How Local Fishers' Knowledge Improves the Management of Fisheries in New Zealand – A Seafood Industry Perspective

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Abstract

This paper focuses on how local fishers' knowledge contributes to the science based management of commercial fisheries in New Zealand. The role of the New Zealand Seafood Industry Council in communicating fishers' knowledge to fisheries management fora is explained. A case study of the Adaptive Management Programme for the bluenose (*Hyperoglyphe antarctica*) fishery (BNS 1), illustrates the contribution of the knowledge of fishers to the understanding of changes in a fishery over time. Fishers provide information from their local knowledge of changes in fishing methods, fish stocks and market behaviour and the relationships between these factors. Their interpretation and explanation of data, behaviour or the results of research is important especially when the scientific data are inconclusive. The future of fisheries management in New Zealand, and the role of Fisheries Plans, is discussed.

Introduction

Local fishers' knowledge is an important component of the decision making process for managing commercial fisheries in New Zealand. This paper will outline the seafood industry perspective rather than focus on customary or recreational fishers' knowledge. At approximately 2.5 million square kilometres of ocean, ranging over 30 degrees of latitude, New Zealand's marine exclusive economic zone is the fourth largest in the world and is 14 times larger than its land mass. The seafood industry makes an important contribution to the New Zealand economy and is the 4th largest export earner, worth NZ $1.43 billion in 2000. Approximately 650,000 tonnes is harvested from wild fisheries and aquaculture each year. This represents only 1% of the world's catch by volume, but makes up 2% of the world's catch in terms of value, as New Zealand is home to a number of high value species such as abalone and rock lobster. The total revenue to New Zealand from seafood and all associated businesses is NZ $4.5 billion a year, with around 26,000 people directly or indirectly employed in the commercial fishing industry.

Since 1986, New Zealand's main commercial fisheries have been managed under the Quota Management System (QMS). Under the QMS, existing operators in the fishery own a quota that represents an entitlement to catch a proportional share of the Total Allowable Catch (TAC) for an individual fish stock. The commercial proportion is the Total Allowable Commercial Catch (TACC). While the quota is issued in perpetuity, the quota is tradable either by lease or sale. The annual costs of managing the commercial fishery, including stock assessment research, are directly recovered from the quota owner on an annual basis.

The Fisheries Act of 1996 requires that a TAC is set at a level that will maintain a fish stock at or above, or move it towards, a level that can produce the Maximum Sustainable Yield. The Adaptive Management Programme (AMP), as well as other seafood industry based sampling programmes, is an opportunity for the fishers to play an important role in the management of their commercial fisheries. The success of these initiatives is largely dependent on the support of fishers of the objectives of the relevant AMP. It is therefore a partnership between fishers and their representatives.

One of the main conduits of fishers' knowledge in New Zealand is the NZ Seafood Industry Council (SeaFIC) which was formed in 1997 to represent fishers' generic interests. The seafood industry includes individuals and companies participating in fishing, aquaculture, processing, wholesaling, retailing and exporting of seafood products. SeaFIC is a company owned by 20 shareholders and managed by a Board of Directors elected by a majority of industry interests. SeaFIC shareholders - each of whom represents a particular sector of the seafood industry - collectively represent over 90% of the seafood industry by value. A majority of the fishing industry recently voted to fund SeaFIC by a compulsory levy collected on all fish landed and processed.

One of the objectives of the present Government is to involve those with a stake in fisheries in the management framework. The active and informed contribution of fisheries stakeholders is encouraged through participation in the decision-making processes. The seafood industry pays the full costs of both fisheries management and the research required to assess the sustainability of fish stocks, and the effects of fishing on marine biodiversity and the aquatic environment. Fishers can attend Fishery Assessment Working Group (FAWG) meetings or be represented by their stakeholder groups or SeaFIC. Meetings consist of Government officials, research scientists, customary fishers, recreational fishers and environmental NGOs. The latter three groups can at times be under-represented due in part to their funding base. A generic function for SeaFIC is the provision of scientific advice. Its staff can represent commercial fishers' submissions, are able to attend all meetings, and unlike fishers, they are able to focus solely on fishery issues rather than commercial business.

The indigenous people of New Zealand (Aotearoa) - Maori, are another key commercial stakeholder in New Zealand's seafood industry. Traditionally Maori are a maritime people - without metal tools or a written language, their Polynesian forebearers crossed the Pacific Ocean centuries before Europeans made it across the Atlantic. In 1992 the Crown agreed to fund Maori into a 50/50 joint venture to purchase Sealord - New Zealand's biggest fishing company. In addition, Maori are entitled to 20 per cent of quota for all species not yet in the quota management system. The Sealord purchase was enshrined in the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992 which also set up Te Ohu Kai Moana - the Treaty of Waitangi Fisheries Commission. The Act also outlined the process for protecting Maori non-commercial customary fisheries rights. Maori now have a substantial interest in over 300,000 tonnes of quota, representing over 35% of the New Zealand TACC.

The Fisheries Management Process

The TACC for the main fish stocks is reviewed annually through a formal stock assessment process. The Ministry of Fisheries chairs a series of Fishery Assessment Working Groups (FAWG) that review recent trends in the fishery and the results of research programmes relevant to the fishery. Where sufficient information is available, a quantitative stock assessment of the fishery may be conducted and estimates of yields and reference biomass updated. The Ministry of Fisheries summarises the conclusions of the FAWG and identifies any fish stocks that may require a change in the level of TACC due to concerns regarding the sustainability of the current catch level. There is also the opportunity to propose an increase in the TACC where a higher catch can be supported by the fishery. The Minister of Fisheries makes the final decision regarding any proposed changes to the TACCs following consideration of submissions from the main stakeholders in the fishery, including commercial, recreational, customary, and environmental agencies.

An important opportunity for fishers' knowledge to be incorporated into the fishery management process has been the development of the Adaptive Management Programme (AMP). It was a research tool introduced by the Ministry of Fisheries (MFish) in 1991 as a basis for varying the TAC levels of fish stocks for which MFish has limited information on stock size. It allows for experimental increases in the TAC in instances where it is believed that there is a strong likelihood that the stock abundance is above the optimal yield level. This is coupled with a monitoring programme to track the response of the fish stock to the increased level of exploitation. Annual reviews ensure that the Minister of Fisheries does not breach his/her statutory obligations to ensure stock sustainability. The emphasis is on gaining useful information and improving the management of the fish stock.

In general, most TACC increases under the AMP are modest and are initially for a five-year term, with annual reviews. The quota owners, usually through the relevant stakeholder group, are required to fund the additional costs associated with monitoring the fishery. The monitoring regimes are generally multi-faceted and may include: trawl surveys, analysis of catch and effort data, a detailed logbook completed by fishermen, and catch sampling. These programmes are designed to monitor stock abundance and to collect sufficient information for an assessment of the sustainable yield for the fishery. The onus is on the seafood industry to provide the required data and arrange analysis of that information. If industry fails to fulfil their commitments they face a reversal of the TACC increase and a loss of credibility. The AMP is an integrated research programme which uses "fisher power" to obtain some of the scientific information. The 'carrot' for fishers therefore is the increase in quota. If they subsequently do not take part in the collection of data, the 'stick' is the loss of quota.

SeaFIC employs its own stock assessment scientists to assist industry stakeholder groups to participate fully in the annual stock assessment process and to provide advice to the fishing industry which is independent of the government research provider. Its Science Unit has, up to now, provided most of the scientific input into the AMP. SeaFIC often acts as the interface between the seafood industry and the

Ministry of Fisheries (MFish). In this buffer role, it is able to encourage open communication between the different sectors, providing a filter for the more extreme views.

BLUENOSE 1 FISHERY

One of the ongoing success stories of the AMP is the bluenose (BNS 1) fishery, presented here as a case study of how local fishers' knowledge and dedication improves the management of fisheries in New Zealand. By being actively involved in the design, implementation and interpretation of the results of the logbook programme, local fishers have guided the project with their knowledge and experience.

Bluenose, *Hyperoglyphe antarctica*, is a semi-pelagic species widespread in the Southern Oceans. It is found off the coasts of New Zealand, southern Australia (where it is known as "trevalla") and South Africa. Its maximum age is thought to be approximately 15 years and maximum size is about 90 cm for females and 80 cm for males, although specimens of 140 cm have been recorded (Horn 1995).

Bluenose have been landed by commercial line fishers since the 1930s and can be readily taken by trawl, line and setnet. Before 1981 there was little target fishing because most fishers concentrated on the more traditional "grouper" species (häpuka and bass) and bluenose was often mis-reported as häpuka. Bluenose is considered to be reasonably resilient to fishing pressure because of their pelagic juvenile stage, moderately fast growth, widespread distribution, and occurrence in untrawlable areas.

Bluenose is managed in New Zealand by division into six Quota Management Areas with BNS 1 encompassing the area around the northern North Island (Figure 1). The BNS 1 fishery initially developed as a bycatch of the hapuka/bass line fishery with bluenose sold locally to domestic fish shops. During the early 1980s, increased fishing effort was targeted at bluenose and catches steadily increased from around 200 tonnes in the early 1980s to 696 tonnes in 1990/91 (Figure 2). During this period, most of the increase in catch was taken from the developing target longline fishery in the Bay of Plenty. Bluenose was being recognised as a high quality fillet and as markets were developed, exports grew. An important target fishery for bluenose was established in east Northland in the 1980s. The fishery is now dominated by the bottom longline fishing method which accounts for around 90% of the total annual catch. The remainder of the BNS 1 catch is taken by other line methods and by bottom and midwater trawl.

In 1996, SeaFIC proposed that the BNS 1 fish stock be included within the AMP with the intent of increasing the understanding of the biology of bluenose, determining the geographical extent of the species, and estimating the long-term sustainable yield for the stock. The programme involved an increase in the level of monitoring of the BNS 1 fishery in conjunction with an increase in the TACC from 705 to 1000 t. The TAC is 1,023 t with allowances of 8 tonnes for customary Mäori, and 15 t for recreational fishers, whose annual catch was estimated in 1996 by a national telephone/diary survey at 5,000 fish (Annala *et al* 2001).

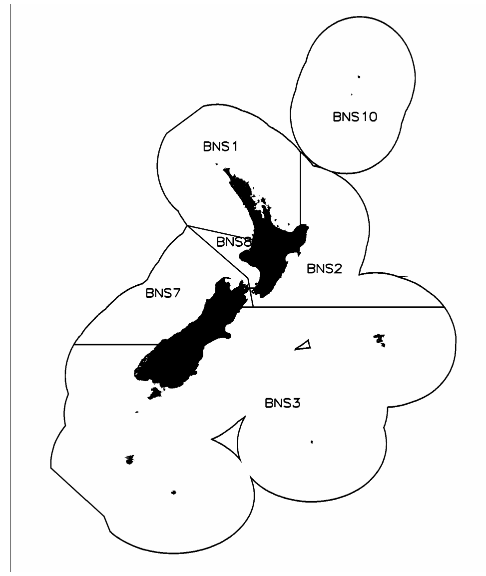

Figure 1. Quota Management Areas for Bluenose in New Zealand

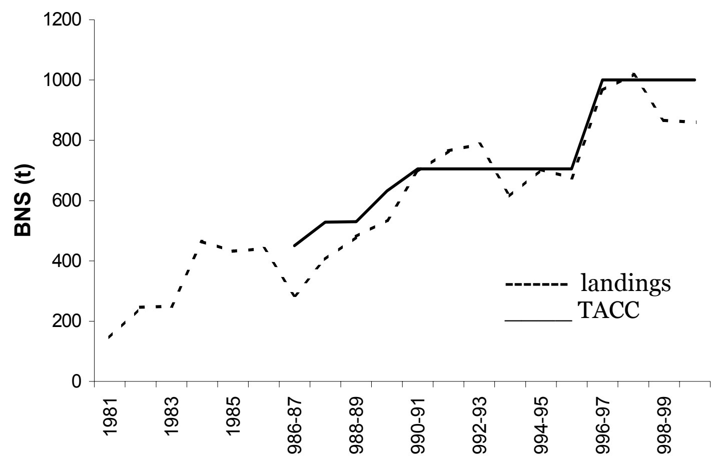

Figure 2. Catch and TACC(t) for BNS 1

The BNS 1 AMP is currently administered by the Northern Inshore Fisheries Company Ltd, which is the stakeholder group representing the commercial sector operating in the inshore fisheries around northern North Island. The commercial longline fleet is comprised of around 20 vessels operating from 4 main ports along the north-eastern coast of the North Island. The vessels are typically around 20 m in length with a crew of 1-2 (Figure 3). Fishing trips are usually of one to three days' duration. The level of fishing effort varies with the size of the vessel, with individual vessels setting between 200 and 2,000 hooks, and 1-3 longlines per day.

Figure 3 A Typical BNS 1 Longliner –the 'Lady Sarah'

The BNS 1 AMP is monitored from catch and effort data obtained from the target bluenose longline fishery and through a logbook programme which collects more detailed catch, effort and biological data. The Logbooks (Figure 4) which detail the location of the catch and the number of fish caught by species, are used to gather auxiliary information for the annual Catch Per Unit Effort (CPUE) analysis. These logbooks are placed on most of the long line vessels fishing in BNS 1 which target bluenose.

The general intent of these programmes is to use sole-operator fishermen on the smaller vessels or crew members where they are available to sample the biological characteristics of their own catch while actively fishing. This ensures that the collected biological data are correctly linked to the overall catch and effort data and are collected in conjunction with the fishing operation. Only a small amount of the catch (10 fish) is sampled as randomly as possible, but it is sampled routinely and frequently. This allows for the accumulation of large amounts of information and offsets the fact that individual participants only collect a small amount of data. Such a design automatically adjusts to changes in fishing practices, both in area and over time.

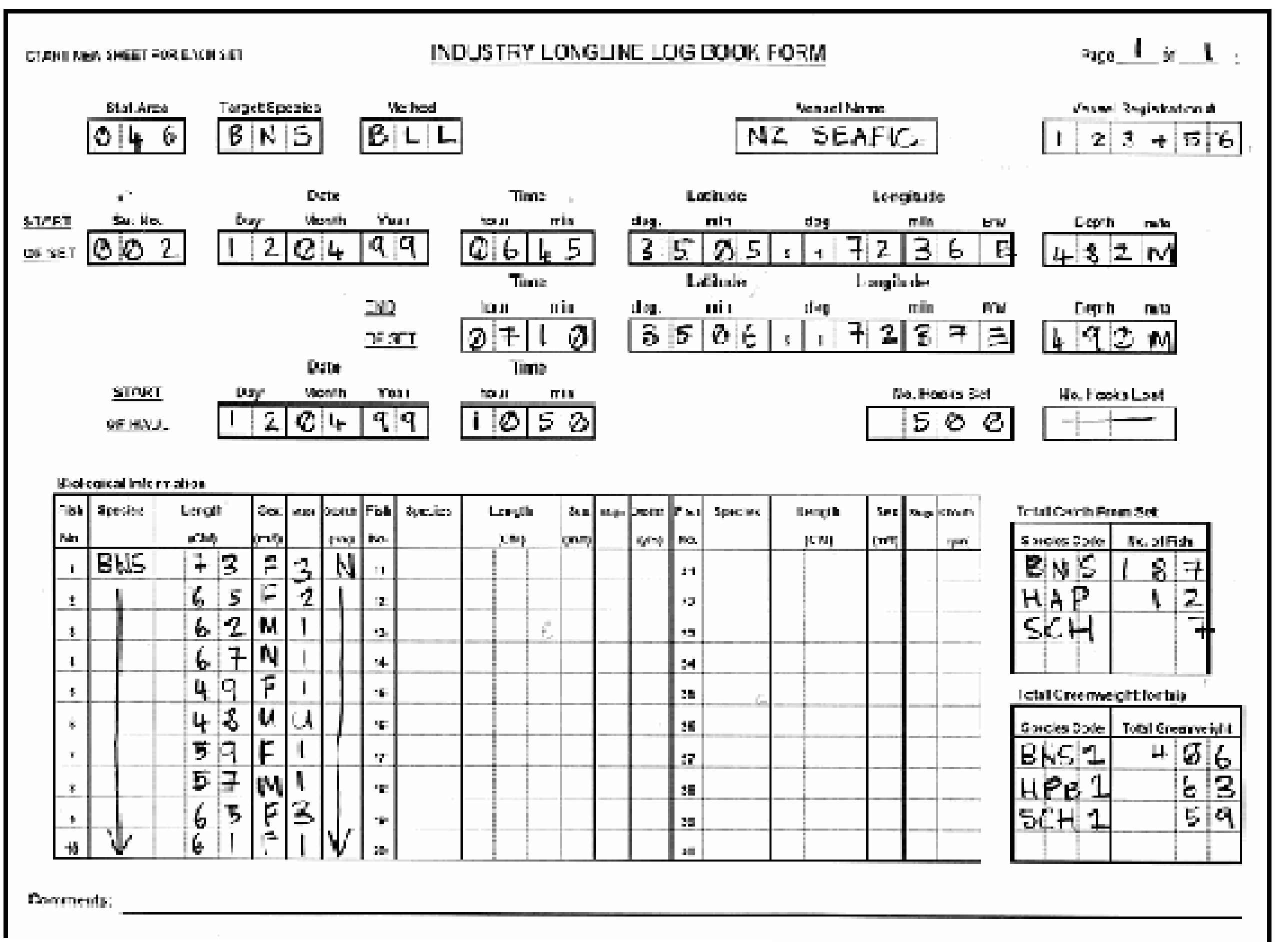

Figure 4. Example of a Completed Logbook Form

If fishers are too busy to do the biological sampling, coloured cattle tags are attached to identify the 10 fish from a set and they are subsequently sampled at the shed on shore.

Analysis of the logbook data has enabled a confirmation of trends in CPUE derived from the statutory reporting data and has enabled trends in fishing activity to be examined in more detail (Figure 5).

duration of the bluenose spawning season to be determined. Bluenose otoliths have also been collected from a subset of the fish sampled during each trip. A total of 7,360 otoliths have been collected so far. These samples will enable the age composition of the bluenose catch to be determined once a suitable aging technique has been established.

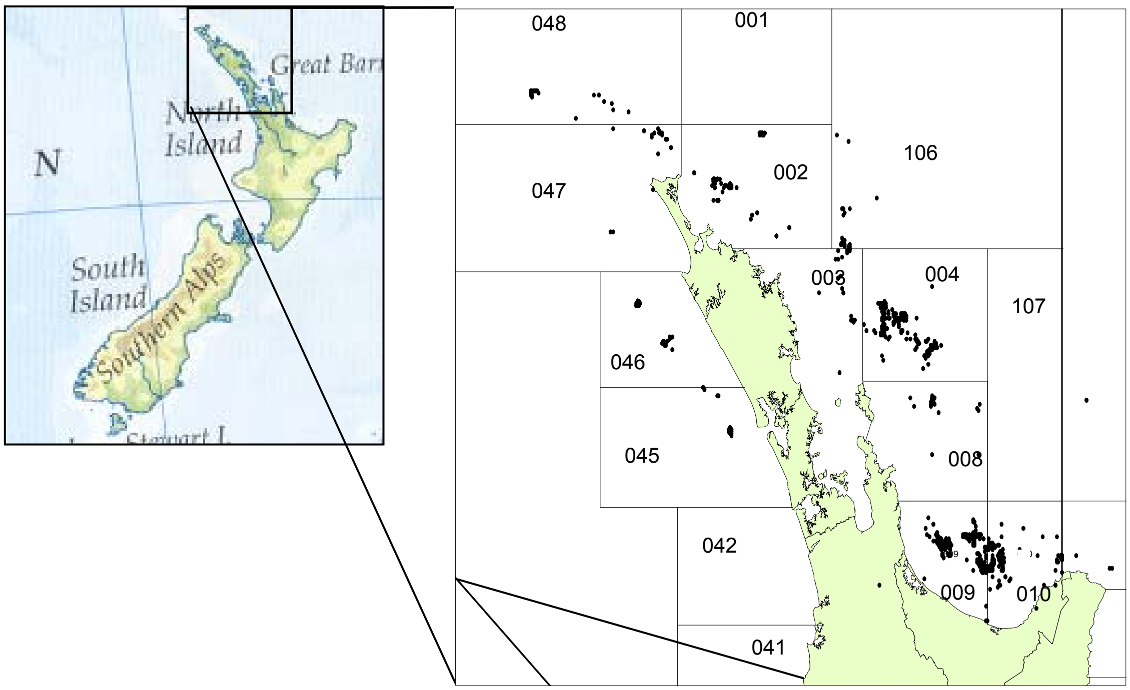

Figure 5 Distribution of bluenose longline sets identified from the logbook programme 1995 to 1998 (numbers indicate statistical areas).

The logbook coverage was assessed by the Fishery Assessment Plenary in May 2001 to be very good i.e. 34% of the days fished in 2000 and 76% of the vessels in the BNS 1 longline fishery had participated. The logbook programme has achieved an annual coverage of 30-40% of the total hooks set in the target longline fishery since 1996/97 (Table 1, overleaf).

The large quantity of length frequency data collected from the BNS 1 fishery by the logbook programme (25,528 fish have been measured) has enabled the determination of the length composition of the bluenose catch from each of the main fishing grounds in BNS 1 by fishing year. Gonad staging data collected from the logbooks have enabled the length at maturity of male and female bluenose and the timing and

The large quantity of high standard data collected by the BNS 1 logbook programme is attributable to the dedication of the participating fishermen. These data have been used to define important biological parameters of the species, including length at maturity and spawning period. In the absence of the logbook scheme, the collection of comparable data from the BNS 1 fishery could have only been achieved using an intensive, and prohibitively expensive, research programme. The data collected to date provide important baseline information from the fishery. Future trends in catch composition and fishing performance will be monitored against these data to examine the impact of the higher TACC on this fishstock.

Table 1. Annual Coverage of the BNS 1 longline fishery by the logbook programme

Data Source	Fishing Year	Days Fished	Hooks (1000s)	Number Sets	Total BNS Catch (t)	Number Vessels
CELR data	1995/96	792	836	1,377	510.4	18
	1996/97	1,255	1,238	2,237	734.3	22
	1997/98	1,120	1,156	2,078	709.9	20
	1998/99	1,364	1,406	2,361	919.4	20
	1999/00	933	1,222	1,607	651.7	21
Logbook	1995/96	61	74	121	37.9	8
	1996/97	420	507	590	348.0	18
	1997/98	310	418	544	264.4	10
	1998/99	336	441	383	199.1	14
	1999/00	319	472	361	170.0	16
Coverage	1995/96	8%	9%	9%	7%	44%
	1996/97	33%	41%	26%	47%	82%
	1997/98	28%	36%	26%	37%	50%
	1998/99	25%	31%	16%	22%	70%
	1999/00	34%	39%	22%	26%	76%

The Role of Fishers in understanding BNS 1 Stock Assessments

With time and experience, fishers gain through observation and trial-and-error, a knowledge of their environment that could never be gained in a classroom or by statistical analysis. Johannes *et al.* (2000) give examples of how the local knowledge of indigenous fishers of the behaviour and movements of marine fishes and mammals can be crucial to fisheries biologists and managers. Dunn *et al.* (2000) note that every analysis of catch and effort data requires a good understanding of both the fishery and the factors that can influence the CPUE/abundance relationship. The interpretation of catch and effort statistics therefore needs to take into account not only changes in the spatial distribution of the fish stock caused by changes in abundance, but changes in fisher behaviour, fishing technology and markets, and catchability between different fishers. This is where the knowledge of the local fishers' is crucial.

Fishers' knowledge and practical ability has been an important component of the annual review of information collected for the BNS 1 stock assessment. The participation of fishers, particularly in the programme design and initial discussions, has enabled the AMP to be put into the context of the commercial fishery, including its operational constraints. Fishers have knowledge of:

- the players in the fishery at the present time – whether skippers are experienced or new comers,
- changes in the fleet,
- local weather conditions and the constraints this can place in terms of a safe fishing operation, and
- economics and operational constraints (the commercial realities) e.g. how far from port a vessel can fish.

Discussion

The skill, knowledge and expertise of local fishers in New Zealand, has a recognized and important role in management decisions that contribute to a successful sustainable fishery. The people that are out there fishing generally have a detailed knowledge of the environment and what affects it. This is important in a fishery that is dynamic and constantly evolving.

For the Bluenose 1 fishery, local fishers have been able to contribute to the analysis of the historical perspective – they witnessed the fishery develop before scientific programmes were initiated and can therefore put the current fishery in context. Fishers can pinpoint when the watershed changes in technology were introduced and catchability subsequently improved, for example the adoption of radar and Global Positioning Systems. Changes in BNS 1 fishers' gear made a difference as fishers changed from "j" hooks to the more efficient circle hooks, and from wire to monofilament line (Peter Jones *pers comm.*). Fishers can explain fishing behaviour in relation to weather, time of year and time of day or month.

New Zealand is often colloquially called a big village and fishing involves a small community within that village. Fisheries management needs to be about relationships, credible input, trust and good liaison with fishers. Conversely fishers need to understand the policies, politics and management processes and where they fit in. The collection of the best available knowledge will enable the best stock assessments. The interpretation of scientific analysis can be challenging and some fishers choose to opt out and not contribute local knowledge. It may not just be because of a lack of understanding – the scientific terms, jargon and concepts can be too abstract. Opting out can also be due to apathy, self interest, feeling insubstantial, a reliance on others or simply a lack of time to take part.

Those that do contribute to the decision-making process are more likely to understand and accept the ultimate outcomes and have a sense of ownership especially if they are involved in data gathering. The information collected becomes more valid to them. In terms of commercial fishers' input to the BNS 1 stock assessment, there are two groups: the first is made up of the various types of fishers - those that lease quota, those contracted to large companies and the quota owner-operators. The second group is the representatives – the New Zealand Federation of Commercial Fishermen, Stakeholder representatives, SeaFIC and Customary groups. The members of the second group are 'bureaucrats' and are more likely to attend Government research or stock assessment meetings. They often personally obtain fishers' knowledge and input before attending fishery management meetings. When an important fishery issue is on the agenda, experienced fishers are often asked if they can also attend to contribute their knowledge and convey the impact a decision will make on their fishing operation.

Fishers can find that Fishery Management meetings are at times very technical in nature, the jargon and mathematical concepts are complex – the learning curve can be steep. It takes time to get to know the individuals and personalities, and to develop trust and respect. To the average fisher, scientists can appear as 'boffins' and modelers as 'number crunchers.' At first for fishers attending meetings, the adage of Mark Twain can hold true – *"that it is better to keep your mouth shut and appear stupid than open it and remove all doubt"*. A more effective and credible option has been for fishers to collect information on BNS 1 themselves with a soundly designed logbook programme, and contract SeaFIC scientists to analyse and present the results to the fishery management meetings. By taking part in and funding an AMP such as BNS 1, the fishers became more involved in the decisions made and gain ownership of the research.

It is extremely difficult to manage wild fisheries or the marine environment. However, people and their activities can be managed. Effective fisheries management requires the co-operation of those whose activities are being managed, both in relation to the provision of information and in relation to ensuring compliance. Consistent with this understanding, the overall direction in fisheries management in New Zealand is one of increasing collective stakeholder responsibility. Local fishers' knowledge is crucial to this process and is provided by representation, participation in data collection and investment in credible scientific research.

Recently there has been a gradual move towards co-management of fisheries with incentives created for commercial fishers to take responsibility for fisheries research (Harte 2001). Fishers have the opportunity to be part of the consultative processes for research planning and stock assessment working groups for inshore, mid-water, and deepwater fish stocks and also recreational, socio-economic and aquatic environment groups. The quantitative data collected by fishers in various industry logbook programmes is directly incorporated in the annual assessments of fish stocks. Fishers also provide information from their local knowledge of changes over time of fishing methods, fish stocks and market behaviour and the relationships between these factors. Their interpretation and explanation of data behaviour or the results of research can be important especially when the scientific data is inconclusive.

