from sales is equal to the cost of fishing. This equilibrium can result in populations that are depressed to far below the optimum estimated through biological stock-recruit assessments. In sport fisheries, economic returns can be expressed in terms of angling quality. The equivalent of an economic equilibrium occurs in a sportfishery when harvest by anglers drives angling quality down to the point where additional anglers stop entering the fishery.

In many sportfisheries, a mobile angling population ties numerous independent production units (e.g. stocks in hundreds of lakes) together into a single fishery. When anglers are free to move between alternative fishing opportunities, angler behavior is an important component of the balance between effort and angling quality. The behavior of anglers can be modeled using ideal free distribution (IFD) theory, which has been developed by behavioral ecologists to make predictions of the distribution of foragers as a function of the distribution of prey resources (e.g. Gillis et al 1993, Levin et al. 2000). IFD theory predicts that angling quality should be similar on all lakes. This prediction is based on the belief that differences in angling quality should result in shifts in effort which, at equilibrium, results in a situation where individual anglers cannot experience an improvement in quality by moving to another lake. Assumptions in IFD theory include: zero cost to moving, perfect information about angling quality on all lakes, equivalent costs (e.g. travel time, regulation complexity) on all lakes and, equivalent ancillary benefits (e.g. facilities, aesthetics) on all lakes. If size dependent processes are ignored in both the biological and harvest models, this suggests that numbers per unit effort (CPUE) should be the same on all lakes. External factors, such as aesthetics and facilities, also influence angling quality but are usually assumed to be independent of fish biology.

In this paper we explore the consequences of these processes on both angling quality and fish populations. Our objective is to use such a model to demonstrate that, if lakes differ in stock recruitment parameters (i.e. stock productivity, habitat capacity), then most lakes will not sustain the population levels that will result in maximum numerical yield to the fishery. Our goal is to identify conditions that are likely to lead to over-exploitation in open access fisheries and quantify the gains that might be expected under alternative management policies. Size structure is an important factor in quantifying both angling quality and the dynamics of fish populations. Results of a size structured model were presented at the conference but have not been included in this paper because of space limitations.

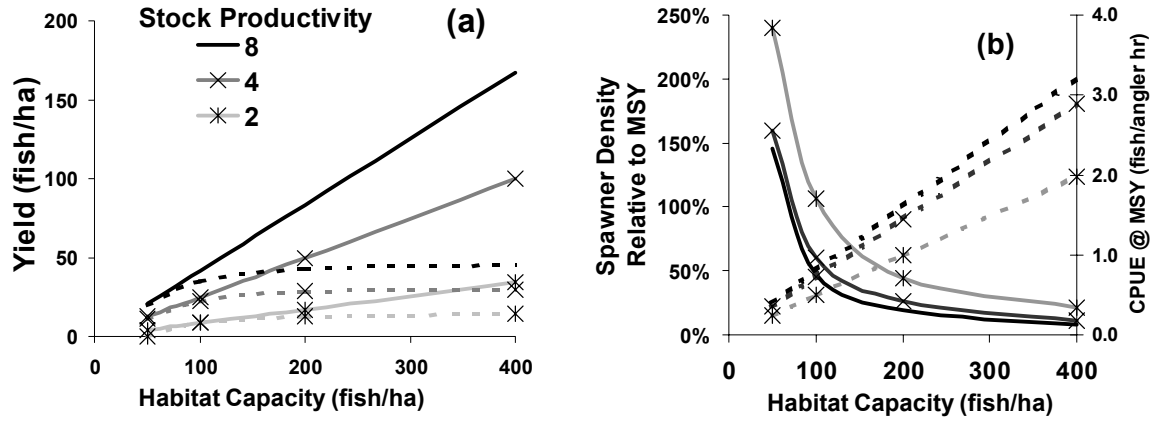
Methods

Our population dynamics model is based on the Beverton-Holt stock recruitment curve

$$N_j = \frac{\alpha \cdot N}{\left[1 + \alpha \cdot N/\beta\right]} \qquad (1)$$

where α is stock productivity (maximum recruits/spawner) and β is habitat capacity (the asymptotic number of juveniles produced with very large spawner numbers). Using this model, solutions can be derived which describe the populations under no harvest and maximum sustained yield (Ricker, 1975). With the additional of a catchability parameter, these solutions can be expressed in terms of CPUE and angling effort. An iterative search was used to find the amount of effort that produces both a stable population and a specified target CPUE. Parameters were varied over an 8 fold range in the case of β (50, 100, 200, 400 fish/ha) and a 4 fold range for α (2, 4, 8 recruits/spawner). Catchability was set at (q = 0.08 ha/angler-day) and target CPUE at 2 fish/angler-day. These are all typical values for rainbow trout in small lakes. We have also constructed a more complex size structured model that is driven by empirical information on growth and survival as functions of fish size and density (Post et al., 1999) as well as empirical data on CPUE and fish size in 34 lakes. The results of this model were presented at the conference and will be published in the formal scientific literature.

Figure 3. Key status indicators for simulated populations that vary in stock productivity and habitat capacity: **a**, Harvest achieved at MSY (solid lines) and at a target CPUE of 2 fish/angler day (dashed lines); **b**,Spawner population density at target CPUE as a percent of that at MSY harvest (solid lines) and angling quality at MSY (dashed lines).



Results

Each combination of α (Stock Productivity) and β (Habitat Capacity) can be characterized in terms of MSY the spawning population that generates that yield, and CPUE at MSY (Figure 3). Similar indicators can be calculated for a situation driven by effort that either enters or leaves the fishery when CPUE is either greater (more anglers enter) or less than (some anglers leave) a target angling quality (2 fish/angler day in this case). Since MSY is by definition a maximum, the yields for different combinations of α and β, but the same target CPUE, are almost always less than MSY. However, this simple model illustrates that, in many cases, yields, and the corresponding spawner densities are often only a fraction of that possible under optimal management control. At low habitat capacity and low stock productivity, angling quality is not high enough to attract the amount of effort necessary to produce maximum yields. Alternatively, when Stock Productivity and Habitat Capacity is high, then CPUE at MSY is >> 2, which attracts additional effort and drives the equilibrium spawner populations below MSY levels. These populations are capable of sustaining much more effort at the target angling quality but do no do so because of systematic recruitment over fishing. This simple analysis suggests that, in multiple-lake fisheries with a range of Stock Productivities and Habitat Capacities, populations in many lakes will not be at optimum levels if a mobile angler population drives all lakes to a common level of angling quality that is generally lower that that experienced under MSY conditions.

Discussion

The process of population regulation in harvested species has typically been considered in isolation from the dynamics of the harvesting effort. Biological management models predict densities and surplus production over a range of harvest rates, but the role of catch rates in determining the level of harvesting effort is rarely incorporated into the dynamics of population regulation. Our simple numerical model illustrates the generality of the problem. We are currently extending these results to size structured populations using a detailed model of rainbow trout populations where the biology of population regulation is well documented. A simple Beverton-Holt model of population dynamics, combined with an assumption of simple IFD angler behavior, predicts that open access management will rarely result in optimal population densities and, in some cases, densities will be depressed to a small fraction of pristine values. Populations that are naturally capable of generating high quality angling are the most likely to experience severe over fishing but stocks will rarely be driven to extinction. These results can be generalized to a wide variety of fisheries. The theory behind the dynamics of harvesting effort has been empirically tested in some fisheries (Holland and Sutinen, 1999) and it is clear that effort dynamics plays a critical role in determining current densities in many species. The fact that commercial fisheries with inadequate regulation have depleted many species to a fraction of their former abundance is generally recognized (Pauly et al., 2001) and the role of recreational harvest is now being documented (Post et al., 2002).

The biology of the system will also affect the outcome. In some species, biomass accumulates in older age classes under pristine conditions and optimal populations consist of relatively high densities of large, old fish. If these high-density populations result in unusually high angling quality, harvesting effort will increase and deplete the stock. In general, depletion should be expected to be more severe in long-lived, slow-growing species than in short-lived species.

We recognize problems associated with focussing on the equilibrium when assessing the outcome of a dynamic process such as angler movements and fish population dynamics. Neither of these processes is expected to be particularly stable. Angler effort and distribution will be perturbed by factors such as the state of the economy, shifting social values, and changes in access to fishing opportunities. Annual fluctuations in weather, as well as longer-term changes in climate and habitat, will affect populations. As a result, there is no particular reason to expect a system such as the one we have modeled to exist in a state of equilibrium. However, at least some of the processes involved strongly favor equilibrium. Anglers clearly use cues such as new access points, regulation changes and the experiences of others to quickly focus in on exceptional angling quality that result from perturbations. Knowledge of angling quality is not perfect and varies among individuals. Anglers may be very good at detecting differences in average fish size but may have relatively poor estimates of CPUE. However, studious anglers with many connections in the angling community may be adept at detecting transient opportunities with better angling. If these are regular seasonal occurrences or predictable from factors such as weather, we expect rapid response to exceptional opportunities.

The implications of IFD angler movement have parallels with the more familiar mixed-stock fishery problem (Paulik et al., 1967). In the conventional mixed stock fisheries, several stocks are exploited in a single fishery with at a single exploitation rate. If they differ in stock productivity, optimal harvest rates will differ among stocks and the combined yield from all stocks is below MSY. In mixed stock fisheries involving IFD angler distribution, a mobile angler population holds all stocks at similar population densities. If stock productivities or capacities vary among stocks,

then optimum population densities will differ among stocks and MSY cannot be achieved without restricting angler movement.

A key reason for the disconnection between sportfish management and angler dynamics may be the perception that management can effectively regulate fisheries without controlling angling effort. Biological models are often designed to provide reference points for the regulatory process rather than to explore the consequences of ineffective regulation. A variety of models (e.g. Leuke et al., 1994) have considered the effectiveness of alternative regulatory regimes, but have not incorporated the dynamics of angler effort. Catch and release regulation is an effective conservation measure but pressure to permit harvesting and non-harvest mortality can both be serious problems when catch rates are high. In some cases, the simple observation that anglers are less inclined to fish when catch rates are low has lead to the popular notion that sport fisheries are "self-regulating", that is, anglers will leave a fishery that has been over-harvested and thus allow it to recover. Our results suggest that sportfishery management should be refocused onto strategies that deal with the negative consequences of unrestricted growth in effort.

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SALMON ALLOCATION – THE BRITISH COLUMBIAN EXPERIENCE

Donna Petrachenko

Fisheries and Oceans Canada, 555 West Hastings Street, Vancouver, B.C. V6B 5G3, Canada

Abstract

In order to continue to evolve its management strategies and resolve sector conflicts, Fisheries and Oceans Canada has developed an allocation policy. The Department has long felt that to achieve rational management of salmon stocks, a clear, understandable allocation policy needed to be in place. The reduced ocean productivity of the late 1980s caused the Department to take action on recreational, commercial and aboriginal harvesting activities, with particular reference to affected chinook and coho stocks. This situation of low stock status and reduced harvest opportunity increased the potential for inter-sector conflict and emphasized the requirement for an "Allocation Policy".

Between 1996 and 1998, based on earlier recommendations found in a departmental "Directions" paper, the Department embarked on a series of public consultations carried out by third parties who were charged with developing specific allocation scenarios. The first step was an in-depth review of current policy that included recommending changes. This was followed by a sector by sector and public review of the analysis and recommendations to ensure understanding and to seek further input. Coinciding with the more public review, the consultant established an advisory group of representatives selected from the recreational, commercial, and First Nations sectors. The formation of this advisory group played a key role in developing a final draft policy including guidelines for implementation. Foremost amongst their recommendations was that any policy should have clear and concise, easily understood guidelines to allow for pre-season and in-season management. Following a final round of public input on the draft policy, in October of 1999, the Minister of Fisheries and Oceans Canada announced the final "Allocation Framework for Pacific Salmon". The policy has majority support of the participating sectors and has been adopted as part of regional operational policy since its inception. The extent and degree of this cross- sectoral support is unique in Canada, if not North America, in that the policy allocates first priority to some stocks of salmon to the recreational sector and a minimum percentage of other stocks to the same sector.

It is the finding of the Department that while the task was never easy, the development of an allocation policy in Canada was successful for a number of reasons; not the least of which were that we had careful planning, committed participants and respected guidance, developed in an atmosphere of mutual respect. The fact that we had representative consultation by the sectors affected and improved the probability of success. Implementation of the policy is now entering its third season and has provided sufficient time to review results and to recommend adjustments towards improving its application.

Introduction

Few of those in fisheries management would disagree that when there are competing harvesting sectors, the management of any one species, or multiple species, becomes much more workable if there are a clear set of allocation rules or principles in place. Although this may seem obvious, in reality the management of many fisheries has evolved in the absence of clearly defined allocation policies. In periods of high abundance, the requirement for such a policy is less critical. However, with few exceptions, the growing demand by aboriginal, recreational, and commercial fisheries, coupled with the added complexity of periods of reduced abundance and total allowable catch, clear allocation rules become a requirement for rational fishery management, to say nothing of the sanity of the managers themselves.

Historically, in the British Columbia (B.C.) salmon fishery the primary competition was between different sectors of the commercial fishery, particularly seiners and gillnetters. With abundant salmon and a recreational fishery that was limited in terms of numbers of participants and in distribution, there was little real impact on the recreational sector's opportunity to harvest fish. Even with the major growth in the recreational fishery after World War II through to the peak years of the early 1980s, the recreational sector had little impact on the ability of the commercial sector to harvest their fish. This was largely due to the inefficiency of recreational fishing techniques and, to some extent, on the fishing limits imposed. Consequently inter-sectoral allocation of salmon was not an issue.

However, in B.C. in the late 1980s and early 1990s, poor marine survival of salmon due to oceanographic and environmental factors resulted in the need to establish stringent management measures to curtail the harvest of salmon, particularly chinook and coho. These are the two species most sought after by the

recreational sector and they also have comprised a significant component of the commercial troll catch. By the mid-1990s, Fisheries and Oceans Canada was faced with the challenge of managing fisheries on stocks that in many instances could not achieve escapement goals, let alone support traditional harvesting levels of the aboriginal, commercial and recreational sectors. Resource-use conflicts occurred fairly often and, in some cases, were quite rancorous. It became evident that a policy to clearly articulate the rules for sector allocation needed to be developed.

Former Fisheries and Oceans Deputy Minister, Arthur May, was commissioned to carry out a review of the existing policies and to provide recommendations on future policy development. His final report, delivered in late 1996, was not universally accepted by the harvesting sectors. However, the report did highlight and recognise the value of the recreational fishery, both in an economic sense and as an important social activity, and its unique management requirements. Further, Dr. May's report emphasised it was time for a change in the approach to managing salmon fisheries.

In 1997, Fisheries and Oceans Canada tasked retired Supreme Court Judge, Samuel Toy, to use Dr. May's report as a foundation for consultations with the aboriginal, commercial and recreational communities to draft an implementation process that would lead to the development of an allocation policy. As a first step, Mr. Toy established an advisory council comprised of representatives from the aboriginal, commercial and recreational sectors.

As in any negotiation process, it is extremely important to ensure the negotiators are empowered to represent their sector. In most jurisdictions, the recreational fishing sector is a highly diverse, largely unorganised and, dare I say, 'fractured' group. In British Columbia, we arguably have one of the most "organised" recreational fishing communities in the world. Since 1964 the recreational community has, for the most part, been able to speak with a unified voice on the majority of issues of concern to that sector. This unified sector representation came about in 1964 at the request of the Minister of Fisheries and Oceans, who was instrumental in establishing the Sports Fishing Advisory Board. This board, composed primarily of representatives of provincial recreational fishing organisations, was and continues to be the recognised advisory body on Pacific coast recreational fishing for the department. It is a community-based process, with local committees established in most of the coastal communities in British Columbia that have significant salmon interests. This results in the recreational fishing community being able to deliver a cohesive position on virtually any fishery management issue or policy proposal.

Commercial salmon fishers, in contrast, are organised into several sectors but have no over-arching advisory body. And yet the representatives of the various commercial sectors certainly worked together in this process.

A significant initial challenge for the advisory bodies in the late 1990s was to consider the designation of "priority" of chinook and coho to the recreational sector, recognising that these species represented the foundation of the recreational fishery. Cognizant that conservation requirements simply could not allow for all sectors to target all salmon species at the same time, and since the sport fishery did not require large numbers of fish to be sustained, it was suggested by the recreational sector that chinook and coho be designated 'sport species'. The commercial sector could not accept an outright designation. A counter-proposal was developed that suggested that if there was a need for a reduction in the harvest rates of chinook and coho, the recreational fishery would be "last on the water", meaning that they would be given priority of access. This approach satisfied the general needs of the recreational community and was agreed to by the commercial community. The other key factor was that the recreational community was prepared to recognise the validity of the commercial sector and make some concessions to allow that fishery to operate on stocks of abundance while limiting the by-catch of chinook and coho.

Out of these discussions came an unprecedented working relationship between the recreational and commercial sectors, and ultimately a suite of recommendations that the majority of both sectors could adopt.

Following Mr. Toy's report, in October 1998 Fisheries and Oceans Canada released a policy paper outlining a New Direction for Canada's Pacific Salmon Fishery. This was closely followed in December 1998 with the draft allocation framework for Pacific Salmon, which was distributed for public review and input. In October 1999, Fisheries and Oceans Canada announced the finalisation of an Allocation Policy for Pacific Salmon. The policy was a first attempt at addressing the allocation issue and at recognising the importance of the recreational fishery. With this policy, a totally new direction for salmon management in British Columbia was established.

The working relationship between the commercial and recreational sectors which Mr. Toy had established was not lost, and the majority of recommendations put forward by both groups reflect the policy that is in place today.

It should also be noted that throughout this same period, the Canadian government embarked on a "rationalisation" of the commercial salmon fleet, the end

result of which has been a reduction of the fleet by approximately 50%. This "rationalisation", or reduction in the fleet, featured a voluntary "buy back" of licenses by the federal government.

I have outlined the development of a policy which has and will have a profound impact on the future of all salmon fisheries in British Columbia for the 21st century and beyond. It establishes some basic principles that help to provide certainty to all salmon fisheries, and in particular recognises the unique characteristics of our recreational fishery, thereby ensuring a strong and viable fishery. Perhaps of greatest importance, the policy provides a basis for the recreational fishery to develop stability and growth. It does this by providing a surety of supply as much as possible, recognising the vagaries of managing natural resources. It also recognises the unique characteristics of the recreational fishery, that is, it can be very closely regulated, it depends on chinook and coho more than any other species, and it is not merely an adjunct of the commercial fishery.

Beyond the general overview of the development of the policy, I would like to touch on the seven principles that make up the policy. They are as follows.

Principle 1. Conservation of Pacific salmon stocks is the primary objective and will take precedence in managing the resource – conservation will not be compromised to achieve salmon allocation targets.

Principle 2. After conservation needs are met, First Nations' food, social and ceremonial requirements as a constitutional right and treaty obligation to First Nations have first priority in salmon allocations.

Principle 3. Salmon is a common property resource that is managed by the federal government on behalf of all Canadians, both present and future.

Principle 4. After conservation needs are met, and priority access for First Nations as set out in Principle 2 is addressed, recreational anglers will be provided:

- Priority to directed fisheries on chinook and coho salmon; and,
- Predictable and stable fishing opportunities for sockeye, pink and chum salmon.

Principle 5. After conservation needs are met, and priority access for First Nations as set out in principle 2 is addressed:

- The commercial sector will be allocated at least 95 per cent of the combined commercial and recreational harvest of sockeye, pink and chum salmon; and,
- The commercial harvest of chinook and coho will occur when abundance permits.

Principle 6. To encourage selective fishing:

- A portion of the total available commercial catch will be set aside for existing commercial licence holders to test alternative, more selective harvesting gear and technology; and,
- Over time, commercial allocations will favour those that can demonstrate their ability to fish selectively.

Principle 7. Target allocations for the commercial sector will be:

- Established on a coast-wide basis by gear, with the catch of all species expressed on a sockeye equivalent basis; and,
- Subject to adjustments over time to account for conservation needs, including selective fishing and possible changes resulting from the Voluntary Salmon Licence Retirement Program.

Fully recognising that all of the elements depend on principles number one and two, I would like to discuss principle four in some details it speaks to the "heart" of the recreational fishery, and was a key point in the policy development process.

Application of the policy

A minimum daily limit for salmon was established for the recreational sector as a basis for management of the fishery. For chinook salmon, the standard for the recreational fishery in the tidal waters is currently two chinook per day. In British Columbia, the possession limit (the number of salmon a person may possess while away from their principal residence) is two times the daily limit. For non-tidal waters (river fisheries), the standard is one chinook per day.

A similar management scenario is in place for coho salmon, except that the default limits are four per day in tidal waters and two per day in non-tidal or freshwater.

Using chinook salmon as an example, prior to the fishing season Fisheries and Oceans Canada establishes stock abundance. From that estimate, escapement is subtracted as well as the anticipated First Nations' constitutional food, social and ceremonial allocation. From the resulting balance, it is then calculated what the recreational harvest will be, given the specific daily limit and estimated effort. Calculations of any mortalities, as well as the harvest of chinook or coho that will occur as "by-catch" in commercial fisheries,

are also taken into account. Any harvestable chinook or coho remaining after each of these allocations is then available for "directed" commercial harvest.

If, at any time, due to a scarcity of chinook or coho salmon, recreational limits are reduced below the standard limits, there can be no directed commercial fishery for these species.

At the same time, the recreational community recognised that there needed to be some minimum allocation for the commercial sector that could be taken as by-catch in the prosecution of their fisheries that target sockeye, pink and chum salmon.

If there is a harvestable surplus over and above the recreational allocation, then the by-catch will come out of the commercial allocation. This is a key point because although priority is given to the recreational sector for chinook and coho, it recognises that a limited by-catch must be available to the commercial fishery. A by-catch incidentally which is limited by restrictions on gear and a requirement to release as much non-targeted species as possible.

Where there is no surplus available for directed commercial harvest, the by-catch comes out of the recreational allocation. Any such by-catch however must, under such circumstances, be the result of "incidental" mortality. Any salmon commercial fishery must be designed as "non-retention" of chinook and coho fisheries in an effort to minimise encounters.

For the harvest of sockeye, pink and chum salmon, the recreational sector was given an allocation of up to 5% of the coast-wide allowable catch. Given the historic catch of these species for the recreational sector has been 1% or less, such an allocation ensures a viable opportunity for the angling community and opportunity for growth in the foreseeable future. At the same time with 95% of the allowable catch of these species, the commercial sector had a surety of supply for the future.

It is noteworthy that the management regime reflecting the allocation policy has operated under these basic principles for the past three years with minimal problems.

During the development of this policy, the most important factor in the evolution of the history of fisheries management in British Columbia, is the fact that the vast majority of the commercial sector and recreational sector participants were supportive and endorse the proposal.

In summary, the following points played a major role in the development of this policy.

1. All sectors recognised the need for change.
2. In British Columbia, fishing sectors are well organised; in particular, the recreational community is able to speak with one voice on policy issues, greatly facilitating the consultation process.
3. Information on the value of commercial and recreational fisheries was well documented.
4. There was recognition of the needs of the aboriginal, commercial and recreational fisheries by the participants.
5. There was political will to effect change and recognise the growing importance of the recreational fishery.
6. The government recognised the need to deal with fleet over-capacity and over-capitalisation in the commercial sector.

Finally, in my view, the most fundamental factor was the Minister of Fisheries and Oceans who provided support to the Pacific coast to effect change through policy innovation. The point to be decided was - would it be the agency who set the policy, or were the sectors prepared to sit down and work collectively towards a mutually supported policy? As I have reported, the result was the latter.

One of my predecessors was once quoted as saying, "an allocation policy will reduce the stress on managers". I'm not sure I'd go that far. Challenging and difficult, particularly in today's world, and yet in all fairness, rewarding? Yes. In my experience, the development of the policy is a fundamental component in managing today's complex fisheries. Creating a balance between the conservation of the resource and fishing opportunities for First Nations, the commercial sector in addition to the angling community is a challenge that British Columbia continues to work on. Using the salmon allocation policy as a guide, achieving a balance is now a little bit easier.

AUSTRALIANS' RIGHT TO FISH: ACCEPTED COMMUNITY EXPECTATION OR HARD-FOUGHT PRIVILEGE? THE POTENTIAL FOR WORLD LEADERSHIP

Graham Pike

Recfish Australia, PO Box 300, Calwell, ACT 2905, Australia

Abstract

Australians have always regarded their right to fish in the sea as free and accessible as their drinking water. Increasingly, however, drinking water is the subject of usage charges by local authorities and at times its supply is subject to restriction or rationing. Recreational and sport fishers face the same prospect with their fishing.

For the first time, Australians' right to fish is seriously and imminently under challenge. The threats are from a variety of sources including, for example, international pressure to include and limit recreational catches in commercial fisheries; fishing rights and resources allocated to the commercial and indigenous fishing sectors; legislative requirements; environmental, water quality and habitat degradation (particularly from terrestrial land use), and competition for marine resources by other users. The potential for social conflict and disruption on the issue is high; physical violence has already been threatened at a public meeting and there have been demands for the dismissal of a Federal Fisheries Minister. The Year 2002 will determine the future of recreational fishing rights in Australia. The results of the National Recreational Fishing Survey will focus attention on the sector, as will the World Recreational Fishing Conference, just at the same time as the Federal Government has to decide whether or not it will include recreational sector allocation and management arrangements in fisheries management plans. With new Western Pacific tuna management arrangements and continuing intergovernment tension on Southern bluefin tuna, there will also be an international expectation that Australia will properly and formally accommodates the rights of its marine recreational fishers. The tantalising prospect is that unlike any other developed nation, Australia has the opportunity to lead the world and get it right on rights.

Introduction

Australians have always regarded their right to fish as being as free and accessible as their drinking water. This may have stemmed from the fact that together with our cousins in New Zealand, we recreational fishers actually owned and managed some of the fish resources, importing them specifically for sport and recreation from the northern hemisphere in the 1800s and managing them through acclimatisation societies for more than a century until the 1980s in Australia and 1990s in New Zealand (McDowall, 1994).

In recent years, however, just as governments have increasingly taken over management of our fish resources, drinking water has been the subject of increasing usage charges by local authorities and also at times now, its supply is subject to restriction or rationing. Recreational and sport fishers have been facing the same prospect with their fishing.

Australians' right to fish and their access to fish resources has in the past 20 years or so been increasingly challenged, mainly in seas and estuaries but also to varying degrees and from a number of sources, in inland waterways.

My thesis is that, until these threats are dissipated by giving the recreational fishing sector fair and equitable resource allocations and security of access to fishing opportunities in fisheries whose species are shared with the commercial and indigenous fishing sectors, ecological sustainability of Australia's natural resources on which fishing depends is unachievable – and therefore, the future of fishing is limited.

In other words, rights-based and ecosystem-based fisheries management, to which we are increasingly moving, is impossible unless the rights of all extractive user groups and their impacts on managed fisheries are taken into account. Fisheries cannot be properly and effectively managed in the case of shared fisheries when fisheries management plans, for example, do not provide for access and allocation for the recreational sector.

The definition of rights-based management is the sum of all these following factors: "the right for stakeholders to be recognised in the management planning decision making process, the right of formal conflict resolution processes, the right of fishers to negotiate, the right for compensation for impacts of exclusion, and the right for all aquatic sectors to be involved" (Taylor-Moore, 2000).

I contend, therefore, that rights-based fisheries management cannot exist without the granting of these basic rights to the recreational fishing sector.

Moreover, the benefits of wider and more intense stewardship of fisheries resources by recreational and sport fishers, which would come as a bonus with formal recognition of recreational sector resource access and allocation rights, will go unrealised the longer we delay fully introducing them.

But the outlook is very positive. While the past 20 years have been a constant struggle at State/Territory and Federal government levels for recreational fishing rights, the evidence, some of it as late as this week, is that we are well on the way to achieving initial and fundamental rights. The tantalisingly imminent prospect is that unlike any other developed nation, Australia now has the opportunity to lead the world and get it right on recreational fishing rights.

You may ask 'why?' I proffer four reasons. First, because we can. By and large, compared with the bulk of other developed nations, our fisheries resources are relatively intact; we have something worthwhile left to protect and nurture and our recreational fishers are demanding that we do so.

Second, Australian recreational fishers are in the position, unique in the world, of having a robust and united single peak national representative organisation, Recfish Australia. Recfish is in its 19th year and continuing to drive this fishing rights issue hard on behalf of its millions of constituents.

Third, since 2000 there has been a national legislative imperative – the Environment Protection and Biodiversity Conservation Act (EPBC Act), the powerful, catch-all legislation to secure Australia's future ecological sustainability, including, of course, the sustainability of its fish resources.

Fourth and finally, Recfish Australia has received Federal Government funding (from the Fisheries Research and Development Corporation and the Federal Department of Agriculture, Fisheries and Forestry) for Recfish to conduct a national fishing rights Workshop later this year. The Workshop will develop, together with the commercial and indigenous fishing sectors and fisheries managers, principles and an action plan for rights-based management for all fishing sectors and for recreational fishing's involvement in shared Commonwealth fisheries.

The recent moves towards recreational fishing rights in Australia have been stimulated mainly by the fact that the other two fishing sectors have already been granted formal, legislatively based rights. In the case of the commercial sector, the Federal Government, through its Australian Fisheries Management Authority (AFMA), takes the right to fish for publicly owned or common property fish resources in Federal or Commonwealth fisheries and hands them over to commercial fishing operators. These rights are in the form of a tradeable private property called Statutory Fishing Rights (SFRs). There are also quotas of allowable catch allocated to commercial fishers but not currently to recreational fishers in Commonwealth fisheries.

As Western Australia's recreational fishers recently stated in a submission to AFMA, "… any allocation of a fishing right to the commercial sector effectively diminishes the common property access right of the recreational sector. If the fishery were to remain under input control management this would still present the problem in that the recreational sector's available share of the catch is continually being eroded by commercial effort." (WA Game Fishing Association, 2002).

Rights are also clearly defined for the indigenous fishing sector in that Commonwealth native title legislation and court decisions determine them.

At the State/Territory level, as opposed to the Federal level, the introduction of an all-waters recreational fishing licences in Victoria and New South Wales in the past three years has clearly advanced the moves to recreational rights in those States, particularly in NSW, as I'll discuss shortly.

But back to the Federal scene. As late as the end of April this year, the Australian Fisheries Management Authority (AFMA) moved to exclude recreational fishing from coverage under its first statutory management plan for perhaps the most important fishery in Australia – the Eastern Tuna and Billfish Fishery. This fishery encompasses all the east coast tuna and billfish in the Australian Fishing Zone from the tip of the Cape York Peninsula to the South Australian and Victorian border, including Tasmania.

The same AFMA draft management plan also grants fishing rights for the East Coast fish stocks exclusively to the commercial fishing sector as privately tradeable Statutory Fishing Rights. The recreational sector would not get any allocation or other rights even though historically, recreational and sport fishers have always had access to the fish resources in the Commonwealth waters of the Australian East Coast.

These moves by AFMA were in defiance of recommendations to the contrary from AFMA's own Management Advisory Committee and significantly, a desire expressed to AFMA by the commercial longliners to have recreational fishing included in the management plan. In fact, I think it is recognition of the importance and necessity of managing for the sustainability of shared fisheries that in recent years the Australian Seafood Industry Council – Recfish Australia's commercial counterpart – has been concerned to work

with Recfish on encouraging the inclusion of the recreational sector in management regimes.

But most astoundingly, AFMA's moves to exclude recreational fishing from the first management plan for the Commonwealth fishery of Australia's East Coast were in defiance of Federal Government policy.

In the lead up to last November's Federal election, Recfish Australia was instrumental in formulating a policy on recreational fishing. That policy is now the policy of the new Federal Government. The policy states in part: "*...recreational fishing must be an integral part of Commonwealth fisheries management and must be provided with rights and responsibilities ... Rights include negotiated access to quotas of highly migratory pelagic species, such as tuna and billfish. Responsibilities will encompass adherence to observing quota and/or effort controls applied across the board*" (Liberal Party, 2001).

In a news release on 30 April, Recfish Australia alerted Australians to the exclusion of recreational fishing from the first ETBF management plan, which gave fishing rights exclusively to the commercial sector. This would mean that the recreational fishing sector would still not legally be a rights holder in the fishery.

We've already seen recently in Australia, the type of destructive and counter-productive consequences that could reoccur again if recreational fishing were excluded from the East Coast fishery management plan; In September 2001, a public meeting in Tasmania between the then Federal Minister for Fisheries and the stakeholders from the three fishing sectors turned outright ugly when the Minister threatened to ban the recreational take of Southern Bluefin Tuna (SBT). (There is also no provision at all in AFMA's SBT Management Plan, now more than a decade old, for recreational take or for any other type of recreational allocation, access or other rights. That exclusion is, of course, why the Minister could probably have enforced his suggested ban on the recreational take of SBT.) The Minister's threat resulted in an out-of-control meeting in which the opportunity for any constructive resolution of the issues disappeared and at least one participant was invited by the Minister to sort it out physically in the street outside. There also followed, I understand, a number of letters to the Prime Minister seeking the Minister's dismissal. Since the election, he is no longer the Fisheries Minister. I relate these events as another illustration, if any were needed, of the importance of having recreational fishing rights included in the statutory management plan for our Commonwealth East Coast fishery and for all future management plans in which fishery resources are shared with one or both of the other sectors.

As a result of continued Recfish Australia representations to AFMA and other Federal Government entities. I can predict with a considerable degree of confidence that the next draft of AFMA's East Coast fishery management plan will include formal recognition of the recreational sector as a legitimate player in the fishery together with the commercial sector.

An integral part of the formal recognition of the recreational fishing sector in the management plan itself will be provision for a quantifiable allocation of fish resources to the recreational sector. There will also need to be processes and mechanisms established to enable the States, working jointly with the Commonwealth, to apply the management arrangements in their respective jurisdictions.

We expect that there will also have to be a defined process and mechanism for continuing recreational sector involvement in the Commonwealth's management of the East Coast fishery, particularly in relation to any future allocation reviews and reallocations.

During the current debate, questions have been raised about how the recreational sector could possibly pay for its initial allocation of fish resources in such a high value commercial fishery. The answer is, of course, that we have to receive the allocation in the same way that the commercial sector received its share – it was given by the government.

The return to the community will be manifold. It will include the undisputed economic and social benefits which accrue from recreational and sport fishing. It will also include recreational fishing's stewardship of the resource on behalf of the community through the recreational sector's interest in seeing the resource conserved and the sector's increased participation as a partner in ecosystem-based fisheries management.

The introduction of recreational fishing rights and associated resource allocation is advancing well at the State/Territory government level, particularly in New South Wales. Nearly three years ago in Victoria and last year in NSW, all-waters recreational fishing licence fees were introduced with legislation requiring the fees to be invested directly back into recreational fisheries improvement and management.

Recognising the socioeconomic and fishing tourism benefits of recreational fishing, particularly in marginal commercial fisheries, plus most importantly, the fact that recreational fishing is far less damaging than commercial fishing to estuarine and inshore fish stocks and ecosystems, the NSW Government has moved very quickly to apply the proceeds of the recreational fishing licences. From 1 May this year, 29 of the State's most significant estuaries and bays were protected from commercial fishing.

These areas, now called Recreational Fishing Havens, will mean that 27% of the State's estuarine waters will be substantially free of commercial fishing, an increase

from the 3% before the introduction of the licence. The purpose of these havens is to improve recreational fishing by banning commercial fishing in key areas of significance to recreational fishers. Commercial fishers formerly licensed for the areas were treated fairly through a buy-back process where commercial fishing entitlements were surrendered for fair compensation.

As the quality of recreational fishing in these fishing havens rapidly improves in the next two to three years (as it did when the Northern Territory Government took commercial fishing out of a number of barra-mundi waters in the Top End). I'm sure we'll see other States and Territories introducing all-waters licences. Of course, recreational fishers must ensure that every last dollar from such licences is legislated for investment back into the betterment of recreational fishing.

As I've alluded earlier, the recreational sector considers property rights, tradeable and otherwise, as only one wavelength on a much wider fishing rights spectrum. That spectrum includes access to healthy, high quality resources and brings me to the consideration of recreational fishing rights in Australia's inland waters.

It is here that the battle is only just beginning, although there have been some major advances in the past 19 months. Most of Australia's major temperate river systems are in crisis as a result of more than a century of over exploitation and environmental degradation. Irrigation and hydro-electric dams have drastically altered natural flow regimes and irrigation of agricultural crops (such as rice and cotton – which many believe are ecologically unsustainable in Australia) has over-used available waters and deprived streams and their plant and animal communities of environmental flows.

Even the great Australian native fish icon and angling species, the Murray Cod, is threatened and will probably be listed as such under the EPBC Act.

The Federal and State Governments have in the past 19 months committed well over a billion dollars to try to slow and then halt the degradation, to return environmental flows to at least the Snowy and Murray Rivers to rationalise water usage and make water savings. And it's here that recreational fishing faces perhaps its biggest challenge yet on rights.

The recreational fishing sector must engage governments, agribusiness and irrigators to ensure that we regain, in perpetuity, sufficient volumes of water in our drainage basins to support healthy populations of fish and other aquatic resources and that the ecological integrity of waterways are protected in future. These, surely, are the basic rights of recreational fishers as stewards for the fish and waters of inland Australia. The engagement has begun with the release for public comment of a native fish recovery management strategy for the Murray-Darling Basin. The recreational fishing sector must capitalise and build on that.

Finally and in summary, not too long ago most Australians would have derided you if you'd predicted that one day governments would be taking the commercial fishing industry out of marine fisheries in order to make those fisheries exclusively recreational. But it's happened and provided we continue with the energy and responsible strategies demonstrated to date, we will realise our goals and win our rights in inland waters too.

I am not suggesting that Australia will or should end up like the US State of Florida, which I understand no longer has any commercial fishing, its waters dedicated instead to recreational fishing. What I think we will see in Australia, perhaps in my time, certainly in my son's life, is exclusive recreational fishing rights increasingly established in estuaries and inshore waters, as aquaculture replaces the wild-catch commercial fisheries and the wild-catch commercial fishing sector is concentrated on high seas fisheries.

On Australian inland waters, however, I do foresee exclusive recreational fishing rights such as those in Florida. Some Australian States have already moved or are moving to abolish commercial fishing in our stressed and degraded inland waters as aquaculture increasingly supplies fish for the markets. The problem in inland waters will not then be commercial pressure on the fish resources, but actually achieving sufficient flows of clean water in streams which still have the ecological integrity essential to sustain those resources.

This scenario for our inland waterways is surely an accepted community expectation but its achievement will need to continue to be hard-fought by those of us in the recreational fishing sector.

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RECENT RECREATIONAL FISHERIES MANAGEMENT IN AUSTRALIA

Frank B. Prokop

Recfishwest, PO Box 57, Claremont, WA 6010, Australia

Abstract

Dedicated recreational fisheries management has a relatively recent history in Australia. While there has been recreational fisheries management particularly in fresh water over a considerable period, marine recreational fisheries management was largely implemented on an ad hoc basis.

In 1940 in Western Australia it was written by the Chief Secretary "the provision of fish food is considered to be of very much greater importance from the point of view of the population as a whole than the sporting side of fishing, and consequently the professional fisherman must, and always will, receive greater consideration than the angler."

In 1988, Western Australia commenced a two year review of recreational fisheries and in 1989 NSW appointed the first full-time dedicated recreational fisheries manager in Australia.

Since that time, there has been a revolution in community attitudes which has sometimes been driven by management and has sometimes driven management. Recreational fishing has gone from a situation where all bag limits were seen as an infringement of individual freedoms to the introduction of saltwater angling licenses and recreational anglers lobbying for seasonal fishing closures to protect stocks.

The critical steps in recent recreational fisheries management in Australia will be examined as a case study and possible future scenarios will be explored.

Introduction

Fisheries management in Australia has a long and relatively successful history. In spite of its dry nature, relatively infertile waters and a generally narrow continental shelf, Australia has a number of sustainable commercial and recreational fisheries.

From its earliest days, the close association with the sea has become an integral part of the Australian culture. Commercial fisheries were considered the most important under the 'inexhaustible sea' concept and fishing was viewed as part of the primary production export philosophy of this country.

Recreational fishing was viewed as ubiquitous and not worthy of attention. Recreational fishing impacts and benefits were historically ignored. The 1940 sentiment in Western Australia prevailed that "the provision of fish food is considered to be of very much greater importance from the point of view of the population as a whole than the sporting side of fishing, and consequently the professional fisherman must, and always will, receive greater consideration than the angler."

As recently as the 1970s in NSW, additional commercial fishing licences were being issued as it was felt that if the fishing was not viable, that the licensee would turn to other, more profitable activities. The fact that fishers tend to fish harder when times are tough has helped to over-exploit some vulnerable fish stocks, particularly if the recreational catches were not taken into consideration. Ironically, those states that most vigorously pursued limited entry fisheries from the earliest times, in spite of the policies of economic rationalism and National Competition Policy, are in the best position to sustainably manage the resource on behalf of the community.

The view that recreational fishers were loud, ignorant and unworthy of consideration began to change in the 1980s with the advent of improved recreational fishing organisation and an increasing awareness of the political influence of a user group comprising around one-third of the adult population. This recognition, by government at least was grudging and the traditional 'port meeting' forms of communication were totally unsuitable for such a large and diverse group.

Recreational fisheries management

With the exception of trout fisheries management, recreational fisheries management until the end of the 1980s was driven largely by the need for effective

compliance or to reduce the impact of recreational fishers on existing commercial fishing activities.

Trout management was sophisticated but was also typified as reactive to the political pressure of individuals or groups such as the Acclimatisation Societies. There was little or no strategic approach to recreational fisheries management.

In 1962, and apparently without consultation, the Chief Secretary in NSW announced the removal of size limits and a closed season for a wide range of Murray-Darling native species, several of which are now endangered. He said " It is not necessary under normal conditions, or is it practicable to protect all fish until they reach maturity." It took until 1992 to reintroduce many of the same regulations.

In 1988, Western Australia commenced a two year review of recreational fisheries management under the then Minister for Fisheries, Gordon Hill. In October 1989, NSW appointed a full-time recreational fisheries manager. Recreational fisheries as a specific activity in Australia had finally arrived.

And with its arrival came rapid change. Within three years marine fin fish bag limits had increased 16 fold in NSW, six times in Queensland and more than doubled in Western Australia as the recommendations of the two year review began to bite. In the period 1995 to 2002, major reviews of recreational fisheries management had also been implemented in South Australia, Tasmania and Victoria. The Northern Territory also introduced a catch-all possession limit.

Commercial fisheries management moved at a more sedate pace. Table 1 demonstrates that bag limit reforms were dramatic for recreational fisheries but size limit modifications were less dramatic. While many size limits had been put in place for commercial fisheries management for many years, only South Australia appears to have reviewed size limits on a strategic basis since 1990.

Indeed, many managers and scientists began to discover that the previously unquantified recreational catches were causing great problems for the sustainability of fish stocks. The solution in many of these cases was to attempt to control the 'unfettered recreational fishing effort' and to apportion total blame for over-exploitation at the feet of the recreational fishing sector.

A wide variety of recreational fisheries management tools have been applied in Australia with varying degrees of success. These have included the standard bag and size limits, maximum size limits, slot limits and total protection. Possession limits and prohibitions on filleting at sea have also been introduced to allow effective enforcement and a reduction in the overall catches.

More advanced management such as closed seasons, closed areas, gear restrictions and other forms of temporal and spatial management are now being used to a far greater degree.

It is only since 2000 that a serious attempt has been made to establish social and economic parameters for the allocation of the community resource to the commercial fishing industry to the detriment of recreational fishers.

Equity, history and recreational fisheries management

Many of the early bag limits were introduced at a level that was politically acceptable to a group which felt that they had a right to take large quantities of fish. Many anglers felt that they needed to make up for the many unsuccessful trips with large catches when they were available. It is less than 15 years ago that Queensland recreational anglers were allowed to sell their catch.

The renowned author Vic McCristal wrote during the early years of bag limit management that he would rather take the social bag limits of today than the biological bag limits that would become necessary in the future. Gradually bag limits and other forms of management came to be seen as having a role in fisheries management. In the early years, the government was dragging the community forward, sometimes in an autocratic manner, to accept that recreational fishers needed management consideration.

Within 10 years, community attitudes had changed to such an extent that the cumbersome consultative processes and involvement of scientists, compliance officers, managers, legal advisers and other users had become so unwieldy that the community was becoming frustrated with the bureaucracy. In Western Australia, a review that closed submissions in August 1999 has yet to have any recommendations implemented as of May 2002.

Table 1. Changes (%) in size limits and bag limits for marine fish by State and Territory from 1990 to 2002

	Period	WA	SA	Vic	NSW	Qld	NT	Tas
Size limits	1990 – 1993	– 16	17	16	14	19	50	25
	1995 – 2002	9	56	5	19	2	0	80
Bag limits	1990 – 1993	124	0	50	1 600	625	200	33
	1995 – 2002	8	222	950	48	26	50	1 500

Recreational fishers are leading the charge on new management, including closed seasons to protect spawning aggregations. Ironically the major opposition seems to be coming from researchers, concerned that the implementation of management without research could have implications for future funding.

Many agencies are slaves to their history. The most difficult management to implement is that which challenges a traditional or historical practice. For example, although it is not consistent with recreational fishing philosophies, recreational gill netting is still permitted in all areas, except inland Victoria where it has been traditionally allowed. NSW has been unable to ban set lines in inland rivers even though it is opposed by the vast majority of anglers and compressed air spearfishing continues to be allowed in jurisdictions where it was not banned when it first appeared. Even trout stocking into 'traditional' waters that provide little return continues.

In all cases, a small but vocal group will expend almost limitless energy to protect their own practice. In most cases there is significant intergenerational change and younger anglers are lobbying just as hard for the abolition of these practices. A former Minister for Fisheries in Western Australia, Monty House said that those opposed to netting will be voting for a lot longer than those who support it, so netting has a very limited future.

But the single biggest impediment to increasing recreational fisheries management controls is the lack of equity in natural resource management. Many of the government agencies have developed a close working relationship with the commercial sector which provides them with data in a form that has been long accepted in making management decisions. Dealing with a smaller sector that has fishing as a full time profession means that is possible to get all participants together, and usually during work hours. Recreational fishers, by virtue of their size, can never fully agree and a small percentage (but a large number) will write letters objecting to any proposal.

As with the challenging of traditional fishing practices with recreational fisheries, government fisheries agencies have traditionally been commercial fisheries managers. They find it uncomfortable to penalise those that they have built up a long and often successful relationship with to benefit a largely unappreciative recreational fishing sector. This will change as the old guard of fisheries managers retire and younger, more open managers take their places.

There is a need for flexibility in dealing with the increasingly difficult problems of resource sharing. In Western Australia, while the rock lobster industry is worth around A$250 million, the recreational sector takes only around 5% of the catch. Ironically, the recreational sector pays more per kilogram to government than the commercial sector does. In spite of this, there are strong pushes from the commercial fishing industry and with some support from fisheries to further limit the recreational share of the catch. The recreational sector only has a small representation in decisions on this stock, approximately in line with its catch share.

Recreational fisheries are worth an estimated A$650 million in Western Australia of which around 75% would be for fin fish species (close to A$500 million). Fishing for fin fish by the commercial sector is worth around A$15 million or around 3%. Even with full multipliers and flow-ons, the commercial fishing contribution is only a very small fraction of the recreational economic activity. The recreational sector is frequently unrepresented or only offered token representation on committees making resource management recommendations for these stocks.

The key is to recognise that the maximum community return for fin fish clearly lies with the recreational sector and ensure that the needs of recreational fishers are given appropriate consideration. As fisheries move towards integrated management, the revolution in recreational fishing attitudinal changes will allow more innovative and adaptive forms of management, but if, and only if the equity questions are satisfactorily resolved.

In many cases, temporal and spatial management will mean that few real changes to commercial fishing will result, but the community return can be optimised. The commercial industry insistence on compensation for a share of the resource that was, in the opinion of the community, inappropriately allocated to them in the first place is unhelpful and frequently mischievous.

The future for recreational fisheries management will provide many additional challenges. Once the legitimacy of recreational fishing is recognised, it will be up to the industry leaders to act responsibly and ensure that the recreational sector acts as professionally as we have demanded to be treated.

If the revolution in community attitudes continues at anything like the current rate, then quality recreational fishing will be assured into the future.

MANAGEMENT OF RECREATIONAL FISHERIES IN DENMARK

Gorm Rasmussen, Peter Geertz-Hansen and Niels Jepsen

Danish Institute for Fisheries Research, Deptartment of Inland Fisheries, Vejlsoevej 39, DK 8600 Silkeborg, Denmark

Abstract

This paper provides an introduction to the recreational fisheries in Denmark and the management of the resources. Fishing is a popular leisure activity and there is a variety of options for high quality fishing in streams, rivers, lakes, 'put and take' ponds (P&T ponds), on the coast and offshore. As the streams have become significantly cleaner during the last decades, the management focus has moved from stocking hatchery fish to improving fish habitats and securing migration in the rivers. As the interest in recreational fishing has increased, several conflicts have emerged and management also includes reconciliation of conflicts between user groups.

The resource

Denmark (total area 43 000 km^2; total coastline 7 314 km; population 5.36 million; GNP 250 000 DKK (US$30 000) per inhabitant) is a moraine landscape formed during the last glacial period. The inland waters consist of about 30 000 km of streams of which about 4 000 km are fishable for salmonids and about 6 000 km for other fish species. We have 1 008 named lakes with a total area of about 45 000 ha. Additionally, there are about 300 P&T ponds with a total area of about 450 ha and many thousand unnamed ponds less than a few ha (Rasmussen and Geertz-Hansen, 2001). A highly developed infrastructure provides easy access to potential fishing areas in freshwater and along the coastline.

Nearly all streams and lakes are influenced by human activities. The nutrient content of the water is high, and thus, so is the plant production (algae and macrophytes). Many of the small lakes are highly eutrophic, with a fish fauna dominated by omnivorous species (cyprinids) and low in predators. Only 2% of the streams have never been physically regulated, whereas the vast majority have been regulated and channelled. Water diversions by weirs and dams at fish farms, old mills and small hydropower stations create great problems for the freshwater fauna and especially for the migratory fish species. During the past decade, restoration work in streams and rivers has been undertaken, many fish-ways have been established and very few streams remain highly polluted by waste water (polysaprobic). Neither are there many pure (oligosaprobic) streams left. Most of the streams are small and shallow with abundant macro-phyte growth, necessitating frequent weed clearance.

The most important target species in freshwater (i.e. lakes, rivers and P&T ponds) by recreational fishers are pike (*Esox lucius* L.), perch (*Perca fluviatilis* L.), pikeperch (*Stizostedion lucioperca* (L.)), eel (*Anguilla anguilla* (L.)), salmon (*Salmon salar* L.), trout (*Salmo trutta* L.), rainbow trout (*Oncorhynchus mykiss* (Walbaum)) and grayling (*Thymallus thymallus* (L.)) all of which are used for human consumption. Roach (*Rutilus rutilus* (L.)), bream (*Abramis brama* (L.)) and other cyprinids are fished for by coarse anglers and many foreign visitors come to Denmark and fish these species. The most important species for recreational fisheries in saltwater are trout, salmon, whitefish (*Coregonus laveretus* (L.)), eel, plaice (*Pleuronectes platessa* (L.)), flounder (*Platichthys flesus* (L.)), garfish (*Belone belone* (L.)) and Atlantic cod (*Gadus morhua* (L.)).

Overall, the sea-run trout (*Salmo trutta*) is the most popular species and it is fished for in streams, rivers, estuaries and directly from the coast. Most of our rivers and even very small streams hold good populations of trout and produce fair numbers of smolts. These migrate to the sea and return as spawners to their natal stream after one to four years. Very large fish are not rare and in some rivers sea-trout over 10 kg are regularly caught by anglers.

The users

In Denmark, there are two types of recreational fishing and distinction is important: Anglers fish in fresh and saltwater with rod and line. Recreational fishermen use long lines, gill- and fyke nets, alone or in

combination, in fresh and saltwater. It must be noted that many restrictions exist for the use of nets and long-lines in freshwater so by far the most of the recreational fishermen fish in the estuaries and along the coast.

In 2001, about 215 000 anglers paid a total revenue of 21.5 million DKK (US$2.58 million) and about 36 500 recreational fishermen paid a total revenue of 9.1 million DKK (US$1.1 million). In 1997 and 1999 questionnaires (Bohn and Roth, 1997; Toivonen, et al., 2000) showed that the number of native recreational fishermen and anglers (age group 18–69) in Denmark was about 450 000 and they spent about 5.5 million fishing days (mean 12.1 days) with 48% in saltwater, 16% in rivers, 19% in lakes and 17% in P&T ponds. The mean age was about 40 years and 79% were males and 21% females. The survey showed that the total annual fishing expenditures (i.e. license, transportation, lodging, information and food and drink but excluding long-lasting equipment like fishing gear and boats) were about 1 200 DKK per person amounting to a total of about 517 million DKK.

Around 47 000 anglers are organised in three associations and 4 250 recreational fishermen are organised in two associations (Roth, 1994). Therefore these associations represent only about 10% of the total number of people who go fishing.

Administration

The right to fish in streams and lakes belongs to the owner of the adjoining land. The fishing rights to nearly all streams are in private hands, but about 25% of the lakes are owned by the state. Half of the state lakes are accessible to recreational fisheries, very often through fishery associations. In coastal waters fishing and access is open to the public.

Since 1 January 1991, recreational fishermen aged 12–67 must pay an annual licence fee (250 DKK) to fish in inland and marine waters. The amount of fishing gear is restricted to six pieces of which only three can be gill nets. The gear must be marked for personal identification and gill nets must be at least 100 m from the coastline. Since 2000, all catch is only for private consumption and must not be sold.

Since 1 January 1993, anglers aged between 18 and 67 must pay a license (one day 25 DKK, one week 75 DKK and one year 100 DKK) to fish in inland and marine waters (except P&T ponds). In inland waters, anglers have to obtain additional permission or rent fishing rights from the landowner, either individually or through membership of a fishery association (anglers club). Such clubs are often responsible for the daily management of the fisheries in river(s) they administrate. They often agree upon local extensions of the national regulations as bag limits, minimum size of 40 cm for trout, extended closed season, closed areas and even a total ban on killing salmon.

The license revenue from anglers and recreational fishermen is used for stock enhancement which includes activities like habitat restoration, fish stocking and research projects, as well as for license-administration, control, and information activities (Rasmussen and Geertz-Hansen, 1998). The distribution of funds is planned by a central committee with representatives from ministerial authorities including fishery biologists, fisheries associations, landowners and The Danish Society for the Conservation of Nature. The committee has a running three-year plan of action, which has to be approved and signed by the Minister.

Besides the plan of action, the committee is responsible for regulation of gear types, minimum fish sizes, closed seasons and forming local advisory committees. The revenue from anglers also fund habitat restoration of rivers, stocking of salmonids and lake fish as well as related research activities. The revenue from recreational fishermen goes to stocking eel, flounder and turbot (*Psetta maxima* (L.)) and related research activities.

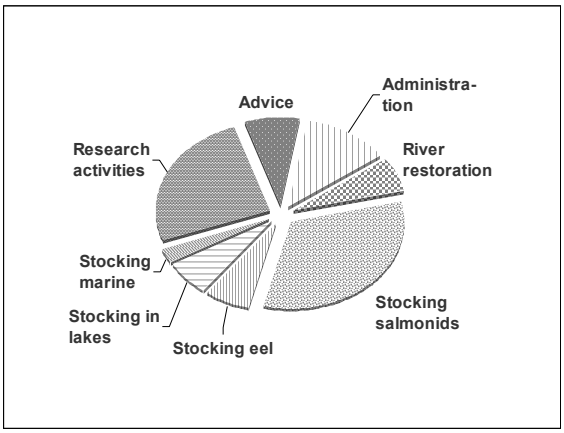

Figure 1. Distribution of licence fee into management activities in 2001.

Mitigation

Fish stocking in inland and marine waters requires permission from the relevant authorities (Rasmussen and Geertz-Hansen, 1998). The fish are stocked in numbers appropriate to the given habitat and in accordance with stocking plans. The plans are made in cooperation between the state and local anglers and cover the whole country. They dictate the number, size/age and stocking position for the individual fish species. Fish reared in commercial hatcheries or facilities run by fishermen associations are used. Fish are only released in areas where the species is already present but in low numbers or where it is now extinct.

The notion of carrying capacity and authenticity is the dominant guiding principle for all national stockings (Berg and Hansen, 1998). The fish used for stocking are offspring of either local wild-fish or national domesticated fish. From 2006, only offspring from local wild-fish must be stocked. In P&T ponds domesticated fish (mostly rainbow trout) are used.

Regulations and conflicts

There are conflicts (Møller and Petersen, 1998) between anglers, recreational and commercial fishermen in marine areas and these are negotiated in either the central committee or local committees. In order to protect migratory fish (i.e. salmonids) on spawning migrations and reduce gear-conflicts between anglers and recreational fishermen, gill nets must be placed at least 100 m from the coastline. Recreational fishermen consider this an unfair protection of anglers and in areas, where they claim there are few salmonids. Local committees are formed to discuss these matters. However, until now, no changes have been made and some illegal net-fishing takes place within the "100 m zone". Thus, the controlling authorities confiscate many illegally placed and unmarked gear. Checks of anglers reveal that 10-15% of anglers have not paid their license when fishing and these people are subsequently fined.

The current restrictions on the number of gear (i.e. a reduction from six to three gill nets) and the ban on selling fish from recreational fisheries is approved by anglers, but criticised by recreational fishermen organisations and raised in the central committee. Some illegal trade does indeed occur.

Anglers using trolling gear conflict with both recreational and commercial fishers because their tackle catches on standing gear and therefore trolling is not permitted in some areas.

Commercial fishermen have claimed that charter boats with sea anglers take a significant part of the official quotas, especially for cod, but no reliable statistics are available. Trolling for salmon and sea-run trout in some marine areas has become very profitable so the allowable number of rods has been reduced to two per person and four per boat.

Additionally to these conflicts between (fish) user-groups, we see an increasing number of conflicts between recreational fishing and other interest groups. Clearly the modern way of living has lead to increased pressure on natural living resources and there are conflicts between anglers and boaters, canoes, kayaks and birdwatchers. There are also conflicts between conservationist groups and recreational fisheries especially in regard to the protection of seals and cormorants.

The future

The future for recreational fishing in Denmark seems quite bright. Options for anglers fishing salmonids in particular, have greatly increased over the last decades due to improved water quality, river restorations, removal of migration obstacles and stocking. Also the decrease in commercial fisheries in the lakes means better fishing for anglers. Traditionally trout and salmon fishing in the rivers was the most popular, but now fishing for sea-run trout in the fjords and off the shores has become a national sport. Also increasing interest for coarse (and specimen) and P&T angling have helped divert fishing pressure away from rivers and streams. If the water quality in the lakes can be improved as in the rivers a large potential for anglers may be revealed. However, if angling pressure on the salmonid stocks increase, bag limits and no-kill rules will be necessary as regulating tools on a national level.

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AN INTEGRATED APPROACH TO SUSTAINABLE FISHERIES MANAGEMENT

Peter Rogers and Ian Curnow

Department of Fisheries, 168 St George's Terrace, Perth, WA 6000, Australia

Abstract

Over the past decade, fisheries management agencies throughout Australia have increasingly adopted, through legislation and practice, the principles of ecologically sustainable development (ESD). These principles include the requirement to consider, not only the sustainability of the target species, but also the impacts of fishing on the broader ecosystem, the social and economic issues associated with the fishery and the system of governance used to achieve these objectives.

A sectoral based approach to management has been used successfully in Western Australia (WA) to date and most stocks are in good condition by world standards. However the majority of fish stocks are now fully exploited and under increasing pressure from a growing population, coastal development and the demands of competing user groups. The current management approach is not able to effectively counter these pressures, nor meet the requirements of a wider ESD approach .

The WA Department of Fisheries intends to shift to a more integrated management framework, incorporating explicit allocations to each sector, to meet these challenges. The key to the success of this approach, is the development of an agreed framework, in which decisions on optimum resource use can be determined and implemented. There has to be an allocation and reallocation framework, whether by mediation or market forces, in order to maintain fisheries. Fishery managers will not be able to deal with this in isolation and nor will scientists. It will need to involve the community, so structures and processes must be put into place to enable them to reach consensus decisions, if not on a year-by-year basis then at least on a decade-by-decade basis.

To ensure accountability in the data and the indicators used, having the performance of agencies assessed is essential whether this is by the Federal Environment agency, or the State Auditor-General or Environment Department. The value of independent accreditation processes may be all-important in de-politicising the process and giving recognition to effective resource management.

The path to develop and gain widespread acceptance and agreement of a new framework will not be easy, however the alternative is declining fish stocks, increasing dissatisfaction among user groups and lost economic and social benefits.

Introduction

The purpose of this paper is to provide an outline of the direction in which management must head if we are to maintain sustainable fisheries in the future and an indication of the type of framework within which recreational fishing, and indeed all sectors, must be managed.

By means of introduction I want to briefly reflect on where fisheries management has been and where we are at present. Over the last decade or so, there has clearly been substantial debate about the effectiveness of fisheries management. World fisheries at large appear to be failing and the real challenge is not only in the management of large fisheries, but also that of the many smaller fisheries, particularly at the national level.

As an explicit example, I was at a conference recently discussing the question of the management of billfish and tuna around the world. One can only form the opinion after the conference, that the world has failed. If you take the Atlantic as the showcase for tuna management, that too has failed in terms of the responsibility in catch, maintenance and delivery of effective management. Virtually every tuna and billfish stock in that part of the world is overexploited, collapsing, or in major decline. So, there is a real challenge in terms of what we must do. The American Environment Agencies and non-Government Organisations (NGOs), because of their concern over the way fisheries are managed, have in fact used environment legislation to close a significant part of the Hawaiian tuna industry. So if we use that as a backdrop, we really have to meet the challenges of dealing with the future in terms of Environment Reporting, otherwise the rest of the community, will increasingly seek to use environmental legislation, such as the Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth of Australia, 2000) in Australia, to close those Fisheries down.

Perhaps some recreational fishing advocates will be rubbing their hands together with glee at this prospect, however, I should point out this scenario will apply equally to recreational fisheries. This is not an idle threat, it is a reality in terms of where management directions are heading. The more recent ESD/sustainability debate has, in fact, refocussed where we need to go in terms of national fisheries management.

Ecologically sustainable development

The term 'Ecologically Sustainable Development' (ESD) was adopted in Australia to emphasise the importance of the environment to long-term survival and to ensure that there was a balanced approach in dealing with environmental, social and economic issues. ESD is the concept that seeks to integrate short and long term economic, social and environmental effects in all decision making.

With the introduction of environmental legislation at the Commonwealth level, exports will not be permitted from our commercial fisheries unless we can accredit those fisheries in terms of Environment Australia's (EA) requirements. The EA requirements are based on sustainability and on the impact of fisheries on the broader environment. Within Western Australia the policies push supporting Ecological Sustainable Development has been further enhanced with the State Government establishing a stanability policy unit with the department of premium cabinet.

The State Governments have begun to develop frameworks and policies for the implementation and reporting on ESD for fisheries. These initiatives recognise and examine all elements of sustainable fisheries resource management, going beyond the requirements of sustainability of the target stocks and the fishery itself, to examine the direct and indirect impact on the environment including the broader ecosystem. In addition to meeting these Commonwealth requirements, the State model also extends the evaluation of acceptable performance of the social and economic impacts of the industry sectors, along with the governance of all the parties involved in its management.

The implementation of ESD for fisheries will therefore involve a comprehensive assessment of fisheries, including the governance arrangements of each fishery, of which effective allocation is a major component. It is likely that many of our fisheries that share resources would not pass an objective test on this aspect because there is no explicit specification of access shares amongst the sectors. Such a deficiency may also have long-term implications for the overall performance of these fisheries.

Amongst the various sectors, there are significant differences in the degree to which current management arrangements can ensure effective governance. Most commercial fisheries already have systems in place that allow catch levels to be manipulated. This is not the case, however, within nearly all recreational fisheries and for some of the commercial fisheries with which they interact. Finally, while the legislative mechanisms for implementing no-take areas have been established, the contextual framework for precisely why and how requires further thought.

If one follows the ESD route, there are a number of reporting requirements that go beyond those of the environment and the ecosystem, extending into economic and social impacts as well as governance issues. The WA State Government is currently examining the case for 'Triple Bottom line Reporting' for all departments. Triple bottom line reporting means that you not only must report on the financial management in terms of running your business, but also on the impact on the environment and the contribution you are making towards the social and economic development within your community. In translating this to fisheries, you must ask the question, what do we now need to do? If we take the ESD debate, which also covers a further question of governance, you can see there is a spread of new information requirements and data that must be developed over the coming decades to meet these challenges.

This would change the very nature of reporting, not in terms of the fish caught by the commercial fisheries, but increasingly the interaction with recreational fisheries and more importantly, around the impact of the fishery on the environment and the ecosystem generally.

I believe the outcomes being developed by the ESD process in WA will continue to evolve as the new reporting requirements become more sophisticated and the community comes to better understand the data and what it is saying. I see this shift as an evolutionary rather than a revolutionary process.

Fisheries management in Western Australia

To date, WA's fisheries have coped quite well using a sectoral management approach. However, the increasing pressures on our fish stocks are starting to show. Most fish stocks in this State are fully exploited and consequently competition between sectors is intensifying, as is the debate around resource sharing and the best use of our fish resources. A new approach is required if we are to meet these challenges and ensure the future quality of our fisheries.

Historically, State and national legislation has, by and large, focussed on the management of commercial fisheries and the implementation of management arrangements such as licence buy-backs, reductions in fishing capacity, effort restrictions and quotas, etc. In the last decade we have seen a suite of new legislation that has expanded beyond the focus of commercial fisheries, gradually moving into recreational fisheries in a much more positive way. More recently, the debates are progressing on issues such as Aboriginal fishing rights and Native Title.

The recognition of the importance of managing recreational fishing, I believe, has only been an issue in the last decade, and certainly much of the debate has focussed on equity issues such as appropriate bag limits and minimum size limits - but the debate has to shift if sustainability is to survive.

By way of example, I would like to briefly discuss the Western Australian dhufish (Glaucosoma hebraicum) – an icon species for both commercial and recreational fishers.

Dhufish is a demersal species found along the west coast of WA. It is a prized eating fish and is targeted by both commercial and recreational fishers using similar methods of line fishing. Importantly both groups generally target dhufish in the same areas along the west-coast. The commercial fishery lands about 170 tonnes while the recreational fishers catch about 130 tonnes. The recreational bag limit for dhufish is 4 fish/day, however catch surveys indicate that the average catch of dhufish for recreational fishers is 0.4 dhufish per person/trip.

It appears that even if the commercial fishery was shut down immediately, the likely impact on the total dhufish catch would be nil. While there may be some benefits to the recreational users, at least in the short term, in terms of increased average catches, the benefits to the fish stock itself would be nil. One could perhaps hypothesise that if recreational fishing was perceived to be of a better quality, the result could be a further increase in participation and effort and perhaps even an increase in the total dhufish catch.

While issues such as these may be logical to scientists and hopefully fishery managers, I do not believe all recreational lobbyists, the wider community or politicians yet recognise this. I still consistently hear the view put forward that the solution to sustainability issues is to reduce or close the commercial fishery. I believe this view is currently being put forward extremely loudly in New Zealand.

Clearly, the major question facing fisheries management in recent years is to solve the problem of increasing populations, technology changes and the issues that flow in terms of the impact on exploitation rates and hence the sustainability of fisheries. To a degree, this debate has been had and there is now widespread acceptance that a total yield must be set for each fishery. However, the key step which has not yet occurred is to obtain clear recognition within the community that if we have to set a yield limit, then the catch of all sectors must be managed. This is essential if we are to gain the required support for implementing an effective management framework.

Controlling the total take of all user groups requires that we must deal with the question of allocation and reallocation to user groups within the community. If we do not meet that challenge, there is one thing that can be guaranteed - we will lose fisheries.

In the Australian context, we have focussed very much on the exploitation of the commercial fishing sector but not on other sectors, and this has to change as the population grows. Managing the recreational sector within a specified catch, or more likely a target catch range, will present new challenges for managers and recreational fishers. Recreational fisheries can no longer be simply managed by 'social' management measures, and new and innovative management solutions which can meet these requirements are required.

Allocation decisions

Despite, or perhaps because of, the intensely emotive nature of debates related to the sharing of access to fisheries resources, public policy prescriptions have rarely attempted to explicitly manage the relative level of access of each of the sectors. Instead, they have simply dealt with public perception and made adjustments to the rules as combined fishing pressure (or lobbying pressure) of all groups has continued to grow. Consequently, these decisions have tended to be politically influenced, and generally not based upon any ideological platform.

Where this has occurred, it has usually been done on a spatial basis, by allocating an area to one sector or the other, or in a small number of instances in WA, by introducing differential size limits between sectors. Where commercial fisheries take place alongside recreational fishing there has generally been minimal recognition of the other sector within their respective management arrangements.

Consequently, the current 'share' of access to these resources has evolved implicitly through the historical patterns of exploitation exerted by each group of users.

These 'shares' have resulted from a combination of factors including, the relative market value of the re-

source, the relative effectiveness of fishing gear, the relative extent and ease of access to the resource, differential levels of controls placed on each group and the numbers of individuals participating.

Changes to any one of these factors, most of which are currently not subject to effective management controls, can substantially alter these "shares". Moreover, the other sectors, such as the "non-take" sectors, have been effectively excluded from this process except for where the creation of protected areas has coincided with areas of interest.

In order to maintain both sustainability and community values around the use of our fisheries resources, there is a strong case for historical practices to be discontinued and a move to a more explicit framework. This requires the allocation of the sustainable catch as defined resource access shares.

The major challenge, which has beset fisheries worldwide, is how to determine how the catch should be allocated. This is the million dollar question!

There are expectations about the outcomes of any allocation decision, and by later this year I hope we will have some clarity around the path chosen by WA. The challenge will then shift to management of sectors within allocations and how to manage shifts between sectors in the future, as community demands change over time.

So what are the key issues which have stymied attempts to move down this path?

Appropriate legal framework

A prerequisite for any process of allocation amongst sectors is to have an appropriate legal framework upon which these allocations can be 'attached'. Such a framework is only likely to operate effectively where there is some system of 'rights' associated with these allocations. The concept of property/access rights in fisheries has been an issue of concern in WA for the last decade.

An integral component of this debate centres around the nature of this 'right' and this is by no means resolved in Australia. Some of the law has focussed on the questions of commercial fishing rights, but what about the rights of recreational fishermen, where do they stand in that debate? Even less has been said on the question of use of fish for the purpose of conservation (no-take uses) or the use of fish by Aboriginal people in terms of meeting their economic development whether it be for aquaculture, commercial fishing or customary fishery needs (an issue which has not been adequately described in the context of Australian law). There could also be issues around the rights which are attached to offshore waters, intertidal zones, or waters within Aboriginal reserves.

Some clarification over the form and nature of any 'rights' is important, given the disparate views of various stakeholders. I do not believe one should leave those requirements to the courts alone and a review is underway in WA to develop an Aboriginal fishing management strategy.

How to define shares

If specific allocations are to be made, these need to be in a form that can be quantified and monitored and be a proportion of the total allowable take/effort levels. The total level of access granted (either expressed in terms of a relative catch level, or relative effort level, or areal extent) must be consistent with ensuring that the resultant impacts on the stock(s) are sustainable.

In most cases, due to the natural variations in stocks, this is unlikely to be a set as an actual catch level, but needs to be a percentage of what can be taken annually.

The allocation of access to sectors can be made using a variety of management tools. These can be divided into three main categories, which are not mutually exclusive and can be used in combination.

Space – restricting the areas of operation of one or more sectors to provide a greater or lesser level of access to other sectors. This can be achieved by allowing activities to only occur in a designated area, or the reverse, allowing activities everywhere except in designated area(s).

Time – restricting the time when access is allowed. This can take the form of restricting access to some periods, such as months, total days, weekends, holidays etc. These can be designed to achieve both total effort levels and/or minimise interactions amongst the sectors.

Quantity – this can take the form of:

- restricting how many participants are allowed ie by restricting 'licence' numbers,;
- restricting the amount of gear that can be used. These together can form a Total Allowable Effort (TAE) level, based on the combination of the gear and time used and the numbers using it; and
- restricting the catch that can be taken per day, per boat, per licence, per year. This can, in some circumstances, take the form of a Total Allowable Catch (TAC) where the actual catch level is prescribed. Bag limits are not generally expected to be a direct constraint on recreational catch.

Each of these methods have strengths and weaknesses but whatever methods of allocation are determined, they must be appropriate to the sector e.g. a TAC is unlikely to be useful for the recreational sector. Furthermore, the method of allocation doesn't need to be exactly the same for each sector as long as in combination they achieve the outcome wanted. By its very nature it will be an evolving process, or 'adaptive management' that, with time and development, should eventually enable explicit sharing of the available resource in a sustainable way.

How to make initial allocations

Once the total level of access has been determined, the initial allocation to each sector can occur. This could be based upon priority access, historical access, a 'start again' approach involving an objective review of total community use or some combination of these models.

These models differ in their complexity, the implications (including the costs and consequences) from their application and the robustness of the outcomes depending upon the type of fishery being examined. Consequently, it is likely that no one model will suit every situation and that each may be applicable under some circumstances.

If the 'start again' model is be used in the initial allocation process or subsequent future reallocations, determining the most appropriate levels amongst the various sectors may require objective assessments that use criteria based upon the costs and benefits related to the social, economic and environmental components of ESD. In general, as the difference between the current levels of allocation and the proposed optimal allocation levels increases, so does the requirement to quantify the justification for this change.

In WA, the data needed to enable these assessments should be available following the completion of the full ESD assessments for each fishery when all elements of ESD are covered. In fact, the collection of detailed social and economic data for fisheries makes more sense in a situation where it will be used for comparisons amongst sectors.

Information requirements

Even with the advent of a new framework the challenge will remain to question: what are the future data requirements? How quickly will you need to commence collection? What techniques need to be developed?

Knowledge of current fisheries management practices, historical levels of catch taken by each sector, information on the fishery, the species biology, yield status and localised / regional catch and other data is required – including important regional employment, economic and social/lifestyle issues. Future trend information on population, coastal development and data on social and economic issues around the cases for any shift in future resource use patterns are also necessary.

Much of this will be collected as part of the requirement to complete ESD reports on each of the fisheries. Clearly much of the data requirements for effective decision-making will take time to evolve and will increase in sophistication, as more become known and the issues become more complex.

All of these examples point clearly to the message that data collection must move well beyond the requirements of biology and ecology and incorporate wider socio-economic information. The challenge lies in the adoption of the right subsets of data and accurate collection of data to help address those answers.

There is no question, that as we become more sophisticated and more experienced in our modelling, knowledge and data collection, our ecosystem and environmental assessments will improve. For example, in the WA rock-lobster industry, the collection of puerulus data began in 1969, but not understood for a decade after it was introduced. Today, using this data alone, we can predict about 95% of the catch variation within the fishery on a four year forward projection. The challenge is therefore to identify key data sets required and having the conviction to start the process.

I must emphasise the urgent need for cost effective recreational fishing data because this area is probably the most under-resourced of all the data sets required. Over the last 12-18 months, we have seen the first national survey of significance, for the measurement of recreational fishing catch and effort. The challenge is working out what it really means. Are the broad national figures suitable in dealing with local debates? Possibly not, but they may still provide important positioning data.

If we had a licensing system for instance, this could be used as a tool in finding more cost effective ways of gathering data from the fishery and facilitating the collection of volunteer information through log-book programs, etc. Furthermore, if we are moving to address the issue of resource sharing and managing those shares, we will need to understand the total catches taken, where the shares are becoming disproportional (in terms of what was planned) and finding new management measures to address and readjust catches to meet the agreed plans. These plans must have community acceptance that the outcomes are fair and reasonable for all sectors.

The other interesting challenge is within most budgets of natural resource management agencies, compliance always costs more than research and cost recovery arrangements are not seen favourably for compliance. The challenge is to obtain better compliance activity data and determine, on a risk assessment basis, the resources needed to get the required level of compliance effectiveness.

The final big challenge in managing costs for recreational fisheries is to find sensible social and economic indicators to address both the triple bottom-line reporting requirements and the long-term issue of reallocation as the population increases and resource use priorities change.

How to make comparisons between sectors

There is substantial disagreement about how to make comparisons of the relative benefits of allocation of resources amongst sectors. Previously, debates often compared the dollars spent by recreational fishers compared to the dollars generated by the commercial sector. Despite, the spurious nature of this comparison – which is often described as comparing "apples with oranges" - such data are still cited as justification for shifting allocation from one group to the other (mostly from commercial to recreational).

More appropriate economic analytical techniques are now available which generate values of sufficient equivalence to directly compare the economic benefits of the sectors directly. These methods usually involve determining the "willingness to pay" levels for each sector. In most cases, unless very good data are available (which is rare) there can still be ongoing arguments about the assumptions used in making these calculations. Thus, there is currently no agreed method for making such comparisons.

In WA, a study is currently underway to examine the usefulness of these techniques to estimate the value across three different fisheries. It is hoped that this study will assist to determine whether the efficacy of these techniques is sufficient to assist with this issue.

Given that debate about the methods of using a single figure to compare across sectors is likely to continue relatively unabated, there is reasonable justification to examine the effectiveness of other techniques. One alternative approach is for the assessment to examine the relative impacts of any potential shifts in allocation amongst sectors on all or some ESD components and model the relative costs and benefits within sectors. Because these assessments are mostly completed within a sector, there may be fewer assumptions to generate conflict. Thus, with the costs and benefits measured within the sector, taking this approach could reduce the level of disagreement that has plagued such debates over the years and help progress a more acceptable process for determining optimal allocations.

How to affect reallocations

Once the initial allocation of access to the various sectors has been determined and assigned, rearrangement of entitlements or catch shares can be achieved by two principal processes. One, a continued administrative intervention at regular intervals and the other, by the creation of a market for allocated access rights which achieves trading across sectors, as well as within sectors.

Within WA, where access rights have been issued to the commercial fishing industry, together with transferability of entitlements, markets have become established. These arrangements have allowed adjustments to take place within the sector (i.e. between the commercial licence holders of the one fishery, but not for a species between fisheries), facilitating a market price for the entry and exit of licence holders. These arrangements occur within the private sector, are economically efficient and all costs are met by the private sector, including the cost of registration for transactions.

To effect resource shifts from one sector to another (or even within the one sector) in an explicit way has been achieved through administrative intervention in the market place for the acquisition of commercial licences. This has been undertaken in WA through licence buy back schemes which have worked efficiently in the absence of a market structure across sectors. The schemes have reduced actual and potential commercial fishing effort through industry restructuring programs (with financed costs being met by industry) or have achieved resource share shifts in favour of recreational fishing (by application of community funding arrangements).

Where specific allocation of access to sectors occurs, there is no reason why administrative market interventions, of the nature previously applied, cannot continue to occur to facilitate adjustments. Buy-backs of industry licences can be used to achieve the agreed level of commercial access both now and in the future. In WA, there is no restriction on the source of funds that can be applied to a buy-back scheme – potentially it can come from the Consolidated Fund, licensing revenue, (including recreational licence funds), local government, the tourist industry, coastal developers or other sources.

To date, there has been no specific scheme to reduce recreational access shares in favour of commercial fishing. Where this has occurred, it has largely resulted from an increase in effective fishing effort by the commercial sector as a result of technology change, or greater use of latent fishing capacity driven by increases in product market value, not an explicit decision.

Where recreational catch shares are deliberately targeted to shift from the recreational sector to the commercial sector, the same administrative approach could be applied by the creation of a new commercial right within the commercial licensed fishery and the sale of that right by tender, auction or some other arrangement (so long as a corresponding decrease in the total recreational effort was achieved by other means).

The need to continue to have administrative intervention applies where markets between sectors covering rights of access to fish cannot function (which may be the majority of fisheries). However, the other possible mechanism is through the use of market based mechanisms. For single species fisheries, such as abalone and rock lobster, it is theoretically possible to establish a market driven reallocation mechanism that facilitates adjustments across sectors, as well as within sectors. This notion can be achieved by creating rights with the recreational fishery that are tradeable. Theoretically, a market-based system could lead to the most economically efficient outcomes in the use of available fish resources by the community. It would remove the need for periodic interventions (by governments and other stakeholders) to address long term shifts sought by the communities and stakeholders in the use of fish, as population pressures and requirements for access changes are sought over time.