The future of fisheries management in New Zealand contains a new framework for the input of fishers' knowledge. The Government has a vision of increased stakeholder responsibility for fisheries management as set out in the Fisheries Act 1996 (Section 11A). It is encouraging the seafood industry to develop Fisheries Plans and released a consultation document in March 2001. In his speech to the seafood industry's annual conference on 3 May this year, the Minister of Fisheries said:

> *"The big idea behind a fisheries plan is that with the right process, the right content and the right management it will allow stakeholders to step up to the plate and allow the Government to retreat... It is about stakeholder solutions where possible and regulation only where necessary."* [1]

Fishery Plans represent a new tool for local self-management and stakeholder involvement rather than centralised control. All players involved with the marine environment want sustainable fisheries and Fisheries Plans are part of the long term strategy to maintain this goal. The hope is that Fisheries Plans will involve more people with a direct interest in a fishery in its management and allow a better provision for their needs. Ideally this will mean greater consensus, a high level of voluntary compliance with the rules and improved management decisions. Local fishers' knowledge will hopefully be an important component of Fishery Plans that require a wide involvement of fishers' in their development to enable the full range of interests to be considered. However, how successful Fisheries Plans will be and when the first will be implemented in New Zealand - remains to be seen.

ACKNOWLEDGEMENTS

Peter Jones and Richard Cade kindly provided many helpful insights and information. The logbook programme was designed and implemented by Paul Starr, who recognised that fishermen are able to collect data of high quality to contribute to the stock assessment of their fishery. Local BNS 1 fishers have collected a large quantity of data often in difficult conditions. The success of the AMP is largely attributable to their dedication.

REFERENCES

Annala, J.H., Sullivan, K.J., and O'Brien, C.J, Smith N.W.(Comps.) 2001. Report from the Fishery Assessment Plenary, May 2001: stock assessments and yield estimates. 515 p. (Unpublished report held in NIWA Greta Point library, Wellington, New Zealand)

Bernstein B.B. and Iudicello S. 2000 National Evaluation of Cooperative Data Gathering Efforts in Fisheries. National Marine Fisheries Service. 77 p.

Dunn, A., Harley S.J., Doonan I.J. & Bull B. 2000: Calculation and Interpretation of catch-per-unit effort (CPUE) indices. New Zealand Fisheries Assessment Report 2000/1 44 p.

Gilbert D.J, Annala J.H, and Johnston K. 2000 Technical Background to Fish Stock Indicators for State-of-Environment Reporting in New Zealand. Mar.Freshwater Res.,2000 51, p.451-464.

Harte M. Opportunities and Barriers for Industry-Led Fisheries Research. 2001 Marine Policy 25 (2001) p.157-167.

Horn P. 1995 Bluenose – widespread but where are the juveniles ? Seafood New Zealand Vol 3 (5) p. 31 –33.

Johannes R.E, Freeman M.M.R, Hamilton R.J. 2000 Ignore Fishers' Knowledge and Miss the Boat. Fish and Fisheries 2000 (1) p. 257-271

Langley, A.D. (in prep. A): An analysis of catch and effort data from the BNS 1 target line fishery, 1989/90 to 1999/2000.

Langley, A.D. (in prep. B): Summary of the BNS 1 longline logbook programme, 1995/96 to 1999/2000.

Ministry of Fisheries 2000 Review of Sustainability Measures and Other Management Controls for the 2000-01 Fishing Year, Initial Position Paper and Final Advice Paper. 400 p. Unpublished manuscript available from the Ministry of Fisheries, Wellington. New Zealand.

Vignaux, M. (1997): CPUE Analyses for Fishstocks in the Adaptive Management Programme. NZ Fisheries Assessment Research Document 97/24.

QUESTIONS

Tony Pitcher: The perception from outside of New Zealand is that the fisheries have been sold out to the industry. So what about the interests of the public and conservation?

Greg Lydon: I disagree. A lot of it is politics and it depends on government policy at the time. The current labor government is quite conservation minded. The fishing industry is taxed to pay for all the research. So if they get what they consider bad proposals for research, which will not take the debate further or increase their knowledge, they will not go for it. You are quite right in that the TAC has been cut. There has been an independent Australian assessment and it was not anyone's fault, it was a scientific thing. We are still learning about the species because it is a deep-water species and there is not a lot of information. But if there were any mistakes made, it was the science, it was not deliberate over exploitation of the resource.

Tony Pitcher: Still the interest of the industry is in making profit using conventional economic principles. What are the checks and balances of the public? Who will take care of future generations?

Greg Lydon: The public and the conservation groups are represented as much as the commercial fishers and have as much say. The TACC is being monitored and reviewed every year.

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[1] http://www.seafood.co.nz/items/documents/conf_speech_ph.PDF

John: How are the quotas managed?

Greg Lydon: A management system was set up in 1986 and management depends on the species or fish stocks. The quota is a property right you have got forever and you can lease it, transfer it etc. If the stock assessment shows the stock to be going down, the quotas are reduced accordingly. If the government sees that it does not have enough information, again the quotas are reduced proportionately.

Historical and Current Knowledge of the Greenland Halibut from Québec Fixed-Gear Fishers in the Gulf of St. Lawrence

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Abstract
Fishing for Greenland halibut (*Reinhardtius hippoglossoides*) in the estuary and the Gulf of St. Lawrence (NAFO divisions 4RST) has been practiced mainly with gillnets by coastal fishers of Quebec and Newfoundland since the beginning of the 1970s. However, little information is available on the development of this exploitation, for example, on the evolution of the fishing practices. In 1997, a project on the Greenland halibut fishers' knowledge was initiated with the aim of documenting the historical and current knowledge of this fishery. The specific objectives were to compile a qualitative database of information from the fishers and to integrate this information into stock status assessments. Semi-directed individual interviews were held with 21 fishers. The information collected touched on four themes: the fishing practices, the biology and environment of the Greenland halibut, the social dimension of the fishing activities, and the management and conservation of this species. The results presented here describe the changes in the fishing practices and strategies that took place between 1970 and 1997. We also examined the relationships between these changes, the prevailing socio-economic context, and the landings of Greenland halibut for the same period. In thirteen years, the Greenland halibut fishing has evolved from a traditional and subsistence fishery to an effective and competitive commercial exploitation.

Introduction
Greenland halibut (*Reinhardtius hippoglossoides*), a flatfish also known as turbot, is generally found in the Gulf of St. Lawrence at depths from 130 to 500 m. In summer, the main concentrations of adult and juvenile Greenland halibut are located in the St. Lawrence estuary, the areas west and north-east of Anticosti Island, and near the west coast of Newfoundland, in the Esquiman Channel (Morin *et al.* 1996; Figure 1). Until the mid-1970s, Greenland halibut landings consisted primarily of by-catches from other fisheries. Later, a directed fishery using mainly gillnets was developed and landings underwent two episodes of large increases followed by sharp declines at the end of the 1970s and the 1980s (Figure 2); landings were quite stable in the 1990s. Since 1993, virtually no fish have been taken with mobile gear because of the moratorium on cod trawl fishing and the mandatory use of the Nördmore grate by shrimpers. The turbot fishery is now dominated by gill-netters whose home ports are in Quebec and on the west coast of Newfoundland. The main fishing areas are the St. Lawrence River estuary, the northern part of the Gaspé Peninsula, and in the Esquiman Channel, close to the Newfoundland coast. The fishery extends from April to November, but mainly takes place in summer months (Morin and Bernier 1999).

The Greenland halibut landings showed large fluctuations in the past, but little is known about this period for two reasons. First of all, the management of the fishery was transferred in 1982 from the provincial authorities to the federal authorities, the Department of Fisheries and Oceans. Unfortunately, most of the fishery data were lost during the transfer so no information is available for the 1970s and the early 1980s. Secondly, from 1988 to 1992, the Gulf of St. Lawrence Greenland halibut stock assessment was not performed because it was thought that the Gulf of St. Lawrence stock was a sub-population of the larger Labrador and Eastern Newfoundland stock. Therefore, some pertinent fishery data were not collected. However, parasite research conducted in the early 1990s has made it possible to distinguish clearly between Greenland halibut of the Gulf, the Laurentian Channel and adjacent areas, and those of Labrador and the northern part of the Grand Banks (Arthur and Albert 1993). These findings have led to the conclusion that some Greenland halibut complete their entire life cycle within the Gulf and are now considered to be a stock isolated from the main Northwest Atlantic population found to the east and north of the Grand Banks of Newfoundland. Since 1992, fishery and population monitoring programs have been put in place; fishery and survey data are now gathered each year and a stock assessment is performed at the end of each fishing season.

An understanding of the factors responsible for the fluctuations in landings during the 1970s and 1980s is essential to a precautionary approach to the management of the Greenland halibut fishery. Indeed, the landing fluctuations may have been caused by a change in the fishing strategy or by a change in resource abundance. The determination of conservation objectives, such as the protection of a minimum spawning biomass, has to take into account the response of the resource to various exploitation rates. Therefore, past events in the fishery, especially when large catch fluctuations were observed, should provide invaluable information on the stock dynamics. Thus, it is most important to learn from the past events.

The Greenland halibut fishery is relatively recent with the first significant landings made 25 years ago, in 1977. Some of those involved in the first years of the fishery are still active. They have valuable knowledge of the circumstances that prevailed in the 1970s and the 1980s that is not available elsewhere. In 1997, a research project was initiated with the aim of documenting the historical and current knowledge of Greenland halibut fishers. The specific objectives were to compile qualitative information on fishing practices and changes over time and to integrate this information into the current stock status assessments and to bring a better understanding to past assessments.

METHODOLOGY

The study area is located in the estuary of the St. Lawrence River and in the western part of the Gulf of St. Lawrence in the province of Quebec. These areas constitute the most important fishing areas since the development of the fishery in the 1970s. During the winter of 1998, semi-directed individual interviews were held in different localities on both sides of the St. Lawrence estuary and gulf (Figure 1). The interviews were conducted with 21 fishers: six on the north shore and 15 on the south. Among the fishers interviewed on the south shore, six had been involved in the developing fishery in the mid-1970s.

Fishers were selected in two steps. First, after consultations with five fisher's associations and DFO fishery management authorities, a list of 55 potential participants was produced, taking into account several criteria: the fishers had to be boat captains and owners, and had to have practised a directed fishery for turbot for at least five years. The 55 potential candidates were then contacted directly, with the aim of including fishers in the study from different age groups, and fishers who had expressed an interest and openness in being interviewed. From these preliminary contacts, the list was reduced to 43 fishers. A proportional draw from the different towns on both coasts was done and the final list included 21 fishers.

The information collected touched four themes: (1) the evolution of the fishing practices of the Quebec turbot fishers in the Gulf of St. Lawrence; (2) their empirical knowledge of turbot biology and its environment; (3) the social dimension of the fishery, such as internal rules governing sharing and access to fishing grounds; and (4) their perceptions and interpretation of DFO's science and fishery management of this species. The study elements were the same as those used in a lobster fisher study conducted in the Magdalen Islands (Gendron *et al.* 2000) and as proposed by Mailhot (1993) and Inglis (1994). The methods used to collect the information were also similar to the lobster project: each interview, which lasted an average of two hours, was tape-recorded and then transcribed. The interviews for the turbot project were conducted by scientists from the Maurice Lamontagne Institute.

After interview transcription, the compilation and analysis of information obtained from the turbot fishers were done in three steps. The information was first gathered together by subject for each interview. A chronological list of the fishing practices was then constructed for each fisher. Finally, the fishing practice histories of all fishers were compiled in chronological order. Of the 21 interviews, ten were fully analyzed for the present study: five from fishers active in the 1970s but now retired and five from still active fishers. All ten fishers come from the south shore. Given the dominance of the south shore in the development of the turbot fishery, the number and origin of interviewed fishers are sufficient to describe the general historical pattern of this fishery.

The results presented describe the changes in the fishing practices and strategies between 1970 and 1997. More precisely, information was gathered on the vessels, navigation equipment, the gillnets, fishing strategies and the fishing grounds. We also examined the relationship between these changes, the prevailing socio-economic context, and the landings of Greenland halibut for the same period.

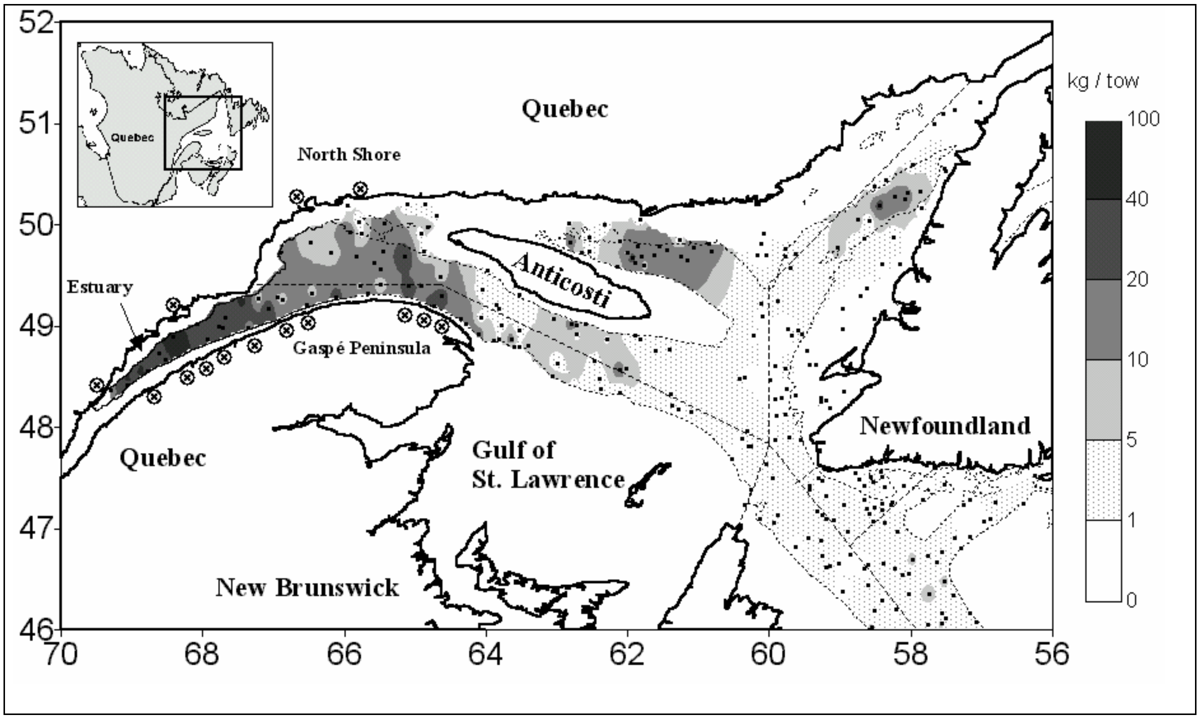

Figure 1. Distribution of Greenland halibut in the summer of 1997 on the DFO research survey. The symbols (⊗) indicate the areas where the interviews took place.

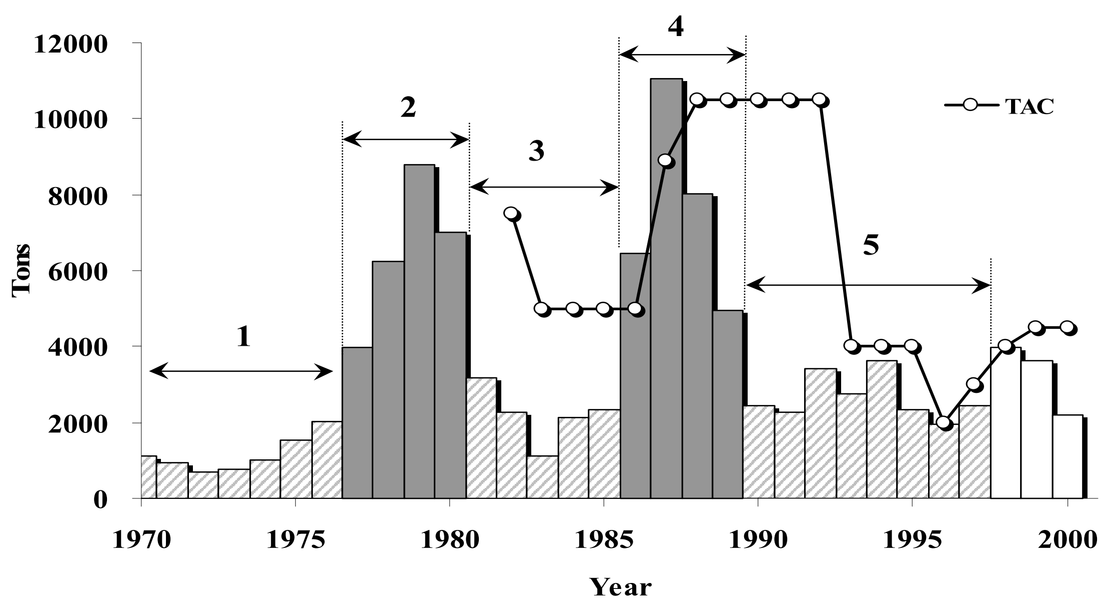

Figure 2. . Commercial fishery landings of Greenland halibut in the Gulf of St. Lawrence (TAC : Total Allowable Catch). The five periods described in the paper are indicated.

RESULTS AND DISCUSSION

The Greenland halibut fishery has shown large fluctuations in landings over the years. An examination of the variation in landed catch (Figure 2) and the information gathered from Greenland halibut fishers (Table 1) allows the identification of five distinct periods. It was possible to link the fishing strategies to the major events that occurred in the fishery, such as the success of other groundfish fisheries, the abundance of turbot and the implementation of management measures. Therefore, the description of the relationships between the fishing practices, the prevailing socio-economical context, and the turbot fishing success (e.g., landings) is presented for five periods that cover the whole fishery, from the beginning of the 1970s to the end of the 1990s.

Table 1. Number of observations gathered among the interviewed fishers by year and by themes. An observation is a new comment expressed by one fisher for the first time. The same comment expressed many years consecutively by the same fisher is counted as one observation and is associated with the first year of its expression. The general themes are as followed : **boat**, type or length of the fishing boat; **boat equipment**, engine, winch or navigational equipment; **fishing gears**, number and type of gears; **fishing techniques**, configuration of nets or frequency of hauling; **mesh size**; **fishing success**, yields, catches or landings; **size of fish**; **fishing grounds**, location or depth of fishing; **fishing season**, month or duration of the fishing season; **crew**, number or origin of crew members; **other fishers**, behavior of turbot, shrimp or groundfish fishers; **market**, buyers, processing plants or prices.

	Boat	Boat equipment	Fishing gears	Fishing technique	Mesh size	Fishing success	Size of fish	Fishing grounds	Fishing season	Crew	Other fishers	Market
<1972	1	2	2	2		1		1	1	2		1
1972	3	3	3	2	3	2	3	3	2	3	1	2
1973	1	1		1								
1974	1	1						1			1	1
1975	1		2			1		1			1	1
1976	1	1									1	
1977		2	2	2	3	1	1	3	1		2	
1978	2	2	2	1	3	2		3	1	1	1	
1979	2	1	1	2		1						
1980	1	2	2	2	2	1	2	1			2	
1981						1		1				
1982			3	1	2	1						
1983												
1984	1	1	2	3	2	3		2		1	1	
1985				1		1				1		
1986	2	2	3	4	5	5		2	1	3	2	
1987	2	2		1	1	3		1		1	1	2
1988		1	2	1		5		1	1		1	
1989				1		3		2				
1990				2	1	4				2		
1991			1	1		1	1	1		1		
1992	1	1	1	1		4		2	1		1	
1993	1	2	2	2	1	1		2		1	1	
1994				1	1	2		2				
1995			1	1		1	1	1		1		
1996			3	3	1	2		2		1	1	
1997		1	2	3		1		1		1	1	

1- The food fishery (up to 1976)

Some fishers remember having fished for turbot in the 1940s with their fathers. During those years, groups of four to five fishers would go to sea in September and October in small boats; they fished turbot with hand lines in shallow waters close to the shore. These men used their catch to make provisions of salt fish for the following winter. This practice was followed until the mid-1970s, with fishers keeping most of the catch for their families. Before 1975, no fish plant would process turbot. Although there were some opportunities to sell fish in a local market, or in some cases, in the Montreal market, the turbot fishery was a small-scale activity that could be characterized as a food fishery.

Landings were low, mostly below 1,000 tons per year for the whole Gulf of St. Lawrence.
At the beginning of the 1970s, fishing activities took place from spring to fall, when the fishing grounds were ice free. Fishers usually started their season in spring by fishing for herring that they sold to lobster fishers for bait. Cod and Atlantic halibut were fished in summer for the fresh-fish market. In fall, fishers directed their effort to turbot for the food fishery. Consequently, the turbot fishery was mainly practised by inshore fishers using cod fishing gear. They targeted large fish, so the gillnets they used had large mesh sizes (6 to 12 inches with the majority between 6 and 7 inches) and the longlines had large hooks. The turbot caught were so large that "they needed their two hands to hold it," as some of the fishers recounted.

Turbot fishing was labour-intensive and inefficient. Fishers experienced many operational problems that made the work very difficult. The buoys were not durable and often had to be replaced. It was difficult to find the gillnets at sea since most fishers had crude positioning equipment: only a chart, a compass, and a divider. Fishers used 10 to 20 nylon gillnets and much time at sea was required to remove the fish because the material tangled easily. Some of the fishers did not have any power equipment and they had to haul the gillnets by hand. There were few fishers, and each had his own fishing territory in front of his house. It was even difficult to find crew members because many men had left the region to work on the hydroelectric plant building projects which started in Quebec in the 1960s and the 1970s.

2- The market development and increase of effort (1977 - 1981)

The market for fresh turbot was developed in the mid-1970s when a processing plant near the fishing grounds began to buy turbot from the inshore fishers. At the same time, the cod fishery was declining and many cod fishers were looking for an alternative to their traditional activity. The inshore cod fishers directed their effort toward turbot while many of those who had trawlers obtained new licences to fish northern shrimp (Savard *et al.*, 2002). Since some of the hydroelectric projects were drawing to a close, many workers, some of whom had fished in earlier years, came back to their communities and were available for the turbot fishery. Turbot fishing underwent an increase in popularity, especially since the yields were very good and the prices paid to fishers were quite high. The landings went up rapidly to reach 9,000 tons in 1979, almost ten times what they had been in 1972.
The resident fishers who had fished turbot for many years tried to continue to practise their activity on the fishing grounds adjacent to their home ports. Some bought new boats with better equipment, but the fishery was still an inshore fleet with boats under 45 feet. With the increasing demand for turbot, fishers began to fish for a longer season from spring to fall. They gradually increased the number of gillnets that they were using regularly, from 10 to 20 at the beginning of the 1970s, up to 80 to 100 at the beginning of the 1980s. However they still went out every day from sunrise to sunset to haul a portion of their gillnets. They did not change the mesh size (6 and 6.5 inches) and the catch of large turbot was still good.

The resident fishers were joined by longliners from the tip of the Gaspé Peninsula who were shifting their activity from cod to turbot. These new fishers moved from the offshore cod fishing grounds to the turbot fishing grounds in the St. Lawrence Estuary, a sector well known for its abundance of turbot. By doing so, they were fishing on the same grounds as the resident fishers, and since gillnets are fixed gears, competition for fishing territory began. Because they had fished offshore, the longliners were bigger (about 60 feet) and very well equipped. They had four to six crew members, used more gillnets (at least 200), worked 24 hours a day, and could stay at sea for several days.

The inshore fishers began to experience a decrease in their catch rates in 1980. One fisher estimated that his catch in 1980 was about 60% less with four times as many gillnets. The fishers also noticed a decrease in the size of turbot and began to use smaller mesh sizes to maintain their catch. Some moved from their traditional fishing grounds to explore new areas where there were less fishers and where catch rates could be better. The competition for fishing grounds was high and the arrival of the new fishers changed the rules as fishing became less territorial.

The decrease of landings in 1980 marked the end of this period of development. It seems obvious that the main cause of the increase of landings at the end of the 1970s was the increase in fishing effort. Since there were very few management measures in place during this period, fishers could increase effort to satisfy the increasing demand of the new market. Moreover, resident fishers were joined by new fishers attracted by the success of this fishery, while their traditional activity, cod fishing, was declining. As some of the fishers had noticed, the resource could not sustain such intense exploitation for long, and abundance as well as fish size began to decline in 1980.

3- Technological development (1981 - 1985)

Landings dropped after the 1979 peak and reached 1,000 tons in 1983, a catch that was equivalent to those landed in the first half of the 1970s. Many fishers left the fishery because of the lack of success. Some directed their effort to other species, while others stopped fishing and turned to something completely different. Those who continued to fish for turbot learned to be more efficient in adapting their fishing techniques to a resource that was sparsely distributed and less abundant. Some decreased the number of crew members during the years when turbot was less abundant, those who remained were often relatives of the licence owner.

In 1982, the management of the fishery was transferred from Quebec's provincial authorities to the federal Department of Fisheries and Oceans (DFO). Given the precariousness of the turbot industry, some management measures were then adopted in an attempt to better control the fishing activities and to protect the resource. Two of these management regulations had an impact on the strategy of resident fishers. First, during the 1970s, fishers were targeting large fish to satisfy the market demand. At the beginning of the 1980s, the mesh size was decreased gradually by fishers from 6 to 5.5 inches in response to the decrease in mean fish size (Morin and Bernier 1999) and in 1983, the 5.5 inch mesh size was made mandatory by the federal authorities. The second important management measure adopted at this time was the limitation of the catch by the imposition of a Total Allowable Catch (TAC). However, the TACs that were set failed to limit the fishery because they were either too high or not implemented. The Greenland halibut stock assessment was imprecise during the 1980s because of the lack of data and because of the uncertainties of the Gulf of St. Lawrence stock status. The Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC), a DFO scientific body that provided TAC recommendations to the DFO Minister until 1993, recognised the difficulty of assessing the Gulf of St. Lawrence turbot, so the first TAC was based on historical catches. Thereafter, CAFSAC indicated that the Gulf of St. Lawrence turbot was closely linked to the larger stock of Labrador and Eastern Newfoundland stock and that there was no biological reason to set a specific TAC for the Gulf of St. Lawrence (CAFSAC, Adv. Doc. 5/82 1983). Thereafter, TACs were set by the fishery managers.

The fishery had become very competitive by the end of the 1970s because of the arrival of new fishers (longliners) targeting this species. A few years later, fishers were still competing for the best sites to set their gillnets and obtain good catch rates. The management by TAC, if it did not limit the catch during this period, incited competition between the fishers to catch more fish before the TAC could be reached and the fishery closed. Turbot fishers had to adapt to become more efficient and increase their chance of success. Many bought new boats when the landings were still high. The new boats were often larger so they could carry more nets and store more fish. Since the boats had more powerful engines, they were able to reach the fishing sites faster, and go farther to explore new fishing grounds. Consequently, they exploited a larger fishing area with more nets. Some fishers extended their fishing territory from the south to the north shore, close to Sept-Îles. As fishers were exploring the territory to find sites with good catch rates, they noticed that the yields were better in deeper waters and adapted their nets to catch fish at greater depths.

Boats were also better equipped. They had new systems for more precise positioning, and radar to locate buoys and gillnets more easily even in bad weather. Before having such positioning systems, it was not unusual that fishers could not find their gillnets in fog and would lose the whole catch because the fish were not fresh enough when they were finally able to return and haul the nets. Fishers usually worked on a three-day rotation, hauling some of the gillnets each day. They changed the configuration of the nets to increase their catch by decreasing the height of the gillnets, which facilitated handling at sea and saved time. They also began to bag their nets by placing cables at equal distances between the head and bottom lines to form a bag that retained more fish.

The landings remained low from 1981 to 1985. Fishers who stayed active during this period were mostly resident. It seems that the longliners from the Gaspé Peninsula went back to the cod fishery, which was improving, while the turbot fishery was declining. The resident fishers, who had spent about five years improving their fishing techniques, were more experienced when turbot became suddenly, in one season, more abundant.

4- The increase of turbot (1986 - 1989)

Turbot fishers had to put in a lot of effort to catch enough fish to make a decent living in the years leading up to 1986, when catches increased substantially, with landings reaching a new record in 1987. Catch then declined again in 1988 and 1989. The increase in the 1986 catch rates was essentially due to the recruitment of the 1979 and 1980 year classes (Morin and Bernier 1999) to a fishery worked by more efficient fishers. The mean size of fish also increased in the following years as these year classes grew. The increase in landings was observed for both the mobile and fixed-gear fisheries. Before 1993, shrimpers were allowed to keep their groundfish by-catches and had specific catch allocations for cod, redfish and turbot that they could fish with groundfish trawls. The processing plants paid high prices for turbot; this and the high catch rates were a very strong incentive to fish turbot.