Can such a system/approach successfully deal with the complexity of resource sharing issues? Clearly, both the benefits and costs of applying such a system needs to be examined, and like most areas of fisheries management, the answers are rarely straightforward.

In summary, we need to find effective arrangements to manage each sector within their allocation. I believe the final outcomes necessary for long-term sustainable resource use in the Australian context can be found by adopting effective ESD settings. In some cases it will be for individual species of fisheries, in other cases it will be for groups of fisheries within bioregions, but it must be effective if we are going to maintain our fish stocks. There has to be an allocation and reallocation framework, whether by mediation or market forces, in order to maintain fisheries. Fishery managers will not be able to deal with this in isolation and nor will scientists. It will need to involve the community and structures and processes must be put into place to enable them to reach consensus decisions. To ensure accountability in the data and indicators used, having the performance of agencies assessed is essential. The value of independent accreditation processes may be all-important in de-politicising the process and giving recognition to effective resource management.

Recreational fishers may feel this is getting all too complex – lets face you just want to get out there and do what you enjoy most – fish. Unfortunately, in a world faced with a growing population, where fish stocks are being fully, if not over exploited, things are no longer that simple.

My hope is that through continuing to improve our management and research processes you will be able to keep doing just that – enjoying quality fishing.

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Management of Western Australia's fishing tour (charter boat) industry

Kristy Saville and Phil Readhead

Department of Fisheries, 168-170 St. Georges Terrace, Perth, Western Australia 6000, Australia

Abstract

Until recently the fishing tour (charter boat) industry in Western Australia (WA) was 'open access'. The industry underwent rapid expansion in the 1990s raising concerns about unregulated growth. The major concern was that if the fishing tour industry was allowed to continue without appropriate management mechanisms in place, it would rapidly become over capitalised, posing a significant risk to the sustainability of fish stocks and the wellbeing of the industry.

The Department of Fisheries (WA) recently introduced a management framework for this component of the State's recreational fishery. Fishing tour operators are now required to hold a licence under the *Fish Resources Management Act 1994* (FRMA) to operate in each of the four management bioregions on the coast. The regulations for the management of the industry have provided a framework to manage the rapidly expanding fleet and its impact on the State's fish resources. In the long term, it will protect and enhance WA's multi-million dollar fishing tour industry.

Under the new arrangements, licensed operators are required to fill in research log books, which will provide essential data to evaluate the impact of the industry on the State's fish stocks and marine environment. The regulations have created a basis for the industry's inclusion in resource sharing discussions within the proposed Integrated Fisheries Management framework.

Background

Over the past decade, increasing population, a growing tourism industry, improved facilities at many coastal locations and better access to remote areas have led to a significant growth in regional tourism opportunities in WA (Fisheries WA, 1997). Many of the opportunities are based upon the use of the near shore aquatic environment and fish resources.

A major challenge for the WA community is to ensure the sustainability of these resources in the face of growing pressure from tourism, and to ensure that the industries based on these resources are able to develop in a controlled and sustainable fashion, to optimise the long-term benefits to the community.

Until last year the fishing tour industry was essentially 'open access'. Any person who had a boat appropriately surveyed as a Special Passenger Vessel (SPV) could operate tours. In 1990 there were 40 boasts providing fee-for-service fishing tours to recreational fishing parties. By 1997, the number of operators within WA's tour industry had grown to 135 (Fisheries WA, 1997), an increase of more than 300%.

The Tour Operators Fishing Working Group (TOFWG) was established in 1996 in response to the fishing tour industry's growing role in the use of marine resources. The working group was comprised of members of the industry and relevant Government agencies. TOFWG acknowledged the rapid growth in the tour industry's fishing fleet. It also identified major concerns from industry participants and recreational fishers, regarding the sustainability of fish resources in the face of the escalation in fishing activity. With the risk of fishing tour operators significantly increasing the exploitation of fish stocks, causing localised fish stock depletions and competing for access to prime fishing locations, the working group saw an irrefutable need for this sector to be managed.

In September 1997, the TOFWG released a discussion paper *"Future Management of the Aquatic Charter Industry in Western Australia"* (Fisheries WA, 1997), which came from extensive consultation with the industry. Submissions to the discussion paper were received from industry members, commercial and recreational fishers, community members and other stakeholders.

The submissions indicated two main concerns regarding the fishing tour industry in WA, both of which related to the open-access nature of the industry:

- negative biological and economic impacts which resulted from overcapitalisation of the industry; and
- poor quality of service provided by some operators which was tarnishing the reputation of the wider industry (Fisheries WA, 1998).

The process

Following consultation, the WA Minister for Fisheries approved the development of a licensing and management framework for the fishing tour industry. The 12 September 1997 was used as the benchmark date for demonstrating "history" in the industry. The regulations governing the industry were gazetted on 29th June 2001.

The expansion of the industry, combined with a lack of knowledge of its impact on fish resources called for a conservative plan for management. In keeping with the objectives of the FRMA, the Minister approved a precautionary approach. Fishing activity was limited to the levels apparent at the time of the benchmark date. Throughout WA, around 250 Fishing Tour Operators Licences were issued with a five year moratorium on the issue of further Fishing Tour Operators Licences until the relative impact of fishing tour activities on fish resources and fish habitat has been established.

A Ministerial Policy Guideline was published highlighting the importance of the benchmark date criterion for entry into the fishing tour industry (Fisheries WA, 2000a).

Ultimately, this guideline was to assist the Independent Assessment Committee (established by the Minister) to assess more than 300 applications for tour operator's licences (from over 500 initial expressions of interest). It's role was to make recommendations to the Executive Director of the Department of Fisheries. An independent objections tribunal has been established to hear the cases of applicants who have been refused licences.

Management framework

In addition to the resource management benefits, the management and licensing framework is expected to promote a more professional, organised industry with a 'Code of Conduct' and therefore, a more marketable tourism product. Organised bodies are forming throughout the State, giving the industry a voice in fisheries resource management and a future role in resource sharing discussions.

WA's 12 000 km coastline is divided into four bioregions for recreational fisheries management purposes. Bioregional management is an acknowledgement of the natural complexity and diversity of WA's marine life and environments, and the clear need to better link management to the biology and distribution of both fish stocks and fishing activity (Fisheries WA, 2000). The regional approach also provides a spatial framework for integrating the management of tour fishing and eco-tourism with recreational fisheries, commercial fisheries and other uses such as conservation. Tour operators are managed and licensed on this bioregional basis.

For management purposes the fishing tour industry is considered to be part of the State's recreational fishery rather than a commercial fishery. The fishing tour industry is closely related to the recreational sector in the species targeted, gear used and motivation for fishing. Therefore, management objectives for fish stocks are the same for the two users groups. As a result, the fishing tour industry is regulated under the current suite of recreational fishing regulations until there is sufficient data to necessitate a change in management arrangements.

Data for ongoing management

The Department of Fisheries (WA) Research Division began receiving logbook returns in September 2001. The daily returns will provide a time series of catch, effort and catch rate data to be used for monitoring the status of stocks for prime recreational species. The time series of catch rate data is also required for developing stock assessment models for recreational species. Given the seasonal nature of the tour industry in WA, 12 months worth of data is the minimum requirement before estimates of catch and effort for the entire coast and therefore, all operators, can be determined. Collation of the first year's data is expected to be completed by the middle of 2003.

Future management arrangements

Managing the fishing tour industry is a relatively new role for Government, and many management strategies can be expected to evolve as crucial data from logbook returns becomes available. Future development of management strategies will rely on consultative mechanisms with the industry and the wider community. This will develop an industry that understands its responsibility to sustainable fisheries and can assist with the education of the State's recreational fishers and wider community.

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RESOURCE SHARING IN A ROCK LOBSTER FISHERY - A UNIQUE CASE STUDY FROM SOUTH AUSTRALIA

Trevor J. Watts

South Australian Recreational Fishing Advisory Council Inc., 1 Boskenna Avenue, Norwood, SA 5067, Australia

Abstract

Formal resource sharing arrangements underpinned by policy and supported by legislation are rare. South Australia has developed an innovative resource sharing arrangement for their rock lobster (*Jasus edwardsii*, formally *J. lalandii*) fisheries, which employs market mechanisms to allow adjustment of shares between commercial and recreational fishers. A percentage share of the fishery has been determined at 4.5 % of the total catch. This is allocated as an agreed number of recreational pot registrations based on historical catch figures and annual recreational fisher surveys. A trigger point of 21 000 pots was set for the 2001/02 lobster season.

This target was not reached even under an open access policy for the community in relation to a maximum of two registered pots per person. The Government has not been required to enter the market for commercial pots and/or quota to offset the expected excessive demand for pots. A full explanation of the history, sharing policy and market mechanisms to adjust shares is provided. This innovative solution to a long standing issue could be used in similar fisheries where access to gear is relative to catch potential.

Introduction

The Rock Lobster Fishery is mostly situated along the southern coastline of South Australia, and is a very important, valuable fishery to South Australia.

Both sectors, recreational and commercial have considerable capital invested in the industry. The fishery has a long history of management checks and balances, and shares the resource between the sectors. The recreational sector's share of this resource is considered to be minor (2.6 %), when compared with the commercial sector.

The commercial sector is a major contributor to the economy of South Australia and likewise the recreational sector, being the only significant fishery in South Australia requiring a licence fee (or 'registration'), for a lobster pot to enable recreational users to catch rock lobsters.

Rock lobster can be pursued by other means not requiring registration, such as hoop and drop nets (used by blue crab anglers and called 'lift nets') and by recreational diving. Divers can only use limited prescribed devices.

Recreational fishing industry statistics

General

Recent surveys (1997), have indicated that 453 000 Recreational anglers over the age of five years fish at least once each year, which represents 31% of the population of South Australia.

It has also been determined that recreational anglers spend A$ 350 million annually in pursuit of their pastime which in turn supports 15 000 jobs in South Australia. This represents an expenditure of A$1 million per day for every day of the year on fuel, bait and accommodation.

The recreational industry has considerable investment in tackle, fishing devices, equipment and owns 44 200 boats. The total investment value of A$1 200 million on boats and tackle includes A$ 220 million invested in fishing tackle and A$ 900 million in replacement boat value.

Recreational Rock Lobster

A survey to determine the estimated effort and harvest levels of recreational rock lobster pot holders for the 1998/99 fishing season was undertaken (McGlennon, 1999). This was the first full description of recreational rock lobster potting effort in South Australia and the level of response provided significant confidence to the results.

This survey was undertaken by an accepted methodology of random sampling of registered recreational pot holders. The number of current registrations at the time was 10 720 (start of October 1998 season and declined to 9 696 by May 1999).

A brief summary of the results are as follows:

- 80 % of the harvest was taken by 20 % of fishers
- The harvest of kept rock lobsters by weight was estimated at a total of 66 932 kg, with 40 332 kg (60%) from the Southern zone and 26 600 kg (39%) from the Northern zone
- The harvest of kept rock lobsters by numbers was estimated at a total of 80 093, with 54 309 (68 %) from the Southern zone and 25 784 (32 %) from the Northern zone
- The average number of rock lobster harvested by those respondents who fished was 25.
- Greatest amount of fishing effort was in January in the Southern Zone and December /January in the Northern zone.
- The average number of trips was 11, with 70% of respondents fishing 10 days or less.
- The magnitude of the recreational harvest is relatively small and when compared with the commercial catch, (represents 2.0 - 2.6 %). However, this does not include rock lobster taken by divers and hoop/ drop (lift) netters.

Management arrangements

Fishing for rock lobster has been pursued in a serious way since the early 1900s, with fishery management reviews during this time.

In 1966, the South Australian House of Assembly appointed a select Committee to enquire into and report upon:

(a) All aspects of the survey and equipment of fishing vessels and regulations therefore; and

(b) The need for any amendments to the *Fisheries Act, 1917 - 1962*, considered necessary to ensure the proper management of fisheries resources, including amendments to provide for licences for master fishermen, employee fishermen, amateur fishermen and fish dealers.

This was the beginnings of a more efficient, formal and scientific approach to fisheries management in South Australia. The Chairman of the committee concluded that there was a need for: " continuing investigation and research into all fisheries to ensure the careful conservation and management of an industry of increasing importance".

The Committee, with regards to the rock lobster fishery, recommended that legislation should be introduced either by statute or regulation to provide: " that no person using more than three crayfish pots or three drop-nets be permitted to engage in crayfishing for sale without being the holder of a crayfisherman's licence and operating from a fishing vessel registered as a crayfishing vessel".

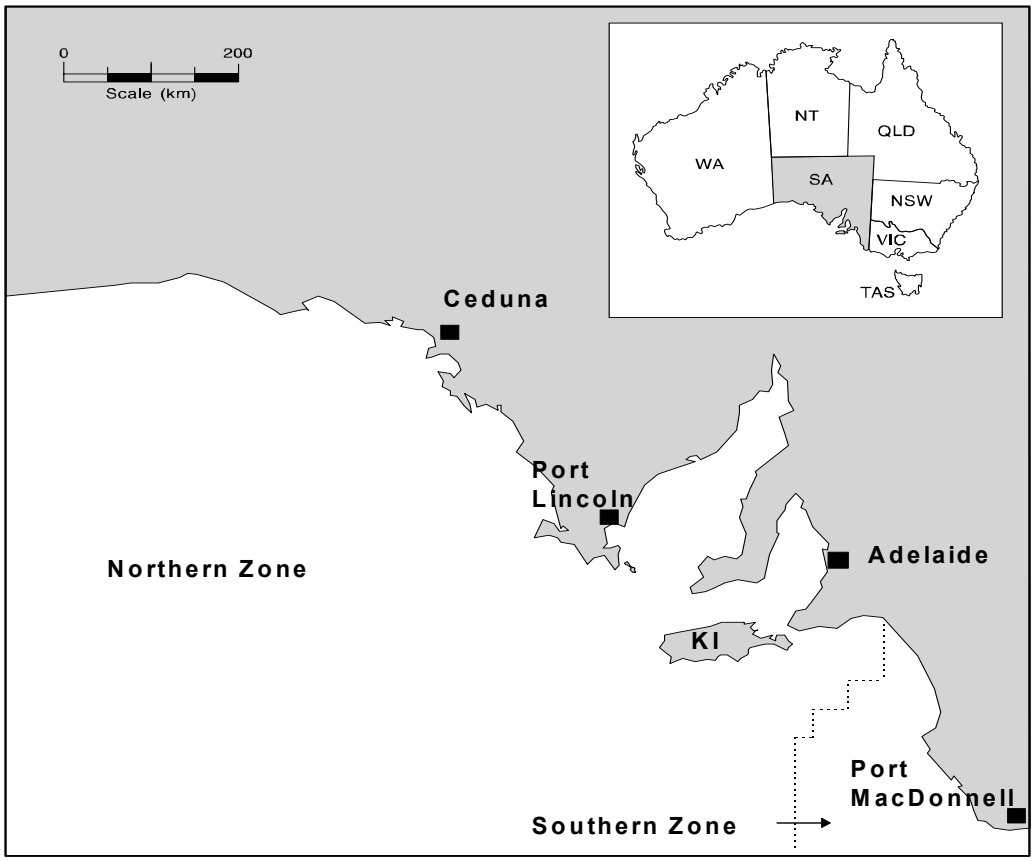

Figure 1. Northern and Southern Zone Rock Lobster Fishery Zones; KI, Kangaroo Island.

This in effect regulated recreational anglers to three lobster pots. There were also recommendations limiting the commercial sector to the number of boats and pots used on those boats.

The report also recognised three geographic zones, two of which are much the same as inexistance today. The third zone covered the waters adjacent to Victor Harbour. This was in recognition that lobsters in that area did not grow to a similar mature size as lobsters in the other two zones.

Seasonal closures

The seasonal geographic zone closure regulations in force in 1966 were:

- Kangaroo Island and southern Yorke Peninsula: male and female - June 1 to October 31;
- Victor Harbour: male - no closed season, female - June 1 to October 31; and
- Elsewhere: male - October 1 to 31 October, female - June 1 to October 31.

By contrast the current regulations regarding seasonal closures are:

- Northern zone: 6.00pm May 31 to 12 noon November 1;
- Southern zone: 6.00pm April 30 to 6.00am October 1

There are also areas where taking of rock lobster is prohibited for both sectors (including aquatic reserves, controlled aquatic reserves, declared waters and marine parks), depending on access conditions and regulations applying at the time.

Rock lobster pot regulations

A rock lobster pot is a device which is required to conform to regulations and be registered by natural persons over the age of 15 years pursuant to the *Fisheries (General) Regulations 1984*. In the case of general pots, the registration is for a period not exceeding 12 months. For 'grandfather' pots the period is three years. In both cases, a registered number is allotted to each device.

'Grandfather' pots, is a colloquial term commonly used for all pots issued to the recreational community prior to 1985. These pots have an implied right of renewal every three years, but are renewable for an annual fee basis. Prior to the 2001/2002 season, regulations remained in place for the renewal of 'grandfather' pots of which, there were 2 610 registrations potentially representing 5 220 pots.

"Grandfather pot" registration holders vigorously defend their three year right of tenure, others describe this as an unfair monopoly. However, prior regulations did not appear to have any sunset clause for this class of registration and is silent on procedures governing tenure of possession. The current status of the three-year 'grandfather' period is unclear.

- Prior to 1985, unlimited access with an entitlement of three pots.
- Number of pots available frozen in 1985 at 18 021.
- Between 1985 and 1997 through natural attrition recreational pots decreased from 18 021 to 10 000. There were no new recreational pots issued during this 12 year period.
- Rock Lobster Task Force recommended in 1995 that " grand father " Pots remain in the hands of registered owners for a three year period but renewable annually.
- 1997 Schedule 5 registration fee for one recreational pot was $ 45.00.
- September 1997 recreational pot entitlement reduced from three to two pots per registration.
- In September 1997 a further 2 000 pots were issued, bringing total allowable pots to 12 000.
- In March 2000, 5 220 'grandfather' pots on issue (representing 2 610 registrations) and 8 512 general pots (representing 4 256 registrations).
- 2001 Schedule 5 registration fee for one recreational pot is $ 45.00 and $ 140.00 for a maximum of two pots
- As at April 2002, a total 13 219 pots on ssue (representing 7 449 registrations).

Possesion limits

- Bag limit of five in any one day, introduced in 1995.
- Boat limit of 10 introduced in 1995.
- Bag limit of five reduced to four in 1997.
- Boat limit reduced to 8 in 1997.
- Carapace size regulations that apply for the 2000/2001 season are:
  - Northern Zone - 105 mm
  - Southern Zone - 98.5 mm
- Female rock lobster carrying external eggs are protected under the Fisheries (general) Regulations 1984.

Fishery management objectives

The fishery is managed on behalf of both sectors (commercial and recreational) through a Fishery Management Committee with a separate committee for each zone. One of the social objectives described in both rock lobster fishery zone management plans is to: "maintain and provide for reasonable levels of public access to the rock lobster resource". The recreational sector has argued that 2.6% is not a fair and reasonable share of the resource.

Resource sustainability

The fishery in both zones is considered to be sustainable at the current harvest levels (reference?)

(something missing?) for Fisherie's decision to release a further 2 000 recreational pots prior to Christmas 1999. The full exploitation rate is not known as there are no studies currently being undertaken to assertain the maximum value of production.

It should be noted that since 2000, the Northern Zone fishery is experiencing a downturn in catch levels and management measures are currently being considered. This particular zone is not under quota management

Cost recovery

All commercial fisheries in South Australia operate on a cost recovery basis, including the recreational sector. Rock lobster registration fees contribute the major portion for the recreational sector. Based on the figure of 13 732 registered recreational rock lobster pots at $45.00 per pot, the contribution is A$ 617940.Allocation proposals

The rock lobster survey (McGlennon, 1999) suggested that a percentage of recreational pot holders did not fish for rock lobster at all. This lends support to the theory that a mentality of 'rare stamp and coin collection' exists amongst registered pot holders because of the level of restricted access.

The level of participation and exploitation rate requires testing to provide the maximum level of participation by all members of the community that wish to seriously engage in this pursuit.

SARFAC submitted the following proposal to the Legislative Review Committee:

- Fair and reasonable access for all members of the community that wish to fish for rock lobster;
- Registration fee (licence) for all devices, including divers, with a maximum number of devices being, two pots, or two hoop/ drop nets and one permit for each diver.
- Permits should be renewable on an annual basis, but purchases may be activated at any time.
- The level of fees should be $50.00 per device to a maximum of two and $ 50.00 per diver.
- A registration application process open to all members of the community, should be considered .
- Alternative consideration for the purchase of rock lobster registrations from 'authorised persons' using the Victorian model for the recently introduced all waters angling licence.
- Previous years applications for pot registrations indicated that an additional 6 000 pots would satisfy the recreational demand at harvest levels of 5 kg per pot per year. This represents an additional 30 tonne and should be easily catered for within current harvest levels (1999).
- Recording and collection of spatial, catch and effort data could be a condition of registration renewal.

1999/2001 registration allocation phone – in

Amended management arrangements for the recreational rock lobster fishery prior to the 1999/2001 season allowed for registration through a phone-in service through an entertainment booking agency, beginning on September 6, 1999 on a first- come, first-served basis, until all the pots had been allocated. The first day resulted in the telephone exchange congestion throwing telephone systems into chaos. It was estimated that the deluge of calls was in the order of 2 million, including some interstate. In the wake of this fiasco and after many complaints regarding fair and equitable distribution, the State Ombudsman began a preliminary inquiry. Large numbers of recreational rock lobster fishers were angry at not being able to obtain a rock lobster pot.

South Australian government legislative review committee

Following the Ombudsman's report that there was nothing improper in the phone-in process, the Legislative Council set up an inquiry to investigate and report upon the Fisheries (General) Regulations and their application to the allocation of recreational rock lobster pot registrations . The committee recommended:

- a trial period for the unlimited allocation of recreational rock lobster pots for two years with two pots per allocation. Divers would also have to purchase a non-transferable allocation.
- a scientific assessment of the effect, on rock lobster numbers . If during that time there is an unstainable increase in the recreational catch, other measures might be introduced to control the catch. The Committee accepted the view that there is likely to be little, if any effect on rock lobster stocks.
- during the two-year trial the system of 'grandfather pots' will be retained (and after if the system fails). If the system is successful, people having these pots would become part of the unlimited allocation.
- research be undertaken into the cost/benefits of recreational and professional rock lobster fishers and the allocation of the resource between the two sectors.
- a review of the penalties currently applying to recreational fishers who exploit their recreational pots

for commercial gain, to ensure any abuse of an unlimited allocation of recreational pots is minimised.

Legislative review implementation

Whilst the Legislative Council can make recommendations, there is no guarantee that those recommendations will be adopted by government. In this case the government adopted the main recommendation for open access, with a voluntary catch record form to complement the existing data base. There was no decision on 'grandfather pot' tenure.

In order to maintain sustainability, a trigger point of 4.5% of the harvest was established. If registrations were greater than expected, the government would buy quota from the commercial sector at an agreed rate until the recreational demand was met.

Trigger points in the recreational rock lobster fishery

Background

In the survey of recreational rock lobster fishers in 1998/99, the total catch estimated for this sector was 66 932 kg, with 40,332 kg (60.2%) taken in the southern zone and 26,000 kg (39.8%) taken in the northern zone.

The number of pot registrations during the survey was 10,720 at the start of the fishing season. Of the 271 survey participants, 30 (9.1%) considered themselves unlikely to fish during the season, and this was confirmed with contact after the season. Only 2.7% of trips yielded more than the daily bag limit of 4 lobster.

The commercial catch in 1998/1999 was 2 729 t. Therefore, total catch is estimated at 2 796 t. Recreational pot catch was therefore 2.4 %.

The average recreational catch per pot was 6.5 lobsters per pot.

Trigger point in pot numbers

Using existing values of 10 205 pots resulting in 66 932 kg of catch which represents 2.4 % of the total. The number of pots required to produce 4.5 % of the catch can be calculated. The calculations provide a range of between 19 134 to 23 333 pots to produce the 4.5% trigger point . The middle point of this range is 21 233 pots.

Other recreational catch

As there were no estimates on the catch taken by recreational divers or recreational drop netters, a precautionary approach was taken to setting a trigger point for pot numbers, so that the total catch by the recreational sector is considered.

Assuming catch from other sources is less than 1 %, the pot estimate could be reduced by between 100 and 200 pots to give a 0.5 to 1.0 % buffer.

Recommendation

It is recommended that a trigger point of 21,000 pots be used in the 2001/02 rock lobster season, as a precautionary approach due to uncertainty of the catch taken by divers.

Current position

At April 8, 2002 registrations were 7 449, comprising of 13 219 registered pots, compared with 13 732 pots registered for the previous (2000 / 2001) rock lobster season under the restricted access regime. The registration costs are $50 for one pot and $140 for two pots, whereas the previous season registration costs were $45 per pot and $90 for two pots.

Registrations have slowed to about five registrations week and the trigger point will not be reached under the current bag and boat limits.

The trigger point was established in consultation with the commercial and recreational interest groups. Funds from pot registrations over the trigger point, will be used to lease commercial pots and / or quota to maintain shares in future years if necessary.

Data collection

During the 2001/2002 season a voluntary catch and effort data form was issued to all registrants with the request that they be completed and returned on completion of fishing activity or at the end of the season.

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APPROACHES FOR THE MANAGEMENT OF HIGHLY MIGRATORY FISH STOCKS - AN AUSTRALIAN PERSPECTIVE

Jonathon H.S. Barrington

Department of Agriculture, Fisheries and Forestry - Australia, GPO Box 858, Canberra, ACT 2601, Australia

Considerable debate has occurred in recent years over the interests and obligations of recreational fishers that pursue the highly migratory fish stocks that travail the Australian exclusive economic zone. While the present arrangements under Australia's Offshore Constitutional Settlement arrangements provide for federal government jurisdiction and administration of such species, the states and the Northern Territory have also undertaken to implement conservation and management measures for these species. Such arrangements are complex and inconsistent across jurisdictions and have led to considerable criticism of governments. Further, they are viewed as insufficient for Australia to meet its obligations under the United Nations Fish Stocks Agreement and to the relevant regional fisheries management organisations, whereby Australia must ensure that its national approaches, be they at the federal or state/territory level, contribute effectively to the long-term sustainability of highly migratory fish stocks (and straddling fish stocks).

This paper provides an overview of the variety of jurisdictional arrangements in place in Australia for the management of recreational fishing for highly migratory fish species, identifies the range of issues currently facing Australian fisheries administrations and stakeholders and provides an analysis of the currently envisaged approaches to manage recreational fishing activity directed at these species in the future.

ANGLERS ACTIVITY AND PREFERENCES IN ENGLAND AND WALES

Guy W. Mawle[1], Diane Simpson[2] and David Clarke[3]

1 Environment Agency, Rio House, Aztec West, Bristol, BS32 4UD, UK
2 UK Independent Research Consultancy, 30, Newall Drive, Chilwell, Nottingham NG9 6NX, UK
3 Environment Agency, Rio House, Aztec West, Bristol BS32 4UD, UK

The Environment Agency promotes freshwater angling in England & Wales and regulates it by a system of licensing. From 1997 to 2000, licence sales declined. Despite increasingly vociferous anti-angling groups, a survey of public attitudes towards angling showed that 73% of people considered angling to be an acceptable pastime. Interest in participation was also high, particularly amongst 12-16 year olds. The main factors which would encourage participation are discussed.

Almost 4 million people said that they had been fishing in the previous two years. About one million licences are sold annually. Reasons for the apparent discrepancy between sales and the level of participation are discussed.

Results from a survey of licence holders are presented, indicating the level of different types of angling activity, and anglers' preferences for different fish species and types of water. The types of fishing anglers choose and the level of angling activity reflects not only anglers' preferences but also the availability of different types of fishing. When encouraging the sustainable development of new fisheries, the Environment Agency will focus on providing angling opportunities near centres of population and for popular types of fishing where provision is lacking.

A COOPERATIVE MANAGEMENT SOLUTION - ALL WHO CARE, SHARE: RESOURCE SHARING DECISION RULES FOR A NORTHERN TERRITORY PELAGIC FISHERY

Ray Clarke

Fisheries Group, Department of Business, Industry and Resource Development,
GPO Box 3000, Darwin, NT 0810, Australia

While integrated management has been actively promoted as the new paradigm for natural resource managers, its practical implementation has been problematic. An innovative management approach is currently being implemented for the Northern Territory's Spanish mackerel fishery, which will see the recognition of individual catch shares for key stakeholder groups. Catch shares will provide a benchmark for future management arrangements and represents the initial attempt in implementing integrated management.

With improved efficiency, particularly the advent of inexpensive sounder and GPS systems, advancements in outboard motor technology and fishing gear, the impacts of a growing population and the further activation of commercial fishing licences, landings in the Northern Territory's pelagic Spanish mackerel fishery will continue to rise. Although highly conservative management interventions are well advanced, including a ceiling on the number of commercial participants (at very low levels), an active licence reduction program and a recreational possession limit, overall catches will continue to increase to levels which may exceed sustainable yield estimates.

Catch shares seek to establish benchmarks for negotiating future management arrangements, in which responses can be tailored to address increased landings by particular stakeholder groups. Such arrangements also provide a valuable platform to discuss re-allocation of fisheries resources between stakeholder groups, should it be necessary.

CAN THE RECREATIONAL CATCH BE EFFECTIVELY MANAGED?

Andrew Cribb and Ian Curnow

Department of Fisheries, 168 St George's Terrace, Perth WA 6000, Australia

The future direction of fisheries management, in many jurisdictions, is a shift towards an allocation based model in which the estimated sustainable catch in each fishery is explicitly allocated to competing sectors. A key premise in this approach is that the catch of each sector can be constrained within a specified target or range.

This paper examines whether it is possible to effectively contain the recreational catch, both from a fisheries management perspective and within the Australian socio/political context.

This paper discusses the limitations of the current recreational management strategies commonly adopted for recreational fisheries in Australia and discusses alternative mechanisms which may be required to more effectively contain the catch of the recreational sector.

Historically, most recreational fisheries have been managed predominately by gear controls (ie prohibitions on commercial type gear) and a combination of bag and size limits. Catch survey data reveals the vast majority of recreational fishers do not catch anywhere near the bag limit for most species - therefore the periodic reviews which inevitably reduce recreational bag limits may have little impact on the overall recreational catch.

The key issue for management, is how to counter the expansion in recreational participation and effort, which in Western Australia has increased dramatically over the past decade. A more innovative approach to recreational management will be required if the recreational catch is to be contained in the future. Consideration must be given to utilising a wider range of controls such as temporal and spatial closures, possession limits, permits, and even tags in high risk fisheries, which will undoubtedly increase complexity of rules for recreational fisher.

A major challenge will be engendering widespread community acceptance of the need for additional controls on recreational fishers to generate necessary political support for implementing and funding a higher degree of management.

A VOLUNTARY BUY-OUT OF COMMERCIAL FISHING LICENCES, FUNDED BY A NEWLY INTRODUCED RECREATIONAL FISHING LICENCE

Alexander K. Morison[1] and Stephen McCormack[2]

[1] Marine and Freshwater Resources Institute, Department of Natural Resources and Environment, PO Box 114, Queenscliff, Vic 3225, Australia
[2] Fisheries Victoria, Department of Natural Resources and Environment, 232 Victoria Pde, East Melbourne, Vic 3001, Australia

An All-waters Recreational Fishing Licence was introduced for anglers in Victoria, Australia in July. Prior to this time, only anglers in inland waters were required to hold a licence. Funds raised have been used, with the endorsement of the peak body for recreational fishing, to buy-out commercial fishing licences in commercial bay and inlet fisheries. The buy-out was voluntary. The buy-out offer was at a fixed price per licence, but the price varied among individual waters. The buy-out removed 52% of licences across all bay and inlet fisheries. A complete buy-out of commercial licences was effected in some waters, and in others, between 10% and 76% of licences were removed. The buy-out removed both latent effort and actively fished licences. An average of 20% of the catch of all species had been reported for bought-out licences. A higher proportion of effort than catch was reported for bought-out licences indicating that operators of those licences had lower than average catch rates. The future effects of the buy-out, on both commercial and recreational sectors, will have to be assessed against a background of high variability in catch rates, and the lack of any suitable control areas against which to compare any observed changes.

USING INVOLVEMENT AND PLACE ATTACHMENT TO PREDICT ANGLERS' MANAGEMENT PREFERENCES

Gerard Kyle[1], Alan Graefe[2] and Thomas Wickham[3]

[1] Clemson University, 263 Lehotsky Hall, Box 340735, Clemson SC 29634-0735, USA
[2] The Pennsylvania State University, 201 Matter Building, University Park PA 16802, USA
[3] California University of Pennsylvania, 250 University Avenue, California PA 15419-1394, USA

In recent years, a number of investigations have appeared in the leisure literature illustrating the usefulness of the involvement and place attachment constructs for understanding a variety of leisure behaviours. Both constructs have been conceptualised in terms of personal relevance (i.e. the perceived importance of specific leisure activities and settings) and have been used to assist with understanding recreationists' setting and equipment preferences, perceptions of crowding and conflict and satisfaction. To asses the criterion validity of each of these constructs within the context of recreational fishing, this study examined a model where involvement and place attachment were hypothesized to predict five areas of service provision (i.e. lake access, lake crowding and conflict, fish quality, rules and regulations, and facilities) for anglers in the New England region of the United States.

Data for this investigation were collected as part of a larger project focusing on anglers in the New England District. A total of 176 useable surveys were collected (23.5% response rate). A follow-up telephone survey was conducted with non-respondents to test for response bias. No significant differences were observed between respondents and non-respondents on demographic variables and several measures of involvement and place attachment. Involvement was measured using a modified version of McIntyre and Pigram's (1992) involvement scale measuring three dimensions of involvement; attraction, centrality, and self-expression. Place attachment was measured using a modified version of Moore and Graefe's (1994) measure of place attachment and contained two dimensions; place dependence and place identity. Eighteen items were also used to measure five areas of service provision (i.e., lake access, lake crowding and conflict, fish quality, rules and regulations, and facilities). The hypothesized model was tested using covariance structure analysis provided through LISREL. Each dimension of involvement and place attachment was hypothesized to significantly predict each area of service provision.

The final results offered limited support for our hypothesized model (c^2=983.64$_{(728)}$, RMSEA=.045, CFI=.86). Significant effects were observed between: attraction '‡rules and regulations (b=.22); centrality '‡crowding and conflict (b=.20); self expression '‡facilities (b=.45); place identity '‡accessibility (b=.29); and place dependence '‡fish quality (b=-.19).

These results suggest that; (a) anglers who perceive fishing to be both important and pleasurable, prefer less regulation, (b) anglers who have strong social ties to fishing and perceive the activity to be an important component of their lives are less likely to be bothered by the presence and actions of others, (c) anglers who perceive fishing to be self expressive are most content with the level of facility development around fishing spots, (d) anglers sharing an emotional bond with the recreation setting are most content with lake access, and (e) anglers who perceived the recreation setting to be an important component of their experience were most concerned about fish size and number.

COMMUNITY ENGAGEMENT IN RECREATIONAL FISHERIES MANAGEMENT

Neville Fowler

Department of Natural Resources and Environment, PO Box 124, Benalla, Victoria 3672, Australia

Objective To demonstrate that effective recreational fisheries management depends on strengthening community partnerships

Findings While Victoria's inland recreational fisheries management plans (FMPs) are focused on the sustainable use and allocation of fisheries resources, the health of aquatic ecosystems is fundamental to the health of these resources. In addition, activity associated with fishing can have adverse impacts on the aquatic environment and in-stream.

Fisheries management planning is undertaken through an independent Co-Management Council outside of *"beaurecrats"* control. Each FMP is led by an independent steering committee, on which, non-consumptive environmental stakeholders focus on environmental aspects rather than on fishing.

Potentially this can lead to tension in the process; the skill is in including common outcomes in which recreational fisheries management objectives are aligned to the community's long-term conservation objectives.

The benefit of exposing management options to these pressures before they are finalised is that the linkage between FMPs and other environmental planning is clearly identified and FMPs are compatible with and do not duplicate environmental plans (e.g. Heritage Rivers Plans, Ramsar Wetland Management Plans, Regional Catchment Strategies, River Health Plans)

While the primary focus of Victoria's first inland recreational fisheries management plan, the Goulburn Eildon FMP is on the recreational fisheries of the region, it will influence and assist those engaged in biodiversity and water and catchment management programs to improve the quality of fish habitats through their policies and actions.

Conclusion The development of this FMP featured direct participation by Victorian recreational fishers. It operates in an inclusive manner to ensure that the wider stakeholder groups are informed and have had every opportunity to have input into the development of the Plan. This was seen as a logical starting and end point for the plan.

POLITICS AND INFORMATION IN DETERMINING ALLOCATION OF FISHERIES RESOURCES

Renae C. Partridge

CRC Reef Research Centre, c/- James Cook Universit, Townsville QLD 4811, Australia

With an increasing number of people inhabiting Australia's coastline, there is rising competition between users for coastal fisheries resources. Each competing user group is demanding more of a 'fair share' of access to these resources, and fisheries resource allocation issues are generally resolved by political means. It will become increasingly important that decisions are based on information, rather than political manipulation.

In order to reduce the significant conflict that is present, I aim to examine the differences claimed in recreational catch quality between north Queensland estuaries that are open and closed to commercial gillnet fishing, through a new study, instigated by the CRC Reef Research Centre and James Cook University. I will collect catch information directly from the recreational fishery, via voluntary logbooks, from historic records, and through structured fishing surveys using standardised effort in both closed and open estuaries. I also will document the opinions of recreational and commercial fishers toward such resource competition issues in order to assess the importance of these issues to the whole fishing community.

The project will provide impartial information to fisheries managers and stakeholders about the degree to which closing areas to commercial net fishing does or does not provide improved fishing experiences for recreational fishers. This may enable more informed decisions to be made regarding resource allocation issues, which may be more readily accepted by each user group. Potentially, this information may reduce the significant conflict that is present today.

Acknowledgments. CRC Reef Research Centre; Supervisors Dr Bruce Mapstone and Dr Marcus Sheaves.

Theme 5

Development issues

Driver or passenger – which seat are you in?

John Harrison

Amateur Fishermen's Association of the Northern Territory, PO Box 40694, Casuarina, NT 0811, Australia

Abstract

A myriad of items face the recreational fishing industry around the world and development has often been the curse and cause of many disasters for fishing. But development comes in many forms and is not restricted to water or land, but a combination of both, with some other twists thrown in for good measure - just to keep everyone on their toes.

Add to this the need for the industry to develop and you have a fascinating array of issues that makes this a complex and vulnerable industry. This paper will explore the range of challenges facing recreational fishing in the next 10 – 20 years. It will look at the reason why the industry must stand up and take hold of its own direction and be the driver of change rather than be driven by agendas that don't necessarily suit the way we must go.

Introduction

The Northern Territory of Australia is one of the most unique places in the world, – a place for the most, that remains as it has been for thousands of years.

We talk about development and the way it can improve the society in which we live – there is no doubt that there are many things that have helped to improve the health and wellbeing of everyone. However, some might say, at what cost to the fragile environment we all live in? The change that has occurred in the last century in particular, is profound.

With the pace of change in the industrial, agricultural and urban arenas, we have seen a dramatic, and, in most cases, an almost irreversible change to the environment that surrounds us. The changes, and in some cases permanent change to many rivers, streams and harbours has seen the desecration of nursery and habitat areas with a very sorry blasé attitude of "well that's progress".

I would like to address a range of topics and provide a perspective on a direction for the future. For too long the angling community has only looked at their own backyard, and said: "*I'm OK I can still catch a fish where I have always been able"*, although this is mixed with age old saying: "*remember what it used to be like*?" We must raise awareness that it is not a matter of my own backyard, but one of a much broader horizon and reflective of the needs of the wider angling community.

Volunteers

During the past the recreational fishing industry has relied upon the fishing agencies to look after their interests and anglers have just gone fishing. The recent realisation by the angling representative groups that this is not enough, has seen the importance of the recreational sector increase in the eyes of the fisheries agencies and politicians of all countries. Diminishing government resources has also meant that if we, as an industry, want management and research to go in a certain direction, we have to step forward and make it happen.

The industry has in many ways already started on this long journey. Hundreds of people are either elected by members of their organisations or make themselves available to assist angling groups. This assistance comes in many ways and ranges from simply folding newsletters to preparing detailed and complex replies on a huge variety of subjects. Without these volunteers, the role of representative groups in the recreational fishing industry would be extremely difficult if not impossible.

There needs to be a clear and decisive program to train our volunteers – those that sit on a range of advisory, management, research, reference committees or groups and offer their time to the cause. These people already embrace the idea of being part of the process. Therefore, by developing their skills, broadening their experience and knowledge we can more effectively utilise this bank of resources . They can

contribute to changing and influencing the direction of fisheries management, research, development and other aspects of recreational fishing. Their devotion to the cause is something that must be harnessed.

Not only do we need to support our volunteers, but we must develop a path so people can move into an area that will benefit them and our industry. Training and skilling our representatives will be the secret to success in the future. There are thousands of them out there, all they need is encouragement and leadership – it is up to us to provide that opportunity.

Education and awareness

Education and awareness programs are seriously lacking any assessment of their effectiveness. When a state in Australia has an icon species and more than 50% of its resident anglers do not know the rules and regulations for this fish, you have to question the past processes of both the fisheries management agency and the representative groups for that state. And from my research, this problem is not limited to Australia – it is world wide. So what are we going to do about a real and effective education program?

We must utilise the network of tackle and bait outlets as one of the key distribution points for educational material. If this involves a remuneration scheme for the outlets than so be it. Why not have a small shopfront or information booth in every tackle shop? Every angler drops into a tackle shop for supplies, a chat to see where the fish are biting or just to brag about their latest catch.

The club angler is relatively easy to get information to. It is the great unwashed masses that we need to address. The method of delivery is only limited by one's imagination – CD, video, brochure, newsletter, email, website, etc. Cost should not be used as an excuse.

Aquatic protected areas

Aquatic protected areas, no take zones or marine parks – call them what you like – they are not going to go away. For some time, many people have been saying if there is a clear need, based on scientific or biological evidence, then maybe we will agree to areas being set aside with a range of take options.

The time has come where we must realise and acknowledge that there are more than just extractive user groups interested in the water and its contents. Passive users also like to know that there will be marine life for future generations. We have to accept that these protected areas will be introduced. What we have to do is to be part of the process that decides where they go and how they are managed. Sticking our heads in the sand only exposes a target!

Access

Guaranteeing access to resources is one of the greatest challenges, if not the single most important one, facing the recreational fishing industry around the world. Does this mean some form of 'rights' for the recreational sector?

What are rights? Is it rights to access, or is it access to rights, or is it both? First is the physical ability to get to waterways to fish, and secondly, once there, the entitlement to actually catch a fish. As for the latter, are we paying, or will we pay for this in the form of a licence, or are we already paying for it in the shape of other taxes, levies and the like?

We, as an industry, have to make sure that recreational fishing is involved in the management process, or the decision circle, and fundamental as it may sound, prepared to pay for the resource. We are a user of the resource and if we want a say in how it is managed, researched and developed then we must pay for that in some direct form.

Lets look at the Northern Territory to exemplify physical access. Vast tracts of the coastline is land in trust, under the Aboriginal Land Rights Act, an act unique to the Northern Territory. Of the approximate 3 500 km of coastline of the Northern Territory about 85% is not accessible, via land, without a permit from the relevant Land Council. This provides a number of challenges.

Firstly, new fishing opportunities is something that the angling public is constantly seeking, as a means of widening the industry or opening up new experiences. Without this, industry will not grow resulting in missed chances for community growth. Secondly, the possibility of concentrating increasing fishing effort in smaller geographic areas is real. However with the relatively small population in the Territory this is not *yet*, (and I stress yet), an issue, although it is looming on the horizon.

The third, and in my view the most important, is the missed prospects for the traditional owners, of this unique and ancient land, to capitalise on the asset of virtually unexplored fishing opportunities on their doorstep. I have been fortunate that my job has taken me to some of these areas and I have experienced some of what is available – it is truly unbelievable.

We need to fashion agreements with the Traditional Owners (TOs) of lands to give both the angling community and the TOs the chance to capitalise on the asset. Of course there will be a cost associated with both developing and accessing it. Developing the opportunity, will require government investment in the form of infrastructure and support. Anglers have already shown they are prepared to pay for camping access and for the use of other infrastructure, and will, I believe, be prepared to pay for the use of new service facilities.

Environment

Of course not all areas in the world are in the same position as the Northern Territory. Agriculture and industrial and urban development has seen massive changes to the environment and river systems in many places around the globe. What is required to sustain and improve the fishing, in these less fortunate locations, is a comprehensive program of habitat restoration and rehabilitation. Many countries, finally, are realising that rivers, stream and bays are not a waste collection option and that it is time to stop and reverse the trend of decades of maltreatment of these watercourses.

In Australia, the recent introduction of the new federal act 'Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth of Australia, 2000) has meant that the exportation of fish by the commercial sector is subject to an assessment of the sustainability of the fishery prior to exportation permits. This also means that the recreational sector of that fishery is also subject to evaluation. I ask this question – "*what agricultural crops or industries are subject to the same or similar appraisal?"*

Is agriculture sustainable in some areas? The answer is obviously no. The difficulty is convincing both the farmers and political leaders. Much of this marginal agricultural land would be of far greater value to fishing – as a nursery or wetland. These lands must be identified and returned to their natural role.

From damming and barricading, to the leaching of fertilisers, herbicides and pesticides, to the stormwater runoff, there is a myriad of challenges facing us as an industry. Most of the political representatives in every country cannot see the fish because of the sheep, cattle, wheat, timber, canal estates and the like. They cannot see the value in what lies beneath, lives in and relies on the water. What we must do is raise these problems higher and higher up the decision line and press home our requirements for remedies.

We need to engender support from the corporate world – "Adopt a river or wetland." Corporate support, particularly from multinational companies, will lead to a greater improvement in the functionality of wetlands, nurseries and river systems. I do not believe that the governments of any country have the financial resources to rectify all the errors of the past. However, a partnership of the community, government and the fishing industry, can deliver. But we must take the initiative to get it off the ground.

Fees

About 15 years ago, I paid A$75 for a seat at a world boxing title defence fight in Sydney. The fight lasted less than 4 rounds – the cost to me was about $6.00 per minute. Compare this to the debate within the angling community where licences for recreational fishing are being considered. Arguments abound that it is a right to fish and not have to pay for the privilege. I question and challenge this philosophy, with the view, that if we want the fish to be there for future generations, then it is incumbent upon us to do something about it now.

Recreational anglers should have to pay for the right to fish – no question. I certainly get more fun and value in a fight with a fish on a rod than I did watching that boxing match. And the argument that we are already paying for it through sales tax, fuel tax etc does not hold water. We are a user of the resource and if we want it managed the way it needs to be, then we should put our hand in our pocket and pay for it.

Catch and release

Increasingly around the world, the practice of catch and release is being adopted by anglers who are fishing for sport and fun. The survival rate of the fish released is a major issue and one that must be researched with recommendations extended to the angling community. We cannot continue this practice without knowing the number of fish that survive. It may mean a complete change to the management tools used by fisheries agencies. As our knowledge on this issue increases, so will the way in which we educate our future anglers.

I saw the following when I left an Irish pub here in Darwin. Although I had a couple of pints of Guinness I did read it correctly. it said:

"A thought on the secret of success – bite off more than you can chew, then chew like hell!"

What I have talked about is change and these development issues are about change, continual change

and then more change. Managing this change is a key task for the recreational and sport fishing industry.

Resisting change is like holding your breath – if you succeed you die!

However, if you are the driver of change our industry will not only survive but thrive. Change requires leadership and future leaders are what we need. They are out there, waiting for encouragement from you.

I will leave you with this. If you are a passenger, change seats, and get in the drivers chair!

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RECREATIONAL FISHERIES: OPTIONS FOR THE FUTURE

Ian G. Cowx

University of Hull International Fisheries Institute, Cottingham Road, Hull, HU6 7RX, UK

Abstract

The importance of recreational fisheries to local and national economics throughout the developed world is well known. However, development in the sector is weak or retrograde in many countries. This paper reviews the current status of recreational fisheries in industrialized countries and the principal management activities and constraints operating within this fisheries. SWOT (strengths, weaknesses, opportunities and threats) analysis is used to review the issues facing sectoral development and identify options for future advancement of recreational fisheries both in industrialized and developing countries. It is concluded that effective management of recreational fisheries consists of three components: science, management and policy, all working within a larger social, political and economic framework. Unless these components work in harmony towards common goals, recreational fisheries is likely to suffer in market driven economics.

Introduction

The importance of recreational fishing as a sport or leisure activity emanates from the sixteenth and seventeenth centuries, and coincides with the publication of Izaak Walton's "The Compleat Angler, or Contemplative Man's Recreation" in 1653. The sport is now highly developed and pursued by large numbers of people around the world, primarily for pleasure, but also for income generation and to supplement food supply, as exemplified by the following statistics.

Amongst 22 European countries there are an estimated 21.3 million anglers, with an estimated expenditure on recreational fishing in 10 of the countries in Western Europe where data were available, in excess of US$ 10 billion (Cowx, 1998b).

In 1996, 18% of the US population 16 years of age and older (35 million people), exerted 514 million angler-days in fresh waters, expending US$ 38.0 billion (US Fish and Wildlife Service, 1997).

In Canada in 1995, 4.2 million anglers exerted 55.5 million days and caught over 254 million fishes while spending US$ 5.1 billion of which US$ 3.4 was directly associated with the sport. Of these fishes, some 113 million were retained (Department of Fisheries and Oceans, Canada, 1998).

It is estimated that total recreational catch worldwide is of the order of 2 million tonnes, and represents an important source of animal protein in many developing countries (Coates, 1995).

Despite the importance of recreational fisheries, the activity is undergoing considerable change, often for the worse, and action is urgently needed. This paper examines the Strengths, Weaknesses; Opportunities and Threats (SWOT analysis) of recreational fishing around the world, and identifies options for the future of recreational fisheries.

Strengths

It is widely accepted by the international community that there is a need to protect the environment and biodiversity, including freshwater fish. This is evident from the numerous Conventions and Directives (e.g. Bern and Washington Conventions, EU Habitats Directive 92/43/EEC, EU Water Framework Directive, 2000 IUCN Red List) that underpin biodiversity protection and were promulgated through Agenda 21 of the Rio Convention. This international recognition, which has filtered into the political arena, should be used to promote recreational fisheries, where anglers are often considered guardians of the environment and protect fish stocks and species diversity (see, however, comments on introductions). Recreational fishing is supported by an expansive network of dedicated people and this strength should be enhanced where possible. Furthermore, efforts should be made to encourage recreational fishing because it is a healthy activity, is accessible to all, and generates important social and economic benefits to local and regional communities.

The importance of recreational fisheries is well-founded within society, and supported by good legal and institutional frameworks. However, many of the institutions lack the resources to protect fisheries or enforce legislation, thus fishes are not always afforded the protection they are designated under law.

Weaknesses

When reviewing the weaknesses of recreational fishing, it becomes evident that there is lack of understanding of the factors that constrain fish populations. There is also an increasing reliance on stocked fisheries because of degrading natural fisheries and shifting angler attitudes from enjoyment of the natural environment towards fishing where a good catch is demanded. As a result, mangers are moving more towards managing stocks by stocking rather than enhancement of the environment. This trend needs reversing. The paucity of information on fishes is universal, partly because of the intrinsic difficulties in studying this species group (Cowx, 1996), but also because of lack of investment in fisheries research *per se*. This is epitomised by the apparent lack of recognition of the importance of fish and fisheries when formulating research priorities.

It should be recognised that recreational fisheries in a multiple user environment is fraught with problems. Fish and fisheries are often considered of marginal importance because the value of the resource is usually ill-defined and poorly represented from an economic and social perspective (Cowx, 2002;b). Fisheries are traditionally managed based on the quality of the fishing experience, and few are managed from an economic perspective (Cowx, 2002a), an issue born out by the paucity of information on the economic value of such fisheries (e.g. Kennedy and Crozier, 1997; Peirson, Tingley et al., 2001). This problem spills over into recreational fisheries because the value of the resource has rarely been assessed. Consequently, recreational fisheries are given low priority in any consultation process and it is difficult to argue for protection of the resource. If recreational fishing is to be promoted in the future, there is an urgent need to provide robust, defensible, social and economic valuation of fish populations and fisheries (Cowx, 2002a). Once this information is available, value will be a powerful tool for arguing the case of recreational fisheries. However, it must be recognised that it is not the only tool to be used, as the economic value of a major water resource scheme will far outweigh recreational fishing value. This is primarily because the methods used are often fisheries specific and do not consider the upstream economic value in terms of aesthetic and conservation value or the downstream value associated with the service sectors.

Although an enthusiastic network of people was considered a strength, it can equally be considered a weakness. This contradiction arises because the fish fraternity frequently work in isolation of other resource practitioners, i.e. they live in a "piscicentric" world where consideration of the needs of other resource users are often ignored or given little respect. Inevitably, this leads to conflict which generally favours the strongest economic argument, often to the detriment of other user or ecological entities, especially fish and fisheries. Fisheries have suffered heavily because, as pointed out earlier, they are poorly valued in economic terms and in a market-driven environment will be largely overlooked.

Some of the blame must fall on recreational fishing practitioners because scientists, managers and policy makers each have their own interests and modes of operation, and they respond to different motivations, constituencies and reward systems (Meffe, 2002). However, as Meffe (*op. cit.*) pointed out, if recreational fishing is to expand, each must be engaged and work effectively with the others as a unit. Recreational fishing often suffers because these three components do not work together well, and even work at cross purposes.

Opportunities

Anglers are excellent ambassadors to promote the fish cause. The biggest problem, however, is that the general populace have poor awareness of the issues and problems facing fish, thus greater opportunity should be made of their willingness to support environmental and conservation campaigns by promoting education and extension programmes. Similarly, fishing clubs and organisations should be encouraged to promote protection of fisheries and front environmental lobbying of potentially damaging development projects. In addition recreational fishing is an excellent opportunity to support urban regeneration through enhancement of degraded waters. This has major social benefits, including increasing employment opportunities.

Threats

Fishes are threatened by a wide array of factors, but anthropogenic disturbance seems to underlie the decline and extinction of many fish species (Figure 1; see Cowx, 2002b for review). The main perturbations can be broken down into five key problems, viz: species introductions and translocations; impoundment of rivers (dams and weirs, water abstraction and water transfer schemes); water quality deterioration (pollution, eutrophication, acidification); habitat degradation and fragmentation (channelisation and land use change, mineral extraction); and overexploitation. These problems seem to be universal (as exemplified throughout these proceedings). Although many of the

issues are being addressed in developed countries through environmental legislation, the rate of progress in reversing the impacts is pathetically slow. Furthermore, the cost of implementing rehabilitation programmes or seeking alternative solutions to the demands on water resources, which underlies many of the issues, is prohibitive and at best only a *status quo* is being achieved with respect to habitat quality, and at worst, as is still commonly found throughout the developing world were financial resources are limited, progressive deterioration is rife.

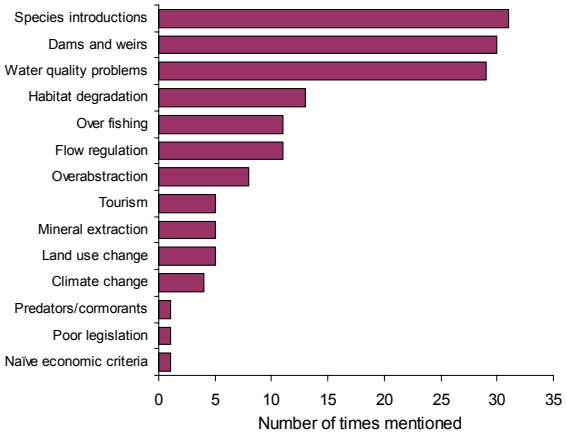

Figure 1. Major threats to freshwater fisheries

Of these key threats, water resource development schemes are a particular problem because the economic value of such schemes outweighs the recreational fisheries arguments, as mentioned earlier. Similarly stock enhancement programmes are a much used and frequently abused management activity. This is because the social and economic value of recreational fishing is high and environmental issues are largely ignored (Cowx, 2002a). To reverse these philosophies is going to be a major challenge to conservation managers, but neither will be achieved if the true economic value of conserving fish species is not enunciated or the fishing fraternity is not educated to the deleterious effects of introductions and translocations of fish species (Cowx, 1998b; 2002b). There is growing concern that holding of fish at high density in keep nets, coupled with the hooking, playing and handling of the captured fish, causes unnecessary distress (Berg and Rösch, 1998). Although the impact of catch and return on fish behaviour and populations is not well understood, there is evidence that fish do suffer from being caught and handled, and have reduced recruitment success (e.g. Bettoli and Osborne, 1998; Cooke et al., 2000). By contrast, recent studies on holding fish in keep nets suggest that the fish are not unduly stressed until the density held is high (Pottinger, 1997; Raat et al., 1997). Another argument being presented by environmental lobby groups is that fish may sustain damage, especially from barbed hooks, which increases their proneness to disease and feeding difficulties. As a consequence, some regions of Europe have now banned put-and-take fisheries, and the use of live bait and keep nets (e.g. Norway, Netherlands and several Landers in Germany), and others are looking carefully at the issue. Whatever the outcome, anglers must be aware of animal welfare issues and continue to do everything possible to minimise the impact of their activity on fisheries and wildlife.

Options for the future

One of the major problems facing recreational fisheries in the future, is lack of knowledge about species abundance and distribution, and the factors constraining sustainability of the resources. Consequently, further efforts need to be focussed on the underlying problems and how they can be overcome. The most commonly used practices used in recreational fishery management are rehabilitation and stock enhancement, but little is known about the efficacy of these approaches. Research should therefore be targeted on these aspects to develop low risk rehabilitation measures and sustainable stock enhancement strategies. However, in view of the critical status of many fisheries, there is a pressing need to take action and not fall back on the old addage that more research is required to ensure the decisions being made are appropriate.

Increasing pressures on aquatic resources dictate that recreational fisheries can no longer be treated in isolation and an integrated approach to aquatic resource management is required (Cowx, 1998). Fishing opportunities are being constantly eroded, not only by exploitation of fish directly, but mainly through degradation of their habitat. However, the demands for sustainability have put emphasis on the need to manage exploited resources. Consequently, conflicts between these various interests must be resolved by involving all stakeholders in the management process. This can be achieved through integrated aquatic resource planning and management. River basin management plans, at both the national and multi-national scale, will support this process but the profile of recreational fisheries needs to be raised and be better integrated into the planning process. Without this involvement the future of freshwater fishes remains bleak.

Similarly, there is a need to develop partnerships with stakeholders in affected ecosystems to strengthen and implement recreational fishing activities, and develop mechanisms to influence other players. To achieve this, scientists must expand their range of activities from monitoring and reporting the status of fisheries to more influential and preventative work. They must use the best available data to educate other stakeholders and the wider public. They need to be involved in accurate environmental impact assessments and rehabilitation programmes to argue the case for

recreational fisheries, i.e. there is a need to develop a risk based approach to recreational fisheries. There is also a need to develop fiscal measures, such as the 'polluter-pays principle', and enforce legislation through appropriate channels and institutions. This will only be achieved through valuation of recreational fisheries resources, an issue that is acting against the fishing lobby, and will be essential for integration into river basin management plans. There is an urgent need to adapt environmental economic evaluation tools to value the social and economic importance of recreational fisheries. Until this is undertaken, recreational fisheries will continue to be given low priority in any consultation process, and it will remain difficult to attract investment or credit for protection of the fisheries.

Finally, the science and management of recreational fisheries must be considered in its infancy, and protocols and procedures utilised by many institutions need collation in a format that is understandable by all practitioners and interested parties. It is recommended that a manual of best recreational fishing practices is collated, and is written in a sympathetic manner, which can be referred to by anglers, managers, planners, and assist in their decision making processes.

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ARE STOCK ENHANCEMENT PROGRAMS THE SAVIOUR OF RECREATIONAL FISHERIES IN EUROPE?

Ian G. Cowx

University of Hull International Fisheries Institute, Cottingham Road, Hull, HU6 7RX, United Kingdom

Abstract

The stocking, transfer or introduction of fish species is a practice frequently used in the belief they will improve the quantity or quality of catches and have long-term beneficial effects on fish stocks. This paper examines the impact of stock enhancement programmes on wild fisheries and analyses the economic importance of restocking to freshwater fisheries.

The estimated total value of inland production from the Eropean Union (EU) member states in 1997 was about US$ 1 160 million of which over US$ 819 million was generated from aquaculture. Of the total aquaculture production, approximately US$ 87 million was for stocking purposes. The socio-economic importance of inland fisheries does not lie at a national level - numbers employed (<5 000) and the value of the sub-sector are low in relation to the fisheries sector as a whole. Its importance lies in the contribution made to local social and economic welfare. However, recreational fisheries have great potential to generate employment (and additional income generation) externally. Investment by the EU in this sector is marginal and mainly targeted at aquaculture.

All EU countries report stocking to some degree as more conventional approaches to management have failed to control decline in the fish stocks. An estimated 20 billion individual salmon, of various juvenile life stages, mainly eggs and fry, were stocked in 1998. High levels of stocking were also found for rainbow trout, coregonids, whitefish, eel, common carp and various cyprinids to support recreational and commercial inland fisheries. Licensing is the most widely used technique to exercise legal and administrative control over stock enhancement activities.

Most stock enhancement activities, either deliberate or accidental, have had negative effects on indigenous fish communities and other fauna through predation, competition, loss of genetic integrity, reduction of biodiversity, introduction of pathogens and change in ecosystem dynamics. There is paucity of information about the efficacy of stock enhancement activities both from the production and economic perspectives and thus a real need for comprehensive cost:benefit analyses of stocking operations, as well as other enhancement activities.

Intoduction

The stocking, transfer or introduction of fish species is a practice frequently used in the belief they will improve the quantity or quality of catches and have long-term beneficial effects on fish stocks. This paper examines the importance and impact of operations to enhance fish stocks in fresh waters in Western Europe. Information was collected from European Union (EU) member states, available literature and other international agencies, for the period 1985-1997. Capture fisheries production in EU countries has been relatively stable since 1985 (Figure 1), fluctuating between about 970 000 t and 122 000 t, with an estimated value of 350 million ECU in 1997. Sport and subsistence recreational fishing are extremely important activities in EU countries, but in recent years they have undergone major, often adverse, changes. Aquaculture production from inland waters in EU countries has increased by 17% per year from 180 000 t in 1985 to 400 000 t in 1997 (Figue 1). By contrast the increase in production for stocking was about 7% per year from around 4 000 t in 1985 to 7 500 t in 1997.

The estimated total value of inland production from the EU member states in 1997 was about US$ 1160 million of which over US$ 819 million was generated from aquaculture (Cowx and Godkin, 1999). Of the total aquaculture production, approximately US$ 87 million was for stocking purposes.

The socio-economic importance of inland fisheries does not lie at a national level, the numbers employed (<5 000) and the value of the sub-sector are low in relation to the fisheries sector as a whole. Its importance lies in the contribution made to local social and economic welfare. However, recreational fisheries have great potential to generate employment (and additional income generation) externally. Investment by the EU in this sector is marginal and mainly targeted at aquaculture.

All EU countries report stocking to some degree as more conventional approaches to management have failed to control decline in the fish stocks. Information on quantities of fish stocked was difficult to access. Salmon probably represents the species that has

received the greatest attention, with a huge increase in the volume stocked, to an estimated 20 billion individuals, of various juvenile life stages, mainly eggs and fry in 1998 (see Figue 2). High levels of stocking were also recorded for rainbow trout, coregonids, whitefish, eel, common carp and various cyprinids to support recreational and commercial inland fisheries. The frequency of fish introductions into individual countries varies considerably (Cowx, 1996): Italy (50 new species) contributes most to introductions followed by the UK (38 new species) and France (36 new species). Information on the reasons for introductions are incomplete but the principal reasons were aquaculture (19.8%) and improvement in wild stocks (46.6%) (Cowx, 1997; Cowx and Godkin, 1999).

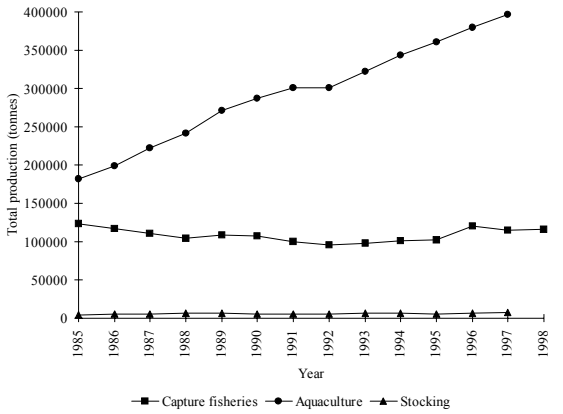

Figure 1 Total EU production (tonnes) for capture fisheries, aquaculture and stocking.

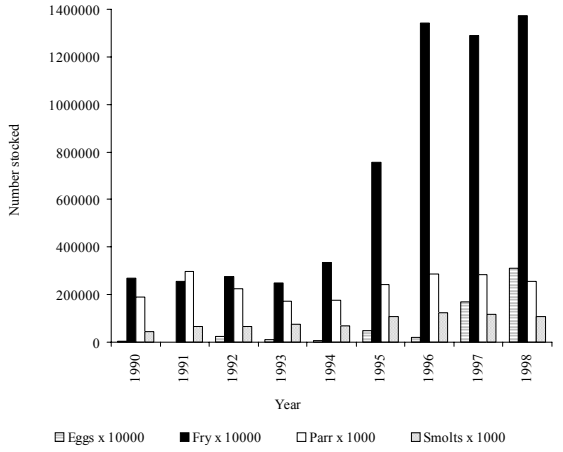

Figure 2 Numbers of Atlantic salmon of various life stages stocked in EU countries from 1990 to 1998

Licensing is the most widely used technique to exercise legal and administrative control over stock enhancement activities. There appears to be no banning of fish transfers *per se* or introduction of exotic species, although the latter is regulated under the EU Habitats Directive and Animal Health Directive.

Most stock enhancement activities, either deliberate or accidental, have had negative effects on indigenous fish communities and other fauna through predation, competition, loss of genetic integrity, reduction of biodiversity, introduction of pathogens and change in ecosystem dynamics (Cowx, 1998). The general opinion about introductions is that they are detrimental, and the effects are usually irreversible. There is also paucity of information about the efficacy of stock enhancement activities both from the production and economic perspectives and thus a real need for comprehensive cost-benefit analyses of stocking operations, as well as other enhancement activities, to be undertaken on a national and international basis.

It appears that little, or no consideration, is given to the fish and fisheries in development proposals. Natural fisheries are all too often being replaced by fisheries that are sustained through stock enhancement strategies. If this situation is not to deteriorate further, the reasons behind the general demise of the stocks need to be identified, and mechanisms to ameliorate problems and enhance the fisheries are required. Concerns over the introduction of a new species are similar to those for stocking. Introductions are generally irreversible and proposals for new introductions call for extreme caution.

Recreational and commercial inland fisheries represent an extremely important commodity which is under threat from many sources. These fisheries need sound development proposals that will maintain and enhance their role to the community including:

- maintaining the fisheries in the face of other aquatic resource developments;
- identifying mechanisms by which the dependence on operations to reinforce the aquatic fauna do not conflict with environmental issues;
- identifying alternative mechanisms to enhance the fisheries other than stocking; and
- investment in the sector to promote inland fisheries, especially recreational fisheries.

There are a number of strategies that should be adopted to minimise the potential impact of stocking operations.

- Develop a code of practice to minimise the potential detrimental effects of impact of stocking on indigenous fish stocks and the environment (see for example Figure 3 from Cowx, 1999)
- If stocking is necessary, develop mechanisms or protocols to improve the efficacy of stocking operations (see Figure 4 for example from Cowx 1994).
- The introduction of new species should be avoided where possible or carried out under appropriate government guidelines (see EIFAC/ICES code of practice, 1988 and Coates, 1998).
- Develop strategies which will minimise the genetic effects of cultured fish and introduction of differ-

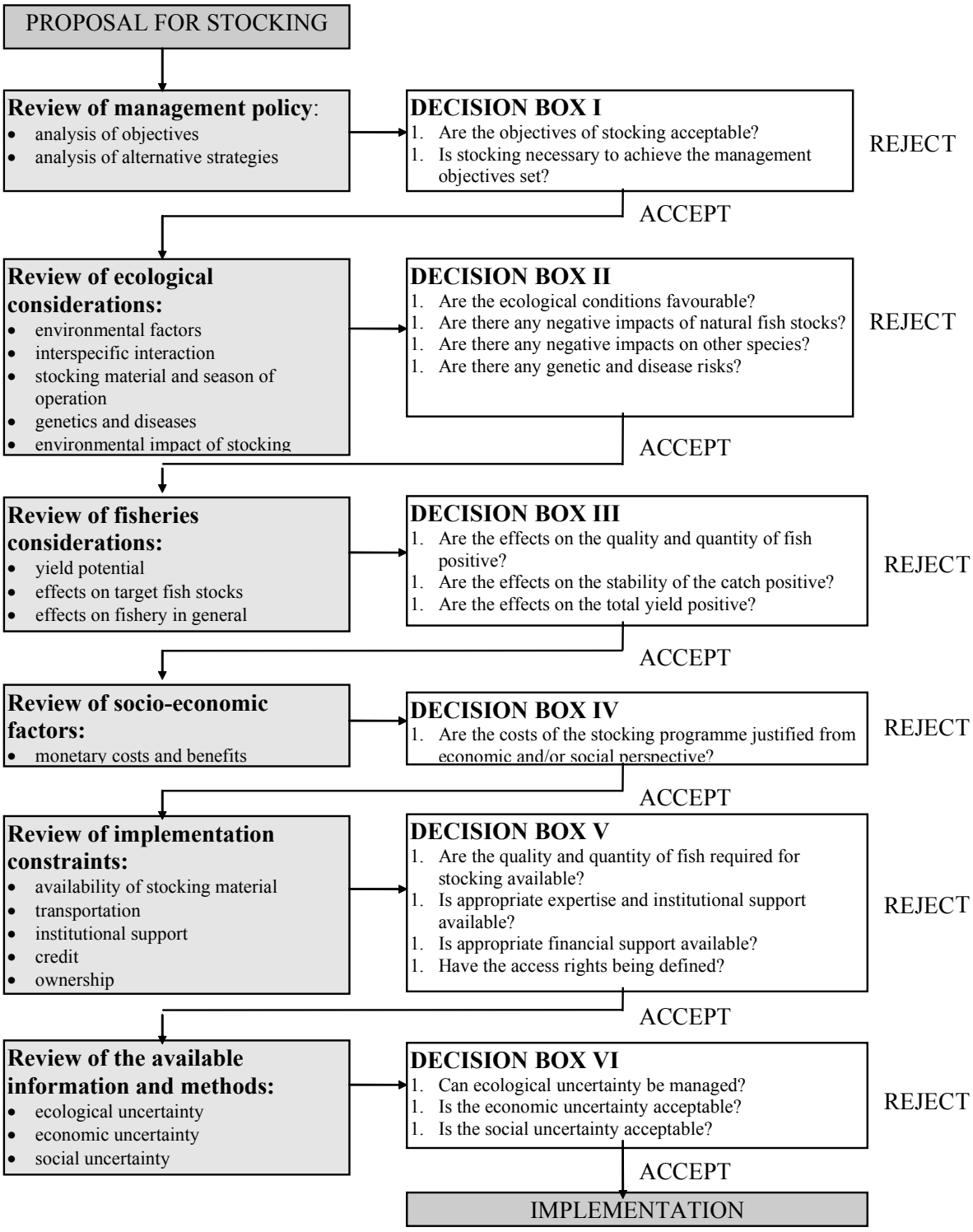

Figure 3. A scheme for planning stocking programmes. Review boxes on the left illustrate the different levels of data collection and processing and decision boxes on the right the respective decision levels with some relevant question. Stocking should be rejected if any answers to the questions are negative (from Cowx 1999)

ent strains on the wild stocks of the recipient water body.
- Improve control over fish movements to stem the continuing dispersion of pathogens and the accidental introduction of fish in consignments of a target species.
- Investment in inland fisheries should be forthcoming in any future development programmes

The strategies should be coupled with two major areas of development:

- improved management of inland fisheries, including rehabilitation of degraded fisheries; and
- development of fish farms specifically set up to support stocking for inland fisheries.

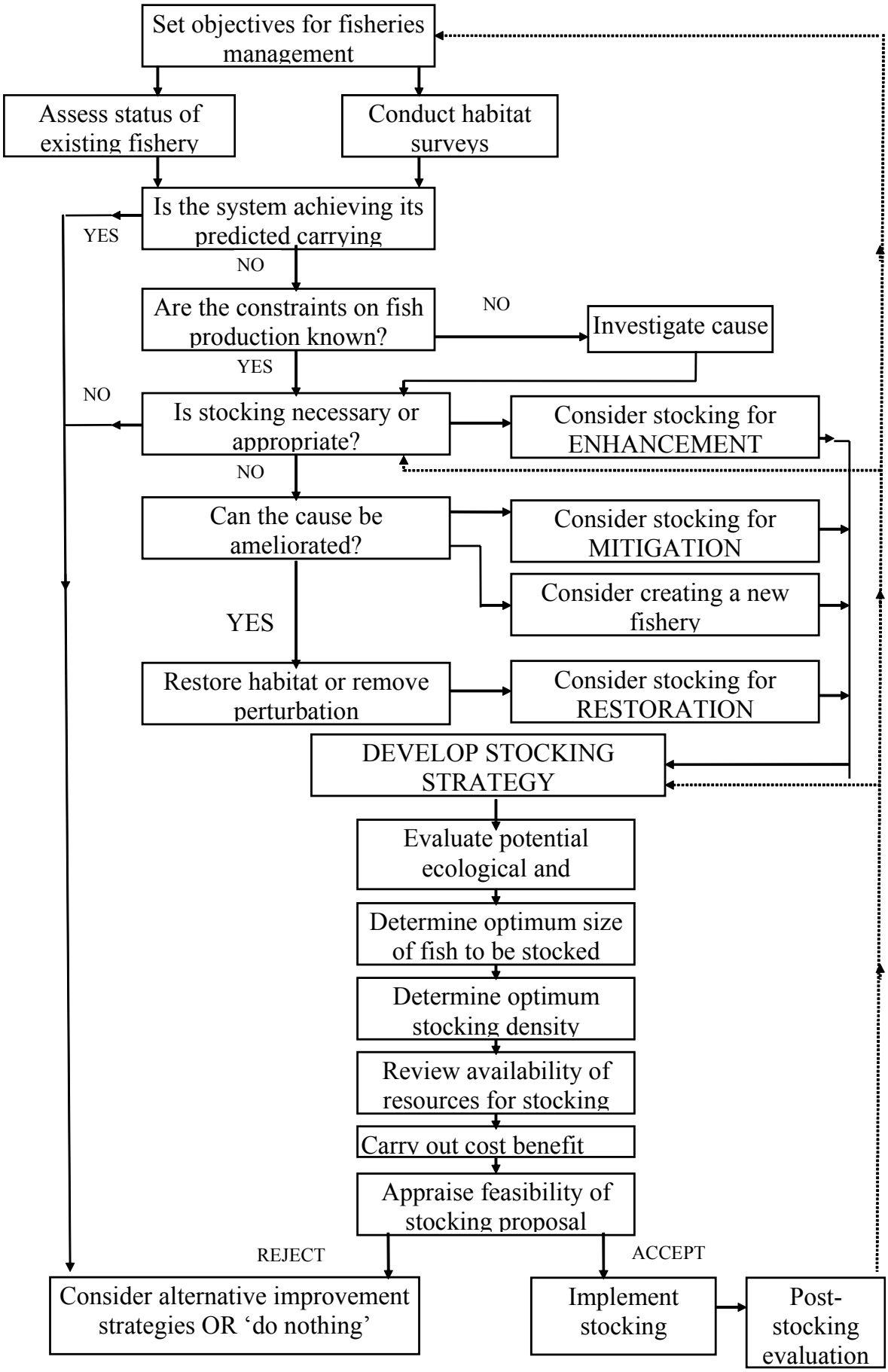

Figure 4. Suggested strategy for evaluating a stocking programme to minimize the potential risk, maximize the potential benefit and monitor the success of the project (from Cowx 1994)

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THE DEVELOPMENT OF FLYFISHING AS A RECREATIONAL SPORT IN SOUTHERN AFRICA

Martin T.T. Davies

Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown 6139, South Africa

Abstract

Flyfishing is a rapidly growing envirosport in southern Africa. Its origins go back to the acclimatisation and subsequent culture of brown trout (*Salmo trutta*) in the late nineteenth century in the Cape Province(s) of South Africa. A close relationship between aquaculture and the development of this fishery was largely controlled and administered by provincial nature conservation departments until about 1980. During this period, these bodies reared and introduced rainbow trout (O*ncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*) and three freshwater bass species (M*icropterus salmoides, M. dolomieu* and *M. punctatus*) throughout the region, with some also being transported and established from the same seed source into Swaziland, Lesotho, Malawi, Tanzania and even Uganda and Kenya.

In South Africa, subsequent official policy changes towards exotic fish species' culture and their introductions have caused privatisation of the hatcheries in the Western and Eastern Cape Provinces and Mpumalanga, with a subsequent deregulation of the recreational fishery throughout the country. Accompanied by this, has been a rapid proliferation of trout farming and fishing activity especially in the two Cape Provinces and Mpumalanga where in the latter, extensive syndicated fisheries exist alongside fewer, more accessible commercial flyfisheries. Many clubs, societies, associations etc. have recently made much of their flyfishing accessible to non-members, thus making available vast fisheries hitherto largely closed, to local and international tourists . In the last 15 years, this has also helped lead to the development of extensive inland flyfisheries for "new" indigenous fish.

During this period, estuarine and saltwater flyfishing has also seen a rapid expansion, and although in its infancy, many hard-fighting game fish species can be caught along the extensive coastline from the cool western coast waters of South Africa to the tropical northern coast of Moæambique.

Structurally, this recreational fishery operates under the auspices of private, public and commercial right of access, with limited or no government controlling bodies, largely ineffective licensing systems and poor controls. In South Africa relevant research and development is primarily undertaken by certain universities who recommend management guidelines (i.e. stocking strategies, GIS tools, habitat improvement methods etc.) to the main representative flyfishing body, the Federation of Southern African Flyfishers (FOSAF). No major conflicts exist as yet between different fishery sectors and flyfishing.

This recreational fishery is in a rapid growth phase with new and exciting saltwater and freshwater venues and species continually being identified.

Introduction

Traditionally, the roots of flyfishing lie with trout and salmon angling in the United Kingdom, where it has been recognised as an important and valuable recreational fishing method since the seventeenth century. Extensive colonisation from Britain in the eighteen hundreds resulted in the spread of the sport, its protocol and fish to all the continents except Antarctica.

The technology for trout farming was well enough understood so that fertilised eggs could be shipped in chilled containers to South Africa. Although attempts to establish brown trout in the Cape Province were made as early as 1875, the first major hatching successes from egg importations were at the Anneberg Brewery, Newlands in Cape Town between 1892 and 1894 (Ness, 1991). It was only with the establishment of hatcheries in the Eastern Cape at Pirie, King William's Town, in 1891 and at Jonkershoëk, Stellenbosch in the Western Cape in 1893, that trout acclimatised to the reversal of seasons in the southern hemisphere and could be produced and stocked reliably. Other provincial trout farms were later established in Mpumalanga at Lydenberg and in KwaZulu Natal for this purpose. Initially brown trout (*Salmo trutta*) and shortly afterwards rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*) were stocked into as many "suitable" waters as possible. This stocking was legitimised by the passage of Act No. 10 of 1867 of the Cape Government "*for encouraging the introduction into the waters of this colony of fishes not native to such waters*" (Ness, 1991). It was thought that such introductions would be able to provide good quality flyfishing that the small or coarse (i.e. non-gamefish) indigenous spe-

cies (some later considered as pests) could not (Impson, 1995). It was from newly established trout farms that these species (but not the over-sensitive brook trout) which did not acclimatise, were successfully introduced into Lesotho, Swaziland, Zimbabwe, Tanzania, Uganda and even Kenya.