Most of the cod fishers had a groundfish licence that allowed them to fish for turbot as well as cod. However, they did not use it when turbot abundances were low. It seems that the success of the resident fishers in 1986 attracted many other fishers for the second time in ten years. As some of the turbot resident fishers mentioned, "when the fish come back, the number of boats increases". In addition to the mobile gear fleet, the Gaspé Peninsula longliners got involved in the turbot fishery again, and effort increased substantially. Not only did turbot fishers use more nets and spend more time at sea, the number of boats active in the fishery also increased rapidly between 1985 and 1987. There are some indications that not all catches were recorded during those years and that landings could have been at least 50% more than the amount declared. Some resident fishers explained that when the resource is rare, fishers tend to declare all catches because the weekly income counts in the computation of the unemployment insurance they get in winter. However, when fish is abundant, fishers may wish to keep some income for themselves without declaring it.

The effort increased substantially not only because of the involvement of other fishers but also because the turbot fishers increased their effort. They used the maximum number of gillnets and hauled their nets more frequently than before. Fishers mentioned that they used between 120 and 300 gillnets during that period. A fisher explained that it took two days to haul 120 gillnets. They were leaving at three o'clock in the morning and coming back at 11 o'clock at night. The following night, they would leave at 3 again and come back at 3 in the afternoon. Many kept that pattern for a few years and some mentioned that, at that time, they were spending days and weeks at sea to catch as many fish as possible. At one point, the fish were so abundant that they could not haul all their gillnets. Some mentioned that they had too many gillnets and that their boats were too small. One fisher even explained that he stopped fishing not because the catch rates were decreasing but because he estimated he was making too much money and would have to pay high income taxes. Despite high revenues, many fishers mentioned that they did not enjoy fishing during this period of high effort and competitiveness.

It seems that turbot fishers did not improve their fishing techniques during this period. They talked less about the configuration of their nets or their boat's equipment than about the very high catch rates they experienced. In fact, it seems that the fish were very abundant on all grounds and that the fishers did not need to adopt any sophisticated strategy to get good catches. Some mentioned that they came back to their old fishing grounds in front of their home ports because it was not necessary to go farther to get good catch rates. In 1989 and 1990, they noticed that catch rates were going down and their catches decreased. Many think that the resource was overexploited.

5- The implementation of management measures (1990 - 1997)

At the beginning of the 1990s, many marine species were declining in the Gulf of St. Lawrence. Cod and redfish abundances had decreased rapidly until a moratorium was imposed on the cod fishery in 1994 and on the redfish fishery in 1995. Shrimp was also declining, and the TAC was not reached in the main fishing area of Sept-Îles in 1992 and 1993. At the same time, there was a general willingness to ensure that all catches were recorded. Fishery management authorities negotiated with fisher associations for the implementation of TACs for some species (e.g., snow crab), the allocation of individual quotas (e.g., shrimp), and the obligation of weighing all catches at designated landing ports (e.g., all groundfish, shrimp, snow crab).

The turbot fishery also decreased at the beginning of the 1990s. Catch rates decreased substantially at the end of the 1980s and stayed low in the early 1990s. A fisher explained that he had two crew members at that time but could have fished alone because there was not enough fish to keep them busy. Fishers began to experience high by-catches of snow crab in their nets and some had to move to deeper waters where snow crab is less abundant to avoid these by-catches. Snow crab was increasing at the beginning of the 1990s and was found in great numbers at the eastern part of its usual distribution range in the St. Lawrence Estuary (Dufour and Bernier 1994). However, by moving to deeper water, the fishers began to experience gear conflicts with the shrimp fishers.

The decrease in catches and catch rates in the early 1990s may have been actually much larger than what was observed. There are strong indications that fishers haul their gillnets less often when the fish is not abundant. Therefore, the immersion time can vary between one and three days, depending on resource abundance. The impact of this longer immersion time on the estimate of effort could be important; catch rates at periods of low abundance could be overestimated because of longer immersion time. In 1987 and 1988, fishers hauled their gillnets every two days while they reported that in 1990 and 1991 they were hauling their nets only every three days. Moreover, there are indications that not all catches were recorded during the 1986-1989 period, so catch rates for this period may have been much higher than those estimated.

Although the landings and the abundance decreased at least five fold between 1987 and 1990, the TAC was not changed until 1993, when a new study indicated that the Gulf of St. Lawrence turbot should be considered as a separate stock (Morin *et al.* 1992) and managed accordingly (CAFSAC, Adv. Doc. 15/92 1993). Until then, the TAC had remained high, at the level fixed for the abundance observed at the end of the 1980s.

Starting in 1993, a series of management measures was adopted for the conservation of turbot. The by-catches of the trawl fishery were reduced because of the cod fishery moratorium in 1994 and the redfish fishery closure in 1995. Shrimpers were also required to use the Nördmore grate to significantly reduce the groundfish by-catch. In 1994, any directed mobile fishery for turbot was forbidden and catches from mobile gear have been negligible since then. The TAC was decreased in 1993 by a factor of almost three, from 10,500 tons to 4,000 tons. Given the precariousness of the turbot stock status, the FRCC (Fisheries Resource Conservation Council) recommended in 1994 that strong conservation measures be taken to reduce the fishing effort on turbot and to decrease the proportion of immature fish in the catches. Since 1995, new management measures have been implemented: an increase in mesh size from 5½ to 6 inches, the adoption of a gillnet configuration that is more selective, the introduction of a minimum size limit for turbot (42 cm in 1996 and 44 cm since 1997) along with the application of a protocol to reduce the catch of small fish, the establishment of a dockside monitoring program to record all catches, and the gradual reduction in the number of nets used. The number of nets was finally set at 120 in 1995 but Quebec fishers voluntarily decided to use only 80 nets after 1995.

Inshore turbot fishers adjusted their fishing strategy to the new management measures. They decreased the height of their nets to facilitate handling at sea. Instead of having nets of 20 or 25 meshes in height, they now use nets with a height of 15 meshes (sometimes 12). Gillnets are now smaller, but fishers seem satisfied because their nets stay clean, they catch less snow crab, it is easier to work on the boat, and catch rates had been increasing during the last few years. Because of the reduction in the number of nets, fishers now haul them every day and take some days off during the week or on the weekend. The fishing season became shorter, from about 17 weeks in 1994 to 7 weeks in 1996. Because there are fewer fishers and fewer gillnets per set, fishers can cover more territory in search of good catch rates and large fish. However, competition for the catch is still present since fishers did not agree to implement an individual quota management program until 1999.

Conclusion

This study has been very useful for describing the historical pattern of the turbot fishery by Quebec fishers using fixed gears. Our approach allowed us to identify the main events associated with the five different landing periods and also to show the relative importance of resource abundance and fishing practices in the fishery success and in the landing fluctuations. The periods of high landings were both characterized by an increase of fishing effort with the introduction of new fishers and the use of more nets. However, the first period (1979) was in the context of market development for this species, whereas the second (1987) followed an important period of improvements to fishing efficiency. The similar landing values for the two periods could suggest that the abundance of turbot was comparable. However, scientific information from DFO winter surveys conducted between 1978 and 1994 showed that the abundance of turbot could have been three times higher at the end of the 1970s and beginning of the 1980s than in the mid-1980s (Morin *et al.* 1995). This would indicate that improvements in efficiency made by fishers in the early 1980s contributed significantly to the high landings observed in the 1986-1989 period. In the 1990s, fishers also increased their efficiency but when the turbot abundance improved during the second half of the 1990s, the landings did not increase as they did during the two previous high landing periods because the TAC was limiting, being reduced and set to 4,000 t or less in comparison to 10,500 t in the late 1980s.

The drop in landings that followed the 1979 and 1987 peaks reflected a decrease in the biomass and a lack of interest in turbot fishing. The fishers that stayed in the fishery made a constant effort to increase their yield by improving their efficiency with the purchase of high-performance equipment and by changes in fishing methods. Our analysis of the changes made in the fishing equipment and practices over the past 25 years has clearly shown that the variations in landings are not linked exclusively to the abundance of turbot but also to changes in fishing practices and efficiencies that affected the fishing effort.

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1 List of Associations and representatives :
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REFERENCES

Anon. 1983. CAFSAC Annual Report Vol. 5/82 p. 101.

Anon. 1993. CAFSAC Annual Report Vol. 15/92 p. 135.

Arthur, J.R. and E. Albert. 1993. Use of parasites for separating stocks of Greenland halibut (*Reinardtius hippoglossoides*) in the Canadian northwest Atlantic. Can. J. Fish. Aquat. Sci. 50: 2175-2181.

Dufour, R. and D. Bernier. 1994. Potentiel d'exploitation du crabe des neiges, *Chionoecetes opilio*, et des crabes *Hyas araneus* et *Hyas coarctatus* dans le Nord de la péninsule gaspésienne. Rapp. tech. can. sci. halieut. aquat. 1994 : viii + 51 p.

Gendron, L., R. Camirand and J. Archambault. 2000. Knowledge-sharing between fishers and scientists: toward a better understanding of the status of lobster stocks in the Magdalen Islands (Quebec). In Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management. Neis, B. and L. Felt, Contributing Eds. St.John's: ISER Press.

Inglis, J. T. 1994. Introduction. In Nature & Resources (Traditional knowledge in tropical environments), UNESCO 30 (1).

Mailhot, J. 1993. Le savoir écologique traditionnel: la variabilité des systèmes de connaissance et leur étude. Évaluation environnementale du projet Grande-Baleine, Dossier-synthèse No. 4, Montréal, Bureau de soutien de l'examen public du projet Grande-Baleine, 52 p.

Morin, B, A. Fréchet, M. Aparicio, L. Lefebvre and B. Bernier. 1992. Evaluation du stock de flétan du Groenland (*Reinhardtius hippoglossoides*) du golfe du Saint-Laurent. CSCPCA Document de recherche 92/85, 39 p.

Morin, B., B. Bernier, D. Chabot and J.J. Maguire. 1995. Evaluation et biologie du flétan du Groenland (*Reinardtius hippoglossoides*) du golfe du Saint-Laurent (4RST) en 1995. Document de recherche sur les pêches dans l'Atlantique 95/59: 1-47.

Morin, B., B. Bernier, R. Arthur, G. Chouinard, A. Fréchet and P. Gagnon. 1996. Évaluation et biologie du flétan du Groenland (*Reinardtius hippoglossoides*) du golfe du Saint-Laurent (4RST) en 1995. Document de recherche sur les pêches dans l'Atlantique 96/53: 1-59.

Morin, B. and B. Bernier. 1999. Évaluation et biologie du flétan du Groenland (*Reinardtius hippoglossoides*) du golfe du Saint-Laurent (4RST) en 1998. Document de recherche du Secrétariat canadien pour l'évaluation des stocks 99/185: 1-57.

Savard, L. H. Bouchard and P. Couillard. 2002. Revue de la pêche à la crevette nordique (*Pandalus borealis*) dans l'estuaire et le golfe du Saint-Laurent pour la période 1982 - 2000. Rapp. tech. can. sci. halieu. aquat. *In prep.*

QUESTIONS

Paul Fanning: How much of the fishery is actually a turbot fishery?

Rejeanne Camirand: The fishermen that I interviewed were specialists of their activity – that is, they fished directly for turbot.

Jean Guy D'Entremont
The catch has not reached its TAC yet in the last couple of years. There was an understanding that the fishers fishing crab and turbot together were catching so much crab that they decided to avoid fishing turbot together.

Rejeanne Camirand: For the last two years there has been a high abundance of crab and fishermen fishing for turbot had some difficulty because a lot of crab got caught in the gill net.

Jean Guy D'Entremont: Is that your understanding of why the TAC was not caught?

Rejeanne Camirand: No fishers and no biologists comprehend why fishermen didn't reach the TAC in 1999 and 2000. The fishers said that the turbot was not catchable, possibly because it has moved out of the estuary or it was hiding.

Daniel Lane: Recently there has been the idea that fishing for turbot with gillnets is not very effective. Furthermore, it seems that the market allows to get much bigger and a greater quantity of turbot. Are any of the fishermen changing to longline?

Rejeanne Camirand: The fishers wanted to fish turbot with gill nets and to obtain DFO permission to keep the crab bycatch. But the DFO did not allow fishers to sell the crab.

Marine Resource Knowledge Related to Fish Classification in Haïti: An Examination of Créole Terms, Local Knowledge, and Definitions Related to Fishing and Fish Classification in the Port-au-Prince Bay Area of Haïti

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Abstract
The Haitian fisher classifies his resources either by its morphology, habitat, economic value, or a combination of these. For morphological classifications, characteristics may include any combination of color, size, shape, etc. Certain of the fishers' classifications may follow taxonomic lines, for example: *Bouki* (*Pomacentridae*), *Fwoo-Fwoo* (*Tetraodontidae*), *Sol* (*Bothidae*), and *Venkatrè* (*Scorpaenidae*). Organisms may also be classified by the habitat in which they are found such as *flôt, gran dlo, gran fon, gwo dlo,* or *gwo lanmè* meaning they are found far from shore in deep and/or open waters; *zèb*, in sea grasses and algae on the bottom; or *wòch*, in rocky areas or coral reefs. Both *zèb* and *woch* fall into the category of *à tè* (on land or near land) or *nan sèk* (in the dry or near land) meaning that the subject is near shore and not in waters that are very deep. The most important classification of fish as far as the fishers are concerned is based on its economic value. This classification system involves the color of the skin of the fish and includes *pwason wos/wouj,* 1st Class (pink/red fish), *pwason blan,* 2nd Class (white/silver fish), and *pwason nwa,* 3rd Class (black fish). It is also directly related to the commercial value/attractiveness of the various fishes, and is usually discussed upon the landing of the fish between the fishers and the fish merchants as well as at the markets, although it is already clear to all which fishes belong to the different categories. There is a definite hierarchy in this classification system in relation to pricing, with *pwason wos/wouj* demanding the highest prices, *pwason blan* the next highest, and *pwason nwa* and the rejects/trash fish (4th Class) rounding out the bottom of the scale. Various sizes or developmental life stages of the same fish may be classified differently in terms of economic attractiveness according to this classification system.

Introduction
The traditional environmental information system used by indigenous peoples being commonly referred to these days as Local Indigenous Knowledge (LInK) has helped humans feed themselves, heal themselves, and to survive for untold millennia. Before the advent of "modern" science, this information, passed down from generation to generation, and in the process systematically modified and improved, was, and still is, undoubtedly responsible for the survival of many cultures.

The understanding of local knowledge and its importance to local communities in terms of their capacity to protect and manage their own resources is of vital importance for any "outsider" manager. The precise identification and denomination of living elements of the marine coastal environment (species, varieties, life stages, life forms, etc.) are an essential foundation for any resource management program. A management program which is to be community-based requires that these names, naming systems and concepts relating to the environment be anchored in the local language and local systems of representation. Furthermore, if management is to be co-operative, involving scientifically trained resource managers, community development specialists, and local knowledge resource users (fishers), then it is imperative to understand the extent to which scientific and local names and concepts concur or differ. Only with this information can an exacting and mutually respectful dialogue be established between manager and resource user.

Methodology
Step 1- Introductory meetings with fishers and others from the fishing communities were held in order to discuss: the overall aim and approach of the research; the data collection process (interviews, and tape recordings); and the identification of key informants (based upon extent and wealth of knowledge, familiarity with different geographic areas or fishing techniques or differing expertise with respect to specific ecological systems).

Step 2- Semi-directive interviews were conducted with individuals identified in Step 1. These began as exploratory, but then began to delve into more substantive matters, increasingly focused on: local names for natural objects (first "species" names and then also sex/life stage names, e.g. male/female, egg/juvenile/adult); relationships/associations/groupings of these locally named species (ecological relationship and/or taxonomic relationship and/or symbolic or society-based relationship, for example fish used/eaten only by women, children, or the elderly, resources used only in times of hardship, etc.).

Target Area

This work is ongoing and the information presented herein was undertaken in the Port-au-Prince Bay area in Haiti concentrating on the Arcadins Coast from *Source Matelas* to *Montrouis* from 1998-2000.

Interviews

More than 175 interviews were held involving more than 250 individuals. Interview times ranged from anywhere between ten minutes and six hours, with individual interviews generally being between one to two hours long and group interviews two to six hours.

Data collection

As with most activities taking place in the Haitian country-side, individuals wandering by, or observing you from a distance, may become intrigued by the goings-on, and may freely join in on a conversation and offer their own "expertise" on the subject matter. This occurred on more than half of the occasions that interviews were being held in open or somewhat open community areas. In one example, a small group interview began with three individuals and by the time the session was finished four and a half hours later there were more than 32 individuals providing various inputs. Unless interviews are being undertaken specifically to gather an individual's knowledge (and therefore usually performed away from possible crowds) this type of community participation was encouraged.

Interviews in large groups were generally held only with books/pictures, individual and small group interviews were generally held with live specimens with the use of books for confirmation of identification if doubts were raised. Most participants in single person interviews also participated in at least one of the group interviews. At no time did any of the interviews feel rushed. There was always plenty of time to go over names and to make clarifications if needed. Approximately one half of the interviews were recorded for later review.

The relative proportion of information gathered using live specimens versus books/pictures is estimated to be approximately 50-50. The names of the more common and more commercially-attractive fish were generally well agreed upon, however, all fish, especially those identified by fishers down to species level were cross-checked with several identification guides. No data were entered unless corroborated by at least two individuals.

Location of interviews

Fishermen were interviewed at the headquarters of the *Association des Pêcheurs de Cont (APEC), Association des Pêcheurs de Mitan (APEMI),* and *Association des Pêcheurs de Luly (APEL)* as well as at various random locations along the coast, including certain markets where fishermen and vendors were encountered and willing to cooperate (all were willing to cooperate for anywhere from a few minutes of their time, to most of a day).

THE SITUATION IN HAITI

Marine resources have always been open access in Haiti. Fishers have the basic knowledge handed down from generation to generation by others (family, friends) that allows them to fish in basically the same way as the generation that preceded them. This knowledge includes fishing areas, how to make traps, when and where to fish, etc. In the past, up until perhaps fifty years ago, this knowledge was revered and respected as the best method for allowing what may be considered sustainable fishing. According to the older fishers, these techniques were used with a definite eye towards maintaining a strong, healthy and sustainable resource base. Different fishing methods were used at different times of the year in order to help manage the resources. Small and egg-bearing lobster, small conch and turtles, and juvenile fish were, in general, not intentionally harvested or were thrown back into the sea if accidentally caught.

Fishing methods: Traditional and Modern

In the past, when resources were abundant, there were generally no conflicts over one fisher entering another's fishing area because fishers at that time were not possessive of different areas. Resources were abundant. The concept of "I can't stop someone from making a living" especially since "the sea is for everyone", goes back further than any of the fishers can remember. It is really only recently that the fishers have begun to develop a sense of possession of certain fishing areas, brought about no doubt, by a decrease in productivity and an increase in the number of fishers (crowding), as well as the numbers of unsustainable/ destructive methods. These conflicts usually arise when a fisher using older "sustainable" methods (i.e. traps, hook and line) reacts against a fisher using what would be considered a new, damaging method (i.e. compressors, small meshed nets).

Where and When to Fish and Methods

What may be referred to as the traditional rotation of fishing areas and seasons have not changed much over the past few generations. Now, however, with a tripling, quadrupling, and according to some of the fishers, a quintupling of fishers in the area over the past fifty years, there are fishers who will tend to fish only one area all year long and/or use only one type of method (Compare Mangahas, this vol). This gives rise to the correct impression that all waters are being fished at all times. The fishers described the current situation as one where any method may be used at any time depending on if the fisher feels it is in his best interest to change method/materials and/or location.

Fishers tend to be more active around the deeper open waters around the *Kanal* and *La Gonâve* areas from approximately September/October through to around April/May (the *Kanal* is the deeper waters of the Canal of St. Marc located between the north/north-east side of *La Gonâve* island and the Arcadins Bank; paralleling *La Gonâve*).

The main methods used during this season, both now and in the past, are hook and line and the *gwo nas* (large trap). The main reason for being in the *Kanal* at this time is the increase of migratory pelagics, which along with the usually present non-migratory pelagics, now increases the fishers' chances of catching something substantial. Hook and line during this season is generally used to catch Vermillion Snapper (*won*), Yellowtail Snapper (*kola*), Tilefish (*viv*), Lane Snapper (*agenté*), Dolphin (*dorad*), Wahoo (*mèlan*), Ballyhoo/Balao (*balawoo*), Barracuda (*békin*), and other "*gwo pwason*" "big fish". The *gwo nas* (large trap) may be used as *gwo nas fon,* laid on the sea floor down to approximately 100 ft., or as *gwo nas flôt*, floated in the water column with a buoy at 5 to 15 feet deep, depending on the target fish. The *gwo nas fon* is usually laid out along the shallower edges of the *Kanal* and is used to catch Parrotfish, Angelfish, Cardinalfish and other near shore fish. The *gwo nas flôt* is put out in this area with the hopes that something else will swim into it. It has been known to catch Yellowtail Snapper, Dolphin (fish), Wahoo and other fishes, including sharks.

During the season which extends from May/June through to August/September, fishers who still use more traditional methods fish closer to shore, both inside or very near the fringing reef at *La Gonâve*, near the Arcadins Islands or between the Arcadins Islands and the mainland. They have now switched over to *ti nas* (small traps) and are catching parrotfish (*pawoket*), goatfish (*babarin*), eels (*kong*), cardinalfish (*kadino*), angelfish (*magrit*), and other smaller reef fishes (*ral-ral, rebeka, bouki*, etc.) found closer to shore. The *ti nas* are usually placed in fairly shallow waters; usually where the bottom is visible from the surface; the water clarity in Haiti is such that this may be as deep as 80 ft. in certain areas. These traps may also be used as *nas flôt,* and as with *gwo nas flôt*, the hope is to catch anything that may stumble into the trap, including any Jacks (*karan*) *(Carangidae)* and Rainbow Runners (*pilot kola*).

The basic method of "law enforcement" in the past was chastisement by other fishers, or not being able to sell your catch because you've harvested an underdeveloped, unmarketable resource. This was/is the basic premise behind using sustainable methods and the "wisdom of the elders" technique, the only type of regulation ever used to any extent in Haiti.

The older fishermen are in agreement that the main type of fishing in their day was the use of traps both large and small, and hook and line.

CLASSIFICATION OF FISHES

This section discusses the classification of fish by fishers and merchants in terms of morphology, habitat, and economic value.

Morphology

The Haitian fisherman physically identifies and therefore classifies fish according to certain common characteristics. These characteristics may include any combination of color, size, habitat, shape, etc. Many of the fishers' classifications follow taxonomic lines, for example: *Bouki* (*Pomacentridae*), *Bouse* (*Balistidae*), *Fwoo-Fwoo* (*Tetraodontidae*), *Karan* (*Carangidae*), *Sol* (*Bothidae*), and *Venkatrè* (*Scorpaenidae*). Other fisher classifications which do not precisely follow taxonomic lines, may use one or a varied combination of several of the above mentioned characteristics. An example of this is fish which are classified by the fishers as *Magrit*. The Angelfish (*Pomacanthidae*) make up this entire taxonomic classification as well as the vast majority of the fisher classification. However, the fisher classification *Magrit* also includes the Atlantic Spadefish *Chaetodipterus faber,* a member of the genus *Ephippidae*. The *Magrit* are all generally described by the fishers as colorful, large flat ovals, with a three-tailed appearance. Although not as colorful as the *Pomacanthidae*, the Atlantic Spadefish complies with the other two attributes, and is therefore included in the fisher classification of *Magrit*.

Habitat

Fish are also classified by the habitat in which they are found, such as *flôt*, *gran dlo, gran fon, gwo dlo,* or *gwo lanmè* meaning they are found far from shore in deep, open waters; *zèb*, in sea grasses and algae on the bottom; or *wòch*, in rocky areas or coral reefs. Both *zèb* and *woch* fall into the category of *à tè* (on or near ground) or *nan sèk* (in the dry or near land) meaning that the subject is near shore and not in waters that are very deep (greater than approximately 50 *bras* – 300ft. -- a *bras,* is equivalent to approximately six feet and is the distance from hand to hand measured by a fisher with outstretched arms).

Economic Value

This classification system involves the color of the skin of the fish and has been in use longer than any of the fishers can remember. It includes *pwason wos/wouj* (pink/red fish), *pwason blan* (white fish), and *pwason nwa* (black fish), and is directly related to the commercial value/attractiveness of the various fishes. It is usually discussed upon the landing of the fish between the fishers and the fish merchants, as well as at the markets, although it is already clear to everyone which fish belong to the different categories. There is a definite hierarchy in this classification related to pricing, with *pwason wos/wouj* demanding the highest prices, *pwason blan* the next highest, and *pwason nwa* and the rejects/trash fish (4th class) rounding out the bottom of the scale.

Pwason wos/wouj (pink/red fish), also known as the 1st class*,* includes the more commercially attractive pink and red fishes such as Snapper (red), Red Hind, Graysby, Stoplight Parrotfish, Glasseye Snapper, Bigeye, and Cardinalfish. These fishes are usually sold in higher class markets and hotels, and to wealthier individuals. Most of the fish classified as *pwason wos* are also classified as *pwason flôt*. The prize of prizes for the Haitian fisherman is the large Red Snapper.

Pwason blan (white fish – refers more to silver fish), also known as the 2nd class, includes Dolphin (fish), Barracuda, Wahoo, Triggerfish, certain of the larger Parrotfish, some of the lighter colored Snappers, Jacks (*Carangidae)* as well as sharks and Mackerel. These are commercially less attractive fishes than the *wos/wouj* 1st class fishes, are sold to a more middle class market and are generally considered to be middle quality fishes. The smaller of these fishes, as with the smaller *pwason nwa,* are more commonly eaten by the fishermen themselves or sold to the more destitute, including the elderly.

Pwason nwa (black fish) is also known as the 3rd class and contains most of the darker colored and usually least commercially attractive of all the fishes. They are also largely classified as *pwason wòch*, meaning they are found in rocky habitats and coral reefs, and include Butterflyfish, Damselfish, and Gobies. This group, however, also contains Groupers, and the Jewfish which can grow to well over 100 pounds. A large Grouper or Jewfish, although classified as a *pwason nwa,* may still earn a good price at the market due solely to its size. Pound for pound, however, a *pwason wos/wouj* demands a premium.

Because there tend to be more species of smaller fish, and their commercial value is lower because of their small size, clarity in naming becomes more difficult. The less economically important something is to an individual (or groups of individuals), the less time is spent in categorization. Because of this, there tends to be an often used categorization of *rejet* (rejects) which are sometimes referred to as a 4th class and which encompasses all of the smaller less desirable fishes including: *Bouki* (Damselfish), *Delaké* (Basslets), *Fwoo-Fwoo* (Burrfish), *Goud* (Butterflyfish), *Pé* (Blennies), *Pilot* (Hamlets and Gobies), *Ral-Ral/Rebeka/Girel* (Wrasses and Razorfish). Certain Parrotfish and especially juvenile Parrotfish are categorized as *flérin*. These too are often left for the old, the poor, and children and seem to be vaguely classified just slightly higher than most rejects. Because of similarities in appearance and size, many of the wrasses (*Labridae*) also fall into this category.

It is important to note that various sizes or developmental life stages of the same fish may be classified differently in terms of economic attractiveness according to this classification system. An example is the *Scaridae* (Parrotfishes) in which the small dark or black and white banded initial phase/juvenile may be classified as *flérin,* which is the same category as *pwason nwa/réjet*. As the fish matures, however, and changes color, it may eventually climb the classification scale to *pwason wos*; even skipping the intermediary classification of *pwason blan* altogether. The dynamics of this classification system are therefore wide and varied with basically only the color and size of the captured fish itself having any bearing on its final marketable value.

ACKNOWLEDGEMENTS
Many thanks to UNESCO/CSI for providing all types of support for this research.

QUESTIONS

Richard Hamilton: Are the fish identified to a species-specific level?

Jean Weiner: Yes they are. It is only when the fish start getting smaller and less important that they put them together in one group.

Bill Montevecchi: The situation you describe is the tragedy of the commons. Do you see any way out of this? Are there any options?

Jean Weiner: We need to have serious public sector involvement. State intervention hasn't helped. Instead of being benign they are making the situation worse. In an attempt to help the fishers two years ago, they brought in the Cuban fishers with large trawlers. Haitians have small boats. The Cubans taught them how to use modern fishing techniques but the Haitians can't buy the 36-foot trawlers. That ended up being a major disaster. The money acquired was supposed to go for a fund to help the fishers but no one has seen the fish or the money.