Other alien fish introductions that later became the target of flyfishers were produced and stocked from the 1930's onwards (Hamman, 1986). These included the largemouth, smallmouth and spotted black bass *(Micropterous salmoides, M.dolmieu* and M.*punctatus* respectively). Up until 1986 fish production facilities were important in an introduced species-based recreational fishery. The bulk of the stockings were controlled and funded by the provincial nature conservation departments/boards. The sport was also protected by provincial ordinances so that in the case of trout fishing for example there was a closed season, bag and size limit and fishing was to be by use of recognised, and therefore traditional, fly tackle only. Official support had allowed people through their dedication, effort and pioneering spirit to work tirelessly to establish their native fish in their adopted homelands for their preferred sport. Flyfishing had come of age in southern Africa. No-one at that time could have anticipated the revolution the sport was about to undergo.

The conservation dilemma

During the 1970s, many clubs/societies were having their waters stocked for no charge as long as they only levied their members a nominal fee. It was thought this would make the sport more readily accessible. Unfortunately it had the opposite effect, so that the Eastern Cape clubs tended to selfishly guard their waters by limiting membership and not allowing access to non-members. In this way they became exclusive, similarly to the rapid proliferation of private syndicates in Mpumalanga (then Eastern Transvaal), who bought their fish as well as access to waters, but developed their fishing often in an unregulated fashion and closed it completely to non-syndicate members. Flyfishing in the 1970s and up until 1982 had thus become mainly exclusive in most of South Africa except in the Western Cape and parts of KwaZulu Natal.

Coincidentally, during this period, surveys were beginning to reveal significant declines in both numbers and distributions of indigenous Western Cape fishes many of which were endemics. This was of great concern, especially when several of these species were listed as threatened (Skelton, 1986). It was realised that exotic fish introductions in conjunction with weir and dam construction, water abstraction schemes, pollution, afforestation etc all must have played their part in these declines. Unfortunately, the conservation authorities only had jurisdiction over the fish. In order to demonstrate to the public a will to act, they removed all existing legislation protecting this recreational fishery but gave notice of their intention to curtail and then stop all trout production and stocking programmes, although they would encourage the private sector to take over this role. They felt it should be their mandate to protect only "the indigenous flora and fauna" of the Cape Province and not naturalised well-established, but introduced species that provided a sport to relatively few people (Hamman, 1986). Many thought these moves draconian, as the unobserved impacts of trout to aquatic fauna would have occurred by the late 1920s, as most of the smaller streams had been stocked by then (Hey, 1928) and already had well established breeding populations of trout. Furthermore, it was considered that the few species thought to have been directly impacted by trout alone were small, localised and restricted mainly to upper catchments, where the water was clear and cooler (Skelton, 1986). It was almost certainly unwise therefore to remove protection from a valuable recreational fishery created by the introduction of trout into southern Africa (Jackson, 1986; Bruton, 1986). This debate still continues today, whilst afforestation and rampant soil erosion occur in important catchments of the Eastern Cape province. An area which contains resident populations of trout that are now also becoming threatened.

Infrastructure

South Africa is more the exception than the rule as it does not have a national department or division of inland fisheries. This means that structurally this recreational fishery operates mostly under the auspices of private and/or commercial, rather than public right of access. It has largely ineffective licensing and permit systems and often has poor controls at every level. Relevant research and development is primarily undertaken by certain universities with a limited funding base who can only recommend management guidelines i.e. stocking strategies, habitat improvement methods etc. There is a co-responsibility towards this sport, however, which has developed through necessity by those who interrelate with it (Davies, 1986).

Many important positive developments have occurred largely as a direct result of the reduced involvement of provincial departments in fish production. Twelve clubs and societies, representing 1 000 flyfishers, came together in 1982 to form the Federation of Eastern Cape Trout Angling Clubs (FECTAC). Their sport was threatened, so a spirit of unity and awareness prevailed throughout, such that had not been seen in nearly 100 years. New waters were opened and all those club waters that had been previously closed were made available to day-permit holders, so extra income could

be generated to purchase fish to stock when necessary. New relationships were developed, now that those representing this fishery spoke with one voice e.g. FECTAC and the Department of Ichthyology and Fisheries Science established a close working relationship. Good quality selected fish stocks were made available for teaching, research and stocking purposes, whilst FECTAC provided logistical and funding support. Departmental personnel also provided fisheries guidance to the Federation and were responsible for designing and developing four other trout farms to assist with the increased stocking requirements of the growing fishery.

It was realised by FECTAC and others, that it's ideals and successes should be of benefit to recreational flyfishing throughout all of southern Africa and hence the more representative Federation of Southern African Flyfishers (FOSAF) was constituted in 1986. Subsequently, four magazines, two dedicated entirely to flyfishing, helped popularise and inform an ever-growing and enthusiastic readership.

These circumstances and a proliferation of supporting infrastructure i.e. tackle shops, flytying factories, commercial/non-commercial flyfishing venues and destinations etc., has caused a recent rapid expansion in flyfishing. This growth has contributed towards the rapid proliferation of a supporting trout farming industry, especially in Mpumalanga and the Western and Eastern Capes. Ironically this expansion was assisted in part by the lack of subsidised trout being produced by the old provincial trout farms.

Although closed syndicated waters still predominate in Mpumalanga, many others areas have become available here as well as in the Free State and other provinces. For example, the Wild Trout Association (WTA) in the Lesotho border region of the N.E. Cape where anglers can flyfish on approximately 500 km of streams and rivers which hold good populations of wild trout and yellowfish (*Labeobarbus* spp.).

Along with the proliferation of trout-fishing venues and destinations has come the discovery of many new target species in freshwater. These include yellowfish, the largest species of which can attain over 22 kg, tigerfish, *Hydrocynus vittatus* (15 kg), sharptooth catfish, *Clarias gariepinus* (59 kg) as well as several bream species amongst others. Since 1990, estuarine and saltwater flyfishing has seen a rapid expansion where many hard fighting species can be caught from the cool western coastal waters of South Africa to the tropical north coast of Mozambique. It is envisaged that as Angola and the Democratic Republic of Congo become more politically stable vast undiscovered salt and freshwater recreational flyfishing areas and species will become available.

Conclusions

Recreational flyfishing in southern Africa has and still is largely dominated by trout fishing which is supported by a strong trout farming sector. The fishery is more than 100 years old, but has shown the most rapid expansion during the past 15 years. During this time: its infrastructure has expanded significantly; FOSAF has played a pivotal co-ordination and funding role amongst others; more target species in both fresh and saltwater have been identified; the fishery is broader-based (women and children are actively encouraged to join in the sport by FOSAF) and more accessible. It suffers, however, from lack of government support, a lack of a funding base, no effective legislative protection, poor licensing and law enforcement components and an inadequate research and development base, in proportion to its relatively large size and economic importance.

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THE ROLE OF THE FEDERATION OF SOUTHERN AFRICAN FLYFISHERS AS THE REPRESENTATIVE BODY OF FLYFISHING IN SOUTHERN AFRICA

Brian von Holdt[1], Martin T. T. Davies[2] and Leonard J. H. Olyott[2]

[1] Federation of Southern African Flyfishers, Blaauwkrantz Farm, Belmont Valley, Grahamstown, 6139, South Africa
[2] Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, 6139, South Africa

Abstract

The Federation of Southern African Flyfishers (FOSAF) was constituted in 1986, following the withdrawal of all protective legislation for trout and the closure of government hatcheries in the former Cape Province of South Africa, which left a void in the provision of trout fishing opportunities to the flyfishing community.

FOSAF's role soon developed into a national effort to serve the interests of flyfishing and flyfishermen on a much broader scale. The Federation resolved to operate regionally in five provinces through the structure of chapters which report to a national executive. Trout were initially the prime target of the majority of flyfishers but in recent years, interest in the angling qualities of indigenous species such as tigerfish and yellowfish as well as the untapped potential of numerous saltwater species, has increased exponentially. FOSAF has initiated the establishment of interest groups and made funding available for the development of fishing for these species as well as making representation to government regarding the management of these resources.

The organization furthermore, offers a wide range of services to the flyfishing community including the staging of workshops, the provision of guidelines for flyfishing festivals and the publication of a biannual guide to flyfishing venues for use by local anglers in general and overseas visitors in particular. Catchment management research and wetland conservation also feature strongly amongst FOSAF's activities. The development of sustainable eco-tourism by introducing managed flyfishing in rural communities has also been initiated. Academically, various university projects have been supported and sponsored by FOSAF. The recent development of a junior South African flyfishing club (FLY) is also supported by FOSAF. An informative webpage provides regional overviews and reports on fishing condition around the country.

The objectives of FOSAF are encapsulated within a constitution that is based on sound environmental principles. This ensures that the Federation is the leading proponent of the sport of flyfishing on the African continent and will continue to play a role in the management and development of recreational fishing in the region.

Introduction

The main aims of the Federation of Southern African Flyfishers (FOSAF) are to promote and unite amateur flyfishers and their organisations in southern Africa. A forum has been created that represents the interests of flyfishing that can give direction and assistance to the sport. It can provide a guidance and liaison role and can help provide and improve flyfishing facilities whenever possible.

Before FOSAF was constituted in 1986, flyfishing was managed by various angling bodies throughout the southern and eastern regions of South Africa (SA). The majority of these clubs and societies were, and still are, trout-orientated. The conservation authorities had supported and encouraged trout fishing as a recreational activity and subsidised trout hatcheries were funded to ensure a continuous supply of fish for the replenishment of stock in all angling regions.

The provincial authorities, with protective legislation for trout on the statute book, promoted and protected the sport. From 1978 onwards, the Nature Conservation authorities in the Cape Province began to adopt a new stance. The emphasis shifted away from protection of trout to that of the indigenous fish species, of which a substantial number were in decline. The trout and other exotic predator species, such as black bass, became known as undesirable aliens, and were held partially responsible for the plight of certain indigenous fish species. The protective legislation for trout was rescinded. The production of trout for stocking purposes was immediately curtailed at both of the hatcheries serving the Cape region followed closely by those in the Eastern Transvaal (now known as Mpumalanga).

This unilateral action by the Provincial Government was seen by anglers as the death knell of still-water trout fishing in the Cape Province. It was this crisis

which prompted a concerned group of Eastern Cape flyfishermen, led by the late Fred Croney to call a meeting of sympathisers, to discuss the dilemma and to later (1982) constitute the Federation of Eastern Cape Trout Angling Clubs (FECTAC). The elected committee was deputised to approach the Department of Ichthyology and Fisheries Science (DIFS) at Rhodes University in Grahamstown to help rescue, sustain and improve this important regional fishery. The aim was to establish a relationship between the DIFS and FOSAF (East Cape Chapter) that would secure the supply of fry and fingerlings for the recreational fishery, whilst the department would have the fish for their teaching and research programmes as well as receiving logistical and financial support. An agreement was successfully concluded and the crisis averted.

Further meetings were convened, and attended by delegates from across the country. A national body was then constituted, the main aims of which have been stated. Five autonomous regional chapters were declared, Western Cape, Eastern Cape, Transvaal, Orange Free State and Natal. Each was represented on a National Committee, and answerable to this body. With the infrastructure in place, FOSAF was then able to commence business. FECTAC had evolved into the more representative FOSAF, which was officially constituted in the Eastern Cape in 1986.

As all of the clubs were primarily concerned with flyfishing for trout, FOSAF's initially effort, was devoted to the development, protection and conservation of this resource. It became necessary for FOSAF to create a voice for its philosophy and policy. It needed to establish widespread contact with its constituency. Threrfore, a partnership was established with a publishing company, which soon led to the production of a magazine, called *Flyfishing*, which represented to a substantial degree, the viewpoints of FOSAF. This magazine, the first of its kind dedicated to flyfishing, was launched in 1987. For fourteen years it has served FOSAF and the flyfishing public as an efficient promotional vehicle. Another flyfishing publication has entered the market more recently, and it was deemed necessary by the FOSAF executive to sever its links with *Flyfishing* and permit free competition in the market place.

The fourth clause of our constitution reads: "*to promote conservation generally and research particularly into fresh water ecology*". This prompted the staging of WORKSHOP'94 by our Northvaal (Gauteng, Mpumalanga, North West and Northern Provinces) Chapter. Thirty-three scientists, ecologists and experts in related matters were invited to deliver their viewpoints regarding the preservation, conservation and development of our rivers, catchments, aquatic systems and the management of the flyfishing resources in them in particular. The workshop led to the establishment of a valuable set of guidelines for implementation by FOSAF and other institutions (FOSAF, 1994). High priority projects to be visited included the following:

1. assessment of the economic benefits of flyfishing to regional economies in South Africa;
2. the impacts and control of alien invasive plants occupying catchment areas and riverine environments;
3. the establishment of water quality standards for gamefish and their aquatic habitats;
4. the establishment of minimum streamflow levels for recreation and conservation purposes;
5. restoration of the ecology and development of management measures for aquatic environments; and
6. the production of a book on flyfishing venues in southern Africa.

Other issues such as appropriate legislation, research, sustainable agricultural practices, flyfishing and tourism as well as flyfishing ethics and professionalism (i.e. guiding) were also discussed and evaluated. The implementation of these guidelines has and will continue to represent some of the activities of FOSAF.

In 1997, another workshop was arranged by the FOSAF Northvaal chapter regarding the diverse opinions prevailing about the management of trout stocked stillwaters. High quality contributions by fisheries scientists and others who attended, introduced a new outlook to the management of this resource. FOSAF, in keeping with the guidelines from WORKSHOP'94, recruited the services of a Masters student at the University of Stellenbosch to undertake an economic survey of the flyfishing industry in southern Africa. Vital information about to the status and economic importance of flyfishing (more than R121M annual turnover) has enabled FOSAF to lobby and to plan with assurance, the great effort required to meet the needs of a rapidly expanding angling discipline.

Although heavily committed to flyfishing, FOSAF has assumed a strong supportive role for the conservation and protection of the many indigenous fish species, which are the primary concern of the professional conservationists. Research projects at a number of universities have been funded by FOSAF. Fish conservationists have also been assisted to attend international symposia to highlight the plight and to promote the status of threatened, indigenous species in southern Africa. Mindful of its obligations regarding research and development, and the promotion of tourism, in 1999 FOSAF made funds available for a study to explore the level of support amongst a rural community for the establishment of a community-based flyfishing envirotourism project, for potential income generation. The project, which has set out to examine

the potential for trout fishing in a remote area of the Eastern Cape Province has yielded promising results.

One of FOSAF's major aims is to facilitate and promote the development and provision of new angling opportunities for the rapidly growing flyfishing public to make more fishing water available, accessible and affordable. As a result FOSAF gave strong support to the development of the Wild Trout Association (WTA) of the Eastern Cape Highlands. The WTA was constituted in 1990. It brought together riparian owners, who normally had not allowed access to the rivers and streams flowing over their privately owned land.

Through the WTA, they control their own, shared resource, instead of the fishing being in the hands of anglers, clubs and syndicates. The anglers generate income and the farmer maintained control and obtained fisheries advice, whilst the Association levied a percentage of rod fees to cover administration and marketing costs. Approximately 500 km of private river and stream fishing and many still-waters have become available to the flyfisherman. It is now in the farmers' interests to conserve this common resource for the benefit of flyfishers and the environment alike.

The WTA introduced GIS technology which was later promoted and partially funded by FOSAF. After several years of adjustment and adaptation to the needs of the WTA, the Sport Fisheries Information and Management System (SFIMS) has recently been activated. The benefits to anglers, administrators, riparian owners and fisheries management are immense. The expansion of the SFIMS to other regions throughout southern Africa is inevitable, particularly with regard to its capabilities in fisheries management.

Prior to 1996, there was no national guide book to flyfishing venues in southern Africa. FOSAF, together with the Nedcor banking group, published the first edition of the *'Nedbank guide to flyfishing venues in southern Africa'* (Wolhuter, 1996). The third edition, dramatically larger, and a far more comprehensive guide, was published in 2000, and has already sold out. The fourth edition will be available in November 2002 and demand for it is rising rapidly. It has been designed for both the local angling community and visitors to the country to identify flyfishing venues and accommodation. It is planned to publish updated editions every two years.

Due to the rapidly growing interest over the last ten years of flyfishers in the capture of indigenous fish species, FOSAF, of necessity has also adapted it's policy. In 1996, a specialist grouping, the Yellowfish Working Group (YWG), was formed to promote flyfishing for, and protection of, the yellowfish (*Labeobarbus* spp. and *Barbus* spp.) and other closely related species. Yellowfish are indigenous to the region and rate very highly as angling fish to flyfishers and also lure and bait anglers. The successful functioning of the YWG has prompted FOSAF to introduce both a Tigerfish Working Group (TWG) and a Saltwater Working Group (SWG) similar to the YWG, to fulfil the needs of the interest groups concerned.

The youthful component and enthusiasm of flyfishing is kept at a high level, with opportunities to improve skills encouraged by staging instructive clinics in the various centres around the country. These clinics are popular, and there is good attendance. Young anglers have also been assisted by FOSAF to form their own Flyfishing Club (FLY). Their activities are featured in every edition of one of the popular flyfishing magazines in South Africa. FOSAF has provided support for the promotion of flyfishing as a woman's sport by providing logistical support and instructors for the three annual Pajero ladies flyfishing festivals held so far.

FOSAF's role in flyfishing has increased in keeping with the expansion of the sport fishery. This will continue apace as more indigenous freshwater and saltwater gamefish are targeted by flyfishers and its relationship with respected institutions such as Rhodes University continues to develop. The growing interest of many flyfishers in competitions at regional and international levels will also require FOSAF involvement. The ongoing demands for the implementation of the guidelines from the 1994 worshop will require the dedication and determination of the organisation for many years to come.

Flyfishing in SA has succeeded in reaching world class excellence and as such will continue to play a significant part in attracting flyfishing tourism from abroad. Our presence and participation at this recreational fishing conference is testament to our belief that South Africa should strive towards the establishment of greater contact and involvement with the international community to promote recreational fishing generally and also to make it known that we have much to offer the visiting angler in our country and subcontinent.

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FINANCIAL BENEFICIARIES OF INCREASED EXPLOITATION MUST SHARE THE RESPONSIBILTY FOR ASSESSING IMPACTS

Daniel J Gaughan

Department of Fisheries, Government of WA, PO Box 20, North Beach, WA 6920, Australia

Abstract

CATCH MORE FISH FASTER!! For many, this is the perceived goal of the majority of anglers. Employing a new product or fishing system may dramatically increase fishing efficiency of the general fishing public, thereby increasing exploitation rates – in simple terms, more fish will be caught. This new product may not only increase fishing efficiency, but will also apparently be so easy to use that more people may take up fishing simply because it looks too good to be true. Fishing really is fun! Thus, there may be an increase in effort, as well as an increase in efficiency. Given the traditionally poor knowledge-base regarding abundance of many wild populations of fish species, due to, for example, poor estimates of both effort and catch, our historical knowledge-base is becoming less and less useful. As increases in real effort become more difficult to keep track of, the historical information may even become irrelevant. Should the producer of the new wonder-product contribute to research into sustainability of the resources that the new product now makes easier to exploit? Part of the problem in answering this question is that because of the dramatic changes in efficiency, it remains very difficult to assess whether or not there is in fact a threat to sustainability of the targeted resources. Although the producer of the wonder-product is a business that makes money through sales of the product, ultimately their income depends on sustainability of fish. Indeed, it is in their interest to sell more product and, thus, to increase exploitation rates of fish. It therefore seems appropriate that the producers of the wonder–product contribute in a direct manner towards increasing our understanding of stock size and sustainability – it would be in their long-term interests to do so.

Increases in capacity

Tuna farming in the Mediterranean is thought to not only be causing over-fishing of the resource, but through consistency of supply to markets is also increasing demand – the recreational fishing community would not tolerate the expansion of a competing commercial fishing enterprise. This example is provided to highlight to the recreational fishing community (RCF, the people that go fishing) that they should be aware that increases in capacity are also being promoted for their own group. Thus, there are ongoing increases in capacity, through a combination of increases in participation, effort, and efficiency that ultimately lead to more fish being caught. I contend that the recreational fishing industry (RFI, those that make money out of those that go fishing), are responsible for promoting ongoing increases in capacity and therefore need to assist with determining the impacts of increasing capacity – in other words, what level of catch is sustainable. The "new product" cryptically referred to in the abstract is information, whether this be available through the traditional print- and electronic- media or from the internet. I focus on the angling information sector of the RFI later in this paper because of the critical role that information plays in affecting change.

Capacity and funding in USA

The USA model of funding for recreational fishing is known as the Wallop-Breaux Program. "Wallop-Breaux" is a 1984 amendment to the Federal Aid in Sports Fishing Restoration Act (FASFRA) of 1952. The fund receives its inputs from federal excise taxes; because the taxes redirected under FASFRA are those that can be attributed back to expenditure by the RFC (e.g. fishing equipment), FASFRA is seen as a user-pays program and therefore is strongly supported by the RFC and the RFI. FASFRA funds are distributed to state-level groups and authorities, primarily for restoring sport fisheries.

It is the policy of the USA to promote sport fishing. Through FASFRA, projects increase capacity in the RFC and through this expansion also benefits the industries directly involved with recreational fishing as well as support industries. Because restoration in marine fisheries has a very weak history of success, by default the focus of FASFRA on restoration means a focus on freshwater fisheries. However, FASFRA funds can also be directed into marine fisheries, and indeed must be equitably distributed between freshwater and marine fisheries according to the relative levels of angler participation. A "marine" example is

the use of FASFRA funds by the Gulf States Marine Fisheries Commission to conduct research required to decrease mortality rates of several recreationally important marine fish. In this case, FASFRA funds are being used to address sustainability issues, rather than simply increasing fishing and boating opportunities. In freshwater situations sustainability may well not be an issue if the anglers are happy catching stocked rather than wild fish; this is not yet an option for most marine fish species.

There has been some criticism of the process of distributing FASFRA funds, primarily relating to a perceived conflict of interest for state fisheries agencies attempting to access the funds. The concern is that the availability of significant funds for recreational fishing issues will lead to biases against commercial fishing interests. Regardless of the validity of this contention, a reasonable question regarding expansion and expenditure of the RFC is "Where are the fish coming from to support the expansion?". This argument is well founded for marine species (including estuarine species) and also for freshwater fish in those cases where increased capacity is directed towards wild populations.

Capacity but no funding in Australia.

In Australia, promotion of angling as an activity aims to increase or maintain participation rates, while provision of knowledge through selling information increases efficiency: even without population growth these factors must increase fishing capacity But, in contrast to USA, there has been no concomitant federal funding strategy in Australia to assess the impacts of increases in capacity. Perhaps the information providers can inform the RFC on this issue and thereby empower them to induce change at the required political level.

Information and attitudes

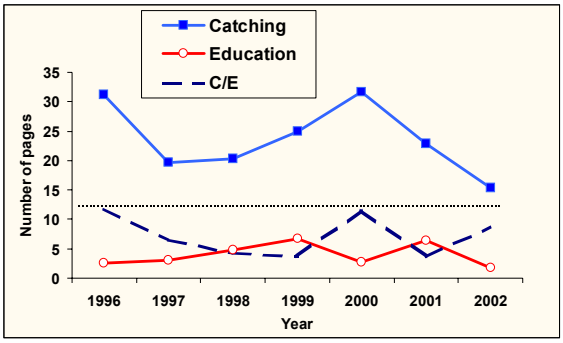

Figure 1. Numbers of pages devoted to catching fish and to educational information for fishing magazines in Australia between 1996 and 2002. The numbers shown are mean pages per issue for a sample of four magazines each year. C/E is the ratio of the two. The C/E ratio for similarly collected data in 1979 is shown as a dotted line.

Australia's fisheries management agencies and angling organizations have developed "ethics" or "code-of-conduct" statements that promote angling as being more than just about catching fish – the experience is also very important. However, this same attitude is not so apparent in the angling media, where the attitude of catching more and more fish is often still apparent. The general constituency of the RFC are well and truly ready to be exposed to issues of sustainability, rather than being exposed only to issues pertaining to allocation.

I undertook a contents analysis of Australian fishing magazines published between 1996 and 2002 (4 randomly chosen each year) to assess whether or not there had been an attitude change associated with the strong growth in the RFC and RFI. Numbers of pages on how and where to catch fish (i.e. information that increases knowledge and therefore capacity) were compared against those devoted to education and or sustainability. No obvious trends were apparent in the seven years (Figure 1). Sustainability is still not an issue being promoted by the fishing media. To determine if there had been any longer term trends, data for 1979 was similarly collected. The catching to education ratio (C/E ratio) did not improve (Figure 1) from 1996 to 2002 and for each year in this period the C/E ratio was less than that for 1979. The media are well positioned to promote an attitudinal change that highlights the fishing experience rather than the size of the take home catch. Also, while catch-and-release is now heavily promoted, post-release mortality is not typically acknowledged. The information sector of the RFI has a responsibility to balance the messages being given to the RFC.

Planning ahead

Finally, if recreational fishing is worth more than A$2 billion annually in Australia, then the RFI as a whole can be considered as a major fishing industry in Australia. As such, it can be considered as a commercial fishery that relies on sustainable fish stocks. There is thus a funding discrepancy, highlighted by the fact that Australia does not have a FASFRA type of program, but has a large industry heavily reliant on increases in capacity for future growth. If this is to continue, then these industries must contribute to their own futures by investing in R&D. If diversion of federally collected taxes will not be accepted, for example because of Australia's much smaller tax base, then another form of collecting R&D contributions needs to be developed. This is not a trivial exercise because the RFI is extremely widespread and diverse. Such an undertaking would therefore require considerable funding in itself, but would provide a strong basis for continued growth in recreational fishing over the next two decades.

THE DEVELOPMENT OF A SPORT FISHERY INFORMATION AND MANAGEMENT SYSTEM FOR SOUTH AFRICAN FLYFISHING

Leonard J. H. Olyott[1], Martin T. T. Davies[1] and David C .W. Walker[2]

[1] Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown 6139, South Africa
[2] The Wild Trout Association, P.O. Box 15, Rhodes 9787, South Africa

Abstract

The first Sport Fishery Information and Management System (SFIMS) in Africa was developed for the Wild Trout Association (WTA), using geographical information system (GIS) technology. The system was developed in collaboration with the Federation of Southern African Flyfishers (FOSAF) and Rhodes University's Department of Ichthyology and Fisheries Science.

The WTA, a riparian owners organisation, manages the flyfishing on approximately 500 km of rivers and streams along the southern border of Lesotho in the North Eastern Cape of South Africa. Here, members of the public can enjoy flyfishing for rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) as well as indigenous smallmouth yellowfish (*Barbus aeneus*). The information and management system stores information about river catchments, access routes and farm boundaries as well as catch returns. It's primary objective is to effectively utilise this information for the management of the recreational fishery. Fisheries scientists may also use the system to study the interaction between the introduced trout and the native yellowfish plus seasonal distribution patterns of all three species. Brochures containing customised maps were produced to aid anglers reach their chosen fishing destinations and provide information about seasonal catch rates, lengths of beats, choice of tackle as well as accommodation and other available services. This enables anglers to plan their fishing trips and avoid disappointment by arriving when catches are poor or booking accommodation too far from the waters they plan to fish. The information was published on an interactive webpage and a CD-ROM.

Introduction

Modern businesses and organisations operate using some sort of information system. Whether this is for checking production lines or storing and analysing client profiles. Such systems and information technology are at the heart of many successful operations. The Wild Trout Association (WTA) is no exception, but has a unique attribute of having as an asset, a resource that covers an extensive area (over 3 500 km^2). As a result, a geographical information system (GIS) is the recognised system suitable for managing the Association's activities.

The development of information and management systems for fisheries is a new concept in southern Africa particularly with regard to inland recreational fisheries. At Rhodes University, the Department of Ichthyology and Fisheries Science has developed a spatial analysis laboratory to train ichthyologists, fisheries scientists and aquaculturists in the use of GIS technology. GIS-based fishery information systems are, however, well established in many countries e.g. in the United States (http://www.dfw.state.or.us/; http://www.ecu.edu/org/afs/st_louis/GISsymposium.htm; http://www.great-lakes.net); in the UK, see Webb and Bacon (1999); Australia (http://chrisweb.dpi.qld.gov.au/chris; and New Zealand (http://www.fish-atlas.com/).

The Sport Fishery Information and Management System (SFIMS) not only provides fishery information in the form of maps and graphs; it is also a dynamic system that can be used for the day to day management of a sport fishery. Angler returns and licenses or permits are administered through the same system which ultimately streamlines all management activities.

There are three essential components to the system:

1. The production of good quality, highly accurate and easily interpreted digital maps which are based on existing topographic maps or aerial photographs, and customised in terms of scale or specific requirements of anglers or fishery managers.

2. The creation and management of a fishery and administration database. In addition to geographical, cadastral (farm and town boundaries) and infrastructure data, it is essential to have fishery information such as catch, catch-per-unit-effort and fish migration patterns, to make informed choices for the management of the fishing itself. The degree of farming activity and catchment modification can also impact on the aquatic environment.

Accommodation and service information is important for visitors and the administration of permit sales is of particular relevance to the Association's administrators and members. All of these diverse types of data are stored in a single database and are connected to each other based on common relationships to one another and to the base map of the area.

3. The use of the data to answer specific queries. As an example, a grading system could be developed for waters based on size and number of fish, availability of accommodation and degree of disturbance to the water. Any other combination of factors required to produce a ranking index that expresses the recreational value of each particular section of water could also be used.

Another element that assists to disseminate the information generated by the system is the publishing of the SFIMS on the Internet. Using specialised viewing software (available from the WTA website http://www.wildtrout.co.za), visitors to the WTA homepage are able to interactively utilise the maps and query the database. This results in an increased awareness of the area and the project and is also a useful tool for obtaining catch returns, as well as feed back regarding accommodation or services, which can be submitted online by subscribers. All of this equates to providing a streamlined, efficient, professional service of mutual benefit to fishery managers and anglers alike. The web page also provides an opportunity to raise funds for the project by offering advertising space to service providers and sponsors.

Materials and methods

Roads, rivers and farm boundaries were digitised from 1:50 000 topographic maps using ESRI PC-ArcInfo software. Coverages were then imported to ArcView (ESRI) and used to produce customised maps. Point locations of farmhouses were added to the maps. Tables containing data fields (farm name, accommodation, length of beat, vehicle access, ease of access, tackle required and contact details) were linked to each point using the common data field, 'farm name'. Data for each beat were accessed via a pop-up table, which was activated by clicking on each respective point. Colour photographs of each beat were also presented using the 'hotlink function' within ArcView (Figure 1).

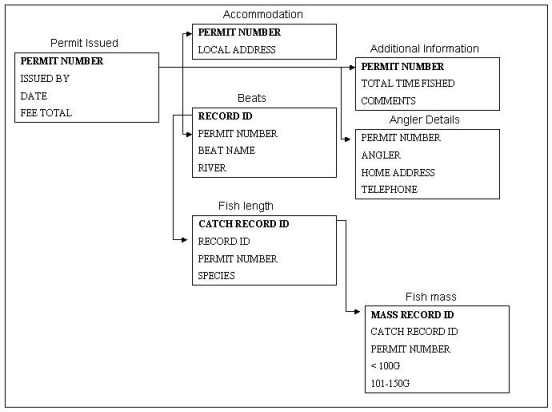

Figure 2.Relationships between tables in the Wild Trout Association database linked by the primary key: PERMIT NUMBER.

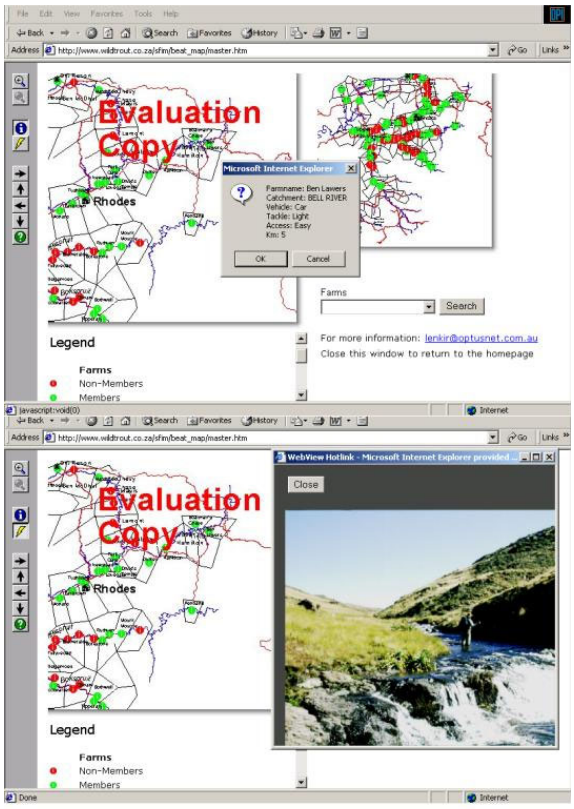

Figure 1. Map of Wild Trout Association waters with information pop-up window and hotlink photograph of the selected beat.

A brochure containing maps of beats, distances from the major centres, length of beat, tackle required, landowner, fish species and best season was printed and distributed to visiting anglers. A compact disc containing ArcExplorer (free visualisation software provided by ESRI) and digital versions of the maps was produced and sold to anglers through the Internet. Using ArcExplorer, anglers can query the database for information about particular beats and print out maps at a variety of scales. Interactive versions of the maps were also published on the WTA website.

A database to process catch returns was designed using Microsoft Access. This software was chosen as it is widely available through the Microsoft Office suite of tools and is compatible with familiar spreadsheet programmes including Microsoft Excel. Access is also compatible with ArcView as well as the Mathsoft S-Plus statistical package, which has additional linkages to ArcView to allow for statistical analysis of geographical data.

The database was designed so that management reports could be generated through queries made on a variety of tables that were linked to each other through common data fields called primary keys (Figure 2). This type of relational database ensures that the size of the database is minimised and data are not unnecessarily duplicated.

Discussion

The system currently contains 636 day-permit records with associated information collected between 1997 and 2001. New permit sales from 2002 will be entered on a monthly basis and used for bimonthly administration of day-permit revenue as well as collection of fishery data. The existing catch data will be analysed to determine seasonal trends in catches as well as interannual variations. This will be attempted initially on a catchment basis and then on an individual beat basis. It is hoped that a pattern will emerge that can be used to predict catches at different times of the year and that this information can be passed on to anglers.

Analysis of annual flyfishing festivals held in December from 1997 to 2001, have provided a good indication of interannual trends and are probably the best source of data, since individual catch returns are often incomplete or inaccurate. Nevertheless, angler participation is vital in the project and through a system of regular, scientific surveys the validity of angler's catches can be tested.

In sport fisheries management, there is often an emphasis on the quality of fishing and the value of the experience, rather than the quantity of fish available. Assessing angler preference, particularly with regard to the selective utilisation of certain beats, will help in the management of the fishery. If specific beats are receiving excessive pressure, it may be necessary to limit the number of anglers accessing the beat. Similarly, if a particularly successful beat appears to be underutilised, anglers should be encouraged to make use of it. Concerns are also expressed about the type of accommodation available and the accessibility of the venue. Factoring these criteria into a grading system would serve as a useful management strategy for the WTA. It would then be possible to charge different rates for different grades of water. Since landowners receive two thirds of day-permit revenue, this would be an incentive for them to better manage their waters by fencing out stock, minimising erosion and conducting habitat enhancement programmes. Improving their accommodation facilities and access roads to the water would also help improve their grading and hence increase their revenue. Providing this level of information will ensure that visitors arrive with realistic expectations of the region. By knowing the type of accommodation, distance from the water and what they can expect to catch, it is unlikely that visitors will be disappointed. Contented anglers inevitably will return to the region and are also likely to tell fellow anglers about their experiences.

In the North Eastern Cape Highlands, there are no officially declared conservation areas. In a small but successful way, the WTA is assisting in the conservation of the area through its promotion of flyfishing. Many other alpine (between 1800 and 3000m) activities are also available including horse riding, hiking, cycling, visits to San rock art sites and skiing in the winter. Flyfishers' families often participate in these activities. Through the Sport Fishery Information and Management System, the administration of the WTA is made easier, and with a greater public awareness, this unique area and way of life may be both preserved and enhanced for future generations.

Conclusions

1. A GIS-based SFIMS has been developed that can provide interactive maps and a database suitable for the management of recreational fisheries.
2. Through the Internet, this tool is widely accessible to fishery managers, anglers, fisheries scientists, tour operators and other service providers. It therefore has a broad-based appeal when compared to websites that are either purely academic or totally commercial.
3. By emphasising the geographical component, regions rather than just venues are promoted. Similarly, the incorporation of additional useful information adds to the potential value of the angling experience. Combined with an online booking facility, the system can become a powerful tool in developing and managing regional tourism.

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http://www.great-lakes.net the Great Lakes Information Network

http://chrisweb.dpi.qld.gov.au/chris

http://www.fish-atlas.com/For further details on the project contact the author lolyott@hotmail.com

National Marine Fisheries Service Angler Public Awareness Program

Martin F. Golden[1] and William L. Price[2]

[1] NMFS, Recreational Fisheries Division, 501 W. Ocean Blvd., Suite 4200 Long Beach, CA 90802, USA
[2] NMFS, Recreational Fisheries Division, F/CS, 1315 East-West Hwy., Silver Spring, MD 20910, USA

Abstract

The National Marine Fisheries Service (NMFS) Angler Public Awareness Program is a key component of our overall public outreach initiatives. Collectively, the agency outreach initiatives are critical to educating the public about sound resource management and building support for our programs. The Angler Public Awareness Program is designed as a three-part program that includes presentations to angling clubs, fishing tackle loan programs, and displays. This presentation will provide the details on how each of the parts of the program are actually implemented. Presentations to angling clubs is at the base of our Angler Public Awareness Program. The key to a good club presentation program is to be sure to have a program that is interesting to the anglers, something that they want to know or something you can convince them that they need to know. Current issues related to why certain fishing regulations are being considered, information about an invasive species of concern, a habitat or water quality issue, and a research need, all make for good topics. Ideally you will leave them with a simple course of action that they can take to deal with the topic presented.

The NMFS Saltwater Fishing Tackle Loaner Program is the second part of our Angler Public Awareness Program. This part of the program focuses on youngsters, especially those from under privileged communities and urban areas. Children from these settings are least likely to have an opportunity for a saltwater fishing experience, but are critical to the long-term effort to promote marine conservation through an enthusiastic cadre of saltwater anglers. Two kinds of loan programs have worked well for the NMFS, one involves having a library or similar facility loan equipment in a similar manner as they might loan a book. Another kind of loan program involves a more structured program where a sponsor organization conducts regularly scheduled events and supplies equipment to participants for the event. Both kinds of programs have been quite successful.

The third part of the NMFS Angler Public Awareness Program is our public display initiative. Public displays are an excellent way to draw attention to an agency and its programs. Angler specific displays can be an effective way to interest the public in saltwater fishing and make them aware of important angling issues. One venue that is proving to be an effective strategy for public displays is partnering with local museums and aquariums where there is an opportunity to reach large numbers of saltwater anglers and potential anglers. The details of how NMFS has designed, developed, and implemented the three parts of our Angler Public Awareness Program are included in this presentation.

Introduction

In 1999, at the Second International Recreational Fishing Symposium, "Evaluating the Benefits of Recreational Fisheries," we discussed the importance of resource agencies developing and maintaining effective communications and education programs for anglers and the public. This presentation focuses on the details of how we are meeting these challenges previously identified. The National Marine Fisheries Service (NMFS) Angler Public Awareness Program is organized into three categories and includes presentations to angling clubs and groups, fishing tackle loaner programs, and displays.

Angling club presentations

We believe the key to a well-received angling club presentation is to present a program that is not only interesting to the group, but is something that they want or need to know. Current issues related to why certain fishing regulations are being considered, information about an invasive species of concern, habitat or water quality concerns, marine protected areas, artificial reefs, research results and research needs, can all make for good topics. However, to make any of these or other topics attractive to your audience, leave them with a *simple course of action* that they can take, to deal with the topic presented.

To do this, we find out as much as possible about the club members before making the presentation. A key factor to be aware of is that often, the person that asks you to speak does not necessarily share the same general perspective of the topic they asked you to address, as the rest of their group. The age, gender, numbers of members expected, and meeting facility characteristics are also helpful to know in designing presentations. The more focused your presentation is to the interests of the club, the better the effect it will have, and last but not least, a cardinal rule to follow if you want to maintain audience interest – don't read to them.

Additionally, our experience with angling clubs is that the inclusion of a slide or videotape presentation is a good way to get the attention of the audience, but it should complement and only be a part of the overall presentation. Regardless of the subject, we always provide handouts related to the presentation and generic agency contact information (catch-and-release cards, ethical angling stickers, web site flyers, etc.).

NMFS fishing tackle loaner program

The NMFS Saltwater Fishing Tackle Loaner Program is the second part of our Angler Public Awareness Program and focuses on youngsters, especially those from urban areas and under represented groups in the angling community. Children from these settings are least likely to have an opportunity for a marine fishing experience, but are critical to the long-term effort to promote marine conservation through an enthusiastic cadre of saltwater anglers. To start, NMFS supplies all the tools and equipment to "prime the pump" and get the program off the ground. The tools include not only rods and reels, but tackle boxes, tackle, advertisement support, posters, start-up instruction kits, loan cards, rod stands, and other supplies.

Two kinds of tackle loaner programs have worked well for NMFS. One involves having a library or similar facility loan equipment in the same manner as someone might loan a book. The other program involves a sponsor organization that conducts regularly scheduled events such as big brother/big sister, scouting or YMCA type activities. Both kinds of programs have been quite successful.

Library fishing tackle loaner program This program takes advantage of existing facilities and community organizations to develop a partnership approach to getting fishing equipment into the hands of the kids. The basic concept for this program is to identify a facility that is appropriately located and staffed to be the program lead. The facility is responsible for storing and issuing fishing tackle in a manner that complements their ongoing programs and operations. The program is set up to achieve broad community support to maintain the program from year to year. For example, local angling clubs are encouraged to be active partners, by taking the responsibility for equipment repair, holding fishing events, and conducting educational sessions in conjunction with the tackle loaner program. After establishing a program, local businesses and community groups are encouraged to become involved to maintain the necessary level of equipment. The key to this approach is that the program lead (facility) is not required to have any fishing expertise and is supported by various community groups, including anglers. Public and community support for the program is enhanced if a grand opening event that includes media coverage is incorporated into the program planning. For those interested in starting such a program, we can provide copies of planning documents that can facilitate the process.

Sponsored activity fishing tackle loaner program This program involves a single organization as the program focal point (program sponsor), usually an organization with angling expertise. Typical organizations include government resource agencies, community nonprofits, and well established angling groups. There are three parts to this kind of fishing tackle loaner program. Firstly, funding for the purchase of the loaner equipment. Secondly, the program sponsor takes control of the equipment and is responsible for its upkeep. Thirdly and most important, the program sponsor schedules regular fishing events and serves as the event organizer.

The fishing event planning is the key to the Sponsored Activity Fishing Tackle Loaner Program. The Los Tiburones Youth Fishing Program planning process is a good example. The sponsor, the California Department of Fish and Game (CDFG), schedules monthly fishing events at various public fishing piers and urban lakes. Participation at events is limited to eight youth groups, ranging in size from 10 to 50 members each. Each group is required to have their own adult leaders, who are required to attend a monthly event planning meeting, hosted by CDFG, about a week prior to each fishing event. The dates and locations for events are scheduled well in advance.

The actual events involves CDFG setting up an equipment checkout and return booth at the site. All fishing tackle is returned to CDFG at the end of the event. Participants are encouraged to release all fish that they do not plan to eat. Those participants who keep legal sized fish are encouraged to bring their catch to a weighing table, where CDFG staff help identify, weigh, and measure each fish caught. At the end of the event there is always a ceremony where conservation and angling tips are included as part of the festivities. There are also usually numerous "door prizes" donated by sponsors that are given out at each event. A newsletter is issued monthly highlighting past events and addressing future events and activities.

NMFS public exhibit program

The third part of the NMFS Angler Public Awareness Program is our public exhibit initiative. Public exhibits or displays are an established way to draw attention to an agency and its programs. Angler-specific exhibits can be an effective way to interest the public in saltwater fishing and make them aware of important angling issues. One venue that is proving to be effective for public exhibits is partnering with local muse-

ums and aquariums, where there is an opportunity to reach large numbers of potential anglers.

The successful themes used by NMFS include our billfish tagging program, angler conservation, and the "Ethical Angler Program." The goal of these exhibits is to educate anglers and get them more involved in their sport from a resource management perspective. The following focuses on how we put our exhibits together, to give you a perspective on what has worked for us. Please keep in mind that any of these concepts can and should be modified to focus on local issues and culture.

The NMFS has an extensive billfish tagging and survey program that has been ongoing for more than 30 years. One of our displays is designed to highlight the program and its results. The display includes an identification poster, tagging equipment, a tag flag, information on contributing anglers for a given year, photographs of fighting billfish and ongoing research, as well as graphs and charts showing billfish migration routes based on tag returns. Additionally, copies of recent relevant reports, the Billfish Newsletter, and other conservation information are made available to display visitors.

The angler conservation display is an adaptable one that involves the use of a fabric backdrop and is primarily for indoor use. These displays make use of a wide variety of photographs that are mounted on foam board and have Velcro backing. This design allows for an infinite variety of themes to be displayed and is easy to update. Themes can be single or multiple depending on the audience. Themes that we have used in our displays include habitat, pollution, artificial reefs, fish passage (for salmonids), marine mammals, endangered species, sportfish identification and sportfishing activities. As usual, these displays are augmented with a table of angler conservation materials and if electricity is available, a video player can be used to show angler education programs.

Permanent outdoor fish identification displays are also becoming more popular, especially in the vicinity of fishing piers, docks and boat landings. These displays present information of immediate interest to anglers and can include conservation messages as well. Local artists can be involved in developing these displays, often resulting in exhibits that capture the attention of a high percentage of the passing public.

Permanent indoor displays are also becoming more popular especially at local museums and aquariums. A NMFS exhibit near Los Angeles is a good example. The STAR ECO Station is an educational institution that caters to inner city youth, who have little exposure to wildlife or marine issues (i.e. recreational fishing). This particular display uses the "Ethical Angler Program" as its theme. The NMFS teamed with BoatU.S. to develop a code of angling ethics and "The Ethical Angler Program." The code is a simple tool that experienced anglers can use to spread the word about responsible fishing practices to new generations of anglers. The end result is to have anglers adopt the mantra "Ethical Angling = Healthy Fisheries." Many of the elements of the program are included in this display.

A local artist created the display, with a painting of a boat with an angler as a backdrop. The eight by four foot display is about 12 inches deep, which allows for a three dimensional effect. An Ethical Angler Poster is the focus of the display. The base of the display is a physical model of the ocean bottom showing all kinds of trash (i.e. cans, bottles, and a plastic six pack holder). This re-inforces the importance of disposing of your trash ashore.

The display includes a copy of the cover of the fishing regulations booklet as a graphic reminder of the regulations and that all anglers should have copy of the booklet. The accompanying text explains the importance and value of regulations to ensure good fishing for future generations. The exhibit also includes a poster with a detailed description and photo of a seaweed, "Caulerpa," that has recently invaded several embayments in southern California. The poster provides web sites for reporting sightings of the seaweed and is amplified by additional information about why nuisance species should be a concern to anglers.

The display spotlights tagging technology. Fish tagging programs are just one of the many kinds of research necessary to understand how to best manage our fisheries. The display includes three kinds of tags: spaghetti, sonic and satellite pop-ups and provides information on how they work and their purpose. The message for this part of the display is that without good research, fisheries management regulations may not be adequate to protect our fish stocks.

The display addresses the concept of catch-and-release fishing. This concept is predicated on the idea that you should only keep those fish that you plan to eat, releasing others unharmed to be caught another day. To illustrate this concept, a series of different hook types are displayed with explanations as to the advantage of using them for catch-and-release fishing (i.e. circle hooks and barbless hooks). Additionally, dehooking tools, such as a hemostat, are also displayed. Cards with information on how to effectively practice catch-and-release are free upon request or at our web site.

In addition to the seven elements of the Ethical Angling Program in the exhibit, there is also a placard

with agency contact information including our web site and phone number. Associated with the display is a brochure rack that includes items such as catch-and-release cards, the NMFS flyer "Fish on the Web," and Ethical Angling stickers, which may be used on tackle boxes. Facilities that have the NMFS exhibits are also provided with a "Docent Guide," which provides additional information on the details of the issues included in the exhibit.

There are two other kinds of displays that deserve attention, the static display or kiosk and our interactive displays. The static display is primarily used indoors at agency facilities. These displays are designed to attract attention and are capable of holding six or more different kinds of literature. These displays are not labor intensive to maintain and include a compartment in the back for storage of additional materials. The interactive displays operate from a personal computer, and while somewhat expensive to set up, they require little maintenance. The most attractive features of the interactive displays are the ease of changing display information and the large amount of information that can be accessed.

This overview of the NMFS Angler Public Awareness Program provides a good idea of why the program is important and also some ideas for how you might implement such a program in your own region of responsibility. The flexibility, simplicity, and relatively low cost of the program are three of its strong points. The program can be adopted for virtually any area of the world, where there is recreational fishing and it can be implemented with a minimal amount of funds. Where funding is a concern, we recommend you start your program small and after its value is recognized you may find it easier to fund its expansion. It is our hope that this presentation will stimulate new ideas, but most of all help you all to build stronger bridges to the angling community.

FISHOS, SKIPPERS AND BUREAUCRATS – THE INTERACTIONS BETWEEN FISHING TOURISM INDUSTRY STAKEHOLDERS

David Taylor

School of Tourism and Hospitality Management, Southern Cross University, PO Box 157, Lismore, NSW, 2480, Australia

Abstract

The nexus between fishing (as a touristic activity) and tourism is playing an increasingly important role in many areas of Australia, particularly in terms of the potential to complement existing visitor opportunities and to maximise the socio-economic benefit of available resources. But the extent to which fishing tourism (the activities relating to people who travel and fish for leisure purposes, staying away overnight) is understood, planned or managed, is not clear. In Australia, fishing tourism is a growing sector that is under increasing scrutiny by, and control of, fisheries management agencies. Sector stakeholders include tourists, fishing tourism operators, fisheries managers and tourism managers/marketers, representing a variety of perspectives and all with role in achieving the end 'product': the fishing tourism experience.

In the field of nature-based, wildlife tourism, such as fishing tourism, the critical issues of environmental management and natural resource use are fundamental to industry development and sustainability. This paper reflects a qualitative study of interactions between key stakeholders of a specific nature-based marine tourism sector - charterboat fishing - and employed case study analysis in selected areas of Australia' eastern seaboard. The underlying aim of the research was to better understand the involvement of the stakeholders and the relationships between them, in order to provide information to facilitate enhanced management for sustainability of the sector and the resource on which it is based.

The findings reflected concerns regarding management of both fisheries and tourism, and varying levels of stakeholder satisfaction. Gap analysis highlighted significant differences between the stakeholder's expectations and perceptions of each other's involvement in the sector. A range of issues related to fishing tourism product development and delivery and management of the fish resource, were then identified. Underlying this appears to be a considerable lack of communication, information, and understanding between the stakeholders about each other's roles, requirements and responsibilities.

The study led to a more comprehensive understanding of the sector's dynamics. Exploration of the management implications of the findings led to options for an enhanced fishing tourism sector and improved resource management. The findings also facilitated development of an analytical framework with wider application to fishing tourism sectors in other locations.

Introduction

The nexus between fishing (as a tourist activity) and tourism is playing an increasingly important role in many regional areas, particularly in terms of its potential to complement existing visitor opportunities and to generate economic well-being (Holland et al. 1998). However, the extent to which fishing tourism (that is, the activity that revolves around people who travel and fish, staying overnight away from their home) is understood, planned for, or managed, is not clear.

As with many other tourism-related industries, fishing tourism encompasses a wide range of stakeholders. These stakeholders represent a variety of different perspectives and all have a role in the success or otherwise of the end 'product' – the fishing tourism experience. In the field of nature-based, wildlife tourism, such as fishing tourism, the critical issues of environmental management and natural resource use are fundamental to industry development and sustainability (Moscardo, 1999). Therefore, the involvement of key stakeholders, and the relationships between them, must be better understood if the resource on which the sector is based, and the sector itself, is to be managed sustainably and the benefits for regional areas realised.

In Australia, fishing tourism activity occurs around much of the coastline and many of the inland waterways. It involves a large and growing tourism industry sector that is coming under increasing scrutiny and control of fisheries management agencies (Gartside, 1999; Steffe et al., 1999; Fisheries Western Australia, 1998).

Methods

The research employed case study analysis in three regional locations on Australia's eastern seaboard. It comprised both qualitative and quantitative components that included: (1) an initial qualitative explora-

tory investigation, aimed at identifying the range of stakeholder issues related to the key research questions (in order to inform the development of subsequent phases); and (2) the main data collection phase, based on the findings of the previous phase. Random and convenience sampling were employed to gather information from fishing tour operators, fishing tourists and the relevant regional and corporate fisheries and tourism management agency personnel, using a combination of face-to-face and telephone interviews and survey questionnaires.

Findings

By gaining an insight into the attitudes (for example, motivations, expectations and satisfaction) of the key stakeholders involved in the sector (that is, consumers of the commercial fishing tourism product, suppliers of the commercial fishing tourism product or key managers of the fish resource and key tourism managers/marketers) to each other's involvement, a more comprehensive understanding, than currently exists, was developed. The findings reflected concerns regarding management of both fisheries and tourism, and varying levels of stakeholder 'satisfaction'. Gap analysis highlighted significant differences between the stakeholder's expectations and perceptions of each other's involvement in the sector. A range of issues related to fishing tourism product development and delivery, and management of the fish resource, were then identified. Underlying this appears to be a considerable lack of communication, information, and understanding between the stakeholders about each other's roles, requirements and responsibilities**.**

Application of results

The study allowed for the development of an analytical attitudinal framework, which has a wider application to the fishing tourism sector in other regions and to other tourism industry sectors. Furthermore, an understanding of the management implications of these attitudinal perspectives can provide for enhanced fishing tourism experiences and improved resource management.

Conclusion

The research focused on the management of a specific natural resource-based marine tourism activity at a regional level, utilising commercial recreational fishing as the vehicle for case study analysis. A range of issues related to fishing tourism and their management implication were highlighted. From the identification of these implications, a range of stakeholder-focused outcomes that lead to more effective management of regional fishing tourism industries, the resource on which they are based, and of tourism generally are offered.

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THE USE OF ENGINEERED VERSUS NATURAL INSTREAM MATERIALS IN STREAM FISHERY HABITAT REHABILITATION

Paul Brown

Department of Primary Industries, Marine and Freshwater Resources Institute, Snobs Creek Private Bag 20. Alexandra, VIC 3714, Australia

A review of stream habitat rehabilitation projects both internationally and in Australia, shows a trend moving away from using artificial materials instream (eg. steel, sawn timber and quarried rock) and towards the use of natural materials such as large woody debris (LWD) and brush. As elsewhere, some of the earliest Australian efforts at stream habitat rehabilitation were largely erosion control programs using artificial materials such as steel sheet-piling, rock gabions and quarried rock to shore-up stream banks and create grade-control weirs on streams. Functionally, and certainly aesthetically, these "hard-engineered" structures have not largely been popular with (non-engineer) stakeholders. A move towards more "soft-engineered" structures followed in the 1980's with the realisation of the role of LWD in stream ecology and as fish-habitat for native species alongside the increasing realisation that stream managers have a role in managing the natural as well as physical attributes of the system.

Physical habitat rehabilitation projects in Southeast Australian streams have largely failed to deliver the hoped-for fisheries objectives of increases in biodiversity, production, or recreational-value. Successful fishery rehabilitation projects in the USA and Europe have developed instream structures using minimal engineering that are often used in combination with more "soft-engineered" methods. These "firm-engineering" methods provide specific critical habitat for a range of species and have often been attributed with several-fold increases in recreational fisheries production. Although detailed knowledge is scarce, we know enough of the habitat requirements of many Australian species to borrow and possibly redesign some well-known techniques from overseas. By incorporating these types of structure into a patchwork of more natural materials we may be more successful in satisfying functional as well as aesthetic goals.

VICTORIAN FISHERIES NET AMNESTY PROGRAM

David C. Cass

Department of Natural Resources and Environment, Cowes, Vic 3922, Australia

Objectives

1. To reduce the number of illegally possessed nets in the state of Victoria.
2. To assist in the protection of fish populations in marine, estuarine and inland ecosystems by the reduction of illegal nets.
3. To provide a well-publicised opportunity for persons in possession of illegal fishing nets to hand them in during a six-month ‘‘amnesty’’program.
4. To provide an opportunity for ex professional fisherman and ex recreational mesh netters to dispose of fishing nets they are no longer licensed to use or possess.
5. To assist the people of East Timor in restoring their ability to catch fish for food and income. (During the era of the pro-Indonesia Malitia, the fishing equipment, boats etc were destroyed, debilitating the local communities).

Statement of findings

1 The amount of nets handed in during the amnesty was directly linked to a wide-ranging media campaign.
2 Media coverage included: regional and daily newspaper, local radio fishing show broadcasts, advertisements placed fishing magazines, posters and mail drops to tacle stores.
3 Victorian Fisheries Officers provided significant field and logistical support for the program.

Funding

Ausaid provided funds,via ACIL.[Melb] (cost of shipping container from Melbourne to Dili) to assist with this program.

Liaison with UN Fisheries

Close liaison was established with U.N Fisheries staff in Dili to ascertain the suitability of nets collected in Victoria to be incorporated into a new, ecological sustainable fisheries strategy.

Key conclusions

1 601 fishing nets were handed in during a six month Victorian “net amnesty” campaign.
2 Over 80% of these nets will be suitable for incorporation into East Timor’s ecological sustainable developing fisheries.
3 Feed back from the recreational fishing community has been very positive.
4 Ex professional and ex-recreational mesh net fishermen utilised this oportunity to hand-in a significant number of fishing nets during the amnesty.

VICTORIA'S RECREATIONAL FISHING LICENCE - 'A LICENCE TO THRIVE'

Robert J. Krix

Fisheries Victoria, PO Box 500, East Melbourne, VIC 3002, Australia

In July 1999, Fisheries Victoria introduced the All-Waters Recreational Fishing Licence. The licence was the first of its type in Australia, and applies to all forms of recreational fishing in all waterways.

In October 1998, a quantitative survey of Victoria's recreational fishers found that 84 % of those surveyed were supportive of an all-waters fishing licence, if licence revenue would go into improving recreational fishing. A subsequent survey in June 1999. found that support for such a licence had increased marginally to 87 %.
In October 2000, Victoria's State Government enacted legislation to establish the Recreational Fishing Licence Trust Account and establish a stakeholder based Fisheries Revenue Allocation Committee. The Committee's function is to to advise the Minister (for Fisheries) on priorities for the disbursement of revenue from the Trust Account.

All revenue generated from licence sales is remitted to the Trust Account. Similarly to the United States experience, where, through the US *Sport Fish Restoration Act* 1984, licence revenues have been used to restore and enhance fish populations, improve management, expand boating and fishing access and communicate more effectively with that nation's anglers and boaters, an increasing proportion of Victorian recreational fishers' licence revenues will be applied to the following four areas, through the Recreational Fishing Grants Program (RFGP).

- Recreational fisheries' sustainability and habitat improvement (including fish stocking).
- Recreational fisheries access and facilities.
- Recreational fisheries related education, information and training.
- Recreational fisheries research.

The approximate 230 000 RFLs sold annually in Victoria, generate around A$3.8 million of revenue to the Trust Account. In 2000/01 and 2001/02 combined, approximately A$1 million will be allocated to projects. An additional A$2 million will be repaid to State Treasury for funds advanced to buy-out over 50% of the commercial fishery access licenses from Victoria's bays and inlets . Once the repayments to Treasury are completed in July 2003, approximately A$2.5 million will become available annually for disbursement to projects through the RFGP.

(Footnote: The Recreational Fishing Grants Program was introduced in November 2001. Previously funds were allocated to projects by the former RFL Revenue Expenditure Committee).

THE UNIQUE NORTHERN TERRITORY FISHING EXPERIENCE - THE ENVY OF THE WORLD

Richard Sellers

Fisheries Group, Department of Business, Industry & Resource Development, GPO Box 3000, Darwin, NT 0810, Australia

Selected examples of the early days of recreational fishing in the Northern Territory are briefly examined, to provide a context that generated the rapid growth in the recreational fishing sector, fishing access and fishing related tourism that has occurred since the early 1990s and continues today.

This growth in the recreational fishing sector and parallel growth in the other sectors has total fishing effort rapidly increasing and harvest levels approaching predicted limits for individual species. Currently, drivers such as access, the settlement of land claims and the introduction of Ecologically Sustainable Development principles into fisheries management are speeding the rate of change within the NT recreational sector.

The future challenges for the NT recreational sector include:

- the potential for intra sectoral disputes with the growth of the Fishing Tour Operator sector;
- a need for new fisheries models, based on a combination of FTO log book information, varied point information and recreationally generated catch/effort information, as commercial log book information is excluded or becomes less relevant for recreational fishing areas;
- the development of integrated fisheries management arrangements on Ecologically Sustainable Development principles;
- several large infrastructure projects are either planned or underway for the NT and the associated population growth will create pressure on maintaining the current quality of the recreational fishing experience; and
- access rights continue to be a major issue and the challenge is to get all sectors together to communicate and settle issues through an agreed process.

COUNTRY GUIDE TO GAMEFISHING IN THE WESTERN AND CENTRAL PACIFIC

Wade A. Whitelaw

Australian Fisheries Management Authority, Box 705, Canberra Mail Centre, ACT 2610, Australia

Gamefishing is a developing industry for many of the Pacific Island Nations with a number of countries encouraging the industry with tax relief and tourism promotion. To date there has been little quantification of the gamefishing facilities and infrastructure for these Pacific Island Nations.

The level of development of gamefishing varies among Pacific Island Nations with some countries only carrying out subsistence fishing (including billfish) while others have a well-developed gamefishing infrastructure. The gamefish facilities of each country are described, including charter operations, number of private vessels, target species and berthing facilities.

Estimates of recreationally caught billfish are also provided for each Pacific Island Nation. These estimates have been facilitated by the development of a gamefish catch and effort database, by the Secretariat of the Pacific Community. Presently an estimated 1 600 t of billfish are caught by gamefishing in the central and western Pacific. This compares to an estimate of around 32 500 t (including broadbill swordfish) caught by commercial longline and purse-seine vessels.

The level of gamefishing within the Pacific varies markedly between countries. Gamefishing depends very much on tourism and the respective tourism infrastructure. This in turn depends on government promotion of tourism and facilities within the country to cater to the tourism market.

Acknowledgements

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Theme 6

Recreational fishing and traditional fishing

THE RELATIONSHIP BETWEEN TRADITIONAL AND RECREATIONAL FISHERIES

Sir Tipene O'Regan Ngai Tahu

PO Box 6346, Te Aro, Wellington, New Zealand

Abstract

Assertions of indigenous cultures to customary or traditional fisheries have given rise to a substantial body of common law or treaty based litigation over the last three decades. The overall trend internationally has been towards some measure of accommodation of those assertions in the allocation of fishing rights. The trend is likely to continue.

There is considerable variation in the way the claims for such rights are articulated and in the usage of such terms as, *"traditional", "customary"* and *"indigenous"*. The terms have become code for commercial and non-commercial fisheries ranging from highly developed small scale inshore fishing or fish-farming supplying local and urban markets to remote location subsistence fishers.

Developed economies, with suitable geographies, have developed powerful recreational fishing lobbies which advocate strongly for *'access rights'* and their own variant of *'the public interest'*. These frequently have highly tensioned relationships with commercial fishers and with indigenous minorities asserting fishing rights different in character and origin from those claimed by, or on behalf of, recreational fishers. Despite their differences both groups combine in their opposition and hostility to assertions of indigenous culture rights in both inland and coastal sea fisheries.

There is a further tension between those who supply services to recreational fishers by way of charter fishing or guiding and commercial operators because of differences in the way regulators treat the two in the same fishery. Again, however, the two tend to unite in their hostility to the assertion of sea or fish rights by indigenous culture groups. In the context of tourist fishing the tension is commonly over access issues.

Environmental interests set themselves above all such tensions and assert their concern for both the fish and the public interest. With some notable exceptions they are hostile to indigenous culture assertion, even though their language is well clothed in tones of *"multicultural respect"*. Whilst they proclaim the virtues of sustainability they are commonly resistant to indigenous aspirations for an allocation of resource rights, especially in the context of indigenous economic development.

In those countries where fisheries management has been founded on clear definition and allocation of property rights, the accommodation of indigenous minority aspirations in fisheries has been more readily achieved (albeit on a non-exclusive basis). Where rights have not been clearly articulated, cross-cultural tension continues to abound.

Introduction

Discussion of the relationship between traditional and recreational fisheries interests is a somewhat pointless exercise unless it is attempted in a context of the general range of interests in fisheries and some effort is made to identify the other elements in modern societies which claim those interests. Beyond the obvious inclusion of commercial fishing for the local, national and international markets (each different in character and effect) and the ever-present interest of government in pursuit of its obligations in conservation and management, we are now faced with a hugely increased constituency of interest arising from the rise of global tourism and the rise of global environmentalism. The other major factor in the rise of recreational fishing has been the enormous expansion of discretionary wealth in developed societies which has expanded recreational activity far beyond the *"father and son bonding"* version of the dinghy in the estuary or anything Izaak Walton could have dreamed of in his bucolic meanderings. Fishing for fun is now supported by its own industrial base and has significant resource impacts especially in regions surrounding wealthy urban centres.

As well, there has been an exponential development in the technology underlying what one tribunal defined as the *"business and activity of fishing"*. This technological development is not confined to the actual catching of fish – to vessels, horsepower, net technology, computerised long-lines, forward ranging depth sounders, refrigeration and transport. It extends also to the techniques required for fisheries management; GPS, computer simulations of biomass, tagging technologies, surveillance technologies, computer modelling of species populations and a whole range of stock assessment methodologies. And, you

will have noted, I haven't even started on aquaculture methodologies and the wonders of bio-science.

This development can properly be extended further in a more generalised way by considering the effect of the development of airfreight to encompass live fish export which has made possible such dramatic change in the NZ, Australian and South African crayfish business as well as the Netherlands flounder business. Or again, the arrival of four-wheel-drive vehicles which have dramatically enlarged the possibilities for coastal access in the recreational fisheries sector or the use of planes and helicopters which now have such a significant place in the tourist fishing and general eco-tourism evolution. Then there is the dramatic effects of population and culture change; of urbanisation and the increase and distribution of wealth.

I rest from these inventories of change. I only wish to note that, although we are talking about what are essentially old issues and problems today, we are talking about them in very different contexts from those in which they were being discussed a mere three decades ago. The technologies have shifted, there are far more players involved both directly and indirectly. This burgeoning technology has powerful effects. The politics are shifting. It's broadly the situation faced by my Ngai Tahu forebears at the beginning of the 19th century.

It is useful, in my view, to remind ourselves of this generalised context in which all fishing currently takes place, to note that there's little new under the sun or that the only thing which is permanent is change or, indeed, that all change is relative. But none of these observations, of itself, advances the purposes of this conference very much at all. Before advancing to the particular, though, I must generalize a little further.

The business and activity of fishing is essentially about three core issues – Access, Abundance and Exclusivity

Access

Access rights are generally articulated as rights to catch particular fish in a particular territorial area. In most older societies, they are heavily shaped by age-old custom. They are traditionally articulated differently between open sea, estuaries, lakes and rivers. The evolution of English common law has dealt with inland fisheries differently from the sea. Rights to take fish in rivers and lakes have long been accorded to the owners of the adjoining lands and variations of that principle occur in most Northern Hemisphere legal frameworks. In the open sea, the rights of nations to exercise their authority over the seas adjoining their coastlines, are long established and are now, of course enshrined in the Law of the Sea (UNCLOS). They have historically exercised that authority to protect the interests of their own fishers against those of other nations. In my own generation the Icelandic *"Cod Wars"* are a powerful memory. Anyone familiar with contemporary European Union (EU) maritime politics knows that the issues are still vibrantly alive and rich in tension. Again, the activity of the Spanish fleet on the SW African coast has, in the past decade, brought forth the most vigorous Namibian military response. I could quote the Russians, the Japanese, the Canadians and the United States or, indeed, the Australians at Heard Island, in the same context. The ordinary *"patch fishing"* disputes between coastal fishermen in New Zealand (NZ) and Australia are of exactly the same character and frequently no less bitter. The same might be said of the attitude of resident coastal communities in Tasmania, NZ, British Columbia, South Africa and the Republic of Ireland, towards the urban holidaymakers who flock to *"their"* coast in ever increasing numbers and hit *"their"* fish resource like a bomb for a few weeks every summer, with hugely destructive results.

The advent of charter and tourist fishing is an extension of that issue. Although there is a great deal of community ambivalence about tourism and its effects, there is probably no sector, beyond local government rates, where the discussion is more tensioned with bitterness. The notion of a *prior right* of access is a generally held one, be it on behalf of local, regional or national communities. It is a notion with a long history.

Abundance

The idea of abundance or, more correctly, ongoing abundance lies at the heart of nearly all arguments about sustainable fishing. Just what constitutes *"abundance"* or *"sustainability"* is a never ending source of both exceedingly scientific and very unscientific debate, most of it now heavily politicised by sectoral self-interest.

Science and all its handmaiden assumptions and premises aside, the core notion of using a natural resource in such a way that we restrain over-consumption, to a level consistent with ongoing future use, is widely accepted. For my own Ngai Tahu and NZ Maori generally, that notion has been at the heart of most indigenous protest and litigation against both the Crown and the commercial industry for generations. The same argument has been advanced over the years by other indigenous peoples, most notably the Canadian First Nation groups. In NZ, the Maori protest over sustainability of resources has been running now since the late 1870s. As far as the seas are concerned, government environment agencies and environmentalists are very new on the scene.

The tensions between Maori and other indigenous communities with the majority cultures around them have not suddenly vanished. Racism has not been mysteriously abandoned. Majority cultures have not suddenly become less greedy. There has been no new generosity of spirit surging from the sediment tanks of the legal system. But one thing has changed dramatically – virtually all the interests in fisheries are now singing the sustainability chorus. True, they may all be singing it from their own private hilltops and straining it through their own templates. The music may range from *'basso profundo'* to *'singulare castrato'*, but it is essentially similar. It may fairly be said that if all the competing interests groups, anywhere in the world, have anything in common it is that they all cleave to, or advocate that, the notion of the maintenance of sustainable abundance is basic to any resolution of the fisheries debate. Everyone claims some level of moral ownership of the sustainability principle.

Interestingly enough, it is always one's opponents or competitors in a given situation, who offend against the sustainability principle, by some form of piscatorial sin or other wickedness which vacates their moral right to inclusion or participation in a given fishery. It is always the other, never oneself.

Exclusivity

Exclusivity is essentially an extension of the ideas I have referred to above under rights of access. It is a central element in the concept of all property rights and we have been familiar with it in the fisheries sector from time immemorial. It is known as a *usufruct* (literally meaning 'a right to the use of the fruits'). In fisheries, it comprises either an exclusive right to a defined area or territory or, sometimes to a particular species. It ranges from the European landowner's rights in the river or lake adjoining his lands, to *patch fishing* arguments in coastal commercial fisheries everywhere in the globe; to New South Wales (NSW) oyster leases, to Pelorus Sound mussel lines, to Patagonian and Tasmanian salmon farms and to the wholesale destruction of eels in NZ rivers to advance the cause of recreational and tourist based trout fishing (one of the earlier attempts at genetic modification). It ranges in th e Northern Territory from aboriginal claims on the Liverpool River barramundi to locking up the McArthur River for recreationalists. In the former instance the people of Maningrida are denied the right of commercial take in the waters immediately outside their homes, in favour of set-netting commercial operators from hundreds, even thousands, of kilometres away, who seriously pollute their shoreline with hugely destructive by-catch practises. In the latter instance, the commercial fishers are excluded from an area they have been accustomed to work for a living, in favour of recreationalists who want it reserved for them to play in.

In support of commercial closure, Aboriginal, recreationalists and tourist fishing operators are all quoting by-catch and waste issues under their own variations on the *mantra* of sustainability, but the hard fact is, that excluding commercial fishing *per se* in favour of other fishing has not, anywhere in the world, resulted in a return to abundance. In some cases total closures have worked; there are some few examples of marine reserves that have worked; but sectoral exclusions haven't. The resource continues to decline as those favoured by the exclusion simply expand their effort to absorb what's left. I deplore the statutory fisheries management requirements which foster, even create, the by-catch problem in this region. I just want to spell out my view that it is not commercial fishing *per se* that is the issue but the regime under which it occurs.

All of which, however interesting, is an aside from the core point that claims of exclusivity to the use right (or usufruct) are a form of property claim against others. A central element in all such assertions is that others do not have a moral claim to such rights or they have a lesser claim or more commonly, no claim at all, moral or otherwise. Those asserting the right invariably state that they have a higher moral claim because of their devotion to the cause of sustainability or community benefit or some such – such people tend to see themselves as a form of *"the public interest with legs on"*.

A range of papers in this meeting attest to the fact that the global take in the wild caught fisheries is static or declining, that aquaculture of various kinds is expanding and the recreational take especially in areas adjacent to urban wealth, is growing. All sorts of graphs are available to demonstrate this phenomenon. What we all know as well – and what the graphs invariably fail to show – is that indigenous claims to the sea and coast also have an expanding presence. On the African coast, for example, those claims are on behalf of indigenous nations and as such are seldom disputed at that level. In others, such as NZ, Australia and Canada they are asserted on behalf of indigenous minority cultures and, particularly in democracies, they are hotly and vociferously contested by the, generally wealthier, majorities which control either the commercial or recreational industries.

The basis of indigenous culture claims has tended to be either in colonial treaties or in the common law principles of aboriginal rights or in a combination of both. The NZ Treaty of Waitangi 1840 was essentially a Treaty formulation of the latter drafted to secure British sovereignty. Amongst other things, it guaranteed to Maori tribes the

"...full exclusive use and possession..." of "...their fisheries..."

From the earliest NZ fisheries legislation in the 1860s to the settlements of 1989 and 1992 the Treaty protection of tribal rights in fisheries was maintained but never defined, making it a formal, but empty right. Changes in NZ fisheries management from 1986, provided a basis on which these rights could have substance and they were consequently litigated successfully. The subsequent negotiation between Maori litigants and the Crown provided that a proportion of commercial access rights would transfer to Maori. Over the past decade, these have been significantly increased on an open market basis, by both the purchase of quota and interests in quota holding companies. As well, provision was made for customary non-commercial rights. The latter were limited, exclusively to meeting community needs. Individuals were to fish under the ordinary recreational constraints in the general legislation.

Although the Maori litigants theoretically claimed 100% of all fishing rights, it was acknowledged from the outset that such was not their aim or intent. They sought inclusion in the allocation of commercial access rights and provision for their customary or non-commercial rights. It is fair to say, however, that inclusion and provision was on the basis that the rights belonged to them in the first place and had never been properly acquired by the Crown, as one of the incidences of its sovereignty. The NZ commercial sector raised NZ$5M to litigate and campaign against the Maori claim and various environmental non-Government Organisations (NGO) lobbied in opposition at every turn. At the heart of the negotiation was the new fisheries management system which was itself founded on clearly defined and allocated rights. Maori acceptance of that model was a fundamental trade-off of the settlements.

The historical absence of definition of Maori rights in fisheries and their consequent non-recognition made the new quota management system (QMS) hugely appealing to Maori with some understanding of the character of their collective dispossession. They were unwilling on that account to buy into the wider public and political debate which simply saw the issues in terms of the usual western mantras of *"privatisation"* and *"socialization"*. Even more important, though, was the entrenching of sustainable use as the central statutory post of the QMS. This had enormous cultural appeal on account of the centrality of that principle in Maori resource use custom. The wider NZ public, with the assistance of its traditionally ill-informed media saw the whole fisheries settlement agreement in terms of cash and handouts. This perspective has diminished with the comparative economic success of the Maori fishing interest since the settlement, which compares more than favourably with the performance of major NZ companies such as Air NZ, Ansett and Fletcher Challenge. Maori are now a major force in NZ fisheries.

I would be wrong, though, to conclude this very brief and compressed sketch of the past decade, by suggesting that NZ has reached some state of *nirvana* in cross-cultural fisheries. Despite the whole background litigation having been founded on a rights base, there has been a long drawn struggle since 1992 as to whether the regained asset in fisheries should be allocated on a rights base or a needs base. This struggle is essentially regionally and demographically driven and is still unresolved. Certain of the customary fisheries arrangements with the Crown have broken down, largely over representative status issues and some freshwater fisheries issues are still at large. Still, for a set of issues that has been alternatively simmering and boiling for one and a half centuries, progress over the past 10 years has been significant.

How, then, does this new status of Maori in NZ fisheries position the tribes in respect of the recreational sector? The NZ recreational lobbies have been obdurately opposed to the notion that they should be required to hold quota within the QMS although the legislation requires them to be included in all TAC setting procedures. Whilst there are, admittedly, some conceptual and administrative difficulties in this regard, there is increasing acceptance of the view that all commercial recreational operators, charter and tourist, should carry individual transferable quota like any other commercial operator. Maori have strongly supported that view in the public policy discourse.

The more intractable area of conflict, however, lies in the provision of exclusive zones for the Maori customary use, that was made in the 1992 settlement and for the inclusion of local tribal communities in regional and local fisheries management. The former provides tension with recreational fishers, the latter with the Crown playing its old game of clawing back control, through its self-assumed role as the referee. The Maori customary zones or *maitaitai* seem to have an uncanny knack of overlapping zones proposed by the Department of Conservation for marine reserves and the latter have an uncanny knack of overlap with areas proposed by environmental NGOs. This is all complicated further by the NZ Resource Management Act which introduces local government into the mix, with unending consultation process and environmental due process which is both cripplingly expensive and produces outcomes more by exhaustion than rationality or clarity.

Maori fisheries interests increasingly find themselves aligned with recreational interests in these debates. They both dislike marine reserves which exclude everyone except the eco-tourist entrepreneurs and seem increasingly to be reconciling their mutual loathing in the fact of the pressure on them both from the environmental lobbies and the rapid public buy-in to green politics. There is a marked willingness becoming apparent for accommodation and negotiation. They both

see quite clearly that the environmental movement's political influence will quickly exclude them both from access to fish on any basis.

This political shift is beginning to have some quite interesting effects in the way that Maori and recreational interests are both becoming more intelligently challenging in their questioning of NGO public policy assumptions about reserves and species protection notions. The Maori dimension is sometimes, but by no means always, rendered difficult in that it has both a commercial and customary aim to reconcile, but this is ameliorated to some degree by the developing background in industry awareness, knowledge resource and access to science that is frequently beyond the recreational sector.

The Maori voice is better informed and equipped in these areas than it has ever been. It is an active and formidable participant in the public discourse. It is challenging the NGOs assumption of perpetual leasehold of the moral high ground and more confidently, asserting its right to pursue the traditional Maori position of sustainable use in a modern context. It is opposing both NGO and government agency absolutism and is seeking to find a more traditional balance in resource use, amid the swamp of policy phrases and difficulty-ridden imponderables of biodiversity, ecology, precautionary principles and ecology. In doing so, it finds itself increasingly converging with the interests of at least the sea fisheries side of the NZ recreational sector.

INDIGENOUS FISHING ISSUES

Robert Carne

Fisheries Group, Department of Business, Industry and Resource Development, PO Box 3000, Darwin, NT 0801, Australia

Abstract

Although Aboriginal and Torres Strait Islander groups have traditionally managed their marine resources for over 40 000 years, they have had little recognition since European settlement. Much has changed in the Northern Territory over the past eight years with the NT Government aiming to incorporate Aboriginal cultural values and beliefs into the contemporary management process.