Barbara Neis: You mentioned that the trash fish are becoming more commercially viable. Are there links between the names and this that you are describing?

Jean Weiner: Not really. As the resource base becomes more depleted, fishers move on to different species. Species that were never looked at 15 years ago have become very important for the fishers' survival today.

Anonymous: Are there any names for fish that no longer exist?

Jean Weiner: There are fish that the fishers say they don't see anymore. I don't know if they still exist.

PLATEAU FISHING TECHNOLOGY AND ACTIVITY: STL'ATL'IMX, SECWEPEMC AND NLAKA'PAMUX KNOWLEDGE

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ABSTRACT

The image of Aboriginal men perched over turbulent water with fish nets in hand is well known to many people. Though this picturesque scene may be viewed as romantic and daring, it is actually a way of life for many people in the Plateau region of British Columbia. The ability to carry out this practice relies not so much on bravado and adventure but rather on knowledge of the people passed down for generations.

In a museum environment, collection and presentation of many facets of various cultures is a primary focus. Documentation of Aboriginal fishing from the Plateau region of British Columbia has been very weak, however. The Canadian Museum of Civilization (CMC) has only a few artifacts related to fishing. These do not accurately reflect the importance of fishing to Interior Salish peoples, such as the Stl'atl'imx, Secwepemc, and Nlaka'pamux. Nor does the collection encompass the variety of tools and techniques employed by fishermen in this region.

Fishing activity is better represented in archival photographs held in the CMC, the Royal British Columbia Museum (RBCM), and Provincial Archives of British Columbia. These photographs span from circa 1868 (Frederick Dally photographs) to the 1950s.

INTRODUCTION

In 1999 I began research on the topic. Initially, I planned to conduct field research to document contemporary fishing practices. However, I was unable to continue field research, so shifted focus to summarize ethnographic fishing practices of Secwepemc, Nlaka'pamux, and Stl'atl'imx people; to analyze fishing tools held in museum collections; and to review various impacts on Plateau fishing practices throughout history. Finally, I provide a summary of comtemporary fishing practices as observed through my own field research and by others involved in fishing today.

FISHING IN THE PLATEAU REGION

There is general agreement among scholars that fishing activities, especially those related to salmon, have been the foundation of Aboriginal economic, cultural, and social lifestyles along the Fraser, Thompson, and Nicola rivers. All Interior Salish groups have access to fish and salmon is the most abundant. The principal salmon harvested along interior rivers are Chinook (*Oncorhynchus tschawytscha*) and Sockeye (*Oncorhynchus nerka*). Chum salmon (*Oncorhynchus keta*) were part of the Fraser River fisheries before the nineteenth century. Coho salmon (*Oncorhynchus kisutch*) travel up to the middle reaches of the Fraser River in the summer. Steelhead salmon (*Salmo gairdneri*), sometimes referred to as trout, is also available in the Fraser River[1]. According to Pokotylo and Mitchell (1998), the distribution and population densities of the Plateau people are directly linked to their access to this resource. Archaeological evidence of "extensive exploitation" of salmon dates back three thousand years (Lohse and Sprague 1998:25). Harris (1997) estimated that the Fraser Canyon supported large human populations prior to the devastation caused by introduced diseases. This large population could only be maintained with sufficient food resources, in this case salmon that was caught and cured along the banks of the river. In aboriginal times, the ability to process and preserve fish influenced the amount of fishing that would take place. Once the dry racks were full, one had to wait until the fish were sufficiently dry before removing them and filling the racks once again.

Little research has been done on the level of fish consumption other than salmon. However, a variety of other fishes is harvested in the Plateau area. Many of these species are resident year round, and so are consumed fresh. These fish include: largescale suckers (*Catostomus macrocheilus*), northern pikeminnow (*Ptychocheilus oregonensis*), peamouth (*Meilocheilus caurinus*), mountain whitefish (*Prosopium williamsoni*), Dolly Varden trout (*Salvelinus malma*), cutthroat trout (*Oncorhychus clarki*), longnose suckers (*Catostomus catostomus*), and lake trout (*Salvelinus namaykush*).

The geography of British Columbia's Plateau region is varied, from high mountains to rolling foothills and vast grasslands, all intersected by large rivers. Aboriginal people of this region have developed distinct languages and societies

[1] The health of all salmon stocks other than the Sockeye is now considered precarious or nearing extinction.

but share some cultural traits. Perhaps the most evident of these is their reliance on fishing. Interior Salish groups included in this research are the Stl'atl'imx, Secwepemc, and Nlaka'pamux (their traditional territories are shown in Figure 1).

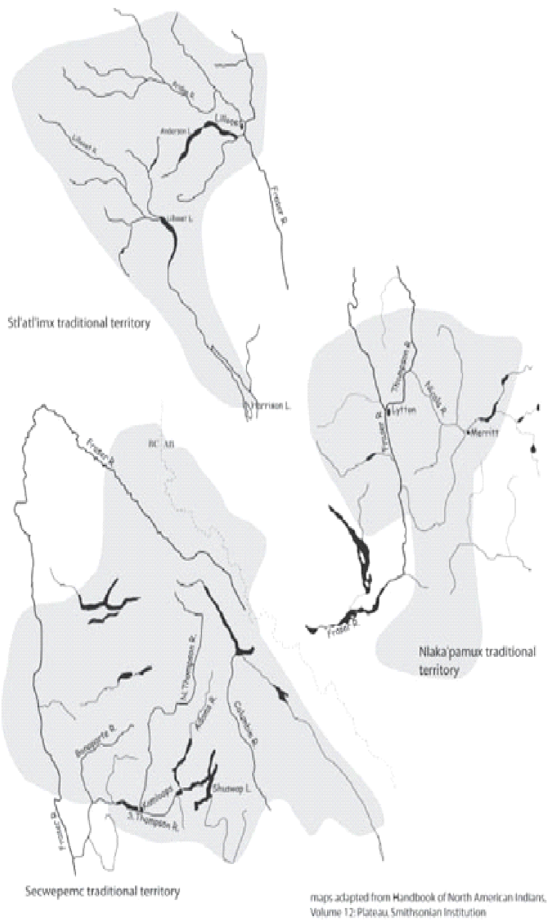

Figure 1. Maps of the traditional territories of the Stl'atl'imx, Secwepemc, and Nlaka'pamux Interior Salish groups of British Columbia.

Stl'atl'imx

The Stl'atl'imx are also called Lillooet and can be divided on the basis of dialect and geography into Upper and Lower divisions (Kennedy and Bouchard, 1998). The term Stl'atl'imx designates them as speaking the same language. The Upper Stl'atl'imx share more of the Plateau cultural traits while people living in the Mount Currie region tend to be tied closer to the Halkomelem peoples of the lower Fraser River.

A comprehensive study of Stl'atl'imx fishing is found in Hayden (1992), which compiles research on Stl'atl'imx resource use, both historical and contemporary. The Stl'atl'imx have some of the best salmon fishing and wind drying spots in their territory. In Aboriginal times, spring salmon began running in April, followed by a second spring salmon run in late summer, then a series of sockeye salmon runs starting in June. Due to the decline of many fish stocks today, the majority of Stl'atl'imx fishing is now centred on the sockeye runs of July and August at the Bridge River /Six Mile site near the town of Lillooet.

Teit (1906) noted that the Stl'atl'imx used a variety of fishing gear:

> *The Upper Lillooet gathered at different places along the Fraser River between Lillooet and the Fountain, where they caught large quantities of salmon with bag-nets. The spears used were similar to those of the Thompson Indians. Single and double pronged spears were used from the shore, and three-pronged ones from canoes or rafts. Very long-handled spears and gaff-hooks were used for catching fish in muddy pools or large eddies. Barbed hooks of antler with short handles, as well as spears with detachable points, were used for pulling out fish at weirs or dams. Metal hooks were used at the present day. Fish-traps were of two kinds, as among the Shuswap and Thompson Indians. They were set at gates or openings of weirs, in creeks near the outlets of lakes, or near mouths of creeks flowing into lakes. .. Fish were also caught with lines and baited hooks. The latter were made of bone, wood, and thorns of the hawberry-tree (Crataegus rivularius Nutt.). Copper hooks were also used, which were similar in shape to the double bone hooks of the Thompson Indians (227-228).*

Once caught, salmon was wind or smoke dried and kept over the winter. Some fish was rendered into fish oil, a practice that does not appear to be common today. The American Museum of Natural History has a number of Stl'atl'imx artifacts related to fish oil rendering which are not found in other collections. Teit collected these near the turn of the twentieth century. The process for rendering salmon oil is mentioned by Kennedy and Bouchard (1992; 1998) but it is not evident whether or not fish oil is still produced today. I did not see fish oil production in 1999 nor did I hear people talk of it.

Stl'atl'imx people are renowned for their wind dried salmon. Today, as in the past, they wind dry salmon in August when grasshoppers are singing. It is said that when grasshoppers make a particular clicking sound, it resembles the sound of a knife cutting through a salmon's backbone, announcing that conditions are perfect for wind drying.

Secwepemc

The Secwepemc people are also known as the Shuswap and the two names are used interchangeably. There are seven divisions of Secwepemc people within seventeen bands. Their territory is in the southern interior of British Columbia, around the Thompson and Fraser rivers. Traditional villages and current Indian reserves are located along the rivers. There are two physiographic areas within Secwepemc territory, known as the Fraser and Thompson plateaus. The Fraser plateau is characterized by rolling lowlands along the Fraser River between the Coast and Rocky Mountains (Ignace 1998). The Thompson plateau includes narrow plateaus and highlands of Cascade and Coast mountains. The Secwepemc territory is rich in salmon spawning beds. It is estimated that "about 57% of all Fraser River sockeye salmon, as well as 25 to 34% of Fraser River Chinook and Coho salmon respectively" spawn in Secwepemc territory (Pinkerton and Weinstein, 1995:149).

Ignace (1998) and Teit (1909) have documented traditional Secwepemc fishing practices. According to Ignace (1998), fish weirs were important to Secwepemc fishing[2]:

> *The weirs consisted of a framework of poles, ticks, and rush, which were built across a creek like a fence. As they gathered in front of these fences, salmon were speared or dip-netted by the fishermen. Another form of weir consisted of two fences, the first one of which was built in such a way as to be penetrable by the salmon ascending the river, but preventing their return. The fish thus remained between the two fences until they were removed with spears (p. 206).*

Ignace went on to discuss the egalitarianism of the Secwepemc in sharing salmon and other resources. Men fished together and their catch was distributed among the various families participating in the fishing. Additional fish were caught and sometimes processed for the elderly or those incapable of doing this work themselves. This practice continues today.

[2] Aboriginal people have not been permitted to use weirs and traps for many years. As part of an Aboriginal Fishing Strategy project, the Secwepemc maintain a fish monitoring fence at Scotch Creek where people are allowed to catch salmon.

The continuing importance of fishing to Secwepemc is evident in the cultural and educational material they produce today. Fishing activities are featured in the Secwepemc Heritage Centre in Kamloops. This exhibit includes a salmon trap, a *mineep* (toggle spear), a dip net, two leisters (one made with bone and wood, the other from a pitch fork), and fishhooks as examples of Secwepemc fishing technology. The Heritage Centre has produced a video entitled "how to make a pitch fork leister" which is used in schools. The Secwepemc Cultural Education Society (SCES) has produced a number of textbooks that include information on fishing. The Teachers Guide, for example, states as one of its learning objectives of the summer module, "Students will recognize the ingenuity of Shuswap fishing technology" (Mulligan 1988:37).

Nlaka'pamux

Nlaka'pamux people have been known by other names including Thompson, Couteau, or Knife Indians. They are divided into Upper and Lower groups; currently there are fourteen Nlaka'pamux bands. Nlaka'pamux territory, like the people themselves, can be divided into two areas. The upper area is characterized by dry grasslands along river valleys with the higher elevations covered with fir and aspen. The lower area is more influenced by the coastal climate with stands of cedar and fir (Wyatt 1998). Villages were located along the Fraser, Nicola, and Thompson rivers. One of the most important fishing sites and trading areas was near Spences Bridge, at the confluence of the Nicola and Thompson rivers.

Little research has been done on Nlaka'pamux fishing practices since James Teit's book *The Thompson Indians of B.C.* was published in 1900. Wyatt devotes two paragraphs to fishing in a chapter on Nlaka'pamux culture; she mentions their use of "a variety of hooks, gorges, nets, and traps" (Wyatt 1998:193). According to Teit (1900), the principal fishing gear was the bag or dip net. This type of net is attached to a hoop at the end of a pole and the fisherman dips it into the water to catch fish. It is used in areas where the fish "hug the shore" in their attempt to move upstream against a strong current (Teit 1900: 250).

Nlaka'pamux had numerous fishing sites along the Fraser River. While traveling along the Fraser River in 1868, photographer Frederick

Dally had opportunity to see many active fishing sites from Yale northward[3]:

> *They build a light platform of poles jutting out of the clefts of the rocks overhanging the river with two or three short planks to stand upon. There are numbers of each in the rocky places of the Fraser River cañons for about 20 miles above Yale (I have not observed them anywhere else either on Vancouver Island or British Columbia). They certainly are very light and picturesque to look at, but for anyone but the most skilled to stand upon, most dangerous. An Indian will stand in the hot sun with only a shirt and pair of pants all day, over the boiling and wirling [sic] eddies below him intent on looking into the water, with his long pole and net ready to plunge it into the water, and bring up a heavy struggling salmon perhaps weighing 20 lbs. He skillfully lands the fish at his feet, strikes it a blow on the head, then puts his forefinger into its gills and dexterously throws it to his wife or family who are on the watch near at hand and at once proceed to gut it. Then they split it with many others on a light frame work of poles beneath which a fire is kept burning and what with the smoke and sun together they are thoroughly dried and seasoned and rendered fit for storing... Some of the salmon cured in that way are excellent eating. I enquired [sic] of an Indian whether any of those who fished from those light temporary looking structures over the river were ever lost. He informed me that two had been drowned during the late salmon season. Should an Indian happen to fall in there is not the faintest hope of his ever reaching land alive... Salmon in ascending a rapid river like the Fraser require to stop and rest in these eddies before making a spring for higher water, as the water is no where level in these cañons. Then is the Indians [sic] opportunity to catch them in his net (BC Provincial Archives MS2443 box 1 file 13).*

People stopped building and using fishing scaffolds around the 1960s (Kennedy and Bouchard 1992). I have found no reason for the abandonment of fishing platforms, but I suspect it may be that people now travel to fishing sites where the fishing is easier.

[1]Text has been edited from the original by adding punctuation and capitalization.

IMPACTS ON FISHING IN THE PLATEAU REGION

As in other parts of North America, there came a time when settlement of the Plateau region by non-Aboriginal people began. "First contact" between Plateau peoples and non-Natives is generally identified as the meeting in 1808 of Simon Fraser, an explorer for the Northwest Company, as he descended the river now named after him.

Fort Kamloops was built in 1811 and the Plateau peoples were drawn into the fur trade. Dried salmon became a commodity of trade. It was purchased for provisioning post employees, as transporting food to this remote region was very expensive. The Fort Kamloops trade journal of 1822 includes the notation, "Mr. Montigny(?) and 10 men started for Fraser River, he has goods to the Amount of 364 Skins, the principle cause or reason for sending him to procure dried fish for our winter. [illegible] we have nothing else to depend on but dried salmon" (HBCA B.97/a/1 August 26th). Teit (1906) also noted this practice. "Sometimes Hudson Bay Company employees would come as far as Spences Bridge, trading tobacco, ribbons, etc., for furs and dried salmon" (Teit 1900:260). Salmon was sold by the "stick" which was about 100 salmon (Teit 1900). The September 24th inventory for that year reveals a stock of 10,300 dried salmon "in store." (HBCA B.97/a/1 Sept.26th).

The 1858 Cariboo Gold Rush hurried the arrival of Europeans into the B.C. interior. An estimated 25-30,000 miners arrived that year (Laforet and York 1998). Almost immediately, salmon fisheries were affected as miners disrupted creeks where salmon spawned in search of gold. In 1858 there was an incident where Aboriginal people attempted to stop miners from disturbing salmon spawning beds (Souther 1993); this event foreshadowed many other confrontations over the next century. In 1860 construction of the Cariboo Wagon Road began, again increasing people's access to the interior.

The Indian Act, first passed in 1876, marked the beginning of legislated control of Canada's Aboriginal people. Native people in the Plateau region would soon feel the effects of legislation by the colonial governments (federal and provincial) on fishing and other activities. The earliest fisheries legislation was the Dominion Fisheries Act in 1878. It made no mention of Indian[4] fishing but restricted the use of nets in fresh water, which related directly to Aboriginal

[4] Indians is used here as the legal term with regards to the Indian Act. Any Aboriginal person not defined as an "Indian" under the Act could not, in effect, participate legally in the fisheries.

fishing practices (Ware 1978:20). The practice of bartering or selling salmon was not acknowledged in this legislation. That year, the Indian Reserve Commission under Gilbert Malcolm Sproat, began setting aside reserve lands in the Plateau region. Already at this early date, there were tensions over the land as settlers and miners had taken much. When reserves were surveyed, some fishing sites were identified and set aside as reserve lands in recognition of the importance of fishing in the region. In some instances, the reserve commissioner noted an "exclusive right" to fish for salmon in certain areas along the rivers (Harris 1998).

The following decade, Aboriginal people were specifically restricted from selling salmon by the British Columbia Fishing Regulations Act. The salmon run of 1886 was particularly small and with 6,000 commercial fishermen already on the Fraser River, competition for the fish was fierce (Newell 1997). In 1886, new fisheries regulations were enacted which restricted aboriginal peoples' access to fish (Newell 1997; Ware 1978).

At the turn of the century, a number of canning and fishing enterprises owned by Euro-Canadians were operating along the British Columbia coast. These owners actively lobbied government to restrict fishing by Aboriginal peoples as they were in direct competition for the same fish stocks. As a result, Native people throughout the province found themselves requiring "special" permission to fish by 1894. By 1910 the Fishing Regulations Act limited Aboriginal fishing to specific areas and times. In addition, it defined legal fishing gear based on Euro-Canadian models (Newell 1997).

Two railway lines were built along the Fraser to Lytton then along the Thompson River as far as Oregon Jack Creek. The Canadian Pacific Railway was completed in 1885 and the Canadian Northern Railway in 1915. Rock slides caused by railway construction in 1913-1914 disrupted the salmon runs (Newell 1995). Laforet and York (1998) described the events.

> *In 1913 a slide of rock and debris caused by CNR construction blocked the Fraser River, stopping the upriver passage of sockeye, and in February 1914 a slide at Hell's Gate compounded the already serious damage. Because it was the very populous 'fourth-year' run, the implications for succeeding runs were serious (p.100).*

While some of the devastation to the fisheries was ecological, there was also political fallout for the Aboriginal people. According to Souther (1993)

> *When the magnitude of the Hell's Gate disaster was acknowledged by officials in 1914, it was the Natives who again bore the brunt of restrictions, in the name of conservation. Traditional methods of fishing with dipnets and sidenets were banned and officials attempted to prohibit all fishing between Hope and Lytton (p.11).*

Chiefs and community members protested to government representatives and sent letters to the editor protesting fishing closures, demanding the restoration of fishing or, at least, compensation (Laforet and York 1998: 100). Testimonies at the McKenna-McBride Commission hearings in 1914 and 1915 often included complaints about disruption to fishing. In 1915 the Chief Inspector of B.C. fisheries stated that Aboriginal food fisheries had to be limited further as their effect on the commercial fishery was too profound. In 1922 the permit system was established whereby Aboriginal people had to apply for a permit to catch salmon for personal consumption (Newell 1997; Souther 1993). From that point on, B.C.'s Aboriginal peoples barely held on to their fishing rights, and were constantly at the mercy of government legislation, which openly supported commercial fisheries[5].

Disruptions and limitations to Aboriginal fishing have continued through the twentieth century. Legislation, guardian patrols, and outright intimidation of Aboriginal fishermen created a tension-filled environment that became part of the summer news of British Columbia, along with forest fires and tourist reports. While Pacific coast salmon provided a lucrative income for those involved in the commercial sector, the opportunity for Aboriginal people to fish for their own purposes was often curtailed or severely restricted. During the second half of the nineteenth century, a continuing history of protests, arrests, confiscation, and confrontation marred Aboriginal fisheries.

> *Nowhere was the issue of the Indian fishery more pressing than on the all-important Fraser River where over half the B.C. Indian food-permit salmon was caught. New fisheries regulations for British Columbia for the 1967 season*

[5] It is interesting to note that it was during this early turbulent time when most current museum collections of fishing artifacts were created. Fishing implements collected by James Teit, Charles Newcombe and Harlan Smith were acquired between about 1900 to 1920.

> *closed Fraser River fishing from Mission Bridge to Lytton from 3 to 25 July, citing the need to protect the crucial early sockeye run at Stuart Lake. Officers conducted 24-hour patrols, arrested Indians, and confiscated Indian nets – all in the name of fish conservation. But conservation for whom? As Indians were quick to observe, the industrial salmon fishery of the Fraser estuary remained open during this period (Newell, 1993:146).*

In addition to government pressures in the twentieth century, the increased occupation of land along interior rivers disrupted Aboriginal people's access to many fishing sites. Railway lines, highways, roads, and bridges sometimes facilitated access to fishing stations but they also made these places more accessible to everyone. Towns grew up along the Cariboo Highway and logging rapidly became the main industry of the province. Several large mines opened in the Plateau region. Increased industry and over-fishing by the commercial sector resulted in the serious decline of some species of fish, especially Chinook.

In 1977 the Fishing Regulations Act was amended again, requiring Native people to obtain a license rather than a permit. This license specifically stated that fish could not be sold or traded. In 1981 further amendments specified species and quantities of fish that could be harvested. Authors such as Newell (1997) and Harris (1998) provide excellent summaries of the effects of legislation on Aboriginal fishing although their research is not specific to the Plateau region.

In 1978, the Union of B.C. Indian Chiefs commissioned a study of the salmon fishing situation. The resulting document *Five Issues – Five Battlegrounds* (Ware 1978) provides a grim view of the Aboriginal fisheries at that time. Ware writes:

> *Despite the guarantees for Indian fishing [sic], the Fisheries Department is "granted" sweeping powers to abrogate these guarantees and abolish Indian rights. Such conflicts in laws and regulations made arbitrary and discriminatory actions against Indians possible, even likely. A case in point is the destruction of the Nicola fish dams because it was more likely that damage to the Nicola runs was caused by the mill dam erected by white settlers, rather than the Indian techniques which had been used for many generations (1978:28).*

Ware goes on to say that the "discriminatory actions" comprise the sum total of Canada's and B.C.'s approach to Aboriginal fishing. Through all of this, the belief of the Secwepemc, Stl'atl'imx and Nlaka'pamux was that their right to fish was inherent, given to them by their practices and the practices of their ancestors, not by any government.

The Sparrow Decision

In 1982 Ronald Sparrow, a member of the Musqueam Band near Vancouver was charged by Department of Fisheries and Oceans (DFO) for fishing with an oversized net, according to the *Fisheries Act*. The case went to the Supreme Court of Canada and the resulting "*Sparrow* Decision" brought Aboriginal rights to the forefront of Canadian politics and legislation. In the *Sparrow* case, anthropological evidence was used to demonstrate the integral aspect of fishing to the Musqueam way of life. Sanders (1995) summarized the decision:

> *In Sparrow Canada argued that any aboriginal rights to fish had been ended by the comprehensive system of regulation, permits and licences under the Fisheries Act. The Supreme Court of Canada rejected the notion of "extinguishment by regulation". It ruled that extinguishment required legislative measures showing a "clear and plain" intention to extinguish the rights in question. Without such a measure, the Musqueam aboriginal right to fish continued as an existing aboriginal right protected by section 35(1) [of the Canadian Constitution]. .. In managing the fishery in the light of section 35(1), the federal government had to accord Indians a priority over commercial and recreational fisheries (p.17).*

The *Sparrow* decision was celebrated as a victory by Aboriginal peoples throughout Canada but the effects in British Columbia were profound. While many communities were still actively involved in fishing in 1990, the *Sparrow* decision eased some of the tensions surrounding fishing rights and may have re-invigorated Aboriginal fishing practices.

Plateau Fishing Technology

Traditional technology used for catching fish was similar throughout the Plateau region in both Canada and the United States. Hewes (1998) found that, "fishing gear used by the Plateau peoples was remarkably similar throughout the region, probably representing centuries or millennia of exchange in techniques" (622). Indeed, variations of fishing technology can be traced to the environment in which one is fishing (i.e. in a lake, stream, river, etc.) rather than to the cultural group of the user.

Throughout history, tools used were primarily long-handled dip or bag nets, harpoons and spears, leisters (three pronged spears), and gill nets. The construction of fishing gear varied slightly from place to place and not all people used all of the tools available. In aboriginal times, materials for the construction of fishing gear were taken from the environment – plant fibre, wood, bone, and stone. After contact, materials such as iron, steel, cotton, and linen were incorporated into the fishing gear. Today there is a mixture of traditional and contemporary materials.

Dip Net

All Plateau groups make use of the dip net see Figure 2). Romanoff (1992) and Kennedy and Bouchard (1992) distinguish between a set net and a dip net, though most Aboriginal people I encountered refer to either net as a dip net. Both nets are used in areas where salmon hug the bank of the river, taking advantage of eddies or areas where the current is not swift.

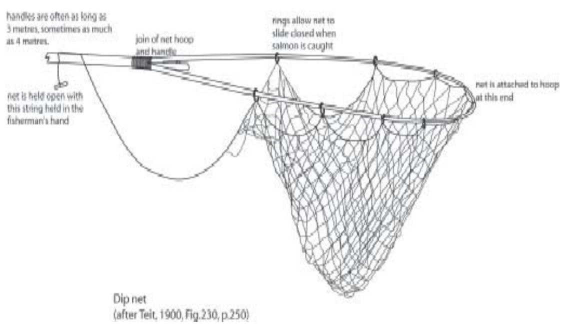

Figure 2. Diagram of the dip net.

The set net is the larger of the hand-held nets and the net is attached to the frame with sliding rings. A cord is attached to the net and held by the fisherman that keeps the net open; when this line is released, the net closes like a purse as it is lifted out of the water. Very often, there is a second person on hand to receive the fish and he or she removes it from the net. While the second person clubs the fish and pulls back its head to bleed it, the fisherman resumes position with his net.

Teit (1900) described Nlaka'pamux dip net fishing techniques and his observations of fishing at the turn of the twentieth century mirror the activities at the turn of the twenty-first century:

> *When he [the fisherman] is sure of a capture, he lets go the piece of stick, when the weight of the fish causes the horn rings to come together, and thus close the mouth of the net. The fisherman then draws the net ashore, pulls the stick, thereby opening the bag, and throws the fish out. It is then put into a rather large circular hole made by scraping away bowlders [sic], which are piled up around the sides, leaving a clear space of pebbles, sand, or gravel in the centre. The bowlders [sic] around the edges form a wall a foot or two high. Near this hole is kept a small stick to be put into the fish's mouth and gills, and to break its neck by pressing the head backward, as well as a short club of wood or stone for striking the fish on the head and killing it when first taken out of the water. (p.250).*

The smaller dip net is fixed and is used in eddies where the water flow is, in effect, reversed thus pushing salmon upstream. Fishermen take advantage of high concentrations of fish in these places, sweeping through the water with a dip net thus catching fish. The fisherman uses a sweeping motion, scooping up a fish and bringing it to shore. There is normally a second person on hand to remove the fish from the net and to club it. I observed this type of fishing at Siska in the summer of 1999. The individuals fishing were using an aluminum fish net purchased commercially, though admitted that the dip nets made traditionally were usually stronger and of better quality.

The CMC collection contains several dip nets but only one (II-C-934) purchased in 1999 is on a frame. The older nets are made with "Indian hemp" (*Apocynum cannabinum*)[6] and are in very good condition (II-C- 640 – dip net from North Bend, ¾" mesh; II-C- 642 – small fish net, collected by Teit; II-C- 643 – net from North Bend, collected by Newcombe; II-C- 639 – net from Ruby Creek, collected by Newcombe). Few people make Indian hemp nets today as it is time consuming and few remember the techniques for making the twine. People mentioned that they knew of old dip nets made with Indian hemp that were still used for fishing. There was general agreement that Indian hemp was superior to modern cotton or nylon twine.