The importance of Aboriginal subsistence fishing has been widely acknowledged with Indigenous interests recognised as a stakeholder group for marine resources. The specific cultural needs and aspirations of Indigenous stakeholders are recognised in establishing Aboriginal Consultative Committees in parallel to existing consultative arrangements for other key stakeholder sectors.

Established Aboriginal Consultative Committees seek to gain broad knowledge from Aboriginal Traditional Owner's and Government and Industry representatives regarding shared stocks. This consultative process aims to allow greater participation of Aboriginal people in the fishing industry through management and stock allocation.

A challenge for Fisheries Division has been to allow access to recreational fishers to waters adjacent to Aboriginal land, which makes up approximately 84% of the NT coastline.

Introduction

Aboriginal and Torres Strait Islander people have lived along the Australian coastline for over 40 000 years prior to European settlement. During this time they have managed their resources in a sustainable manner to ensure they did not deplete local stocks. Customary Indigenous management was not uniform throughout Australia due to the diversity of Indigenous groups and their beliefs. European settlers brought their ideologies and western management regimes and Indigenous input was rarely sought. These values have changed and Indigenous custodial rights were recognised by the Northern Territory (NT) Government. Aboriginal people were included in the provisions as part of the implementation of the NT Fisheries Act. It wasn't until recently that the NT Government realised the value of consultation with Aboriginal traditional owners due to their historic knowledge and land acquisition. Today, Fisheries in the NT are managed with input from the Commercial, Recreational and Indigenous fishing sectors which are the key stakeholders. All three fishing sectors have formal input through consultation processes.

Northern Territory Fisheries Act

Customary Aboriginal management practices ensured that local stocks were not under threat of depletion. The *NT Fisheries Act 1999* has in place provisions which allow NT coastal Aboriginal residents to continue their traditional hunting and collecting of marine resources. Many non-Aboriginal fishers have also been enjoying the benefits of Territory fishing but have greater difficulty in accessing premium fishing locations due to approximately 85% of the NT coastline being Aboriginal land.

Customary Aboriginal management and education relating to the sea have been passed on over generations through stories, dance, song, art and ceremony. Some Aboriginal groups elect families to act as sea managers/police. Others allow people to take on this role in their mother's country while residing in their father's country. This means that people usually would only fish and hunt within their own country and would need to ask permission before fishing in someone else's country. Cultural practices such as this may hinder Aboriginal owned commercial fishing licences (which allows fishing in any NT waters that are not subject to specific closures).

The NT Fisheries Act exempts Aboriginal people from the restrictions of bag limits, size limits and taking protected species, if they are proven to be fishing and hunting within their traditional country. This allows Aboriginal people to continue to assert their custodial rights. It also provides an opportunity for Aboriginal people to continue the practice of customary

management with regard to their resources. Aboriginal groups face the challenge of managing their traditional resources while living a static life-style rather than a nomadic lifestyle as their ancestors did. There is also added fishing effort from both recreational and commercial fishing operations. This may increase the pressure on localised stock, which may then require the enforcement of restrictions. The NT Fisheries Act has provisions indicating that the Aboriginal fishing sector would be last to have any such restrictions imposed.

Aboriginal community licences

The NT Government has implemented Aboriginal Coastal community licences, which can be issued to community groups or individuals. This allows the catch and sale within their local communities of fish species, which are not under specific management plans. It gives Aboriginal people the opportunity to obtain a fresh source of protein. Many of the Aboriginal fishers that obtain these licences tend to give fish away to family, which is a strong cultural custom.

Consultation

The NT has a cosmopolitan population with a large mix of cultural groups. The NT's Indigenous population is over 25% in contrast to the National population of approximately 2.5%. The NT Government values the diversity of cultures residing in the Territory and ensures there is a consultation process in place with relevant groups.

One of the NT Government's major management tools used for fisheries is the 'Fisheries Management Advisory Committees' (FMACs). These committees are established on a fishery basis. The NT Fisheries Act specifies who can be on these committees and include the commercial and recreational fishing industry, NT Police Marine and Fisheries Enforcement Unit, fisheries researchers/managers, wholesalers, consumers, and retailers. The committees are very formal in their structures and processes. Issues are raised and discussed in an attempt to find resolutions and identify actions that may be required. The Aboriginal fishing sector has not been included on the FMACs due to the large number of different Aboriginal groups throughout the NT. This would not only be a difficult task but it would also prove to be very costly. Choosing one person to represent all coastal Aboriginal people in the NT would not cost much, but choosing the right person would prove to be a daunting task, as Traditional Owners can only speak for their own country. It was decided that there was a need to implement an alternate process for consultation between Government and Aboriginal coastal groups.

In an attempt to include Aboriginal people in the fisheries management process, the NT Government began the process of establishing Aboriginal Fisheries Consultative Committees (AFCC). In 1993, the Anindilyakwa speaking people of Groote Eylandt entered into negotiations with the NT Government to establish the Anindilyakwa Consultative Committee, the first of the Aboriginal Fisheries Consultative Committees. These committees act as a link between Government and Aboriginal groups where matters related to fisheries can be discussed and any concerns may be raised. These committees were established separately but to compliment the FMACs. Any relevant information or issues discussed at the AFCC is referred to the relevant FMAC or *versa visa*.

The AFCC structure is less formal; this has been to allow many of the more traditionally orientated Aboriginal members to meet on their own country. This has been important in getting the members to feel comfortable in expressing themselves during meetings. Members may be less likely to speak out if they are the only Aboriginal person in a meeting full of "white fellas". Meetings are generally chaired by an Aboriginal Traditional Owner and are open to all Aboriginal residents and more recently, non-Aboriginal residents at the wish of the Aboriginal members. Special guests are invited, through the Chairman, to attend meetings when their expertise may be required. Aboriginal members decide the membership of these committees with the following Agencies and Departments represented; NT Police Marine & Fisheries Enforcement Unit; Fisheries Group; Amateur Fishermen's Association of the NT (AFNT); NT Seafood Council (NTSC); Northern Land Council (NLC); Office of Territory Development and Department of Infrastructure, Planning and Environment.

There are currently seven AFCCs across the NT, with the intention of establishing another two. Committees were established to give coastal Aboriginal communities an avenue to voice their concerns to Government with matters relating to fisheries. The structure and process of these committees are currently under review in order to ensure they are more active in resolving matters and achieving outcomes. This review followed receiving advice from the NLC, that Aboriginal members wanted the AFCCs to be the same as the FMACs. It may be that the communication process between the AFCCs and FMACs needs to be improved rather than the committee structures themselves. An idea currently being investigated is the possibility of the Fisheries Group's Aboriginal Liaison Officer (ALO) being included on the FMACs either as a member or guest. The ALO could then record and forward relevant information to the relevant committees, including exchanging information between the FMACs and the AFCCs.

The AFCC structure allows the NT Government to promote any of their initiatives relevant to coastal communities. Including, the introduction of a possession limit on painted crayfish, establishment of recreational fishing campsites on Aboriginal land, Aboriginal coastal net licences, Fisheries Compliance Course for Aboriginal Community Police Officers, a greater awareness of the FISHWATCH campaign, implementation of "dugong code of practice" and the introduction of Aboriginal Marine Rangers. There have also been several small and large scale fishing projects which include research and clean ups.

It is a reality that funding for the AFCCs is limited and several meetings have had to be postponed until next financial year. Available resources are used where they are most needed. The Fisheries Group normally visits the Borroloola region once per year but has had to make six visits in the past 10 months. These extra visits restricts available funding for other uses, such as AFCCs meetings. The Fisheries Group wishes to keep the consultation process with Aboriginal Territorians alive and to expand its coverage across the NT.

Access over three years ago, the Tiwi people expressed concern over the number of recreational fishers frequenting the waters surrounding the Tiwi Islands. The Tiwi felt that their sacred sites and other sites of significance were at risk of being damaged or degraded. Rather than erect signs or advise people of places not to go, the Tiwi people worked closely with the Amateur Fishermen's Association of the NT (AFANT) to identify six campsites around the Islands for recreational fishers. The Tiwi and AFANT have taken a positive approach by promoting places in which fishers can camp. Fishers must obtain a permit to use the camp sites. The permits expire after one week and fishers can go from one campsite to another, but must remain within the boundary of these campsites while on land. Fishers are given information pamphlets showing the various campsites as well as highlighting sacred sites and other sites of significance. The Tiwi Island campsites have received mixed success. They are excellent if recreational fishers obtain permits to use the campsites. Some fishers have suggested that the cost of the permits is too high, and many of these fishers are reluctant to obtain permits.

In April 2001, the Tiwi people estimated that only one in five vessels fishing the Islands had actually obtained a permit. This gives the impression that the permit system is not working to its potential. When one considers all the costs involved in a fishing trip from Darwin to the Tiwi Islands, each person should be able to afford an extra $27.50 as part of their expenses. To date, there is been no reason to believe the campsites are working to protect sacred sites due to the lack of reports received about sacred site trespass from the Tiwi people.

Other areas where Aboriginal people have shown interest in identifying such campsites are the English Company Islands and Cape Scott. Various levels of planning has already gone into these proposals, but a lack of funds to run any consultation meetings means these ideas will be put aside until funds are available.

Problems faced in developing campsites include organising consultation meetings with the Traditional Owners. It is a difficult task to set a date suitable for all the relevant Traditional Owners. A meeting may also incur costs from A$1 000–A$10 000 for plane charters. Discussions have taken place with some Traditional Owners, regarding possible tourist enterprises as a flow-on from the campsites. Cultural fishing and hunting safaris and eco-tours have been discussed as possible joint business partnerships. This would allow tourists to experience Aboriginal culture directly, as well as allow Aboriginal people (especially the young) to be engaged in work they are more likely to enjoy.

The NT has a higher percentage of Indigenous residents than the rest of Australia. In recognition of this, the NT Government has implemented various consultative processes and management practices to incorporate Aboriginal people into the Fisheries Management process. Two-way communication between Aboriginal and non-Aboriginal Territorians will play an important role in future development, research and management of marine resources in the NT.

Recreational versus subsistence fishing: insights from South Africa

Andrew C. Cockcroft

Marine and Coastal Management, Department of Environmental Affairs and Tourism, Private Bag X2, Rogge Bay, Cape Town 8012, South Africa

In the past, subsistence fishers had little or no legal access to South African marine resources because the harvesting methods used and the quantities required did not conform to conditions set out for recreational or commercial permits. Most subsistence activities were thus deemed illegal, and these fishers found themselves classified as an "informal sector" or as poachers. This changed when the *Marine Living Resources Act (MLRA) of 1998* provided a definition of subsistence fishing and therefore legislatively recognized this sector along with recreational and commercial fisheries. Because subsistence fisheries were not formally recognized prior to 1998, no specific management systems were in place and they were largely managed by enforcing regulations applicable to the relevant recreational fisheries.

One of the major challenges emanating from the MLRA is to balance the requirements for sustainable utilization of resources with equity (fair and broadened access) and stability within all of the fishing sectors. Recreational and subsistence fishers often target similar species, fish in the same areas and use similar fishing gear. The potential for interaction and/or conflict between these two sectors is therefore high. This paper reviews the development of subsistence fisheries in South Africa with specific emphasis on how these fisheries have impacted the recreational fisheries for rock lobster, abalone and linefish.

Who owns the fish?

John Christophersen

Cobourg Peninsula Sanctuary and Marine Park Board, PO Box 496, Palmerston, NT 0831, Australia

Cobourg Peninsula is a national park east of Darwin managed jointly by the Traditional Aboriginal Owners and the Northern Territory Government. Landowners recently renamed the Park to reflect their knowledge and practice of treating the land and sea as a continuum of their estate. It is now named Garig Gunak Barlu National Park (land and deep sea).

During earlier negotiations between traditional owners and the Northern Territory Government over the area, the then Chief Minister, Mr Paul Everingham stated in the Legislative Assembly on 4th March 1981: " part of this agreement shall include two kilometres of seas surrounding the area". This statement was reiterated in the Chief Minister's correspondence to the Northern Land Council on 11th May 1981. Our desire is to ensure that this occurs.

I wish to discuss today the issue of "who owns the fish": the Commonwealth or Territory Governments; the commercial fishing interests; recreational fisher folk; the Algalda, Murran, Njaindjarr and Mudjanbalmi; other Aboriginal nations; or no-one at all. All have very strong views, I would like to express mine.

RECREATIONAL FISHING ACCESS TO ABORIGINAL LANDS AND WATERS: CONFLICT OR COOPERATION?

Norman Fry

Northern Land Council, PO Box 42921, Casuarina, Darwin, NT 0801, Australia

Aboriginal people comprise a significant sector of the Northern Territory population and hold title to approximately 85% of the Northern Territory's coast. For Aboriginal people, the seas and waters are a vital part of their cultural, spiritual and economic lives. Their coastal communities continue to depend on the marine resources of their sea country. Sea country people are knowledgable about marine ecosystems, and have successfully and sustainably utilised the marine environment for subsistence over millennia. They traded commercially in trepang for centuries with the Maccassans, and achieved a high level of cooperation regarding access and what we would now term benefit sharing. The Maccassans obviously understood what was important to their trading partners.

The recreational fishing lobby's desire to access Aboriginal lands and waters for their purposes is not dissimilar to that of the Maccassans. Gaining access to an increasingly scarce resource (near pristine waters and relatively high fish numbers) will require an understanding and recognition by the recreational fishing industry, and the fishers themselves, of what is important to Aboriginal traditional owners. The Northern Land Council has developed a "Caring for Sea Country Strategy Framework" to provide the policy platform to deal with a spectrum of marine activities. The Strategy also aims to focus the resources of the Northern Land Council on increasing Traditional Owners' capacity to participate in all levels of sea country management, planning, research, and commerce.

Concluding remarks

CONCLUDING REMARKS

Margaret Moore

Thank you. I'd like to focus on some some issues that have been brought out, discussed and developed at the congress and I'd like to start at the global level and bring it into the national level. The main issue - do you want to be institutionalized at the global level? Do you want to go down the FAO route? I would suggest to you that when we leave this place we need to take a charter of recommended actions. I think this charter should be honoured because it is something that you need to do to be taken seriously globally. Bringing it back to the National level – I think a National association that can be truly representative is required

In the structure around ESD management, I think one of the very good visionary models that we have heard about is the WA model. They are trying to integrate every element of fishing, commercial, recreational and even the illegal into their management. Is this a model that we should look at for your very widely dispersed, recreational sector. Access, bag size, number of days, all of those things have been talked about as controls or limits in a regulated management system - all have been discussed and those are the decisions that you are going to have to make. Looking at the research issues , it must inform management. Under ESD it is required. There are fishers that don't want to pay fees. I suggested that perhaps what you need to do is set up a fund, for the type of research that needs to be done. There's already a lot being done. Let's integrate it. Let's get the results. Let's inform management. If we look at the things that need to be done in the regulatory process that will include things like stock assessment and strategic assessment of the fishery, and risk assessment. You are going to have to do measuring and monitoring to move forward in your management regimes.

Some of the tools that should be incorporated are protection and conservation measures, and no-take zones. We also need to look at the habitats, all the way along fresh water systems out into the coastal and marine. These are things we are going to have to deal with because they are, in a sense, the external factors that are going to impact on whatever you do in a management regime. If you don't deal with the external factors or have an influence on mitagating those factors, your internal management won't achieve its outcomes. In identifying external factors, think about marine pollution and that's not just about water quality, that's also looking at marine debris. We also heard this morning about weeds, invasive pests and exotic species. If we consider the degradation of habitats, we need to do something about all of these factors. These are all issues that you need engage at the decision making levels, the policy makers and the implementation agencies that actually implement those policies. So please seriously consider what you want to take forward, what you want as a charter but please include that institutionalised, formalised structure and be taken seriously. Thank you.

Ken Pollock

I just wanted to say thank you once again for inviting me to the conference. I've really enjoyed it, it's been a great experience and I'm looking forward to the dinner tonight.

We spent a lot of time talking about the Australian National Recreational Survey here. We had some talks on it and a workshop yesterday. I just want to say to the people involved - I think you really did an excellent job on the survey and when the results come out soon, I think you'll see the quality of the product that you get. The only recommendations I have is for the people involved to make sure they publish some articles about the methodology as well as the results and

consider some more validation studies. I know there are some validation studies planned with on-site surveys compared to the off-site survey methods.

More generally, I think there are a lot of hard methodological issues in surveys and there needs to be a lot more research on these angler surveys. I think it has been really neglected by the fisheries profession. There are really important issues about bias and precision. There are also important issues about combining recreational and commercial data from different surveys that have different biases. I think there's a lot of naivety about those sort of comparisons. I think sometimes people are not really interested in the quality of that data. Once you get the data well you say "this data is gospel" and we just believe it without thinking about it.

I think catch and release valuations need a lot of attention. We had one paper on this at the conference. I think these studies are just normally done atrociously from a statistical viewpoint. People don't think enough about the design, the sample sizes or the objectives of the study, and as the speaker pointed out, authors often don't present standard errors on anything - you get an estimate with no standard error attached. So, I'd make a strong recommendation that a group looks at this in terms of these studies. Certainly, if an agency is designing a study, they need to involve statisticians in the design of the studies because it is so important. You are just not going to get anything out of the studies unless you really do a good job on the design.

This is a real truism - but sound methodology is absolutely crucial to management, but yet I don't really see a lot of agencies really following that through with much action. I find I have difficulty getting methodological research funded. I have talked to colleagues who work for agencies and they often have to do the methodological research in a crisis situation, when someone says they want to know something. I think fisheries agencies need to do a much better job of realizing that if you want to have a good product then you have to put some resources into developing the methodology. There are no good funding sources for methodological research in fisheries in general, and I think for recreational fisheries it's even worse. I've talked to some of the people here in Australia and they agreed with me on that, at least privately.

I would recommend thinking of ways to fund more research on methodological issues that affect recreational fishing - like surveys and catch and release methods etc. so that things really stand up to scrutiny. I'd also encourage people to publish their work in periodic journals. Often recreational angling work is published in what we call the grey literature in the US, where they are not refereed. Part of the reason is that people don't have time for this kind of work - they are government employees and they are expected to do more with less every year. I think their supervisors in these agencies need to encourage them to publish their work in periodic journals.

I also think there should be more workshops like we had yesterday and special conferences on methodology to address some of these issues. Thank you.

John Harrison

I am just going to run through what I got out of the theme of the 'values of recreational fishing' and ask a question - " what does value mean"? - I think to everyone it would mean something different.

Some of the points that Rex [Hunt] so passionately got across on Wednesday was the shaping of the attitude and the upbringing or way of life for our children, etiquette, ethics. Other speakers have also touched upon it - not necessarily in this particular theme. This issue of value, whether it is economic, social or something else seemed to be coming across through a number of themes and through a number of presentations. It links right back to our initial keynote address by Tony [Pitcher] where we are promoting the experience. It's not just catching - I think we need to focus on how to make it better and that is the complete angler if you like. I think there was a great opportunity during the last four days of really recognising all sectors and the value of every sector to each other. There was also the danger of not valuing the fishery and that is something we need to take with us as well. I'll put a plug in for something that's been a bit of pet of mine for sometime - it's an assessment of what the real social value of recreational fishing is to our societies is. I think that is a great challenge that faces the world - to really make some kind of inroads into how we can work out the real social value. On that note, thank you.

Sean Cox

So my theme was the management of recreational fisheries. It was a small part of the larger conference but just about every presentation and poster this week had something to do with recreational fisheries management. They all contribute to what I have to say and really everybody did a great job - I commend everyone for a job well done.

Fisheries management in general deals with three main issues. Firstly assessment, and in assessment we collect information like catches, fishing effort and size, age, composition of the catch and all sorts of things. We then interpret the data through some sort of stock assessment model, where we develop expectations of how the stock will respond to changes in the future. Once sustainable harvest levels are estimated, we then have the process we call allocation. This is where we divide up the harvest among the various competing sectors. Finally there is the problem of control. This is where we use regulations and monitoring and feedback systems to ensure that the harvest is taken safely. This week the theme of management of recreational fisheries has given us really excellent examples from all of these areas. I have learned a lot of about what goes on, in Australia, in particular. Recreational catch and effort surveys are providing the data we need for stock assessment models. Recreational fisheries are increasingly trying to gain access in allocations and the control of recreational fishing effort and catch has been examined in light of angling quality and sustainable harvest objectives. So what I would like to do is outline each one of these areas and what I have heard from the conference in each area.

Firstly assessment. Fisheries management is plagued with uncertainty. Anyone will admit this to you. If the stock assessment biologist is honest he'll be up front with it - they'll admit further that stock assessment is more art than science. It really depends on who is doing your assessment as to what answer you get. Better data means you will get a Picasso instead of a Groneager. Accurate statistics aren't available on the species, the amount, size, age structure, or the characteristics and the spatial distribution of effort – that's difficult to collect even in commercial fisheries. In a commercial fishery there's relatively very few boats participating and the landings are centrally located. If you compare this to recreational fisheries where you can catch the same amount or even more and then spread that fishing effort over millions of angler trips and spatial locations that we only vaguely know at best - the prospect of more invisible collapses are certainly very real and it's something that we should really try to pay attention to. But we are making substantial progress in the design and implementation of fishing surveys, but as we've learned in commercial fisheries, this really won't be enough. Recreational fishers have to be willing to accept implementing more monitoring methods that give us a better idea on what they are actually doing out there. These include mandatory log books or vessel monitoring systems, the same types of things that commercial fishers are expected to do.

To the issue of allocation. I think absolutism was one of the most interesting ideas presented this week and the sooner recreational anglers realise the need to move away from this the better. I have just a little example here. On the US East coast the commercial fisheries were trying to get allocations of 300,000 kilos of Strait Bass. Anglers took the position that Strait Bass should exclusively be a game fish - there shouldn't be any commercial harvest. The stock assessment scientists use a hooking mortality rate of 8% in their stock assessments. They figure that about 1 ½ times the recreational landings dies every year and sinks to the bottom due to hooking mortality alone. That's 1,800,000 kilos of Strait Bass dead on the bottom. This isn't a sustainable way to go and it doesn't give you a very good bargaining position when you are trying to grab allocations. I think the same thing applies to indigenous allocations as well. What Tony [Pitcher] mentioned earlier - we are playing with the fish and they want to eat them. I think a little bit of humility is needed when it comes to what our impacts really are.

Finally on the issue of control. There's a lot of anglers out there and even if they catch one fish each, which we've seen today in three or four cases, one fish each can still be too much, so we have to use size limits. This is also what happened in the Strait Bass fishery and the reason why 1,800,000 kilos of Strait Bass die every year. The length limit means you have to catch many Bass before you catch the one you can actually keep. Even though you don't see the catches landed. it doesn't mean that size and bag limits are as effective as we think they are.

Where do we go from here? I think these issues of assessment, allocation and control have come from this conference - but really we haven't even scratched the surfaces as to how these things really work. Global conferences should be a place where we can look at recreational fishing in a global context and see what works and what doesn't for each of these different areas. This whole conference is evolving, there's been a big improvement over the conference we had in Vancouver, and I think the next one will be even better. Thanks.

Ian Cowx

I have got a couple of messages I would like to pass over to you. I have been to all three world recreational fishing conferences - if you class the Dublin conference as the first - which I do. I have seen great progress in what has happened with the recreational fishing sector since Dublin in 1996. I saw changes through to Vancouver 1999, and coming here I have seen huge developments. There are a couple of issues that have followed me through the last 6 years. I think we now clearly recognise the importance of recreational fisheries to society. It has become a common theme and it definitely includes the social, cultural and economic roles. Certainly during this conference the cultural and the social role came through much stronger. The economic issues were developed and pursued quite strongly in Vancouver. The question is "how do you use the information to promote sustainable development"? And that is sustainable development of recreational fisheries in real terms. This is a challenge. That is a challenge I leave for the organiser of the next conference.

We need to resolve the problem of equitable sharing of the resources. Sean (Cox) touched on it. I think it is a real issue. Bob Kearney's paper was the one that left an impression on me. It is an important issue and I think it is one that you have to resolve. If you don't resolve it, recreational fisheries is going to be a problem in the future.

I think we have identified many clear common issues worldwide. We all know there are problems out there, but we are not very good at identifying the solutions. I am not saying we don't have solutions, I don't think we are good at identifying common solutions from the world at large. What we need is networking, what we need are partnerships and what we need are people bringing information together towards a common goal. One of the ways forward is how do we turn fish into 'charismatic megafauna'? Like this ugly looking beast (picture of a rhino) - which I have to say is not charismatic to me as it did about $2,000 damage to my car, because we got too close to it. However, a lot of people like rhinos. How do you turn a fish into something like this - an animal that people want to go and see and handle. I went to a conference on fish conservation a few years ago in Portugal and we raised this issue - how do you make fish charismatic? What I did to make an impression on the people (and I wish I had it now) is that I held up a cuddly bear and a rainbow trout and I asked the people which one did they want to go to bed with?

To summarise though, in my talk at the very end I gave you five words - I have changed them around since listening during the last four days and I have actually put numbers by them. Now numbers to me mean priorities. I think the words have not changed, but I think the priorities have. I think the number one priority is certainly partnerships. We have got to develop worldwide partnerships to find the solutions, not address the little issues that we tend to deal with. Education and influence are very important. We have got to start to influence the people and you have got to get your message across. We have got to get your message through to politicians because that is where you are going to have the influence. You have also got to protect your resource and the bottom line, because I am a scientist, is you have got to have your knowledge base. This means using the knowledge you have got now rather than saying 'well I have got to get out and get more information'. Let us use what we have got, there is a lot of knowledge in this room and there is a lot of knowledge out there so let us go forward. Thank you.

Sir Tipene O'Reagan

Thank you. I think that this gathering has had a remarkable range of information and some of it has been quite stunning in terms of its capacity to stimulate our attention. I'm a little less certain about how well I have pulled those various elements together in my mind and if I have that problem, it's probably arrogant of me, but I'm going to assume that at least some of you have had the problem too.

I've looked at and considered the huge range of ideas from careful descriptions of stocking regimes, processes and consultations to quite passionate pleas against stocking. I have heard a range of views put about the nature of rights. I have listened to various arguments about the moral qualities of fishing - all of the glorious things it can do to set the youth of the nation upon a right and proper path . I think I could probably do the same just by changing the words in the appropriate places for 'sailing', 'chess' or 'tiddlywinks'. In other words I am not very open to the idea that just because we like doing it, it has moral benefit for others. It sounds to me a bit like the way most of the political gains get played out. It also gives rise to a distortion of the thing that does bring us together in this sector which is to do with the sustainable management of the resource. It takes our eyes off that ball. I think we have got to try and be ethical about everything. We've all got to be better. We all know that. And we all know perfectly well that sin is a distinct possibility given the opportunity. The busi-

ness and activity of fishing is not in my view, despite Rex Hunt's persuasive arguments, the sole possible route to redemption and salvation. We have got to look at it from a somewhat different base.

I think it comes down to three questions that we have got to get our heads round. As we've already discussed, these questions occur around the globe in different permutations, in different places with different species and in different environmental contexts, but the core questions are the same.

I see allocation as a part of access (I must say that my visit here has enlarged my perception of what access is about). The issue of access here is one of access to the sea by a range of Northern Territory recreational fishers. This is an issue in which there is some tension with the indigenous communities, in some cases they are resolving them well and in other cases they are not. The important point is that it is possible for people to resolve them well. We have heard similar examples of this in other areas where we've had a particular species which is working quite well in some places in terms of management and less well in others.

I have found nothing however to counter my earlier concerns I put to you about the management or treatment or approach to bycatch here in the Northern Territory. It seems to me if all you are going to do is exclude this bycatch problem from certain fisheries and take it offshore, you've done nothing, you've cleaned up your beach maybe, but you've actually done nothing to alter the issue of the wastage of fish and the unsustainable management of the resource. It's that sort of 'parking the issue elsewhere because it's off my patch' is very much part of the overall fisheries scene internationally. I think we've got to look at the triangle of recreational, commercial and indigenous use and the role of the State as the regulator much more creatively than we tend to do.

Abundance is something we are all in favour of. It's like motherhood and apple pie. Everywhere in the world, everyone wants abundance. That's the context in which we discuss sustainability and we've all got our different views on what it means. We have all got our different definitions and interpretations, but at the end of the day it is the one thing that all the protagonists in the fisheries sectors, discussing allocation or access, actually come back to. It is something they agree on, or say they agree on. It seems to me, that unless you make abundance the core and you build your access or some definable rights around the core of sustainability, you will not maintain a sufficient level of abundance into the future. You must find that one ground you've all got in common, and you build your rights from that principle. In other words, if you are found to be offending against this principle you lose your rights or are deprived of your rights. In my tribe, when we found our own sinning against the general rules back in the 1980s, they were blacklisted for life from access to the tribe's own quota or rights. Out!! Gone!! Finished!! Dead!! Would the recreational sector be prepared to have a structure with which they did that to their own? I think this is the kind of approach you've got to have. The fundamental point was that sustainable abundance was put at the core and the centre of the right, you offend against that and you are out. This regime worked reasonably well, but of course before very long the macro legal system put those people back in possession of access - but at least we tried and I believe it's a route that has to be taken.

Exclusivity is a fundamental incidence of rights. And the need for defined rights in my view is the one thing I hear throughout the discussions we've been having, outside and inside the conference. I say to myself: if only those rights were more defined, if those conditions of access were clear, if these people were able to deal because they had clear rights. If the indigenous community had an acceptance of the other two sectors who had clear rights then they would be in a position to sit down to negotiate - if the recreational sector had some acceptance by the other two sectors and the commercial sector had the same. Not sitting there saying "Yes, you have some sort of rights but your right is inferior to my moral right because I'm there on behalf of all the children" or "I'm there on behalf of the moral good of the nation" or "we are going to fix the whole face of creation because we have this extraordinary gift of faith, we are recreational fisherman". If you take that sort of attitude or the indigenous community take it on behalf of future generations or the commercial people do it, assuming the high and moral position will reduce the capacity to come to the centre and find the core question - the centre point of the maintenance of abundance, having accepted mutually defined rights in the trinity and ways in which we can have allocation. Talk to each other from positions! We are all sharing the same mountain top and we are not, any of us, going to fall off and leave only two behindto fight it out. The three elements have got to be able to deal together.

We do have one further issue which I think Peter [Rogers] alluded to in his paper on an integrated management approach earlier today. That whole integrated approach is one we are not going to be able to handle as a marine sector. We are not going to be able to handle the planning mechanisms and structures of land based property, assets and effects unless we are able to bring our own acts together. A huge amount of the coastal resources are affected by the kind of environmental management at the other end. The issues of fisheries are by no means issues confined to predation upon species. We know that. We've got to come to terms with those wider environmental questions that press upon us and affect what we do, as a marine sector. Then indeed, we may all go together, to heaven.

Tony Pitcher

In 1995 I met a charming South African lady, Joelle Rowe, that some of you may know. We met again in Brisbane at the World Fisheries Congress in 1996 and at that point John Harrison joined us. There was a considerable message from recreational fishers, Joelle, John and others that recreational fishing needed a voice. So we said 'well let's have a conference in Vancouver in 1999'. We thought we were the first conference, but then as always, the Irish said they invented it first. So Vancouver was actually the second congress and as Ian [Cowx] reminded us so very fortunately, here we are at the third. I concur with Ian and others who said this has moved on a lot. The need for a voice for recreational fishing has gone. This conference, through its three iterations and hopefully the fourth later on, is clearly making a very profound statement about the issues.

The issues that we were concerned with most in Vancouver was methodology, evaluation, and how to evaluate things. In fact most of the papers were concerned with survey methodology, statistical matters and economic evaluation. There are a whole set of papers in the book which go into those in some detail. I hope to the satisfaction of Dr [Ken] Pollock who like most statisticians, wags his finger, admonishes us for bad survey technique and our sample wasn't big enough and we didn't take account of all the sources of variance. But we are getting there. There were some papers in this conference which looked at these issues and took them a bit further. I think we are getting there with the methodology and survey issues and perhaps Ken will, at the next conference, be able to bless what happens.

The second issue of note in the Vancouver conference, that we've had a number of papers on here, is effort dynamics - predicting the stock assessment world of recreational fisheries. Sean Cox, Eric Parkinson, Roland Griffin and Carl Walter's finger gave papers on this issue here. We have a very effective set of models now , although I was a bit amused to see that the barramundi did not fit the Canadian model. It reminded me of something that Eric did not mention in his talk, which takes me back to what I said at the beginning of the conference - about sport fishing being about dreams really, rather than about catching fish. There was a case from a lake in British Columbia where they did a survey (according to all best statistical techniques Ken). They asked anglers about their angling experience for the day as they came away from the lake. Most of them said: "well, you know, it was average, maybe a little bit better than average, quite good really. Quite a good day". This was one of the lakes that has no streams for Rainbow Trout to spawn, so it's stocked every year by Eric's Department. In fact they had forgotten to stock it and there were no fish in the lake at all - yet people had had a really good angling experience. Effort dynamics – when it's zero what do you do with it.

Stocking! We had papers on stocking, oh dear, oh dear. Ian gave a devastating analysis of the European situation on stocking. In my view the only stockings around should be at Christmas! Please read the literature on the disastrous experience of North American Enhancement Scheme where the best thing you can say about it is the cost benefit ratio of four to seven. It's created massive problems in terms of genetics and effort concentration on rare genetic stocks.

The indigenous issues I thought were very powerfully presented at the meeting – John Christophersen, Norman Fry and Bo Carne. Thanks of course to the Larrakia Nation for hosting this conference on their territory. I think the primacy of an Aboriginal indigenous claims are important. If we don't address this we will not have any kind of commercial fishing let alone sport fishing. As we speak, this week Chief Simon Lucas who is the head of the New Chalmouth Nation on Vancouver Island, is being presented with an honorary doctorate from the University of British Columbia. Simon Lucas has been one of the people who has put forward to us 'white people' a way of thinking which is embedded in Aboriginal ethic - which he calls 7th generational thinking. This means what you do today should be sustainable for the 7th generation after you. That is a very long time perspective, more than most of us are used to. He often brings his grandson when he's giving a talk and he says thats what we have to do

In terms of ethics, our sport needs a Code of Conduct that can be applied world wide and encourage the responsible pursuit of our sport. In my opinion, the UN-FAO Code of Conduct can be easily adapted. I was very encouraged in the workshop, which I thought went very well, people were surprising kind to each other. Having a code which both fishery managers and individual anglers can follow, which we hope one day has FAO's blessing, a constitutional blessing, would be wonderful. So if by the next conference we've moved onto that position this would be an excellent thing. I must say I have to agree with Ian [Cowx] that the image of recreational fishing has to be pretty squeaky clean if we are going to get there. I cannot for the life of me imagine what recreational gill netting is? I could also imagine recreational dynamiting? – we must move away from being perceived as a sport where killing things is what we are doing, what we are getting pleasure from. That is not going to get us anywhere.

I want to finish with the feeling that I've been most encouraged – basically I am an optimist, so I am encouraged to see a conservation ethic running throughout the conference – through people's talks, papers and the discussion in the workshops and all of the theme and keynote speakers. The fact that what we've all said has been imbued with that conservation ethic has been very encouraging. Ultimately, I actually disagree with Sir Tipene [O'Reagan] - I think ultimately deep down it's the conservation ethic which is going to take us forward, rather than today's or tomorrow's allocation fight. So the gentle spirit of our 17th century English royalist, Isaac Walton was there even in what our Maori warlord said.

I'd leave you at the end with a quote, (because it's from memory it may not be an exact quote) from the pioneer of conservation in the United States who died in the late 1940s, Aldo Leopold and he said: "*Leaving conservation to Government is like relegating virtue to the Sabbath. It abrogates to professionals what should be the daily work of amateurs*".

Thank you.