The CMC also has a set of eight net rings made from bone (II-C- 650), collected by Newcombe between 1895 and 1901. Kennedy and Bouchard (1992) mention metal rings used on

[6] also sometimes called milkweed. For information, see Turner (1990), pp. 159-163

contemporary dip nets. The dip net bought for CMC in 1999 has sliced PVC pipe for net rings.

The American Museum of Natural History's collection includes two dip nets attached to a frame but the handles have been cut short. This may have been done to make it easier to transport them; some dip net handles can exceed four metres! The dip nets are 16.1/28 collected by James Teit, c.1905, 89" long; and 16/1024 collected by James Teit, c.1905, 229" long. Both are listed as Nlaka'pamux, having come from the Thompson River.

The Secwepemc used dip nets but not to the same degree as the Nlaka'pamux and Stl'atl'imx. The dip net displayed at the Secwepemc Heritage Museum is similar in size and construction to others described here. The Canadian Museum of Civilization has two nets from Kamloops (II-D-71 and II-D-78), collected by Harlen Smith, 1918. These small nets are without frames; one is described as a dip net and the other as a "triangular net."

Toggle Spear

The toggle spear, also called a harpoon, is a tool traditionally used in places where one could spear the salmon, normally at a weir or other type of barricade. Secwepemc used this tool for fishing from canoes at night. They would light a torch and hold it above the water attracting fish, such as lake trout and Chinook salmon. When the fish came within range, the fisherman would strike at them, hard and fast. Such a tool could be used while fishing through the ice in winter or from rocks in shallow streams. I did not witness this tool being used nor did I hear people speak of using toggle spears any longer.

Toggle spear handles were made of ash that had been seasoned and sometimes burned slightly to give it additional strength. Two prongs were joined with twine so that they would be strong and secure. The toggle spears were made of sharpened antler tips that have been shaped to fit snugly on the end of the prongs. These were secured to the handle with twine. When the fisherman struck a salmon with the toggle spear, its tip would enter the flesh and stay there. Teit described how fish were speared:

> *The spear, which has a handle fifteen feet or more in length, consists of two long prongs, each of which has a barb pointing inward fastened at the end. The spear-head is attached loosely with a line to the handle. When a fish is struck, the barbed points become detached from the spear-head. The fish, with the detached barbed points in its body, is then hauled ashore by means of the line (1900:251).*

The American Museum of Natural History has several toggle spears collected by James Teit. They are all made in the traditional manner, with either bone or metal barbs. Artifact 16/1050 is a two-pronged spear made of wood, bone, string, sinew, rope and pitch; the two tips are attached with a thin Indian hemp rope. The handle has been cut short, probably to facilitate shipping.

Leister

The leister or pronged spear (Figure 3) was traditionally made with a fir handle and bone spear points lashed or attached to the prongs. They were used for fishing trout and steelhead and were made in varying sizes depending on their intended use. Like the spear, the leister was used in places where there was some sort of barricade or where the water was fairly shallow. Visibility is an important factor in using this tool. "When the spear was thrust straight down, hitting the back of the fish, the outer prongs spread slightly apart and then settled in either side of the fish while the centre prong impaled the spine" (Kennedy and Bouchard 1992:287). Spear fishing salmon continues at some river sites (for example Spences Bridge) and in lakes for trout.

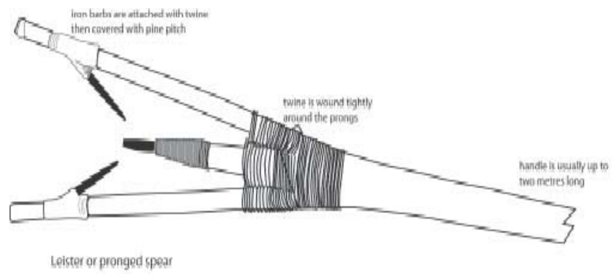

Figure 3. Diagram of the leister (pronged spear)

The American Museum of Natural History collection included several leisters. Artifact16/9325 is a Secwepemc fish spear, 40" long; one of its outside prongs is missing. Artifact 16/9324 is also a Secwepemc fish spear, the handle of which appears to have been broken. According to the artifact record, it was originally 55" long. It has metal barbs replacing the traditional bone. These may have been made with cut nails or other small pieces of metal. This type of leister is called a *mineep* (various spellings). Since the 1930s, the Secwepemc have used pitchforks for making *mineeps*; these leisters are used today and their production has become a unique Secwepemc craft. I purchased a pitchfork leister for the CMC collection in 1999 though this example is a model rather than a functioning tool and the handle is shorter than it would be normally.

An unusual example of a Stl'atl'imx fish spear is one with a detachable head (16/5951). It is 91" long. It is made of wood and Indian hemp twine with metal barbs. The artifact information at the AMNH is not detailed and other authors have not discussed this type of fishing tool.The one Nlaka'pamux fish spear (16/1049) is 52" long and is made with bone points. I have not examined the AMNH collection first hand. Therefore, it is difficult to determine if the objects were made specifically for the museum or whether they had been used in actual fishing activities. One Secwepemc mineep exhibited in the Kamloops museum is in very good condition and had obviously been used for fishing. The handle had been burned off but as it is a found object, there is no way to know if it had been discarded or lost.

Gaff

According to Teit (1906), gaff hooks were not used much before the availability of iron. A variation of the gaff hook was made using bone but it was not as strong as its iron counterpart. The gaff is made from a piece of iron that has been bent and sharpened. It is lashed on to a fir sapling handle that has been well seasoned so that it is not heavy. Historically, lashing would have been made of Indian hemp twine but today baling wire is commonly used. The handle may also be scorched or slightly burnt which makes the wood stronger.

People required specific conditions in order to fish with a gaff. Near Deadman's Creek, for example, there is a rocky place that is ideal as a fishing station if the water is not too high. Men stand on the rocks here, holding the gaff in the water. Ideally, a few white rocks are placed on the river bottom to make it is easier to see fish as they swam over the gaff. The gaff may have a handle as long as 3.5 metres. To hold it steady, a man braces it with his shoulders and hands. Strength is needed to keep the gaff steady against the current; in clear water, fish can see the pole and will avoid it if it moves. When a fish arrives and is in an ideal position, the fisherman must quickly step backwards with the gaff still firmly braced. This requires a tremendous amount of skill, experience and strength. The fisherman must continue to step backward until he has hauled the salmon ashore.

Gill nets

The gill net is one artifact in common use today. In the area along the Fraser River around Sawmill Creek, the water is fairly slow moving and calm. Here people can use gill nets and fish from their boats. The people I met were simply "setting" a net that had a lead line and floaters attached. They let out the net, waited a while, then retrieved it; they caught between five and fifteen salmon with each set.

At Bridge River, there is a small bay over which the Narcisse[7] family has stretched several long nylon ropes. These are attached to spikes hammered into the rock. A gill net is attached to one of these ropes and with a series of pulleys, is hauled out into the water. The net has a lead line attached so it sinks. This particular bay attracts salmon as it provides a resting place out of the strong current. The water is turbid so fish are easily caught in the net. Once the net has several salmon in it, it is hauled ashore and the fish removed.

Kennedy and Bouchard (1992) suggest that gill nets were introduced to the Stl'atl'imx after contact and that they were suspended over the river by a pole or cable (1992:285). Teit (1906) mentions gill nets were set in lakes while dip nets were used in rivers. He collected at least two gill nets; one is at the Peabody Harvard Museum (86455) and measures nearly sixty feet long and made of Indian hemp. He collected stone sinkers (86457) and tule floats (86456) as well. A Nlaka'pamux net at the AMNH (16/9126) measures over 32 feet. Aboriginal people tend to purchase commercial nets today and have done so for a long time.

Fish hooks

Fishhooks were not used for salmon fishing. They were used for fishing fresh water species such as suckers, trout, whitefish, and peamouth. Some of the larger fishhooks (such as AMNH16/5966 and 16/5952) are made with metal barbs. The Secwepemc used fishhooks for fishing through the ice. The early examples are made from bone lashed to a piece of wood (AMNH NAE/0124; 16/1028; 16/4834). The CMC has four Nlaka'pamux fishhooks collected by Teit in 1915. Two hooks are made from two small slivers of bone lashed together at about a 70° angle with Indian hemp (II-C-245a and b). Another hook is made from deer bone (II-C-416); the shank and barb are lashed together with sinew. The fourth hook is made from hawthorne barbs lashed together (II-C-245c). Everyone buys commercially made fish hooks today.

[7] Arnie Narcisse is Stl'atl'imx fishes at Bridge River with his family.

Conclusion

It is ironic that despite everything that has impacted on Aboriginal fishing in the Plateau region, a description of fishing on the Fraser River in 1899 would be so similar to observations of fishing in 1999. Fishing remains intrinsic to Interior Salish people's cultural, social and economic lives. Fishing tools collected by James Teit at the turn of the twentieth century are unique now because of the materials used to make them, not for their form and function. Colonial activities and interests have encroached on fishing activity over the last 150 years. Some impacts were brought by commercial interests, who demanded a share of the fish. Immigrant populations and their conflicting use of the land and water impinged upon Aboriginal fishing practices. Perhaps the greatest intrusion was government legislation which attempted to legislate Aboriginal people's right to fish, resulting in years of threat and intimidation. Throughout all this time, Nlaka'pamux, Stl'atl'imx and Secwepemc people held fast to their fishing sites and tools.

It is important for museums to resist the urge to view Aboriginal people in the ethnographic past. Fortunately, in some regions, traditional practices remain despite modern pressures and impediments. This is the situation with Plateau fishing. To develop a current understanding of Plateau fishing technology, it has been necessary to collect artifacts made from modern materials and to photograph current fishing practices. However, descriptions of fishing by people such as Teit and Dally written over one hundred years ago, along with the artifacts and photographs collected, differ little from those I took in 1999.

References

Hayden, B. (Ed.) (1992). A complex culture of the British Columbia Plateau: Traditional Stl'atl'imx resource use. Vancouver: UBC Press.

Harris, C. (1997). The resettlement of British Columbia: Essays on Colonialism and Geographical Change. Vancouver: UBC Press.

Harris, D. (1998). The legal capture of British Columbia's fisheries: a study of law and colonialism. unpublished LL.M. thesis. Vancouver: University of British Columbia.

Hewes, G.W. (1998). Fishing. In Walker, D. E. (Ed.) Handbook of North American Indians, Volume 12: Plateau. pp.620-640. Washington, DC: Smithsonian Institution

Ignace, M.B. (1998). Shuswap. In Walker, D. E. (Ed.) Handbook of North American Indians, Volume 12: Plateau. pp.203-219. Washington, DC: Smithsonian Institution.

Kennedy, D.I.D. and Bouchard, R.T. (1992). Stl'atl'imx (Fraser River Lillooet) Fishing. In Hayden, B. (Ed.) 1992. A complex culture of the British Columbia Plateau: Traditional Stl'atl'imx resource use. pp.265-354 Vancouver: UBC Press.

Kennedy, D. and Bouchard, R.T. (1998) Lillooet. In Walker, D.E. (Ed.) Handbook of North American Indians, Volume 12: Plateau. pp.174-190. Washington, DC: Smithsonian Institution.

Laforet, A. and York, A.(1998). Spuzzum: Fraser Canyon Histories, 1808-1939. Vancouver: UBC Press.

Lohse, E.S. and Sprague, R. (1998) History of Research. Pp.8-28 in Handbook of North American Indians, Volume 12: Plateau. Washington, DC: Smithsonian Institution.

Mulligan, V. (1988). We are the Shuswap: Teacher's guide. Kamloops, B.C.: Secwepemc Cultural Education Society.

Newell, D. (1997). Tangled webs of history: Indians and the law in Canada's Pacific coast fisheries. Toronto: University of Toronto Press.

Pinkerton, E. and Weintstein, M. (1995). Fisheries that work: Sustainability through community-based management. Vancouver: The David Suzuki Foundation.

Pokotylo, D.L. and Mitchell, D. (1998). Prehistory of the northern Plateau. In Walker, D. E. (Ed.) Handbook of North American Indians, Volume 12: Plateau. pp.81-102. Washington, DC: Smithsonian Institution.

Romanoff, S. (1992). Fraser Lillooet salmon fishing. In Hayden, B. (Ed.) 1992. A complex culture of the British Columbia Plateau: Traditional Stl'atl'imx resource use. pp. 222-265. Vancouver: UBC Press.

Sanders, D. (1995). Pre-existing Rights: The Aboriginal peoples of Canada.

Souther, B. (1993). Aboriginal rights and public policy: Historical review and an analysis of the Aboriginal Fishing Strategy. Unpublished Master's thesis. Vancouver: Simon Fraser University.

Teit, J. (1900). The Thompson Indians of B.C. Franz Boas, ed. Memoirs of the American Museum of Natural History 2, Anthropology 1(4); Publications of the Jesup North Pacific Expedition 1(4). New York.

Teit, J. (1906). The Lillooet Indians. Franz Boas, ed. Memoirs of the American Museum of Natural History 4(5); Publications of the Jesup North Pacific Expedition 2(5). New York: G.E. Stechert.

Teit, J. (1909). The Shuswap. Franz Boas, ed. Memoirs of the American Museum of Natural History 4(7), Anthropology 1(4); Publications of the Jesup North Pacific Expedition 2(7). New York.

Turner, N. J., Thompson, L.C., and Thompson, M. T. (1990) Thompson ethnobotony: knowledge and usage of plants by the Thompson Indians of British Columbia. Victoria: Royal British Columbia Museum.

Ware, Reuben (1978). Five issue - Five battlegrounds: An introduction to the history of Indian fishing in British Columbia, 1850-1930. Unpublished manuscript submitted to the Union of British Columbia Indian Chiefs.

Wyatt, D. (1998) Thompson. In Walker, D. E. (Ed.) Handbook of North American Indians, Volume 12: Plateau. pp. 191-202. Washington, DC: Smithsonian Institution.

Questions

Frank Crabbe: How does the night fishing work?

Nicholette Prince: In some of the lakes people fished at night with a lamp. Fish come to the surface, attracted by the lamp. In the 1800s lamps were made of wood and had sharpened nails and barbs. Since the turn of the century, most of them are modified pitchforks and easier to maintain. After the 1930s they became the most typical lights. Some people fish off the bank with them.

Arnie Narcisse: This also takes place in the Thompson River. They use pots in front of the boat. People will drift miles down the river doing this. It is very dangerous.

Nicholette Prince: They have gas light as well. This type of fishing requires skill, it is not something that you do for fun. People develop the skill and become well known for fishing that way. The reason why I wanted to do this research is to find out why people fished the way they did.

KAT (AMERICAN EEL – *ANGUILLA ROSTRATA*) LIFE HISTORY

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LIFECYCLE OF KAT (AMERICAN EEL)

Kat (*Anguilla rostrata)* is a catadromous fish, which means it spends the majority of its life in fresh water prior to spawning in the sea. The actual birthplace of *Kat* is not known but the smallest larvae are found in the Sargasso Sea, east of the Bahamas in the Atlantic Ocean (see Figure 1). There are no documented cases of the presence of mature Kat in this area at this stage of life. It begins its life between January and March as a transparent larva (Figure 2), shaped like a willow leaf. The larvae feed on plankton over the next year, and develop into the transparent, glass eel, while traveling in the Gulf Stream to the North American coast.

In May the glass eel makes it way to fresh water where it slowly develops pigment and becomes known as an elver, and is now about 4 to 7 cm in length. Once in fresh water, they are known as yellow eel, and will be yellow to olive in colour for the next several years. They are carnivorous, feeding at night or on dull days on the bottom on a variety of organisms from snails to small fishes. In the fall, the eels will remain in the river or return to the estuary to over winter, burrowing down in the soft mud.

The winter eel fishery was the most active fishery for Mi'kmaq in the Antigonish area particularly in Antigonish Harbour. This fishery started at the fall freeze up until the spring thaw. During the early spring when fishing through the ice, you would get eel grass caught up on the eel spear. When cleaning the spear, I have noticed small glass eels sticking to the grass. This was my first visual contact with the glass eel during the winter spear fishery. (Prosper, Kerry 2001 Memory).

The yellow eel will remain in the inland water systems anywhere from 7-30 years or until they reach their sexual maturity. At this stage, they begin their seaward migration taking on a bronze to black colour with a silver sheen, thus called silver eels, and return to the [Sargasso] sea to spawn (Eales 1966).

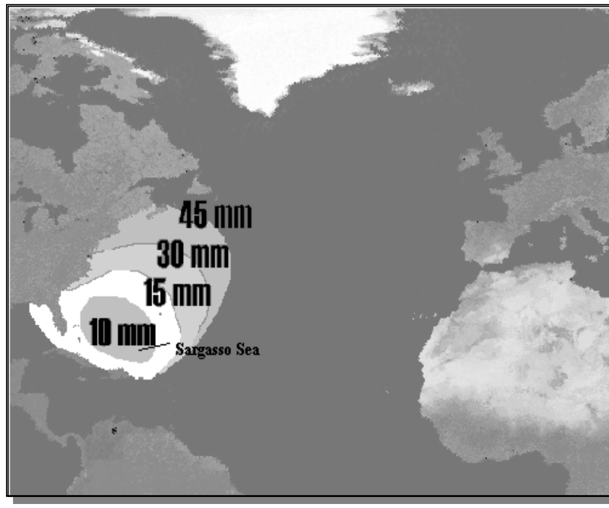

Figure 1: Map of the Sargasso Sea - pointed out here is the area where the smallest American eel larvae are found. The actual spawning area remains a mystery. The numbers represent the larvae's growth as it drifts with the Gulf Stream along the North American Eastern Coast. Available on-line: www.ecoscope.com/eelbase.htm

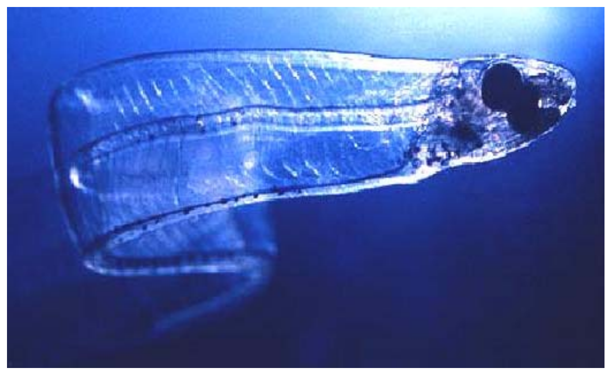

Figure 2. The larva of Kat (*Anguilla rostrata)* as it approaches the North American Eastern Coast from the Sargasso Sea. Available on-line from: www.ecoscope.com/asburyp1.htm

Distribution of American Eel [Kat] Larvae

As indicated in Figure 1, the larva changes in size as it drifts in the Gulf Stream. As it approaches and reaches fresh water it changes shape and appearance. "It is believed that the larvae (leptocephalus stage) undergo both active and passive swimming while in the Gulf Stream. Before the larvae undertake to bridge the roughly 160 kilometer gap from the Gulf Stream to coastal waters, they metamorphosis and are transformed into the glass eel (size range 5—8 cm). The body form now resembles the adult eel in shape but lacks pigmentation. It is better suited to the active swimming required for them to reach the coast." (Hutchison 1981 p. 5)

The Last Journey

The duration of qsow (silver eel's) oceanic travel varies, depending on environmental conditions and its ability to grow. If contamination levels are high, sexual maturity can be delayed or impaired, thus inhibiting growth. Kat (American eel's) potential to lay eggs depends on a length-weight relationship, therefore, its fecundity can range between 0.5 and 4.0 million eggs per female; large females (10,000 mm in length), potentially produce as many as 8.5 million eggs (Facey and Van Den Avyle 1987 in Atlantic States Marine Fisheries Commission 2000).

People often assume the Kat will spawn more than once in its lifetime. This is not true. Kat spawns only once and then dies. Therefore, regardless of when Kat is caught, it is prior to reaching sexual maturity. This will contribute to threats to biological reproduction and abundance.

Migrating Kat have been observed to cover 38 km in 40 hours (Stasko and Rommel 1977). Migration has been suggested to occur within the upper few hundred meters of the water column. However, Robins et al. (1979) photographed two Anguilla eel, believed to be pre-spawn American eel, at depths of about 2,000 m (on the floor of the Atlantic Ocean) in the Bahamas. (Atlantic States Marine Fisheries 2000 p.10).

Pre-Spawning Mortality

There are many possible factors which contribute to the Kat (American Eel's) pre-spawning mortality. These include:

- Chemical contamination of its inland water habitat and oceanic waters;
- Overfishing;
- Lack of policies and management plans;
- *Sargassum* seaweed harvesting;
- Loss of habitat due to deforestation, agricultural practices, obstruction of waterways from dams and causeways;
- Restocking practices of rivers and lakes with fish species that are valued by recreational fishers (ex. Stocking lakes and rivers with trout increases the competition for food amongst various fish species namely the American Eel.);
- Change in ocean climate.

The lack of knowledge of Kat has led to inadequate management of certain areas of the commercial eel fishery. Therefore, decisions are being guided by incomplete scientific research. Kat is a single panmictic population, meaning that it is of one single breeding stock. Offspring from any parents can inhabit any portion of the species range (any river system along the North American east coast). Therefore, absence of basic population dynamics data for American eels has precluded the evaluation of the effects of potentially high exploitation rates on regional stocks and the population as a whole. Also, extrapolation of exploitation rates for numerous regional stocks to an overall exploitation rate for the single panmitic population has not been done.

As with many fisheries the eel fishery has undergone various technological advancements that have increased fishing effort and catches. The commercial fishery brought about the use of motorized boats and electric floodlights instead of the traditional canoe and kerosene lantern. Kat is one of the few fish species that are caught on a year round basis as an elver, yellow and silver eel. Therefore, every living Kat is caught prior to sexual maturity thus contributing to its biological vulnerability and threatening its abundance.

Maritime Eel Landings 1920 - 2000

The location of American Eel fisheries in the maritime provinces in the 1960s is illustrated in Figure 3. Many areas along the Bay of Fundy and the Southern Gulf of Nova Scotia had not yet developed a commercial fishery and the potential was unknown as shown on the map (Eales 1966 p. 47). In recent decades this has changed dramatically. Figure 4 shows the explosion of the commercial eel fishery landings and values for the Maritime provinces in the 1980s and onwards until a sharp crash occurred in the late 1990s. The rise in landings and values was attributed to a new demand from the Asian markets.

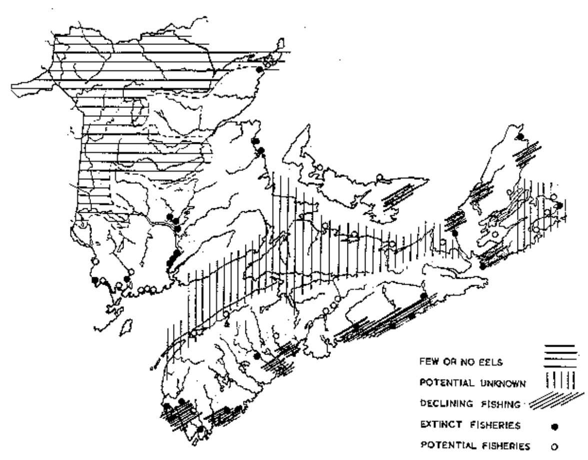

Figure 3: Map illustrating the location of American eel fisheries in the Maritime Provinces in the 1960s.

Figure 4 (overleaf) shows that the Nova Scotia eel fishery was on a moderate scale up to the mid-1960s, with the majority of commercial activity occurring in south shore areas and the upper Southwest Margaree river area. Antigonish, Tatamagouche, Shelburne, Yarmouth and the Cape Breton area were mostly food fisheries, with a small scale peddled fishery (selling of fish to customers in the local area) (Eales, J.G. 1966).

The New Brunswick landings were slightly less than Nova Scotia. The commercial activity occurred mainly in the St. John; Fredericton, St. George, Chatham, Tracadie and Richibucto areas. The peddled and food fishery occurred in Eel River Bridge, Shediac and other areas. (Eales, J.G. 1966).

From 1920 to 1965, the main method of fishing was with spears and eel pots there were approximately 280 people fishing for eels in 1962. Many of the eels were handled by dealers and were shipped and sold to the United States and Europe. The fyke net was introduced approximately from 1961 to 1965 in P.E.I. by the provincial government with their usage spreading to other Maritime Provinces as well. The landings at P.E.I. show a definite increase due to this change of method and increased effort.

Another change in the eel fishery occurred during the mid-1980s with the introduction of spearing eels using electrically powered light (*sasegwa*) for assistance (flamboying). Gas lanterns were now being replaced by high intensity lights and generators. This method of fishing was unlicensed in the Gulf area and continued until 1993. At this point, there was a freeze on all new eel fishing gear types. D.F.O. implemented a licensed eel spear fishery and banned the usage of electronic lights during night time fishing in 1993.

In approximately 1993, N.S. eel landings were on the rise, whereas P.E.I. and N.B. landings were beginning to decline. By 1994-95, N.S. landings then begin to decline to current levels. In the year 2000, N.S. experienced an all time low compared to pre-1965 figures. N.B. and P.E. I. Landings were reduced but only to the average rate compared to pre-1965 figures.

Environmental Indicators

People often view Kat behaviour as similar to Pulămoo (Atlantic Salmon, *Salmo Salar*). Pierre Biard, a Jesuit living in Acadie during the early 1600s describes this misconception:

"...in the middle of September [the Mi'kmaq] withdraw from the sea, beyond the reach of the tide, to the little rivers, where the eels spawn, of which they lay in a supply; they are good and fat" (Biard, Pierre in Thwaites 1896 in Holmes-Whitehead 1991 p.34-36.)

The fact is Kat behaviour is in total contrast to that of Pulămoo. For instance, Pulămoo spawns in the river whereas Kat spawns in the sea. Pulămoo's living environment is the ocean whereas the Kat's is the inland water systems. Pulămoo will spawn more than once in its lifetime whereas Kat will spawn once in the sea and then die.Kat is also noted for accumulating high concentrations of contaminants. Because eels live on the bottom of estuaries, rivers, and lakes, and spend the winter buried in the mud, they are susceptible to poisoning and accumulation of contaminants (PCBs, lead, pesticides) (Haro et al. 2000). They are able to live in areas unsuitable for many other types of fish. For example, studies performed at Kejimkujik National Park have identified highly acidic waters inhabited only by yellow perch and Kat (Parks Canada. Available on-line: parkscanada.pch.gc.ca/parks/nova_scotia/Kejimkujik_np/english/water_e.htm.). With these facts in mind, Kat can be used to tell us about the health of both the oceanic and inland water systems.

We should listen more to the animals...