List of attendees

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Allain, Mr Robert — Regional Manager, Fisheries Management, Fisheries and Oceans Canada, Gulf Region, PO Box 5030, Moncton New Brunswick E1C 9B6, Canada. Telephone (work): (506) 851-7752, Fax: (506) 851-2615, E-Mail: AllainR@dfo-mpo.gc.ca

Appelblad, PhD Håkan — University Lecturer, Department of Social and Economic Geography, Umeå University, UMEÅ S-901 87, Sweden. Telephone (work): 46 90 7867637, Fax: 46 90 7866359, E-Mail: hakan.appelblad@geography.umu.se

Arlinghaus, Robert — PhD Student, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, PO Box 850119, Berlin 12561, Germany. Telephone (work): 49-30-64181-653, Fax: 49-30-64181-750, E-Mail: arlinghaus@igb-berlin.de

Babon, Ms Pauline — Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633

Baird, Mr. Sam — Chief, Oceans Policy, Fisheries and Oceans Canada, 555 West Hastings Street, Vancouver British Columbia V6B 5G3, Canada. Telephone (work): (604) 666-6037, Fax: (604) 666-1273, E-Mail: bairdsa@pac.dfo-mpo.gc.ca

Barrington, Mr Jonathon — AFFA, GPO Box 858, Canberra ACT 2601. Telephone (work): 02 6272 4975, Fax: 02 6272 4875, E-Mail: jonathon.barrington@affa.gov.au

Bateman, Mr David — Executive Officer, Sunfish Queensland, 34 Resolute Court, Scarborough QLD 4020. Telephone (work): 07 3880 4261, Fax: 07 3880 4261, E-Mail: sunfish@modemss.brisnet.org.au

Bathgate, Mr Doug — Chairperson, Recreational Fishing Advisory Committee (RFAC), Department of Fisheries, Level 3, SGIO Atrium, 168 - 170 St George's Terrace, PERTH WA 6000. Telephone (work): 08 9482 7370, Fax: 08 9482 7218, E-Mail: eferguson@fish.wa.gov.au

Bengtsson, Dr Bo — National Board of Fisheries, PO Box 423, Goteborg SE-40126, Sweden. Telephone (work): +46-31-743 0300, Fax: +64-31-743 0344, E-Mail: bo.bengtsson@tiskeriverket.se

Bennison, Mr Simon — Director, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 0400, Fax: 02 6285 4421, E-Mail: kylie.paulsen@frdc.com.au

Bolton, Mr Steve — AFMA, PO Box 7051, CMC ACT 2610. Telephone (work): 02 6272 5282, Fax: 02 6272 4614

Bond, Mr David — Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633

Boxall, Ms Val — Senior Scientist, Recreational Fishery, SARDI Aquatic Sciences, 2 Hamra Ave, West Beach SA 5024. Telephone (work): 08 8200 2448, Fax: 08 8200 2481, E-Mail: boxall.val@saugov.sa.gov.au

Brooks, Ms Kate — Research Scientist, Social Sciences Centre, Bureau of Rural Sciences, PO Box E11, Kingston ACT 2603. Telephone (work): 02 6272 3582, Fax: 02 6272 4734, E-Mail: kate.brooks@brs.gov.au

Brown, Mr Paul	Senior Scientist Freshwater Resources Program, Marine and Freshwater Resources, Private Bag 20, Alexandra VIC 3714. Telephone (work): 03 5774 2208, Fax: 03 5774 2659, E-Mail: paul.brown@nre.vic.gov.au
Brown, Mr Ross	DPIWE, PO Box 44, Hobart TAS 7001. Telephone (work): 03 6233 6061, Fax: 03 6223 1539, E-Mail: peter.trott@dpiwe.tas.gov.au
Buckworth, Mr Rik	Research Scientist, Fisheries Division - DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8924 4176, Fax: 08 8981 3420, E-Mail: rik.buckworth@nt.gov.au
Buxton, Professor Colin	Research Scientist, Tasmanian Aquaculture & Fisheries Institute, Nubeena Cresent, Taroona, Hobart TAS 7053. Telephone (work): 03 6227 7246, Fax: 03 6227 8035
Byrne, Mr Denis	Chairman, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 0400, Fax: 02 6285 4421, E-Mail: kylie.paulsen@frdc.com.au
Cadwallader, Mr Phil	Director, Fisheries, Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville QLD 4814. Telephone (work): 07 4750 0812, Fax: 07 4772 0766, E-Mail: p.cadwallader@gbrmpa.gov.au
Cameron, Mr Darren	Senior Project Manager, Great Barrier Reef Marine Park Authority, PO Box 1379, Townsville QLD 4814. Telephone (work): 07 4750 0862, Fax: 07 4772 6093, E-Mail: camerond@gbrmpa.gov.au
Carne, Mr Robert	Aboriginal Liaison Officer, DBIRD, PO Box 3000, Darwin NT 0801. Telephone (work): 08 89992164, Fax: 08 89992065, E-Mail: robert.carne@nt.gov.au
Cartwright, Mr Ian	Director, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 4421, Fax: 02 6285 0411, E-Mail: kylie.paulsen@frdc.com.au
Cass, Mr David	Fisheries Officer., Natural Resources and Environment.Victorian Fisheries., c/- P.O. Box 271, Cowes VIC 3922. Telephone (work): 03 5952 5910, Fax: 03 5952 5721, E-Mail: david.cass@nre.vic,gov.au
Chan, Dr. Ivan K. K.	Marine Parks Officer (West), Agriculture, Fisheries & Conservation Department, Hong Kong, Hong Kong, Hong Kong Sar, China. Telephone (work): (852) 2150 6872, Fax: (852) 2152 0060, E-Mail: ivan_kk_chan@afcd.gov.hk
Chase, Mr Stephen	Vice President, Govt Affairs, Atlantic Salmon Federation, PO Box 5200, St Andrews NB E5B 3S8, Canada. Telephone (work): 506 529 1057, E-Mail:, schase@nb.aibn.com
Chilcott, Mr Stuart	Senior Fisheries Manager, Inland Fisheries Service, PO Box 288, Derwent TAS 7009. Telephone (work): 03 6233 8767, Fax: 03 6233 3811, E-Mail: chilcott@ifs.tas.gov.au
Christophersen, Mr John	Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633
Clarke, Dr David	Head of Fisheries, Environment Agency, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, Bristol BS32 4UD, England. Telephone (work): 00 44 1454 624304, Fax: 00 44 1245 62033, E-Mail: kathryn.williams@environment-agency.gov.uk.
Clarke, Mr Raymond	Aquatic Resource Manager, Fisheries Division DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2179, Fax: 08 8999 2065, E-Mail: ray.clarke@nt.gov.au
Cockcroft, Dr Andrew	Principal Specialist Scientist, Marine and Coastal Management, Dept of Environmental Affairs &, Private Bag X2, Rogge Bay, Cape Town 8012, South Africa. Telephone (work): 27 21 4023132, Fax: 27 21 4217406, E-Mail: cockcrof@mcm.wcape.gov.za
Coleman, Ms Anne	Recreational. Fisheries Assessment Officer, Fisheries Division - DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2173, Fax: 08 8999 2065, E-Mail: anne.coleman@dpif.nt.gov.au

Connell, Mr. Chris Inland Fisheries Biologist, New Brunswick Department of Natural Resources and Energy, PO Box 6000, Fredericton New Brunswick E3B 5H1, Canada. Telephone (work): (506) 453 2440, Fax: (506) 453 6699, E-Mail: chris.connell@gnb.ca

Conron, Mr Simon Recreational Fisheries Sub-Program Leader, MAFRI, PO Box 114, Queenscliff VIC 3225. Telephone (work): 03 5258 0235, Fax: 03 5258 0270, E-Mail: simon.conron@nre.vic.gov.au

Copeland, Mr Craig Senior Conservation Manager, NSW Fisheries, PO Box 154, Ballina NSW 2478. Telephone (work): 02 6686 2018, Fax: 02 6686 8907, E-Mail: copelanc@fisheries.nsw.gov.au

Cowx, Dr Ian Director, Hull International Fisheries Institute, University of Hull, Hull HU67RX, United Kingdom. Telephone (work): 44 1482 466 427, Fax: 44 1482 470 129, E-Mail: l.g.cowx@hull.ac.uk

Cox, Dr Sean 680 N Park Street, Madison Wisconsin 53706, USA. Telephone (work): 602 262 3088, Fax: 604 291 4968, E-Mail: spcox@facstaff.wisc.edu

Cribb, Mr Andrew Department of Fisheries, Level 3, SGIO Atrium, 168 - 170 St George's Terrace, Perth WA 6000. Telephone (work): 08 9482 7334, Fax: 08 9482 7218, E-Mail: acribb@fish.wa.gov.au

Curnow, Mr Ian Policy and Planning Officer, Department of Fisheries, Level 3, SGIO Atrium, 168 St Georges Tce, Perth WA 6000. Telephone (work): 08 9482 7363, Fax: 08 9482 7218, E-Mail: icurnow@fish.wa.gov.au

Cuttriss, Ms Linda Senior Project Officer, World Wide Fund for Nature, GPO Box 1268, Darwin NT 0801. Telephone (work): 08 8941 7554, Fax: 08 8941 6494:, E-Mail: lcuttriss@wwf.org.au

Daly, Mr John Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633

Davies, Mr Martin Fishery Scientist, Rhodes University / FOSAF, Dept Inchthyology and Fisheries Science, Rhodes University,, Grahamstown Eastern Cape 6140, South Africa. Telephone (work): +27 466038417, E-Mail: f.faithfull@ru.ac.za

Day, Dr Diana Director, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 4421, Fax: 02 6285 0411, E-Mail: kylie.paulsen@frdc.com.au

De Vocht, Dr. Alain Senior Scientist, Centre for Environmental Sciences, Limburgs Unviersitair Centrum, Universitaire Campus, Gebouw D, Diepenbeek 3590, Belgium. Telephone (work): 3211268334, Fax: 3211268301, E-Mail: alain.devocht@luc.ac.be

De With, Mr Warren President, AFANT, PO Box 1128, Katherine NT 0850. Telephone (work): 08 89721020, Fax: 08 89723096, E-Mail: alligator@nt-tech.com.au

Diplock, Mr John Principal Manager Recreational, NSW Fisheries, PO Box 21 Cronulla, Sydney NSW 2230. Telephone (work): 02 9527 8473, Fax: 02 9527 8536, E-Mail: diplockj@fisheries.nsw.gov.au

Donohue, Mr Kevin Ministerial Policy Officer, Department Premier and Cabinet, 11th Floor, Dumas House, 2 Havelock Street, West Perth WA 6005. Telephone (work): 08 92136700, Fax: 08 92136701, E-Mail: kdonohue@dpc.wa.gov.au

Doohan, Mr John Sunfish Queensland, 11 Basnett Street, West Chermside QLD 4032. Telephone (work): 07 3359 3086, Fax: 07 3359 4274, E-Mail: john@logicworld.com.au

Douglas, Mr John Project Scientist, Dept. Natural Resources and Environment, Victoria, Private Bag 20, Alexandra VIC 3714. Telephone (work): 03 5774 2208, Fax: 03 5774 2659, E-Mail: john.douglas@nre.vic.gov.au

Dundas-Smith, Mr Peter Executive Director, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 0400, Fax: 02 6285 4421, E-Mail: kylie.paulsen@frdc.com.au

Eldridge, Mr Brian	Chairman, Marine Recreational Fishing Council, PO Box 1047, Sandy Bay TAS 7006. Telephone (work): 03 6223 2846, Fax: 03 6223 2846, E-Mail: bjeld@vision.com.au,
Elliott, Mr John,	Comminucation Officer (Community), Fisheries Victoria, PO Box 500, East Melbourne VIC 3148. Telephone (work): 03 9412 5709, Fax: 03 9412 5731, E-Mail: john.elliott@nre.vic.gov.au
Eriksson, Prof. Torleif	Senior Scientist, Department of Aquaculture, Swedish University of Agricultural Sciences, S-90187 Umeå, UMEÅ S-901 87, Sweden. Telephone (work): +46 - 907867688, Fax: +46-90123729, E-Mail: Torleif.Eriksson@vabr.slu.se
Fejo, Mr Eric	Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 8920 5100, Fax: 8945 2633
Flaherty, Mr Bill	Deputy Director, DBIRD Fisheries Division, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 89992120, Fax: 08 89992065, E-Mail: william.flaherty@nt..gov.au
Foster, Mr Derek	Innovations & Development Specialist, Qld Department of Primary Industries, PO Box 1565, SCMC, Nambour QLD 4560. Telephone (work): 07 5430 4912, Fax: 07 5430 4994, E-Mail: fosterd@dpi.qld.gov.au
Fowler, Mr Neville	Manager Northern Fisheries, Department of Natural Resources & Environment, PO 124, Benalla VIC 3672. Telephone (work): 03 5761 1512, Fax: 03 5761 1628 E-Mail: neville.fowler@nre.vic.gov.au
Frusher, Dr Stewart	Section Leader, Crustacean Research, University of Tasmania, Tasmanian Aquaculture and Fisheries, PO Box 252-49, Hobart TAS 7001. Telephone (work): 03 62277277, Fax: 03 62278035, E-Mail: stewart.frusher@utas.edu.au
Fry, Mr Norman	Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633
Gardiner, Hon Jenny	Shadow Minister - Fisheries, NSW National Party, Parliament House, Sydney NSW 2000. Telephone (work): 02 9230 2903, Fax: 02 9230 2053, E-Mail: jenny.gardiner@parliament house.nsw.gov.au
Gaughan, Dr Daniel	Senior Research Scientist, Department of Fisheries, PO Box 20, North Beach WA 6920. Telephone (work): 08 9246 8418, Fax: 08 9447 3062, E-Mail: dgaughan@fish.wa.gov.au
Geertz-Hansen, Mr Peter	Senior Officer / Fishery Biologist, DIFRES, Vejlsoevej 39, Silkeborg 8600, Denmark. Telephone (work): + 45 89 21 31 00, Fax: + 45 89 21 31 50, E-Mail: pgh@dfu.min.dk
Gill, Mr Neville	Northern Territory Seafood Council, GPO Box 618, Darwin NT 0801. Telephone (work): 08 89815194, Fax: 08 89815063
Gojuwa, Mr Charles	Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633
Golden, Mr. Martin	Pacific Recreational Fisheries Coordinator, National Marine Fisheries Service, 501 W. Ocean Blvd., Suite 4200, Long Beach California 90802, USA. Telephone (work): (562) 980-4004, Fax: (562) 980-4047, E-Mail: Marty.Golden@NOAA.Gov
Graefe, Dr Alan	Penn State University, 201 Mateer Building, University Park PA 16802, USA. Telephone (work): 814 863 8986, Fax: 814 863 4257, E-Mail: gyu@psu.edu
Griffin, Mr Roland	Senior Research Scientist, DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8924 4170, Fax: 08 8981 3420, E-Mail: roland.griffin@nt.gov.au
Hall, Ms Kylie	Project Scientist, Department of Natural Resources and Environment, Private Bag 20, Alexandra VIC 3714. Telephone (work): 03 5774 2208, Fax: 03 5774 2659, E-Mail: kylie.hall@nre.vic.gov.au
Hannersjö, Mr David	Ph.D. Student, Department of Aquaculture,, Swedish University of Agricultural Sciences, S-90187 Umeå, UMEÅ S-901 87, Sweden. Telephone (work): +46 - 907867689, Fax: +46-90123729, E-Mail: David.Hannersjo@vabr.slu.se

Hansen, Mr Carl Unit Co-Ordinator (Darwin), Australian Maritime College, 3 Mullen Place, Alawa NT 0810. Telephone (work): 0411 552 729, E-Mail: carl.hansen@am

Harrison, Mr John Executive Officer, AFANT, PO Box 40694, Casuarina NT 0811. Telephone (work): 08 89456455, Fax: 08 89456055, E-Mail: afant@afant.com.au

Harrison, Mr Nathan Fisheries Management Officer, Department of Fisheries, W.A., Level 3, SGIO Atrium, 168 - 170 St George's Terrace, Perth WA 6000. Telephone (work): 08 9482 7368, Fax: 08 9482 7218, E-Mail: nharrison@fish.wa.gov.au

Hay, Ms Tracy Fisheries Biologist, NT Fisheries, PO Box 3000, Darwin NT 0801. Telephone (work): 08 89992190, Fax: 08 89992065, E-Mail: tracy.hay@nt.gov.au

Healy, Mr Terry A/Manager, Recrational Fishing Unit, Queensland Fisheries Service, GPO Box 46, Brisbane QLD 4001. Telephone (work): 07 3405 6805, Fax: 07 3229 8541, E-Mail: Terry.Healy@dpi.qld.gov.au

Hearnden, Dr Mark Biometrician, DBIRD, PO Box 3000, Darwin NT 0812, Fax: 08 8999 2200, E-Mail: Mark.Hearnden@nt.gov.au

Henry, Mr Gary Biologist, NSW Fisheries, PO Box 21 Cronulla, Sydney NSW 2230. Telephone (work): 02 95278477, Fax: 02 95278536, E-Mail: Henryg@fisheries.nsw.gov.au

Higgs, Mr Jim Senior Fisheries Scientist, Queensland Fisheries Service, GPO Box 46, Brisbane QLD 4001. Telephone (work): 07 3225 1898, Fax: 07 3224 2805, E-Mail: jim.higgs@dpi.qld.gov.au

Hills, Ms Leslee Extension Coordinator, Fisheries Division - DBIRD, PO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2348, Fax: 08 8999 2015, E-Mail: leslee.hills@nt.gov.au

Hogan, Mr Alf Senior Fisheries Biologist, Qld DPI Fisheries Research, Kennedy Highway, Walkamin QLD 4872. Telephone (work): 07 4092 9921, Fax: 07 4093 3903, E-Mail: alf.hogan@dpi.qld.gov.au

Hollaway, Ms Michelle Senior Policy Officer, Queensland Fisheries Service, GPO Box 46, Brisbane QLD 4001. Telephone (work): 07 3227 7259, Fax: 07 3239 0439, E-Mail: michelle.hollaway@dpi.qld.gov.au

Holtz, Mr Martin Policy Officer, Recfishwest, PO Box 57, Claremont WA 6010. Telephone (work): 08 9387 7864, Fax: 08 9387 7643, E-Mail: martin@recfishwest.org.au

Hone, Dr Patrick Programs Manager, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 4421, Fax: 02 6285 0411, E-Mail: kylie.paulsen@frdc.com.au

Horwood, Mr Angus Dress Circle Farm, 79 Dayrell Road, Nowergup WA 6032. Telephone (work): 08 9407 5171, Fax: 08 9407 5145, E-Mail: dresscirclefarm@bigpond.com

Hunt, Mr Rex Rex Hunt Enterprises, PO Box 31, Sandringham VIC 3191. Telephone (work): 03 9598 9888, Fax: 03 9598 8822, E-Mail: rachel@rexhunt.com.au

Jackson, Mr Steve Project Officer, National Oceans Office, GPO Box 2139, Hobart TAS 7001. Telephone (work): 03 6221 5022, Fax: 03 6221 5050, E-Mail: steve.jackson@oceans.gov.au

James, Mr Dylan Senior Analyst, NZ Ministry of Fisheries, PO Box 1020, Wellington, New Zealand. Telephone (work): 0064 4 4702599, Fax: 0064 4 4702 586, E-Mail: dylan.james@fish.govt.nz

Jarzynski, Mr Stan Manager - Fisheries Action Program, AFFA - Fish & Aquaculture Branch, GPO Box 858, Canberra ACT 2601. Telephone (work): 02 6272 4413, Fax: 02 6272 4215, E-Mail: stan.jarzynski@affa.gov.au

Jonauskas, Mr Paul Technical Officer, Department of Infrastructure, Planning & Environment, PO Box 30, Palmerston NT 0831. Telephone (work): 08 8999 4569, Fax: 08 8999 4403, E-Mail: paul.jonauskas@nt.gov.au

Josif, Mr Paul Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633

Kearney, Professor Bob Professor of Fisheries, University of Canberra, Canberra ACT 2601. Telephone (work): 02 6201 5784, Fax: 02 6201 2328, E-Mail: kearney@scides.canberra.edu.au

Kennett, Dr Rod Natural Resource Manager, Parks Australia North, PO Box 71, JABIRU NT 0886. Telephone (work): 08 8938 1162, Fax: 08 8938 1115, E-Mail:

Kiessling, Ms Ilse GPO Box 1268, Darwin NT 0801. Telephone (work): 08 8979 9709, E-Mail: amanda.pepper@oceans.gov.au

Kilner, Mr Allan Fisheries Analyst, Ministry of Fisheries, PO Box 1926, DUNEDIN 9001, New Zealand. Telephone (work): 64 03 474 2686, Fax: 64 03 477 6275, E-Mail: kilnera@fish.govt.nz

Kowitz, Mr Les Sunfish, 20 Burnett St, Nanango QLD 4615. Telephone (work): 07 4163 1191, Fax: 07 4163 1191, E-Mail: leskowitz5@yahoo.co.uk

Krix, Mr Robert Manager, Recreational Fishing Licence Revenue Expenditure, Fisheries Victoria, PO Box 500, East Melbourne VIC 3002. Telephone (work): 03 9412 5714, Fax: 03 9412 5731, E-Mail: robert.krix@nre.vic.gov.au

Kwok, Mr Rock KY Agriculture, Fisheries & Conservation Department, Hong Kong, Hong Kong, Hong Kong Sar, China. Telephone (work): (852) 2150 6872, Fax: (852) 2152 0060

Kyle, Dr. Gerard Assistant Professor, Clemson University, 263 Lehotsky Hall, Clemson South Carolina 29634-0735, USA. Telephone (work): 1-864-656-0787, Fax: 1-864-656-2226, E-Mail: gerard@clemson.edu

Lane, Mr Michael Manager, Woodside Energy Ltd, GPO Box 3446, Darwin NT 0801. Telephone (work): 08 8980 2700, Fax: 08 8980 2710, E-Mail: michael.lane@woodside.com.au

Larson, Dr Helen Curator Of Fishes, Museum & Art Gallery of The NT, GPO Box 4646, Darwin NT 080I. Telephone (work): 08 8999 8201, Fax: 08 8999 8289, E-Mail: helen.larson@nt.gov.au

Lehtonen, Professor Hannu University of Helsinki, P.O Box 27, Helsinki Fin-00014, Finland. Telephone (work): +358 9 19158468, Fax: +358 9 19158257, E-Mail: hannu.lehtonen@helsinki.fi

Lenanton, Dr Rodney Supervising Scientist, Department of Fisheries, W.A., PO Box 20, North Beach WA 6920. Telephone (work): 08 9246 8441, Fax: 08 9447 3062, E-Mail: rlenanton@fish.wa.gov.au

Leyland, Mr Geoffrey Executive Officer, WA Fishing Industry Council, PO Box 55, Mt Hawthorn, Perth WA 6915. Telephone (work): 08 92442933, Fax: 08 92442934, E-Mail: gleyland@wafic.org.au

Lindner, Mr Garry Environment Australia, PO Box 71, Jabiru NT 0886. Telephone (work): 08 8938 1165, Fax: 08 8938 1115, E-Mail: garry.lindner@ea.gov.au

Lloyd, Ms Julie Research Officer, NT Fisheries Division, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8924 4175, Fax: 08 8981 3420, E-Mail: julie.lloyd@nt.gov.au

Lydecker, Mr Ryck Associate Director, Government Affairs, Boat U.S., 880 South Pickett St., Alexandria VA 22304, USA. Telephone (work): 703 461-2864, Fax: 703 461-2845, E-Mail: rlydecker@boatus.com

Lyle, Dr Jeremy Senior Research Scientist, Tasmanian Aquaculture & Fisheries Institute, PO Box 252-49, Hobart TAS 7001. Telephone (work): 03 6227 7255, Fax: 03 6227 8035, E-Mail: Jeremy.Lyle@utas.edu.au

Macdonald, Dr Murray Manager, Bay and Inlet Fisheries, Fisheries Victoria, Department of Natural Resources & Environment, PO Box 103, Geelong VIC 3220. Telephone (work): 03 5226 4652, Fax: 03 5226 4563, E-Mail: Murray.MacDonald@nre.vic.gov.au

Marshall, Ms Andria Program Coordinator Aquatic Pest Management, Fisheries Division - DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2126, Fax: 08 8999 2065, E-Mail: Andria.Marshall@nt.gov.au

Martin, Mr Kim,	Branch Chairman, Sunfish QLD, 21 Stevenson Street, Yeppoon QLD 4703. Telephone (work): 07 4939 1670, Fax: 07 4939 2461, E-Mail: capsunfi@rocknet.net.au
Mccrossen, Mr Greg	Inland Fisheries Service, PO Box 288, Derwent TAS 7009. Telephone (work): 03 6233 4004, Fax: 03 6233 3811, E-Mail: gregm@ifs.tas.gov.au
Mcdougall, Mr Andrew	Fisheries Biologist, Northern Fisheries Centre, PO Box 5396, CAIRNS QLD 4870. Telephone (work): 07 4035 0134, Fax: 07 4035 1401, E-Mail: mcdougaj@dpi.qld.gov.au
Mcinnes, Ms Kirrily	Policy Officer, Queensland Fisheries Service, GPO Box 2764, Brisbane QLD 4001. Telephone (work): 07 3227 8008, Fax: 07 3227 8788, E-Mail: kirrily.mcinnes@dpi.qld.gov.au
Mcintosh, Mr Barry	Sunfish, PO Box 281, Richlands DC QLD 4077. Telephone (work): 07 3372 2208, Fax: 07 3278 8433
Mcnee, Mr Andrew	AFMA, PO Box 7051, CMC ACT 2610. Telephone (work): 02 6272 4923, Fax: 02 6272 5036
Meerburg, Mr. David	Senior Policy Advisor, Fisheries Research Branch, Fisheries and Oceans Canada, 200 Kent Street, Ottawa Ontario K1A 0E6, Canada. Telephone (work): 613-990-0286, Fax: 613-954-0807, E-Mail: meerburd@dfo-mpo.gc.ca
Melville-Smith, Dr Roy	Principal Research Scientist, Department of Fisheries Western Australia, PO Box 20, North Beach WA 6920. Telephone (work): 08 9246 8406, Fax: 08 9447 3062, E-Mail: rmsmith@fish.wa..gov.au
Monash, Mr. Ross	Environmental Officer, Recfish Australia, P.O. Box 854 Dickson, Canberra ACT 2602. Telephone (work): 02 62571997, Fax: 02 62479314, E-Mail: ross.monash@sportnet.com.au
Moore, Mr David	Business Director, Australian National Sportfishing Association, 37 Arkendeith Drive, Edmonton QLD 4869. Telephone (work): 0417 824 408, Fax: 07 4055 4296, E-Mail: david_moore@hotkey.net.au
Moore, Ms Margaret	Senior Policy Officer, WWF Australia, 1st Floor, 4 Church Street, Hawthorne VIC 4156. Telephone (work): 03 9853 7244, Fax: 03 9853 4156, E-Mail: mmoore@wwf.org.au
Morison, Mr Sandy	Program Leader, Marine & Freshwater Resources Institute, PO Box 114, Queenscliff VIC 3225. Telephone (work): 03 5258 0111, Fax: 03 5258 5270, E-Mail: sandy.morison@nre.vic.gov.au
Munungurritj, Nanikiya	Northern Land Council, PO Box 1249, Pamerston NT 0831. Telephone (work): 08 8920 5100, Fax: 08 8945 2633
Murphy, Mr Ian	Research & Development, PO Box 8, Grange QLD 4051. Telephone (work): 0416157124, Fax: 0732556809, E-Mail: ianmurphy@bigpond.com
Murphy, Mr Jeff	NSW Fisheries, PO Box 21, Cronulla NSW 2230. Telephone (work): 02 9527 8411, Fax: 02 9527 8576, E-Mail: murphyj@fisheries.nsw.gov.au
Murphy, Mr Shayne	Senator, Australian Parliament, PO Box 1223, Launceston TAS 7250. Telephone (work): 03 63345233, Fax: 03 63345236, E-Mail: senator.murphy@aph.gov.au
Nadji, Mr Jonathon	Cultural Advisor, Environment Australia, PO Box 71, Jabiru NT 0886. Telephone (work): 08 8938 1165, Fax: 08 8938 1115
Naslund, Ingemar	Assistant Professor, Department of Aquaculture, Swedish University of Agricultural Sciences, UMEÅ SE 90187, Sweden. Telephone (work): INT+63 146084, E-Mail: ingemar.naslund@z.lst.se
Newton, Mr David	Director, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 4421, Fax: 02 6285 0411, E-Mail: kylie.paulsen@frdc.com.au
Novak, Mr Rich	Marine Agent, University of Florida Sea Grant, 25550 Harbor View Rd, Unit 3, Port Charlotte Florida 33980, USA. Telephone (work): (941) 764-4340, Fax: (941) 764-4343, E-Mail: rlnovak@mail.ifas.ufl.edu

O'Donohue, Mr Patrick Regional Sales Manager, Castlemaine Perkins, PO Box 39731, Winnellie NT 0820. Telephone (work): 08 8947 3899, Fax: 08 8947 4798, E-Mail: steve.lines@lion-nathan.com.au

O'Grady, Miss Annette Assistant Aquatic Resource Manager, Fisheries Division - DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2213, Fax: 08 8999 2065, E-Mail: annette.ogrady@nt.gov.au

O'Neill, Mr Michael Fisheries Biologist, Agency for Food & Fibre Services, Dept of Primary Industries, Qld, Southern Fisheries Centre, PO Box 76, Deception BAY QLD 4508. Telephone (work): 07 3817 9560, Fax: 07 3817 9555, E-Mail: michael.o'neill@dpi.qld.gov.au

O'Regan, Sir Tipene Upoko Runanga, Awarua Ngai Tahu, PO Box 6346, Wellington, New Zealand. Telephone (work): 64 4 384 7352, Fax: 64 4 385 9266, E-Mail: aoraki.wlg@extra.co.nz

Oberhardt, Ms Kristina Research Officer, AFANT, PO Box 40694, Casuarina NT 0811. Telephone (work): 08 8945 6455, Fax: 08 8945 6055, E-Mail: research@afant.com.au

Oleary, Mr Patrick Seas Policy Officer, Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5100, Fax: 08 8945 2633

Olyott, Mr Leonard Fishery Scientist, Rhodes University / FOSAF, PO Box 1415, Kenmore, Brisbane QLD 4069. Telephone (work): 07 3378 4456, E-Mail: lolyott@hotmail.com

Parkinson, Mr Eric Research Biologist, BC Fisheries Branch, Head, Fisheries Management Research Unit, 2204 Main Mall, UBC, Vancouver BC V6T 1Z4, Canada. Telephone (work): 604 222 6762, Fax: 604 660 1849, E-Mail: eric.parkinson @ gems9.gov.bc.ca

Partridge, Ms Renae Research Student (PHD), CRC Reef Research Centre, C/- James Cook University, Townsville QLD 4811. Telephone (work): 07 4781 5196, Fax: 07 4781 4099, E-Mail: renae.partridge@jcu.edu.au

Paulsen, Ms Kylie Communications Coordinator, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 0411, Fax: 02 6285 4421, E-Mail: kylie.paulsen@frdc.com.au

Pearce, Mr Malcolm Fisheries Extension Officer, QDPI Queensland Fisheries Service, PO Box 5396, Cairns QLD 4870. Telephone (work): 07 4035 0130, Fax: 07 4035 1401, E-Mail: pearcem@dpi.qld.gov.au

Pender, Mr Peter Senior Project Officer / Marine, Northern Land Council, PO Box 42921, Casuarina NT 0811. Telephone (work): 08 8920 5167, Fax: 08 8945 2633

Pepperell, Dr Julian Director, Pepperell Research, PO Box 1475, Noosaville DC QLD 4566. Telephone (work): 07 5471 0327, Fax: 07 5449 1147, E-Mail: pepj@austarnet.com.au

Petrachenko, Ms Donna Regional Director General, Fisheries and Oceans Canada, 555 West Hastings Street, Vancouver BC V6B 5G3, Canada. Telephone (work): (604) 666-6037, Fax: (604) 666-1273, E-Mail: bairdsa@pac.dfo-mpo.gc.ca

Phillips, Dr Bruce 11A Luita Street, Wembley Downs WA 6019. Telephone (work): 08 9266 7963, Fax: 08 9266 2495, E-Mail: b.phillips@curtain.edu.au

Pike, Mr Graham, Vice President, Recfish Australia, PO Box 300, Calwell ACT 2905. Telephone (work): 0412 960 032, E-Mail: gofish@primus.com.au

Pitcher, Mr Tony Director and Professor, Fisheries Centre, University of BC, Vancouver V6T1Z4, Canada. Telephone (work): 1 604 822 2731, Fax: 1 604 822 8934, E-Mail: t.pitcher@fisheries.ubc.ca

Pollock, Dr Kenneth H Professor, North Carolina State University, Box 8203, Raleigh NC 27695-8203, USA. Telephone (work): 919 515 1957, Fax: 999 515 7691, E-Mail: pollock@stat.ncsu.edu

Poole, Mr Malcolm Chairman, Recreational Fishing Alliance of NSW, Lot 101 Walmsley Road, Ourimbah NSW 2258. Telephone (work): 02 9782 1007, Fax: 02 9782 1360, E-Mail: mpoole@optusnet.com.au

Presser, Mr Jon	Principal Fisheries Manager, Primary Industries and Resources SA, GPO Box 1625, Adelaide SA 5001. Telephone (work): 08 82260398, Fax: 08 82262320, E-Mail: presser.jon@saugov.sa.gov.au
Price, Mr William	Chief, Recreational Fishing Division, US National Marine Fisheries Service, 1315 East-West Highway, RN 14752, Silver Spring MD 20910, USA. Telephone (work): +301 713 9504, Fax: +301 713 2384, E-Mail: bill.price@noaa.gov
Prokop, Mr Frank	Executive Director, Recfishwest, PO Box 57, Claremont WA 6010. Telephone (work): 08 9387 7864, Fax: 08 9387 7643, E-Mail: frank@recfishwest.org.au
Rasmussen, Mr Gorm	Head of Department/Research Director, DIFRES, Vejlsoevej 39, Silkeborg 8600, Denmark. Telephone (work): + 45 89 21 31 00, Fax: + 45 89 21 31 50, E-Mail: gr@dfu.min.dk
Rawlinson, Mr Nick	Lecturer, Australian Maritime College, PO Box 21, Beaconsfield TAS 7270. Telephone (work): 03 6335 4414, Fax: 03 6335 4459, E-Mail: nrawlinson@fme.amc.edu.au
Reid, Mr Dennis	Senior Biometrician, NSW Fisheries, PO Box 21, Cronulla NSW 2230. Telephone (work): 02 9527 8411, Fax: 02 9527 8536, E-Mail: reidd@fisheries.nsw.gov.au
Reynolds, Mr Ron	Bay of Isles Aboriginal Corporation, PO Box 1547, Esperance WA 6450. Telephone (work): 08 9071 5560, Fax: 08 9071 5860
Rogers, Mr Peter	Director General, Department of Fisheries, Level 3, SGIO Atrium, 168 St Georges Tce, PERTH WA 6000. Telephone (work): 08 94827323, Fax: 08 9481 3576, E-Mail: progers@fish.wa.gov.au
Russell, Mr John	Northern Fisheries Centre, PO Box 5396, Cairns QLD 4870. Telephone (work): 07 4035 0100, Fax: 07 4035 1401, E-Mail: russellj@dpi.qld.gov.au
Sakell, Ms Veronica	Director, National Oceans Office, GPO Box 2139, Hobart TAS 7001. Telephone (work): 03 6221 5026, Fax: 03 6221 5050, E-Mail: veronica.sakell@oceans.gov.au
Salanié, Mr Julien	Dr., ENSA Rennes, 65 Rue De St-Brieuc - CS 84215, Rennes 35 000, France. Telephone (work): +33 2 23 48 59 16, Fax: +33 2 23 48 54 17, E-Mail: julien.salanie@voila.fr
Saville, Ms Kristy	Fisheries Management Officer, Department of Fisheries, Level 3, SGIO Atrium, 168 - 170 St George's Terrace, PERTH WA 6000. Telephone (work): 08 9482 7371, Fax: 08 9482 7218, E-Mail: ksaville@fish.wa.gov.au
Sawynok, Mr Bill	Director, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 4421, Fax: 02 6285 0411, E-Mail: kylie.paulsen@frdc.com.au
Schaefer, Mr Richard	Director, Office of Constituent Services, National Marine Fisheries Service, SSMC#3, 1315 East-West Highway, Silver Spring Maryland 20910, USA. Telephone (work): 301-429 2014, Fax: 301-427 2313, E-Mail: dickschaef@aol.com
Schramm, Dr. Harold,	Unit Leader, U.S. Geological Survey, Mississippi Cooperative Fish and Wildlife, Mail Stop 9691, Mississippi State Mississippi 39762, USA. Telephone (work): 662/325-7495, Fax: 662/325-8726, E-Mail: hschramm@cfr.msstate.edu
Schumacher, Mr Bruce	Chairman, NSW Advisory Council on Recreational Fishing, 164 Woodcourt Road, Berowra Heights NSW 2082, Fax: 02-9456 1615, E-Mail: bruces@mets.mq.edu.au
Scullion, Senator Nigel	Senator For The Northern Territory, GPO Box 882, Darwin NT 0801. Telephone (work): 08 89813567, Fax: 08 89813022, E-Mail: senator.scullion@aph.gov.au
Seipel, Ms Kirsten	Darwin City Council. Telephone (work): 89822549, E-Mail: k.seipel@darcity.nt.gov.au
Staats, Mr Jim	Frasier Coast Branch, Sunfish, 30 Victor Drive, Pialba QLD 4655. Telephone (work): 07 4124 2787, E-Mail: a_sec@sunfish.com.au
Sellers, Mr Richard	Executive Director, Fisheries, DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2142, Fax: 08 8999 2065, E-Mail: richard.sellers@nt.gov.au

Staples, Dr Derek	Director, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 4421, Fax: 02 6285 0411, E-Mail: kylie.paulsen@frdc.com.au
Smith, Dr Adam	President, Australian Underwater Federation, c\- 4 Seaward Cresent, Townsville QLD 4810. Telephone (work): 07 4750 0734, E-Mail: adams@gbrmpa.gov.au
Steffe, Dr Aldo	NSW Fisheriers, Locked Bag 10, Cronulla NSW 2230. Telephone (work): 02 9527 8411, Fax: 02 9527 8576, E-Mail: steffea@fisheries.nsw.gov.au
Smith, Mr Iain	Chief Executive Officer, Northern Territory Seafood Council, GPO Box 618, Darwin NT 0801. Telephone (work): 08 89815194, Fax: 08 89815063, E-Mail: imsmith@ntsc.com.au
St John, Dr Jill	Research Scientist, Department of Fisheries WA, WAMRL, PO Box 20, North Beach WA 6020. Telephone (work): 08 9246 8444, Fax: 08 9447 3062, E-Mail: jstjohn@fish.wa.gov.au
Smith, Mr John	PMO, DPIWE, PO Box 44, Hobart TAS 7001. Telephone (work): 03 6233 3523, Fax: 03 6223 1539, E-Mail: john.smith@dpiwe.tas.gov.au
Sumner, Mr Neil	Senior Research Scientist, Department of Fisheries WA, PO Box 20, North Beach WA 6920, Perth WA 6920. Telephone (work): 08 9246 8438, Fax: 08 9447 3062, E-Mail: nsumner@fish.wa.gov.au
Solah, Miss Rebecca	Fisheries Action Program Coordinator, DBIRD, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2170, Fax: 08 8999 2065, E-Mail: rebecca.solah@nt.gov.au
Taylor, Mr David	PhD Student, Southern Cross University - CRC Tourism, PO Box 157, Lismore NSW 2480. Telephone (work): 02 6620 3051, Fax: 02 6620 3565, E-Mail: dtaylor@scu.edu.au
Speedie, Mr Tom	Fisheries Manager- Gippsland, Department of Natural Resources and Environment, 71 Hotham St, Traralgon VIC 3844. Telephone (work): 03 5172 2195, Fax: 03 5172 2142, E-Mail: tom.speedie@nre.vic.gov.au
Taylor, Ms Roslyn	Business Manager, Taylor Research Services Pty Ltd, PO Box 405, Lindfield NSW 2070. Telephone (work): 02 94168400, Fax: 02 9416 8003, E-Mail: roz.taylor@taylorresearch.com.au
Vallance, Mr Terry	Senior Fisheries Technician, QLD DPI Fisheries Research, Kennedy Highway, Walkamin QLD 4872. Telephone (work): 07 4092 9925, Fax: 07 4093 3903, E-Mail: terry.vallance@dpi.qld.gov.au
Van Voorhees, Dr David	Statistical/Biologist, U.S. Dept of Commerce, NOAA, National Marine Fisheries Service, F/ST1, 1515 East - West Highway, Silver Spring Maryland 20853, USA. Telephone (work): 301-713 2328, Fax: 301-713 4137, E-Mail: dave.van.voorhees@noaa.gov
Veitch, Mr Vern	Sunfish, 4 Stagpole Street, Townsville QLD 4810. Telephone (work): 07 4771 6087
Venema, Ms Sonja	Research Services Officer, Recreational Fishery, SARDI Aquatic Sciences, 2 Hamra Ave, West Beach SA 5024. Telephone (work): 08 8200 2452, Fax: 08 8200 2481, E-Mail: venema.sonja@saugov.sa.gov.au
Vitale, Mr Vincenzo	Herbert Rep., Sunfish, PO Box 813, Ingham QLD 4850. Telephone (work): 07 4777 2775:, Fax: 07 4777 2775, E-Mail: vinmon@ozemail.com.au
Waldron, Mr Garry	Chairperson, West Kimberley Regional Recreational Fishing Advisory, Department Of Fisheries, Level 3, SGIO Autrium, 168 - 170 St George's Terrace, Perth WA 6000. Telephone (work): 08 9482 7370, Fax: 08 9482 7218, E-Mail: eferguson@fish.wa.gov.au
Walter, Mr David	Environment Australia, GPO Box 787, Canberra ACT 2601. Telephone (work): 02 6274 1296, Fax: 02 6274 1771, E-Mail: david.walter@ea.gov.au

Washington, Mr Patrick VR Fish Chairman, Level 3, 250 Victoria Pde, EAST Melbourne VIC 3002. Telephone (work): 03 9412 5164, Fax: 03 9412 5159

Watts, Mr Trevor Project Officer, SARFAC, Suite 11,15 Fullarton Road, Kent Town SA 5067. Telephone (work): 08 8132 0430, Fax: 08 8363 6455, E-Mail: sarfac@chariot.net.au

Wells, Mr Alex Assistant Director MPA'S, Environment Australia, GPO Box 787, Canberra ACT 2601. Telephone (work): 02 6274 1296, Fax: 02 6274 1771, E-Mail: alex.wells@ea.gov.au

White, Mr Damian Fisheries Research Officer, NT Fisheries Division, GPO Box 3000, Darwin NT 0801. Telephone (work): 08 8999 2095, Fax: 08 8999 2065, E-Mail: damian.white@nt.gov.au

White, Mr Graham Technical Officer - Barramundi, Fisheries Division DBIRD, PO Box 3000, Darwin NT 0801. Telephone (work): 08 8924 4162, Fax: 08 8981 3420, E-Mail: graham.white@nt.gov.ay

Whitehead, Mr Noel Sunfish, PO Box 8204, MT Pleasant QLD 4740. Telephone (work): 07 4942 0199, Fax: 07 7942 0399, E-Mail: sunfish_mackay@orion-online.com.au

Whitelaw, Mr Wade AFMA, PO Box 7051, CMC ACT 2610. Telephone (work): 02 6272 4025, Fax: 02 6272 3730, E-Mail: wade.whitelaw@afma.gov.au

Wilde, Dr Gene Associate Professor, Wildlife & Fisheries Management Institute, Mail Stop 2125, Texas Tech University, Lubbock Texas 79409, USA. Telephone (work): 806-742-1983, Fax: 806-742-2280, E-Mail: gwilde@ttu.edu

Wilson, Mr John Business Development Manager, Fisheries Research & Development Corporation, PO Box 222, Deakin West ACT 2600. Telephone (work): 02 6285 0411, Fax: 02 6285 4421, E-Mail: kylie.paulsen@frdc.com.au

Winstanley, Mr Ross Self-Employed, 21 Brownbill Street, Geelong VIC 3220. Telephone (work): 03 5221 0978, Fax: 03 5221 0978, E-Mail: ross.winstanley@bigpond.com

Wright, Mr Neville Regional Recreational Fisheries Project Manager, Department of Natural Resources & Environment, PO Box 103, Geelong VIC 3220. Telephone (work): 03 52264688, Fax: 03 52264563, E-Mail: neville.wright@nre.vic.gov.au

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