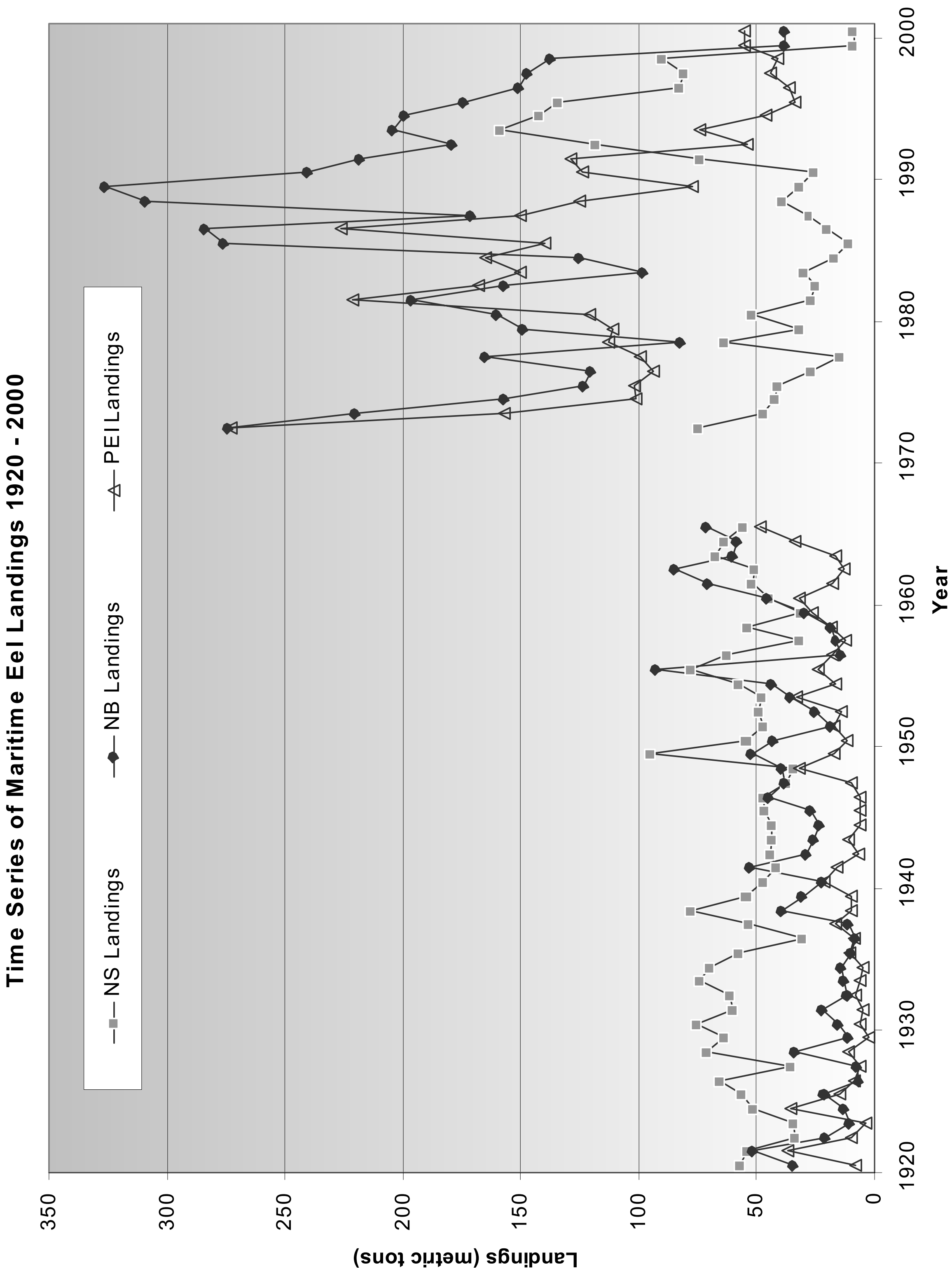

Figure 4. Maritime landings of Kat (American Eel) from 1920 to 2000, based upon Nova Scotia Department of Fisheries. Economic Branch. 1963 and Department of Fisheries and Oceans, Statistics Branch 2000. Available on-line at: www.dfo-mpo.gc.ca/communic/statistics/Historic/landings/1972qe.htm. The lack of data between 1965 and 1975 is due to catches being unreported. Legend: NS = Nova Scotia, NB = New Brunswick, PEI =

The Mi'kmaq Relationship With Kat

The Mi'kmaq people share cultural bonds with many inanimate and animate objects including Kat (the American eel). Animate objects are anything classified as living such as animals, plants, trees, and so on. Inanimate objects are classified as non-living such as hunting tools, decorative items, certain places, etc. The Mi'kmaq believe each animate and inanimate object possesses a *manitou* (spirit).

This belief led to the creation of many cultural bonds between the Mi'kmaq and inanimate and animate objects. Kat is considered one of these spiritual beings. As with many spiritual beings, Kat also serves as an important food source, a medicinal ingredient, and a ceremonial object. It is also believed to be the *Jipijka'maq* (the Great Horned Serpent). This spiritual being is referred to in many Mi'kmaq legends. To understand the diversity of the relationship between the Mi'kmaq and Kat, one must first consider the Mi'kmaq view and its connection to the environment as a whole.

The Mi'kmaq View

The Mi'kmaq believe *Kji-Niskam* (a Great Spirit) created all things in nature equally, therefore all creations should be treated with great respect. To ensure a proper balance with the environment, the Mi'kmaq practiced various traditions and customs. Leslie Upton, an historian (1979, p.11) interpreted this belief based upon archival reporting in the eighteenth and nineteenth centuries:

> *...the Micmacs [sic] accorded animals the same esteem they gave each other. They spoke of them as though the animals lived in the same way, each species a separate tribe living in two villages under its own chiefs...It was all one world indivisible.*

The Mi'kmaq believe this equality aspect applied to them as a people "for man was only one part of a totally interdependent system that saw all things, animate and inanimate, in their proper places" (Upton 1979, p.15).

The Mi'kmaq relationship with the environment and all of its components was guided by these beliefs. Various rituals were performed to give thanks to the spirits that the Mi'kmaq believed were responsible for their overall well-being. These rituals were practiced everyday, throughout the day, and not just on appointed days of recognition. The Mi'kmaq lived with nature and all of its components. As a result, many relationships were developed with both animate and inanimate objects including Kat. This article will highlight some important aspects to display the rich and diverse qualities of this relationship — how it was and how it is today.

Mi'kmaq Uses of Kat

Kat served as an important food source for the Mi'kmaq but its purposes were not restricted to food. It is also considered a multi-purpose item with its usage ranging from medicinal use to a type of binding material.

As a food source, Kat was prepared in many ways. It was sometimes prepared for a stew, baked, smoked and preserved for later use. The Mi'kmaq regarded Kat as:

> *...the favourite catch as it is even today. It mattered not one bit ...whether the meat was cooked or raw, and, if we found we had only tough meat at any time, we would cut and tear it into strips which we would pound on broad flat stones, and thus we were able to chew and swallow it easily.*
> *(Holmes-Whitehead 1991, p.10)*

In preparation for cooking, Kat was usually skinned. The kadaagel (eel skin) when dried would tighten. This tightening ability and its durability further enabled the Mi'kmaq to use the skin for an array of purposes. It was used for bindings for sleds, moccasins, clothing, tying spears and harpoons on sticks, and so on.

Kat was also used for decorative purposes such as the hair string described in the legend Sakklo'pi'k in Ruth Holmes-Whitehead's book Stories From the Six Worlds Micmac Legends. The hair string in this legend is made of "...painted eelskin, porcupine quills and sinews [which] are combined...into a new being—the hair ornament" (Holmes-Whitehead 1988, p.11). This story is about two shy women who wish not to marry any man of the People. Yet, a Chief's son attempts to propose to them but is immediately refused. Along comes a lazy and ugly man who jokingly boasts he could marry one of the women. Later, the ugly and lazy man is walking in the woods and meets up with an old woman. This old woman's hair "is fastened up with many beautiful sakklo'pi'k, many wonderful ornamented hair-strings which tie up her hair and then trail their ends down over her shoulders, all the way down to her feet" (Holems-Whitehead 1988, p.84). The old woman informs the lazy and ugly man she is aware of his wish to marry one of the two shy women and offers her assistance to him. He accepts her assistance. The old woman then removes one of the sakklo'pi'k from her hair and hands it to him saying:

> *Take this. Carry it in your pouch, your medicine pouch. Carry it for awhile, then watch out for a time to get close to her, and throw this sakklo'ipi upon her back. But do not let her see you do this. Do not let her feel you do this. And do not tell anyone else about this at all*
> *(Holmes-Whitehead 1988, p 86).*

The lazy and ugly man agrees to follow her instructions and the next day comes upon one of the women wandering in the woods. He then takes her back to her family. Upon their return, she becomes his wife.

Kadaagel (eel skin) was also used for its medicinal properties. Its tightening ability enabled the Mi'kmaq to use it as a type of brace to relieve sprains. It was also worn next to the skin for relief from cramps, rheumatism, headaches, and lameness (Lacey 1977, p. 40, 56). In addition to the skin, other parts of Kat were also saved and buried until fall. These parts included the heart, liver, heads, and skins. When these parts were recovered in the fall, it was used as bait for trapping various animals (Denny 2002).

Kat also served as a ceremonial object. It was involved in various Mi'kmaq traditions such as the ritual Apuknajit (Feeding of Grandfather). This ritual was performed on January 31st to give thanks to the Spirits for surviving the hardest time of the year:

> *When darkness has settled, food is put out into the night preferably on an old stump or near a tree and offered to the spirits. In days gone by, eel skins and fish heads were offered. An elder would lead the family to a stump, give thanks for surviving thus far and ask for additional assistance until spring*
> *(Marshall 1997).*

Another Mi'kmaq tradition involving eels as a ceremonial offering is also described in *The Legend of Glooscap's Door* by Mi'kmaq author Rita Joe. A portion of this poem is displayed in Box 1. Kat and its involvement in various ceremonies as mentioned earlier demonstrates Kat was more than a tangible object—it was also a sacred being. The Mi'kmaq considered animals as equal in importance to their own existence. Therefore, animals must be treated in a certain manner. For example, a taboo existed on "roasting eels" which was documented by Nicolas Denys in 1672. The fact a taboo exists clearly indicates that Kat possesses spiritual qualities and should be treated with great respect.

Box 1: It is believed among the Mi'kmaq people that in order to have a successful hunt or fishing expedition, one must make an offering to the creator. This offering is referred to as *Pagetunowwedoomkawa'* (Prosper 2001, p.18). A portion of the poem Legend of Glooscap's Door briefly describes eels as *Pagetunowwedoomkawa'*:

> At Cape Dolphin near Big Brads d'Or
> There is a hole through a cliff
> It is Glooscap's door.
> And on the outside a flat stone
> It is his table.
> The Indians on a hunt leave on table
> Tobacco and eels.
> This brings them luck, so the story goes
> The legend lives on
>
> (Joe 1988, p.40).

The Mi'kmaq believe one should not take more than what is needed. *Kji-Keptin* Alec Denny recalls a memory concerning eels as a young boy. He was out spearing eels one day by himself and was eager to catch as much as he could. He caught so many eels that his boat was filled with them. He then came home to brag about his huge catch to his grandfather. His grandfather seeing how many eels he caught asked him: "What are we going to do with them?" There were obviously more eels than they could use. In order for Alec's grandfather to teach him the importance of only taking what was needed, he put Alec through a vigorous training program. Alec's grandfather told him to salt some of the eels and give it to the people during the mission in Chapel Island. He was then told to carefully clean the rest of the eels and to separate the hearts, livers, skins, guts and eel heads into cans. This was a long process and took two days to complete. Once this was done, he was not yet finished. He was then told to put these items into butter tubs his grandfather made him bury them near the river until fall. At this time these tubs were dug up and put into smaller cans and used as bait for trapping various animals. The Mi'kmaq people were careful not to waste anything and to only take what was needed—not to waste and the next time, Alec would be more careful to take only what was needed (Denny 2002).

Kat and Kejimkujik National Park

The Mi'kmaq share a long cultural history with Kat. Petroglyphs in Nova Scotia's Kejimkujik National Park, located in Southwest Nova Scotia, suggest the presence of the water creature Jipijka'maq - the Great Horned Serpent (Whitehead 1990). An example of these petroglyphs is shown in Figure 5.

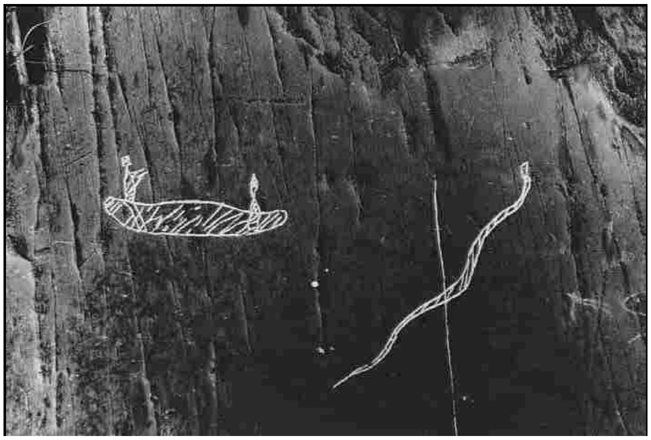

Figure 5. Petroglyphs from Kejimkujik National Park, southwest Nova Scotia. The one on the left portrays a Mi'kmaq man and woman in a canoe in the presence of a serpent.

The Mi'kmaq believe that Kat is Jipijka'maq. There are many similarities between Jipijka'maq and Kat. For example, it is said Jipijka'maq travel "about under the earth in their snake shapes...and sometimes they come up to the Earth World and carve great ruts in the land as they move across it" (Holmes-Whitehead 1988, p.4). In addition, a special distinction is made between snakes and Jipijka'maq. In the legend Miskwekepu'j, the contents of a bag is described as containing both "...snake bones and jipijka'm bones..." (Holmes-Whitehead 1988, p.13). Another similarity exists between Kat and Jipijka'maq behaviour when traveling over land. Kat, when traveling over land, will leave behind it a trail of skimogan (slime). This trail of skimogan enables Kat to reach its destination to the next water source. Each Kat would contribute its slime to this trail and go as far as its slime enabled it to. In turn, the next eel would continue the trail by depositing more slime along the trail. The Jipika'maq on the other hand would carve great ruts in the land as it moved across it. These ruts are referred to as the "track of the serpent people" (Holmes-Whitehead 1988, p.44).

Another connection Kat has to Kejimkujik National Park is the remains of the stone eel weirs located along the various rivers in the park. Traditionally the Mi'kmaq used these weirs to catch eels and other types of fish. The Mi'kmaq had to carefully choose where to construct these weirs due to the great deal of manpower and time that was involved in their construction. Where to construct and when to use the weirs required detailed knowledge of the local area and of various types of fish and their behaviours. Evidence of this type demonstrates the Mi'kmaq relationship to fish and other beings has been in existence for a long time.

Additional weirs have also been located throughout northeastern North America: A Sebaskong Lake Fish Weir dated at 5,100 years old in Maine and the Atherley Narrows site on Lake Simcoe in Ontario, dating around 4500 B.P. A third site—the 4,600 year old Boylston Street Fish Weir, was discovered in the 1950s and covers many acres in the Boston back harbour area (McNab 1998, p. 98).

Traditional Methods of Fishing Kat

The Mi'kmaq traditionally employed various types of tools when fishing Kat. They used stone eel weirs as mentioned earlier and different types of spears. The stone weir required the most labour and time to construct.

"Stone weirs often exhibited a V-shape across the stream, with the point of the V extending either upstream or downstream, depending on the direction of the seasonal migrations. A boxlike bark trap or net bag set in a gap in the weir's fence captured the fish" (Confederacy of Mainland Mi'kmaq and Robert S. Peabody Museum of Archaeology 2001, p.105). The weir sites were occupied by the Mi'kmaq for an extended part of the year. It was at these sites that the Mi'kmaq would "smoke and dry eels for the winter" (Confederacy of Mainland Mi'kmaq and Robert S. Peabody Museum of Archaeology 2001, p.100).

Kat was also fished using spears (Figure 6). There were two different types of spears, a winter and a summer eel spear. Each spear was comprised of bones and wood and was 15-20 feet in length. The winter eel spear had more prongs than the summer eel spear. In the summer, visibility in the water ranged from 4-7 feet and the eel could be caught easier than in the winter. In the winter, fishers would go out on the ice, cut holes and spear for eels (Prosper 2001, p.25). At this time, the eels were in the mud. The winter spear therefore had more prongs placed closer together to enable the fisherman to haul the eel out of the mud.

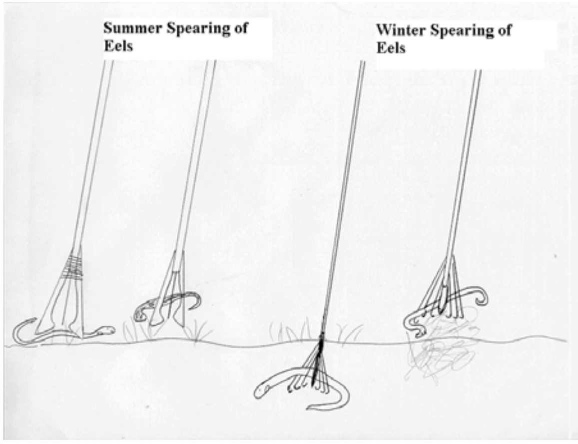

Figure 6: Pictures of the summer and winter spears. Source: Prosper 2001, p.25.

During the 1930s, anthropologist Frederick Johnson traveled throughout several Mi'kmaq communities in his "search of ethnological information" regarding the Mi'kmaq living in the Maritime Provinces (Confederacy of Mainland Mi'kmaq and Robert S. Peabody Museum of Archaeology 2001, p.113). Part of his study also included taking photographs of the Mi'kmaq and their lifestyle.

Overall, the Mi'kmaq and Kat shared a cultural and spiritual relationship within the environment. This relationship provided good health, happiness and long life for all within the environment. Yet, reflecting upon the past practices of the Mi'kmaq indicates to us our relationship with Kat is changing. This changing relationship tells us our environment is now altered. It remains to be seen what Kat can tell us about our environment and the future.
When we look at Kat today and its deteriorating environment we can assume they are suffering due to the high levels of contaminants and loss of habitat. Yet, due to their restrictions as animals, they are unable to verbally inform us of their hardships. On the other hand, the Mi'kmaq people also shared and lived in the same environment as Kat for thousands of years and can express verbally our social and physical problems. Therefore, the Mi'kmaq have become indicators, as has Kat, of the environmental conditions of our ecosystem.

The Paqtnkek Fish and Wildlife Society

The Paqtnkek Fish and Wildlife Society logo (Figure 7) contains the four traditional colours—white, back, red and yellow - each representing the four directions. Its circular shape demonstrates the holistic and collective qualities of the Mi'kmaq nation. Everything and every being within the circle is considered equal. The Great Horned Serpent petroglyph is used as a motif for Kat. According to various Mi'kmaq legends, the Great Horned Serpent's behaviour is similar to that of Kat (American Eel). "*Paqtnkek*" also holds a distinctive definition—"by the bay."

Figure 7. The Paqtnkek logo

Goals

- To promote capacity building within the community in the fields of research and information gathering regarding fish and wildlife.
- To provide information regarding fish and wildlife important to the Mi'kmaq people.
- Develop capacity to co-manage resources important to the Mi'kmaq people. Ex. *Kat* (American Eel).

Social Research for Sustainable Fisheries

SRSF is a partnership linking university researchers and capacity with Mi'kmaq and commercial small boat fisheries community organizations. Although administered at St. Francis Xavier University, SRSF engages and represents a working collaboration between Guysborough county Inshore Fishermen's Association, the Gulf Nova Scotia Bonafide fishermen's Association, the Mi'kmaq Fish and Wildlife Commission—Afton Band, and St.F.X. as well as other university-based social researchers. Additional fisheries and community organizations are linked with SRSF through relations with these core partners.

SRSF is funded by the Social Sciences and Humanities Research Council of Canada (SSHRCC) through its Community-University Research Alliance (CURA). The basic purposes of SRSF are: to develop fisheries-focused social research linkages between university researchers and community organizations, to build social research capacity, and to facilitate specific fisheries social research activities that will examine the concerns of the partnered community organizations. Social research capacity, experience and linkages are developed through research-focused workshops and specific research projects.

Contact: SRSF, St. Francis Xavier University, PO Box 5000, CURA Box 21, Antigonish, Nova Scotia, B2G 2W5, Tel: (902) 867-2292 www.stfx.ca/research/srsf

NOTE

This factsheet contains Mi'kmaq words. These Mi'kmaq words and their English translations used in this factsheet are used in reference to Rand's Dictionary of the Language of the Micmac Indians.

Kat - An eel
Manitou - Spirit
Kji-Niskam - Great Spirit
Kadaagel - Eel skin
sakklo'pi'k - Hair string
Kji-Keptin - Grand Captain of the Mi'kmaq Grand Council
Apuknajit - Feeding of Grandfather
Pagetunowwedoomkawa' - Ceremonial offering of fish
Jipijka'maq - Great Horned Serpent
skimogan - Eel slime
Qsow - Silver eel
Pulămoo - Salmon.
Skimogan - Eel Slime
Sasegwa - Fishing eels with a light

If you are interested in hearing or exploring further some of these words, you can visit the on-line site regarding the Mi'kmaq language at: www.mikmaq.com/new/language/index.html or the Mi'kmaq Online - Mi'gmaq Online Talking Dictionary at www.mikmaqonline.org.

REFERENCES

Atlantic State Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American Eel (*Anguilla rostrata).* Fishery Management Report No. 36 of the Atlantic State Marine Fisheries Commission. Available on-line: http://www.asmfc.org/PUB/FMRS/American%20FMP.pdf.

Confederacy of Mainland Mi'kmaq and the Robert S. Peabody Museum of Archaeology. 2001. *Mikwite'lmanej Mikmaqi'k Let Us Remember The Old Mi'kmaq.* Halifax: Nimbus Publishing Limited.

Deny, Nicolas. 1908. *The Description and Natural History of the Coasts of North America (Acadia)(1672).* New York: Greenwood Press.

Denny, Alec *Kji-Keptin.* March 4, 2002. Personal communication to Mary Jane Paulette.

Environment Canada. Parks Canada. 1994. *Archaeological Sites on the Eel Weir Section of the Mersey River Kejimkujik National Park.*

Department of Fisheries and Oceans. 2000. Available on-line: http://www.dfo-mpo.gc/communic/statistics/stat_e.htm

Eales, J. G. 1966. *A Survey of Eel Fishing in the Maritime Provinces.* Ottawa: Industrial Development Service Department of Fisheries of Canada.

Haro, A., W. Richkus, K. Whalen, A. Hoar, W. Dieter Busch, S. Lary, T. Brush, and D. Dixon. 2000. Population Decline of the American eel: Implications for Research and Management. Fisheries 25(9):7-16.

Holmes-Whitehead, Ruth 1988. *Stories From The Six Worlds Micmac Legends.* Halifax: Nimbus Publishing Limited.

Holmes-Whitehead, Ruth 1991. *The Old Man Told Us.* Halifax: Nimbus Publishing Limited.

Hutchison, Susan. 1981. Upstream Migration of the Glass-eel (Anguilla rostrata) in Nova Scotia. *Manuscript and Technical Report Series Project Report No. 81-02.* Nova Scotia: Estuarine and Inland Fisheries Nova Scotia Department of Fisheries.

Joe, Rita. 1988. *Song of Eskasoni—More Poems of Rita Joe.* Charlottetown: Ragweed Press.

Kils, Uwe. No Date. Glass Eel Photograph [on-line]. Rutger's Institute of Learning and Coastal Sciences. Available on-line from: http://www.ecoscope.com/asburypl.htm.

Kils, Uwe. No Date. Distribution of Eel Larvae by length along the Eastern seaboard of North American [on-line]. Rutger's Institute of Learning and Coastal Sciences. Available on-line from: http://www.ecoscope.com/eelbase.htm.

Lacey, Laurie. 1977. *Micmac Indian Medicine—Traditional Way of Health.* Antigonish: Formac Limited.

Marshall, Murenda. 1997. Values, Customs and Traditions of the Mi'kmaq Nation. *The Mi'kmaq Anthology.* Lawrencetown Beach: Pottersfield Press. 51-63.

McNab, D.T. 1998. *Earth, Water, Air and Fire Studies in Canadian Ethnohistory.* Waterloo: Wilfrid Laurier University Press.

Nova Scotia Department of Fisheries, Economics Branch. 1963. *Notes and Statistics on the Eel Fisheries in the Maritime Provinces.* Nova Scotia Department of Fisheries, Economics Branch: Halifax.

Nova Scotia Museum. 2002. *The Mi'kmaq Portraits Collection.* Available on-line: http://museum.gov.ns.ca/mikmaq/mp0005htm

Parks Canada. No Date. *Kejimkujik National Park of Canada.* Available on-line: http://www.parkscanada.pch.gc.ca/parks/nova_scotia/Kejimkujik_np/english/water_e.htm.

Prosper, Kerry. 2001. *The Mi'kmaq and Kat (American Eel).* Antigonish: Social Research for Sustainable Fisheries, St. Francis Xavier University. Available on-line: http://www.stfx.ca/research/srsf/2005b1.htm.

Rand, Silas T. 1888. *Dictionary of the Language of the Micmac Indians who reside in Nova Scotia, New Brunswick, Prince Edward Island, Cape Breton and Newfoundland..* Halifax: Nova Scotia Printing Company.

Robertson, Marion. 1973. *Rock Drawings Of The Micmac Indians.* Halifax: Nova Scotia Museum.

Upton, L.F.S. 1979. *Micmacs and Colonists Indian-White Relations In The Maritimes, 1713-1867.* Vancouver: University of British Colombia Press.

THE BAREFOOT ECOLOGIST'S TOOLBOX

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ABSTRACT

Updating the Fishing Principle:

- Give a person a fish and they are fed for one day;
- Teach a person to fish and they are fed for life;
- Enable a village to fish sustainably and they are fed for generations.

Reaching the end of a fisheries ecology doctorate on Haliotids, I looked around and saw the seas, particularly coastal and tropical seas, full of small (1-50 km^{-2}) stocks. Extremely valuable to local communities in aggregate, Micro-stocks are myriad and complex to study, assess and manage sustainably. It was depressing; how could we ever hope to address the research and management needs of so many small resources. In the 1950s China faced a similar looking national health problem. They responded with barefoot doctors, not top-end surgeons and technocrats, but low cost, generalist, medical practitioners trained to go out and deal with all the basic village ailments.

Micro-stocks need assessment and management at local scales to prevent component stocks suffering the tragedy of the commons. Community based and Territorial Rights based systems will prove essential for sustaining these resources. But who will service the technical needs of all these communities of stakeholders? Certainly not the existing Universities and Government Agencies funded by shrinking central governments!

When the late Dr Philip Slucanowski and I asked ourselves these questions, the only answer was - Barefoot Ecologists. Embodying the spirits of Johannes and Pauly, and equipped with a toolbox borrowed from Walters, barefoot ecologists would be appropriately trained quantitative, ethno-fisheries ecology generalists, with a love for life, and insatiable curiosity. As with China's barefoot doctor campaign, local people trained and equipped to return to local communities will always be far more effective, than visiting foreign experts. Like the famous Hitch-Hiker's Guide to the Galaxy, the Barefoot Ecologist's Toolbox will be a hand-held computer designed to be useful in every situation, as long as the user does not panic! Armed with this thought and a working knowledge of the Walters personal toolbox, Philip and I set out to design the Toolbox.

INTRODUCTION

I started my scientific career working with the Western Australian lobster fishery, a classic large scale fishery as read about in primary texts (Phillips and Brown 1989) with a sustainable yield of >10,000t per annum caught over approximately 1,000 km of coastline. The larvae of western rock lobster (*Panulirus cygnus*, Palinuridae) have been found across the southern Indian Ocean. The adults migrate to the edge of the continental shelf and may march along it for considerable distances.

At this time I was also introduced to the seminal "Words of the Lagoon" (Johannes 1978).

HALIOTID FISHERIES

My next fishery was the Tasmanian abalone (*Haliotis rubra*) fishery. I had already competed unsuccessfully against many of the abalone divers in national spearfishing championships. So naturally I began my studies by talking and diving with them. Then I read the literature and found that abalone larvae remained in the water column for eight to ten days and had a dispersal distance of 60-80km (Tegner and Butler 1985). Size at maturity was assumed to be relatively uniform. The fishery was managed regionally (Prince and Shepherd 1992) with minimum size limits, limited entry and Individually Transferable Quotas (ITQ). But the divers did not ascribe to the scientific dogmas. They described "non-recovery bottom" which did not sustain fishing, local extinctions that were common at scales of hundreds to thousands of metres. I tested the alternative points of view (Prince 1989), and found that the dispersal power of haliotid larvae, juveniles and adults is limited to tens to hundreds of metres (Prince *et al.* 1987, 1988a, McShane *et al.* 1988). Functional units of stock, in the sense of Gulland (1969), have scales of hundreds to thousands of metres rather than the ten to hundreds of kilometers originally inferred. Regional fisheries consist of thousands to tens of thousands of micro-stocks.

If micro-stocks were biologically similar and fishing pressure was distributed evenly so that fishing mortality was similar for each micro-stock, this would have little implication for assessment and management (Fukuda 1973; Garrod 1973). In this case component micro-stocks could be managed in aggregate and regional management should work. However, life is never simple. Maturity is a function of age not size, and growth is extremely variable (Prince 1989, McShane 1991, Nash 1992). Size at maturity varies with water temperature, latitude, exposure of the coastline, and food availability. Juvenile abalone suffer high mortality and remain hidden in the interstitial spaces of reefs, where they are virtually invisible to fishers and researchers (Prince *et al.* 1988). Maturing abalone emerge from cryptic habitats, and join stable adult aggregations which are highly vulnerable to exploitation by divers (Prince 1989). In the most productive areas, abalone mature and emerge to aggregate well above regional size limits. In nearby, less productive areas, "stunted" populations may emerge, whose individuals grow to a much smaller maximum size. As a result regional size limits will protect little, if any, breeding stock on productive beds, while totally protecting the breeding stock of the less productive "stunted" abalone beds from legal fishing.

Regional size limits commonly preserve little breeding stock, because they have been set for 'stunted' stocks, by researchers who for 'logistical reasons' selected relatively sheltered research sites with 'stunted' stocks for their diving programs. In addition, fishing pressure is never applied evenly but is focussed on preferred reefs. The availability of legal size abalone is the overriding priority for divers, but within this constraint, the choice of dive site is honed by remembered stock density, proximity to port, depth, and predictable sea conditions. On favored reefs, where minimum size limits have preserved little breeding stock, recruitment collapse is common.

Non-Recovery Bottom

The early fishery targeted reefs with the highest density of the largest abalone and recorded extraordinary landings. These large catches only lasted several years, sometimes several dives, before the original biomass was exhausted. After that, these areas provided a much lower catch for five to ten years, until the single generation of pre-fishery recruitment was exhausted. Catches from these areas then collapsed entirely, often into local extinction. Divers label this phenomena 'non-recovery bottom'.

Figure 1 (in Appendix 1) is a map of Cape Leeuwin, Western Australia, prepared with the help of one of the first abalone divers in the area. The original size of the abalone is mapped, which is indicative of the original size of maturity. The regional size limit (Figure 2, Appendix 1) had been set too small: while 70-90% of the breeding biomass was protected on the "small" reefs, and moderate levels (<30%) were protected in the "small to average" sized areas, the "average", "average to large" and "large" growing reefs could be legally stripped, provided a diver had sufficient quota. As the quota is allocated over a 700km stretch of coastline (Figure 2, Appendix 1), it is almost never limiting at the scale of these micro-stocks. With some intuitive understanding of abalone, the local divers, at first maintained a voluntary minimum size limit considerably above the legal minimum. Their voluntary size limit preserved 50% of breeding stock on the "average to large" reefs and limited the extent of "non-recovery bottom". This agreement stabilized catches around 30t/year during the early 1980s. However when a single 'bad egg' broke the voluntary agreement and began using the legal size limit, a short-lived competitive gold rush followed, substantially reducing breeding stocks. By the early 1990s only "small", and "small to average" size of maturity areas were producing; production had fallen to 7 t per annum.

The Tyranny of Scale

In haliotid fisheries, management, monitoring and assessment occur at spatial scales several orders of magnitude larger than the scale of functional units of stock (Figure 2, Appendix 1). The prompt application of regional size limits, limited entry, and ITQs in Australia and New Zealand effectively controlled development and stabilized the fishery (Prince and Shepherd 1992). But despite the superficial appearance of stability the "tragedy of the commons" (Hardin 1968) is still occurring for micro-stocks. With regional management, fishing pressure will always focus on micro-stocks closest to port, or in shallow and relatively protected water.

Even when abalone are legal size, divers know they should not strip reefs of breeding stock. But the current management system leaves them thinking; "If I don't do it, the next person will." Serial depletion and local extinctions continue below the scale of management, while pressure upon the remaining productive beds steadily escalates, all within the 'safe keeping' of a regional quota. The "tyranny of scale" prevents otherwise effective management strategies addressing the "tragedy of the commons".

Re-introducing and re-building breeding aggregations restores productivity, but there is no incentive to rehabilitate because there is no secure reward for voluntary long-term behavior.

When the one 'bad egg' in the Cape Leeuwin area (Figure 1, Appendix 1) was jailed, voluntary size limits were restored and implemented, brood stock translocations occurred, and production was rebuilt to >30t by 2001. Such rehabilitation does not normally occur because the organizational capacity required to voluntarily implement a complex of reef by reef size limits, quotas, translocations and closures, is generally beyond competing divers.

Complicating matters further, the tyranny of scale renders stock assessment unreliable (Prince 1989, Prince and Guzmán del Próo. 1993). Catch and effort data is aggregated over many (hundreds to thousands) of micro-stocks. Divers visually check remembered aggregations before deciding to dive, so catch and effort is normally linearly related. Aggregated CPUE trends reflect the choice divers make between dive sites. Higher catch rate areas, have higher densities of abalone because factors deter frequent diving (ie. deeper, exposed coast, far from port). Material factors such as beach price drive CPUE trends by influencing the choice of divers (Prince 1989).

Nevertheless, because research surveys are extraordinarily few, stock assessment processes remain wedded to catch rate data aggregated over hundreds to thousands of micro-stocks. When they exist, surveyed trends are normally aggregated over many micro-stocks, rather than used as indices of the micro-stock surveyed. This occurs because the complimentary catch data can only be collected on the larger scale, and, there are too few surveys to index a significant proportion of micro-stocks. Stock assessments typically interpret trends in an abalone fishery as the slow decline of a large and unproductive original biomass (Prince and Guzmán del Próo. 1993). But there is never sufficient fine scale data to show the reality, which is the combination of the disparate trends from many smaller but productive populations. These biases cause the actual level of depletion, along with the size and productivity of the original resource, to be under-estimated.

Too Much Environment and Not Enough Taxpayers to Pay for it All.

The tyranny of scale is not confined to abalone fisheries, it is observed widely across the world's fisheries. Many benthic invertebrate and tropical reef fisheries have the same intricate small-scale stock structure (Orensanz and Jamieson 1998). At larger scales, many teleost fisheries with multiple spawning stocks, for example the Norwegian (Maurstad and Sundet 1998) and the Nova Scotian cod fishery (Benham and Trippel in press) and Pacific North American salmon fisheries (Walters and Cahoon 1985), to varying degrees are all subject to tyranny of scale effects.

Fed by an explosion of remote spatial positioning technology, understanding of spatial complexity is growing rapidly. But in general thinking about stock structure remains crude. In my experience unrecognized spatial complexity is normally a primary factor when stock assessments fail unexpectedly. But interestingly, Patterson *et al.* (2001) do not even list it amongst the assumptions used to structurally condition models when attempting to estimate uncertainty in assessment and forecasting.

Dispersal and movement are not simple phenomena (Figure 3, Appendix 1). Species and populations maintain a range of differing behaviors (McDowall 2001). Invariably a few individuals move long distances in contrast to the majority behaviour of moving short distances. Over geological and evolutionary time frames, such minority behavior is vital for colonizing new habitat. Without it, the natural processes that create and destroy habitat, such as changes in sea level, would drive species extinct. We have tended to link the scale of functional stocks to the maximum distances moved by a species, the longest tagging movements, or the scale of genetic isolation. But for management purposes, the shorter 'normal' distances moved within one or two seasons, best indicate the scale of functional management units in a fishery.

With this view it becomes clear that the world's fisheries contain a myriad of micro-stocks (Figure 3, Appendix 1). We fisheries ecologists have been high-grading, selectively targeting the biggest chunks of protein (and funding) first. Research and scientific understanding has focussed on the conspicuous offshore industrial scale fisheries (Orensanz and Jamieson 1998).

Unfortunately the technical challenge of managing, monitoring and assessing the earth's fish stocks is proportional to the number of functional units, not their size or value. Likewise, the cost of the required research is not strongly linked to the value of resources, but more clearly related to the number of units involved. Larkin (1997) had a rule of thumb that the cost of research and management cannot sustainably exceed 10-20% of the value of the fishery. But when the annual cost of a single researcher with government overheads approaches $100,000;

what does one do with a fishery full of micro-stocks worth < $500,000/annum?

Reaching the end of my doctorate I looked around and saw coastal and tropical seas full of micro-stocks (1-50 km² in area), which are valuable to local communities in aggregate, but myriad and complex to assess and manage. How could we ever hope to address the needs of so many micro-stocks? We academics in universities and governmental agencies are too few to assess and manage all these micro-marine resources. The role of central government is shrinking, not expanding, as taxpayers demand leaner smaller government. There is simply too much environment, and not enough taxpayers to pay for it all.

With apologies to Aldo Leopold: Relegating conservation to government is like relegating virtue to the Sabbath. It turns over to [so very] few what should be the daily work of [a vast army] of amateurs.

Beyond Centralized Management

In the over-developed countries, fisheries management remains the last great bastion of the Command-Control Theory of government. Management, monitoring and assessment processes are the proper role of centralized governments. Fishers cannot be trusted and must be compelled by legislation to fish sustainably. But when it comes to micro-stocks the emperor has no clothes because centralized governments are incapable of allocating the decentralized resources required.

Take the example of Tasmania, Australia, which has the largest remaining abalone fishery. Despite its complexity the fishery has the financial and social capital required to manage itself. George III Rock, a 360,000 m² reef, produced an annual recruitment of approximately 5,000 abalone, into an adult population of around 25,000 abalone (Prince 1989). Recruitment had probably been higher from a previously larger parental biomass, and could be sustained even with a harvesting rate of 4,000 abalone/year, worth around $AUD150-200,000. After modest installation costs, an accurate annual stock assessment based on fishery independent surveying, would cost < $AUD15,000 per year, within Larkin's rule of thumb for affordable assessment and management. Multiplied up by the probable 10,000 micro-stocks in the fishery, the entire process might cost up to $15-20 million to extend to the entire resource.

In 2000, Tasmania's 125 commercial divers, and more numerous quota holders, paid the Tasmanian Government approximately $AUD16 million in license fees, for a Total Allowable Commercial Catch worth $AUD90-100 million on the beach. Most of the revenue is retained within Consolidated Revenue, approximately $AUD250,000 is spent on their most valuable fishery's research. An uncoordinated research program is left to a single researcher, two technical officers, a 4WD vehicle, and a dinghy. None of the micro-stocks is reliably assessed or managed and it would be politically unacceptable for a government of any persuasion to spend any more money on 'rich abalone divers'.

Centralized priority setting by modern 'small' government will, of necessity, neglect the needs of localized renewable resources in favor of spending revenue on schools, hospitals and the military. Centralized management is structurally unable to meet the challenge of spatially intricate renewable resources.

Abalone Gardens

It was gratifying to attend a recent (August 2001) conference at UBC and see so many agreeing on the need to make more use of the knowledge fishers in fisheries science. But it is time to recognize the full value of their humanity. Fishers are not tools for scientific research, they are the key to local management because they are the local community. Failure to recognize this will continue the de-humanizing processes that depleted our resources.

Sustaining and optimizing haliotid production requires maintaining productive breeding stocks on all abalone reefs. This requires reef by reef size and catch limits, which can only be assessed and implemented by informed and motivated divers. Divers must evolve from marine hunters, who compete amongst themselves, "bringing ruin to all", into marine gardeners, who co-operatively tend and harvest abalone gardens. They must become resource surveyor, assessor, manager and harvester.

Motivated diver behavior is currently the most under-utilised resource in the fishery. The tragedy of the commons socially constrains people so that they act against the long term communal good for short-term personal profit. Hardin (1968) argued that the 'Tragedy of the Commons' does not have a technical solution, rather that it is a social issue requiring society to change and develop new patterns of behavior. As hard as it may be, governments need to change the social constraints causing negative impacts.

With species subject to the tyranny of scale, some form of Territorial User Rights Fishery (TURF) or Customary Marine Tenure (CMT) can provide the motivation and control needed for local communities and individuals to manage local resources (Orensanz and Jamieson 1998). The recent experience of Chile (Castilla *et al.* 1998) and Vanuatu (Johannes 1998a) demonstrates the "learning by doing" approach to management (Walters and Holling 1990) that local communities and individuals adopt when given local resource ownership. We of the over-developed world should be taking more notice of these experiences.

AGENTS OF CHANGE - BAREFOOT ECOLOGISTS

But who will service the technical needs of all those local stakeholder communities managing all those micro-stocks? Certainly not the existing universities and governmental agencies funded by shrinking central governments. Has anybody else noticed something missing in our field? There are experts, researchers and teachers, but where are the practitioners?

In the 1950s, China must have faced a similar-looking national health problem. Medical skills were required in every village throughout the country but there was a critical shortage of trained doctors. China responded with the barefoot doctor campaign – not investing in more expensive surgeons and fully trained doctors, but in low cost, generalist, medicos trained to go out and deal with all the basic village ailments. Before his death in the early 1990s the late Dr Philip Slucanowski and I debated how micro-stocks could be managed sustainably? The only answer we could find was Barefoot Ecologists.

To be practitioners of the field, barefoot ecologists need to be practically orientated, pragmatic integrated generalists – ethno-socio-quantitative fisheries ecologists. They need to be holistically skilled in the multiple disciplines required to work effectively with micro-stocks and diverse fishing communities.

Acting as Agents of Change in local communities, the barefoot ecologist must catalyze change and build social capital within fishing communities. Their role is to motivate and empower fishers and their communities and families, to research, monitor and manage their own local natural resources. The barefoot ecologist supports the development of social structures that foster community based management. The end goal is the development and implementation of long-term community-based monitoring systems applying appropriate technologies, and providing the expertise needed to annually update micro-stock assessments and facilitate dialogue about future management. Working to strengthen endogenous community structures in all situations, the barefoot ecologist is, on the one hand, an expert in data-less management (Johannes 1998b), gleaning local knowledge, reading the literature and recommending sensible 'rule-of-thumb' management. On the other hand, barefoot ecologists also need to be versed in quantitatively based Management Processes, like 'Adaptive Environmental Assessment and Management' (Walters 1986), and 'Back to the Future' (Pitcher *et al.* 1998), which can capture diverse information streams and simulate alternative scenarios for community discussion.

Barefoot ecologists will serve the communities to which they belong, rather than central government agencies, "big science", "science for science's sake", or the "publish or perish" imperative. In return for local loyalty, they will be rewarded with some share of a community's catch. (Here let us note that this type of advisory role is well developed and accepted in the agricultural sector of over-developed countries, but almost non-existent and even frowned upon, in the fishing sector.) It can be difficult at times for barefoot ecologists to maintain scientific objectivity, but it is time to explicitly recognize that everyone can be influenced by vested interests. All vested interests should be highly visible and linked as directly as possible to the long-term productivity of the resource.

None of this is meant to suggest a reduced role for government agencies or academic academies in the field of fisheries science and management. It is a call for clearer thinking about differing but complimentary roles. Government Agencies need to develop legislation that supports the evolution of social systems, like TURF and CMT, which encourage sustainable small-scale behavior. Government also needs to legislate to protect broader "non-fishing" community approved standards, providing for checks and balances, and establishing auditing procedures. Specialized expertise will always be needed to train and equip barefoot ecologists. Research agencies and universities have a continuing role in discovering and publishing scientific knowledge, and developing innovative techniques and tools for practitioners to use.

THE BAREFOOT ECOLOGIST'S TOOLBOX

Barefoot ecologists will need toolboxes. Like the famous Hitch-Hiker's Guide to the Galaxy, the Barefoot Ecologist's Toolbox will be a hand-held computer programmed to be useful in every situation, as long as the user does not panic! It will contain not only all the handbooks of a diverse training, but also the fisheries ecologist's equivalent of Excel, universally used and available software that can do anything, even if most people only use it for the basics.

Anyone watching Carl Walters work will have seen him using his own personal toolbox. His own software developed over decades that is now rapidly adapted to analyze and interpret the dynamics of every resource; from Florida Everglades water balance to western rock lobster sustainable yield. The basic ingredients include:

- Mapping software for mapping stocks and survey designs
- Spreadsheet for capturing and storing long term data sets (catch, effort and surveys)
- Data analysis and assessment models

But the real power of the Walters' toolbox is visualization, both for visual analysis of historic trends, and also for real-time scenario gaming of alternative futures (Walters 1986). It was the potential for unlocking insight and community involvement through visualization that really excited Slucanowski when he met Walters during the 1980s (Prince *et al.* 1991; Sluczanowksi *et al.*. 1992) and that provided our motivation for designing the barefoot ecologists' toolbox.

A MILLENIUM PROJECT PROPOSAL

Un-orchestrated competition amongst researchers for funding and kudos may make for a lively field of scientific endeavor. But it is time our field matured and began to integrate its skills and intellectual property, so that they can be applied efficiently to the obvious needs confronting our globe. If we do not, we risk becoming nothing more than global tourists and neo-ethno-colonialists, squirreling away the information of fishers for the advancement of our own careers. Scattered around the globe, we collectively possess the thinking, course material, field techniques, models and software code needed to begin training and equipping the hundreds of thousands of barefoot ecologists needed by our seas and oceans. It is not a matter of needing more science. It is a matter of corporate application. Working together, each contributing a small part, our global community of fisheries ecologists could look forward to fully equipped barefoot ecologists taking up their practices before the end of the first decade of this new millenium.

REFERENCES

Benham, A.A. and Trippel, E.A. (in press) Mapping Fishermen's knowledge of Groundfish and Herring Spawning and Nursery Areas in the Bay of Fundy, Gulf of Maine and Eastern Nova Scotian Shelf. Fisheries and Oceans Canada, Biological Station, St. Andrew's, New Brunswick, Canada, E5B 2L9.

Castilla, J.C., Manriquez, P., Alvarado, J. *et al.* (1998) Artisanal "Caletas" as units of production and co-managers of benthic invertebrates in Chile. In: *Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management* (Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management, Nanaimo, 6 March – 10 March, 1995). Jamieson, G.S. and Campbell, A. Eds. Canadian Special Publication of Fisheries and Aquatic Sciences 125 pp. 407-413.

Fukuda, Y. (1973) A gap between theory and practice. *Journal Fisheries Research Board of Canada* 30, 1986-1991.

Garrod, D.J. (1973) Management of multiple resources. *Journal Fisheries Research Board of Canada* 30, 1977-1985.

Gulland, J.A. (1969) Manual of methods for fish stock assessment. Part 1. Fish population analysis. *FAO Manual of Fisheries Science* 4, 1-54.

Hardin, G. (1968) The tragedy of the commons. *Science* 162, 1243-1248.

Johannes, R.E. (1978) *Words of the Lagoon: Fishing and Marine Lore in the Palau District of Micronesia.* University of California Press, Berkeley.

Johannes, R.E. (1998a) Government-supported, village based management of marine resources in Vanuatu. Ocean and Coastal Management 40, 165-186.

Johannes, R.E. (1998b) The case for data-less marine resource management: examples from tropical nearshore finfisheries. *Trends in Ecology and Evolution* 13, 243-246.

Larkin, P.A. (1997) The costs of fisheries management information and fisheries research. In: *Developing and Sustaining World Fisheries Resources: the State of Science and Management.* (Proceedings of the Second World Fisheries Congress, Brisbane, July-August, 1996). D.A. Hancock, D.C. Smith, A. Grant and Beumer, J.P. eds. CSIRO Publishing, Melbourne, pp. 713-718.

Maurstad, A. and Sundet, J. H. (1998) The Invisible Cod; Fishermen's and Scientists' Knowledge. In: *Commons in Cold Climate: Reindeer Pastoralism and Coastal Fisheries* (ed. S. Jentoft), Casterton Hall: Parthenon Publishing. pp. 167-185.

McDowall, R.M. (2001) Anadromy and homing: two life-history traits with adaptive synergies in salmonid fishes? *Fish and Fisheries* 2, 78-85.

McShane, P.E. (1991) Exploitation models and catch statistics of the Victorian fishery for abalone *Haliotis rubra*. *Fishery Bulletin* 90, 139-146.

McShane, P.E., K.P. Black and Smith, M.G. (1988) Recruitment processes in *Haliotis rubra* Leach (Mollusca: Gastropoda) and regional hydrodynamics in southeastern Australia imply localized dispersal of larvae. *Journal of Experimental Marine Biology and Ecology* 124, 175-203.

Nash, W.J. (1992) An evaluation of egg-per-recruit analysis as a means of assessing size limits for blacklip abalone (*Haliotis rubra*) in Tasmania, In: *Abalone of the World: Biology, Fisheries and Culture* (Proceedings of the 1st International Symposium on Abalone. La Paz, 21 November-25 November, 1989). S.A. Shepherd, M.J. Tegner, and S.A. Guzmán del Próo eds. Fishing News Books: Blackwell Scientific Publications. Cambridge, pp. 318-338.

Orensanz, J.M. and Jamieson, G.S. (1998) The assessment and management of spatially sturctured stocks: an overview of the North Pacific Symposium on invertebrate stock assessment and management. In: *Proceedings of the*

North Pacific Symposium on Invertebrate Stock Assessment and Management (Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management, Nanaimo, 6 March – 10 March, 1995). Jamieson, G.S. and Campbell, A. eds. Canadian Special Publication of Fisheries and Aquatic Sciences 125 pp. 441-459

Patterson , K. Cook, R. Darby, C. *et al.* (2001) Estimating uncertainty in fish stock assessment and forecasting. *Fish and Fisheries* 2, 125-157.

Phillips, B.F. and Brown, R.S. (1989) The West Australian Rock Lobster Fishery: Research for Management. In: *Marine Invertebrate Fisheries.* (J.F. Caddy ed.) Wiley Interscience Publications. New York. pp. 159-181.

Pitcher. T.J., Haggan, N., Preikshot, D. and Pauly, D. (1998) 'Back to the Future': a method employing ecosystem modeling to maximize the sustainable benefits from fisheries. In:*Ecosystem Approaches for Fisheries Management.* (Proceedings of the 16th Lowell Wakefield Fisheries Symposium AK-SG-99-01). University of Alaska Sea Grant, Fairbanks, Alaska, pp. 447-466.

Prince, J.D. (1989) *The Fisheries Biology of the Tasmanian Stocks of Haliotis rubra.* PhD. thesis, University of Tasmania, 174 pages.

Prince, J.D. and Guzmán del Próo, S.A. (1993) A stock reduction analysis of the Mexican abalone (Haliotid) fishery. *Fisheries Research* 16, 25-49.

Prince, J.D., Sellers T.L., Ford W.B., Talbot, S.R. (1987) Experimental evidence for limited dispersal of haliotid larvae (genus *Haliotis*: Mollusca: Gastropoda). *Journal of Experimental Marine Biology and Ecology* 106, 243-263.

Prince J.D., Sellers T.L., Ford W.B., Talbot, S.R. (1988a) Confirmation of a relationship between the localized abundance of breeding stock and recruitment for *Haliotis rubra* Leach (Mollusca: Gastropoda). *Journal of Experimental Marine Biology and Ecology* 122, 91-104.

Prince, J.D., Sellers, T.L., Ford, W.B., Talbot, S.R. (1988b) Recruitment, growth, mortality and population structure in a southern Australian population of *Haliotis rubra* (genus *Haliotis*; Mollusca : Gastropoda). *Marine Biology* 100, 75-82.

Prince, J.D. and Shepherd S.A. (1992) Australian fisheries for abalone and their management. In: *Abalone of the World: Biology, Fisheries and Culture* (Proceedings of the 1st International Symposium on Abalone. La Paz, 21 November-25 November, 1989). S.A. Shepherd, M.J. Tegner, and S.A. Guzmán del Próo eds. Fishing News Books: Blackwell Scientific Publications. Cambridge, pp. 744.

Prince, J.D., Sluczanowski, P.R., Tonkin, J.R. (1991) *AbaSim: A graphic fishery.* South Australian Department of Fisheries, Adelaide. ISBN 0 7038 1899 3 Software and Manual pp. 34.

Reference: China's Barefoot Doctors

Sluczanowski, P.R.W., Lewis, R.K., Prince, J.D., Tonkin, J. (1992). Interactive graphics computer models for fisheries management. (World Fisheries Congress, Athens, 3 May-8 May 1992).

Tegner, M.J. and Butler, R.A. (1985) Drift-tube study of the dispersal potential of green abalone (*Haliotis fulgens*) larvae in the southern California Bight: implications for recovery of depleted populations. Marine Ecology Progress Series 26, 73-84.

Tegner, M.J. (1989) The California abalone fishery: production, ecological interactions, and prospects for the future. In: *Marine Invertebrate Fisheries.* (J.F. Caddy ed.) Wiley Interscience Publications. New York. pp. 401-420.

Walters, C.J. (1986) *Adaptive Management of Renewable Resources.* Biological Resource Management Series. Macmillan Publishing Company, New York.

Walters, C.J. and Cahoon, P. (1985) Evidence of decreasing spatial diversity in British Columbia salmon stocks. *Canadian Journal of Fisheries and Aquatic Sciences* 42, 1033-1037.

Walters, C.J. and Holling, C.S. (1990) Large-scale management experiments and learning by doing. *Ecology*, 71, 2060-2068.

APPENDIX 1

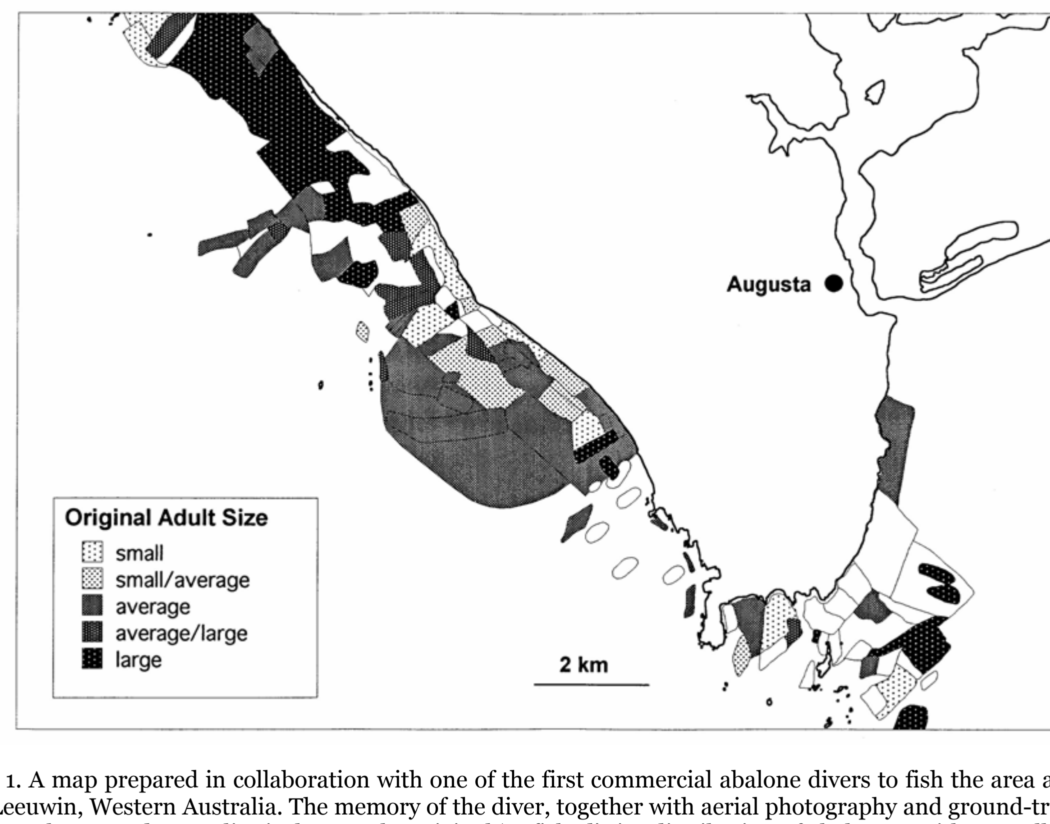

Figure 1. A map prepared in collaboration with one of the first commercial abalone divers to fish the area around Cape Leeuwin, Western Australia. The memory of the diver, together with aerial photography and ground-truthing dives have been used to qualitatively map the original 'unfished' size distribution of abalone as either small, small to average, average, average to large, or large, which is taken to be indicative of the size of maturity

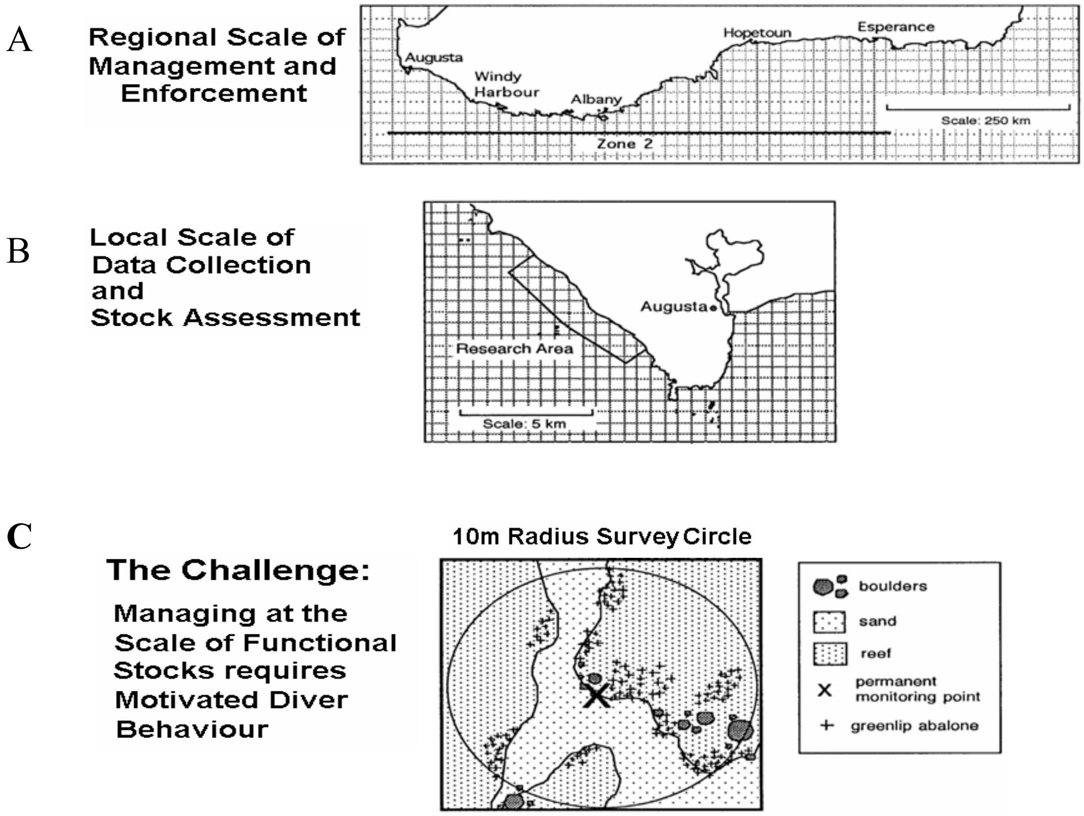

Figure 2: TYRANNY OF SCALE - whereby the mismatch between the scale of assessment and management, and the scale of highly variable functional units of stock, compromises sustainable management by leaving component units of stock subject to the tragedy of the commons

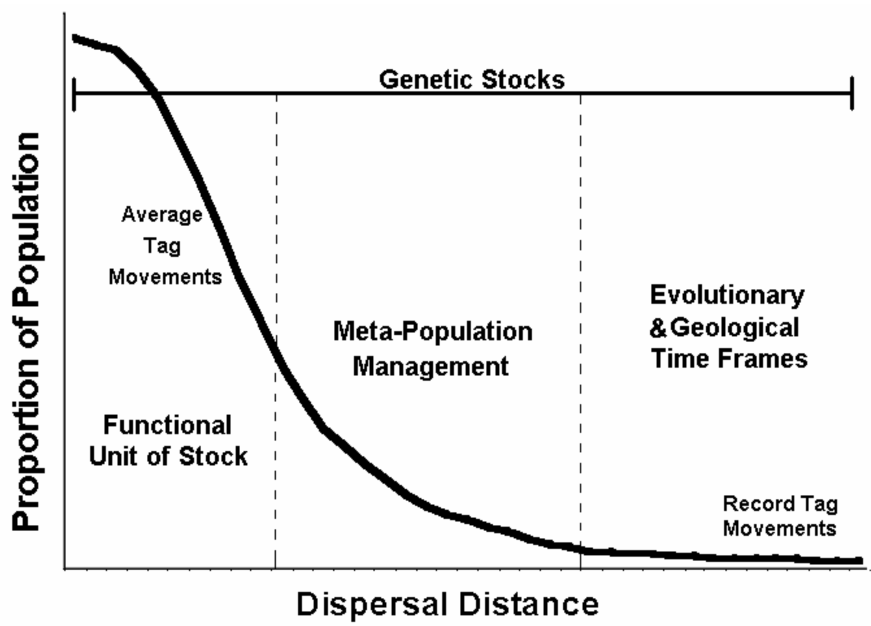

Figure 3. Dispersal and movement are never simple phenomena and should be conceptualized as a distribution curve rather than a mean distance or rate. Long distance dispersal by a few colonialist individuals is important to maintain a species distribution over geological time frames and will determine the size of genetic populations. Much smaller feeding and breeding movements by the majority of individuals determine the scale of functional units of stock for assessment and management purposes

An Example of Conservation and Exploitation Achieved Through a Voluntary Fishery Management System

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Abstract

The Inshore Potting Agreement (IPA) is a voluntary management system conceived by the inshore fishers of south Devon, England. The IPA has functioned effectively since 1978 to reduce conflict between static gear (trap and net) and towed gear (trawl and dredge) fishers. Although there is no legal recognition of the system, the IPA continues to be generally observed by both sectors of the fishing industry.

Fishers from the static and towed gear sectors were interviewed to determine how well the system functioned, what the system achieved, and what factors caused most problems. Fishers were also asked if the IPA could and should evolve further to ensure greater effectiveness and regulatory compliance.

Lessons that may be learned for fishery scientists and managers from the inception and later evolution of the IPA are discussed. In particular, the characteristics of the management system that have enabled the continuation of the inshore fishing industry's traditional practices, despite falling catches in other areas are discussed in the context of the fishers' knowledge that designed them. The general increase in living standards and earning expectations of people in society as a result of this is also discussed.

Introduction

It is widely accepted that fisheries globally are in decline, and the FAO (2000) reports that 72-75% of the world's major fish stocks are over-exploited, fully exploited, rebuilding or depleted. It must therefore be considered that conventional fishery management practices, based on predictive models of stock dynamics and aimed at maximising or optimising fishery output in the long term, have not been working well (Acheson *et al.* 1998; Hofman and Powell 1998; Lauck *et al.* 1998). To prevent further stock failures, it may be beneficial to utilise management systems that were historically successful in local environments. In order that this may be achieved, the preservation, study and use of fishers' traditional ecological knowledge (TEK) may be of vital importance.

TEK is information generated and transmitted over time by people who live and work in a particular location. The development of TEK enables people to survive and prosper in their local environment. Examples of TEK may include an awareness of which crops will grow under local conditions, or where migratory animals will be found at certain times of the year. This information may not be recorded, but will be passed from generation to generation by demonstration and word of mouth (Sillitoe 1998).

The central tenet of TEK research is that the information and techniques gathered and developed by communities should form the basis of their socio-economic development (Chadwick *et al.* 1998). The research agenda is therefore one of learning more about the system and the interactions therein, indigenous users' knowledge and decision making processes, and possible points of intervention (MacKay 1992). The successful extension of developmental programmes will be facilitated if local knowledge and practices are taken into account (Sillitoe 1998).

The present paper focuses on a voluntary fishery management system off the south coast of Devon, England, known as the Inshore Potting Agreement (IPA), that has been the focus of political (Woodlatch and Crean 1998), behavioural (Hart 1998) and biological (Kaiser *et al.* 2000) studies to date. The IPA was conceived and established by fishers to reduce conflict between those that operated static gears (traps and nets) and those that used towed gears (trawls and dredges). At present, there is no legal recognition of the system, though the IPA is generally well observed by fishers from both sectors of the industry, and is an excellent example of a management system that takes account of the social and economic forces that drive the exploitation of living resources. These forces have been identified as factors that should be included in fisheries management if sustainable exploitation is to be achieved (Auster and Shackell 1997; Langton and Haedrich 1997; Charles 1998; Hanna 1998; Murray *et al.* 1999; Knudsen and MacDonald 2000).

The IPA is regarded as a successful fisheries management regime because it has continued to function effectively for several decades. In order to understand the reasons for its success it is necessary to record the historical development of the fisheries within the local area and the technological and biological changes that eventually led to its creation. We have sought to understand the perceived and actual benefits of the system for the fishers whom it affects. Our aims are to identify those features of the IPA that help to make it successful, to highlight those areas that might be improved or are considered to hinder its further improvement, and to characterise those features that may be adopted by fishery managers globally.

History and Background of the IPA

Edible crabs (*Cancer pagurus*) have been harvested from the inshore waters of south Devon, England, for hundreds of years. Fishers from local communities with a strong crab-fishing tradition believe that the crab fishing industry in the British Isles began in villages along the coastline of Start Bay (Fig 1). Static gear fishers that presently operate in Start Bay commonly maintain that they are third or fourth generation crab-fishers, though they also usually state that crab fishing could have a longer tradition within their family. Evidence for this history is available from of the 1891 Census, which indicated that of the 104 men between the ages of 15 and 65 living in the coastal villages of Beeson, Beesands, and Hallsands, 63 (60.6%) listed fishing as their occupation.

Before the expansion and modernisation of the crab fishing industry in south Devon, static gear boats were commonly either launched and retrieved by hand from beaches in front of fishing villages, or operated from deep-water ports. The wooden sailing and rowing boats used were typically five to six metres in length, and fishers worked in crews of two or three per boat, lifting 60-100 traps per day by hand. Traps were constructed to an inkwell design from withy (thin woven willow branches), and were usually laid in strings of up to five below each marker buoy. Willow used for trap construction was cut and then woven in autumn at the end of the main trapping season. The green branches then dried over winter before fishing restarted in the spring. Willow groves, cultivated originally for trap manufacture, can still be seen growing in the vicinity of traditional south Devon fishing villages.

Crab fishing continued in a similar manner until the 1930s, when inboard engines were first employed on inshore boats, and motorised capstans were used on beaches to retrieve boats from the water. The number of traps routinely operated remained small, essentially because the withy traps would disintegrate within one year, thus preventing the number of traps used being added to at the beginning of each season. The boats did not increase in size and continued to be operated either from village beaches or local ports. However, after the Second World War some larger boats operated from ports with motorised capstans, constructed from modified car axles, which were used to haul the pot strings. However, these were not used on the beach boats until the late 1950s because the additional weight made launching and retrieval too difficult.

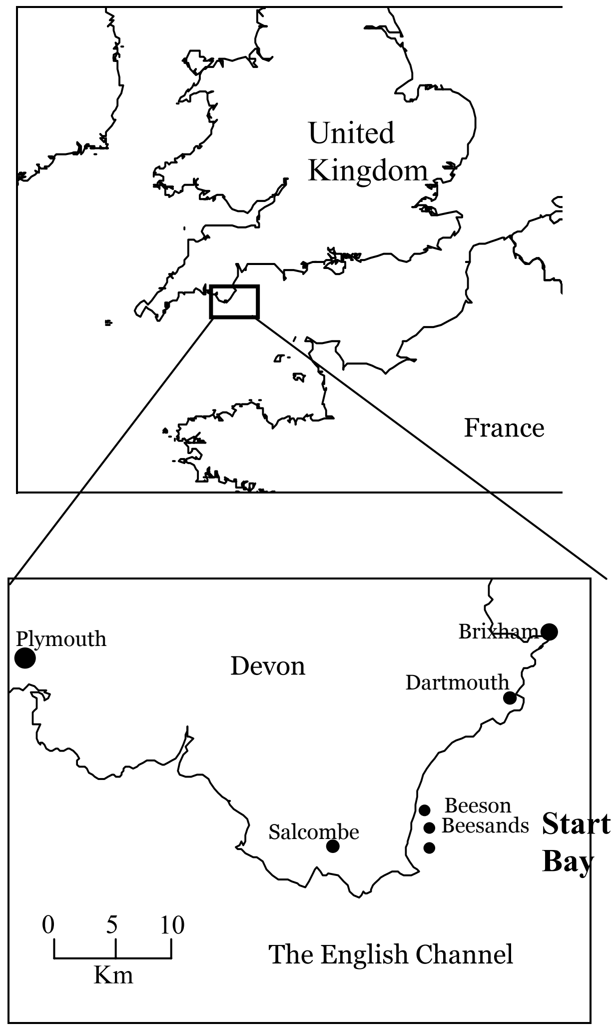

Fig 1: Fishing villages in south Devon.

In the early 1950s, traps began to be constructed from steel wire woven around a cherry-branch frame (hereafter called 'wire' traps). The inkwell design remained essentially unchanged, though these traps were dipped in a mix of tar and creosote to improve their longevity. Wire traps typically lasted from one to two years, allowing each boat to operate up to 200, though a small number of crabbing companies employed trap-makers, thus allowing a greater number of traps to be fished.

After the introduction of larger boats with motorised capstans and net haulers, fishers continued to inhabit the same coastal villages around Start Bay, but by the mid 1960s all the commercial crab boats operated from the nearby ports of Salcombe and Dartmouth. Both towns are within 20km of the crabbing villages, while other ports are only accessible from the Start Bay area via a river ferry or a convoluted journey of at least 35km. Traps assembled from plastic frames and nylon netting were introduced in the early 1970s, and using boats of 10-12 m length, fishers typically operated up to 300 traps in strings of 30 per marker buoy. Developments in the south Devon static gear fishery are summarised in Table 1 (Appendix 1).

The modern crab fishery

In general, the current generation of static gear fishers has continued living in or close to the same traditional Start Bay communities. At present, inshore boats are typically 10-15 m in length, and are operated from deep-water ports by a skipper-owner and one to three crew. Up to 1600 traps are now worked from each boat, although the average number is 6-700 in strings of 40-80. If less than 800 traps are worked in total, all of the traps can be lifted once every two days, leaving every other day free for alternative employment. This work pattern changes during periods of particularly high catches, when fishers will lift their traps daily if weather permits.

The number of traps operated from each boat is no longer limited by the robustness of the trap construction. Modern traps constructed from man-made materials last for many years, if routinely maintained. Many skippers have experimented with more modern soft-eyed creels or parlour traps. Both of these designs feature non-return entries to prevent the escape of animals after entry (Figure.2). Despite this, fishers have commonly continued to use the inkwell design, as they state that these are more efficient than non-return designs on the softer seabed substrates where female (hen) crabs are targeted. In addition, inkwell traps are popular with fishers because unlike square or rectangular designs, they may be rolled across a deck, facilitating the hauling or shooting processes.

The only recent change to the inkwell design is that 'pot-locks' or rubber skirts were added to the funnels of the traps in the early 1990s, making it more difficult for captured animals to escape (Fig.2). Fishers say that before these features were added, crabs would only stay in the traps for as long as bait remained, which was typically three to four days. After this time, the crabs would climb out. Fishers believe that pot-locks or skirts slow the escape process, but state that few crabs will be caught unless traps are checked within seven to eight days of baiting. Lobsters are also generally believed to be able to climb in and out of inkwell traps 'at will', whether pot locks or skirts are used or not.

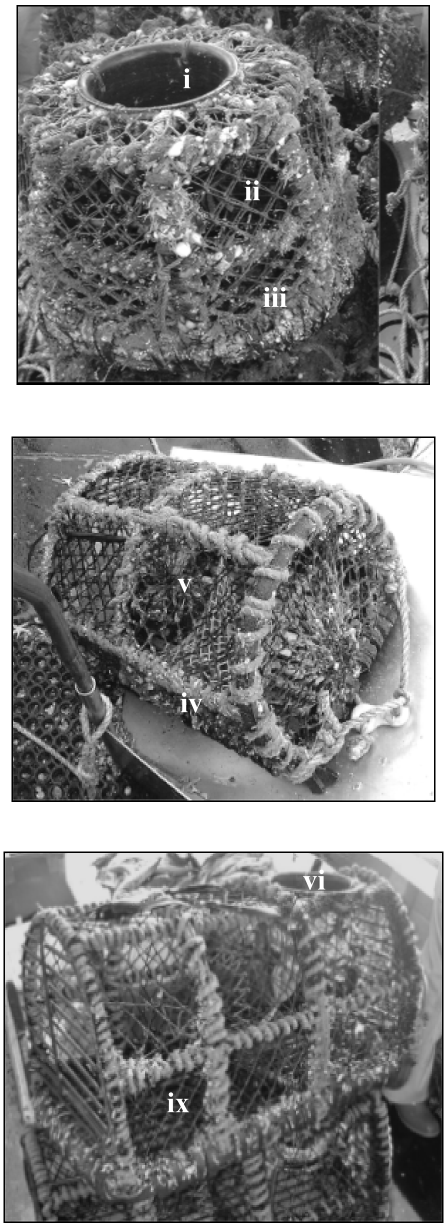

Figure 2: Different trap types used in the IPA. A- Inkwell (diameter 26"). B- Soft-eyed creel (length 36"). C- Parlour (length 42"). i- rigid plastic top entrance, ii- location of rubber skirt used to slow escape of captured animals, iii- heavily weighted base, iv- side entrance, v- soft mesh non-return valve, vi- rigid plastic top entrance, vii- baited chamber, viii- soft mesh non-return valve exit to parlour, ix- parlour chamber.

Conflict within the static sector
Traps were traditionally left in the water to fish over winter, though withy traps tended to rot and disintegrate after this time in the season. However, wire traps were repaired as required, and because of their greater longevity, fishers were able to increase the amount of gear used. This increase created competition for space amongst static gear fishers, such that gear had to be continuously left in favoured sites to prevent other fishers moving their gear to the location. In the IPA system, occupation of an area of the sea (and hence seabed) traditionally signifies the right to fish in that location, but only as long as gear is retained there.

The practice of leaving traps at sea over winter continues today. Space for additional static gear within the IPA is very limited, and fishers wishing to enter the static gear fishery are unable to do so unless they buy second-hand gear already positioned at sea. Vacant sites are also limited because some fishers leave weighted marker buoys in place to discourage other fishers from setting trap strings in unoccupied locations. As territories cannot be expanded, space for additional trap strings may only be created by moving existing strings closer together.

The towed gear sector
Towed bottom-fishing gears including otter trawls, beam trawls and dredges have been used in the inshore waters of south Devon for 5-800 years (Fox 2001). While some towed gear boats were launched from beaches adjacent to villages, the majority operated out of deep-water ports such as Plymouth, Brixham, Dartmouth and Exmouth. Whilst there are now a small number of towed gear fishers based in Salcombe and Dartmouth, the towed and static sectors of south Devon tend to operate from different ports.

Historically, scallop dredging was conducted on a part time basis by static gear fishers, starting at around Christmas time and lasting until the start of the crab-fishing season in April or May, when static gear fishing restarted in earnest. Scallops rather than fish were targeted because the dredges used could be hauled by hand or with hand-operated capstans, while trawling required more specialised equipment. However, the use of towed gear enabled static gear fishers to 'make a living' over the winter when crab catches were low. In the main, this practice stopped in the 1970s when scalloping became less profitable for part-time fishers and trapping became more time intensive.

The inshore towed gear sector now operates boats with dredges, beam trawls and otter trawls. Some boats seasonally use different towed gears to maximise potential earnings, though a local-area byelaw of the Devon Sea Fisheries Committee prevents vessels longer than 15.24m overall operating within six miles of the Devon coastline.

Conflict between sectors
Conflict between the towed and static sectors has long existed within the south Devon inshore fishery. However conflict was uncommon prior to the 1970s simply because towed gears could not be used effectively or safely where trap fishers operated on mixed or rougher ground. Catches were probably sufficient such that there was little need for boats to stray into areas typically fished with other gear types. In addition, static gear fishers used to move gear from one location to another as they followed movements of crabs, which allowed other fishers access to the grounds they vacated.

The potential for conflict between towed gear fishers and static gear fishers has increased through time. As traps became constructed from more durable materials, static gear fishers were able to operate more traps, and leave them in position year-round. The competition for space amongst static gear fishers finally eliminated the traditional pattern of seasonal trap movement in the 1980s, and thus the towed gear sector lost seasonal access to some sites. Most significantly, the development of towed gears such as rockhopper trawls and spring-loaded dredges, in conjunction with higher market prices for scallops and white-fish, meant that it became cost effective for towed gear fishers to target rough ground.

It may seem strange that fishers are unable to avoid each other's gear, but an appreciation is required of the methods of gear deployment if the complexity of the situation and difficulty of finding a solution are to be appreciated. Essentially, while towed gear fishers may attempt to avoid trap strings, static gear loss or damage is almost inevitable when towed and static gears are fished in close proximity. In particular, strong and complex inshore tidal streams make accurate towing difficult, so even when towed-gear fishers are aware of trap positions, interactions with gear can occur. The strong currents also pull marker buoys down-tide and away from the trap strings, or may even submerge them during peak flows, making accurate location of the gear difficult or impossible. In inshore areas trap strings may be tightly packed together, leaving very little room for towed gear use. A further problem in inshore areas is that towed gears must be towed between banks, where static gear may have been positioned to avoid being buried by movement of bottom sediments.

The inshore potting agreement

In the mid-1970s, towed gear fishers expanded the area over which they operated into areas where static gear fishers had previously operated in isolation. Static gear fishers suffered significant losses of traps as a result, which reduced catches and income, and necessitated the extra expense of gear replacement. In response to this, in 1978 the Ministry of Agriculture, Forestry and Fisheries was asked to mediate a meeting between representatives of the static and towed gear sectors, the outcome of which was the Inshore Potting Agreement (IPA). It included areas designated for exclusive static or towed gear use and for seasonal static or towed gear use. The function of the agreement was to maintain the ability of static gear fishers to operate on traditional grounds without the risk of losing gear to the towed sector (Fig.3A).

Subsequent to the creation of the first agreement, fishers suggested a number of modifications. In 1982 a new agreement was established, when temporal and spatial adjustments were made to the design to reduce its complexity, and the diamond-shaped seasonal zone outside the six-mile British territorial limit was removed (Fig.3B). Further spatial and temporal adjustments were made in 1984 in response to requests for access to seasonal resources from towed gear fishers, who gave up seasonal access rights in other areas as compensation (Fig.3C). The current version of the IPA was introduced in 1993, with further minor spatial and temporal changes (Fig.3D). The surface area of the constituent parts of the IPA system from 1978 to present is detailed in Table 1 (Appendix 1).

METHODS

Copies of the 1978, 1982, 1984 and 1993 Inshore Potting Agreements were obtained from the South Devon and Channel Shellfishermens' Association. These were digitised using Arc View V.3.2, and the total area of exclusive use and seasonal access zones were determined using the British National Grid map projection. The areas of zones for seasonal static gear use were calculated as ([total size of each seasonal zone] x [% of the year the zone was allocated for static gear use]). Hence a zone of 50km^2 available for static gear use during six months of the year was calculated as (50 x 0.5) = 25km^{2}y^{-1}.

In order to conduct interviews, towed and static gear fishers of the IPA were approached via their respective fishers' associations, the South Western Fish Producers' Organisation (SWFPO) and the South Devon and Channel Shellfishermens' Association (SDCSA). Meetings were organised to introduce the project to fishers, and interviews were subsequently carried out at sea under normal working conditions. If on analysis, gaps in the data were found, fishers were re-contacted for additional questioning. Neis *et al.* (1999) stated that fisheries researchers can greatly strengthen the quality of data gathered by conducting interviews on the fishing grounds and combining them with observation and follow-up interviews. Interviewing at sea also allowed fishers to provide additional non-elicited information regarding aspects of the fishery that would have been missed had interviews been land based.

The interview process followed a semi-structured system. Each fisher was initially re-informed of the project aims, and what was to be achieved during the day. A series of questions were posed to establish their position in the fishery, including age, experience, number of generations of fishers in their family, and other socio-economic data. These included the value of the boat, types of gears used, number of crew, how much had been caught over previous seasons, where products were sold, and from whom equipment or services were purchased. These questions served to establish each fisher's role within the fishery, and began the questioning process on non-emotive issues.

Finally, more contentious issues were covered, including what services the IPA provided each fisher, whether they felt the IPA served other fishing sectors, and any means by which the IPA could be improved. Fishers were also asked if they had conflict interactions with fishers of other industry sectors, or conflict with fishers of the same sector. By asking these questions last, it was hoped that more responses would be elicited, and that any responses would be more likely to be honest. However, notes were taken earlier in the day if these issues were covered without prompting.

During the course of the project, interviews were conducted with the skippers of nine static gear boats and five inshore towed gear boats. A member of the SDCSA committee and two members of the SWFPO committee were also

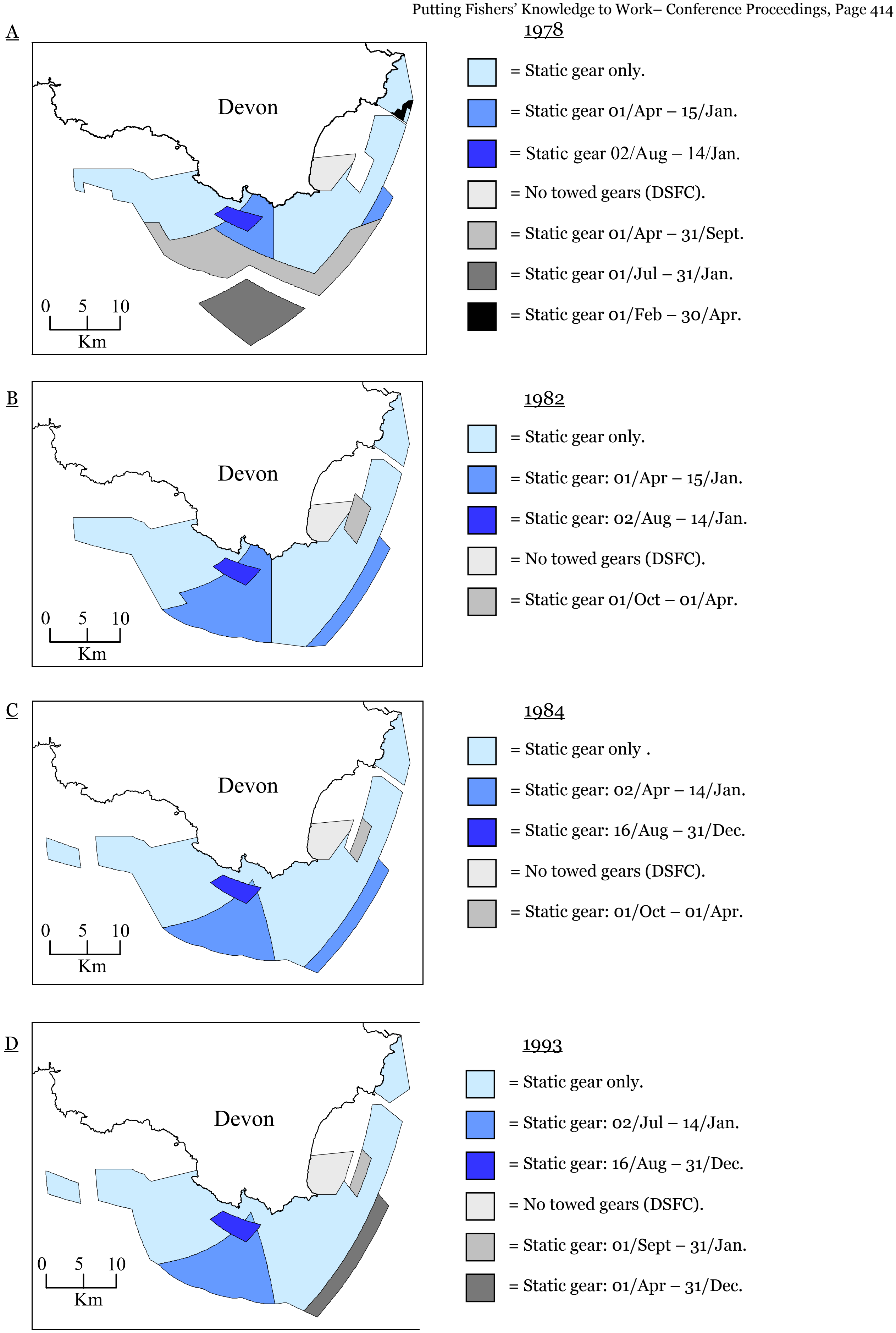

Fig 3: Inshore Potting Agreements for 1978, 1982, 1984 and 1993. 'No towed gears (DSFC)' refers to a Devon Sea Fisheries Committee local area byelaw banning the use of towed gears in Start Bay.

interviewed to determine relevant organisational positions.

RESULTS

Changes to the IPA

The total area of seabed covered by the first Inshore Potting Agreement (1978-1981) was 527.3 km^2. Included in this was a diamond shaped seasonal access zone of 67.7km^2 lying outside the six-mile United Kingdom territorial limit. Then in 1982, the total area covered by the IPA was reduced to 470.7 km^2. The majority of this reduction was due to the removal of the seasonal access zone outside the six-mile territorial limit. Despite this reduction in the total area, the area available for static gear use increased slightly to 444.2km^2y^{-1} as the static gear only area increased in size from 291km^2 to 330.7km^2.

The 1984 the IPA further increased in size to 479.9 km^2, and the amount of ground exclusively available to static gear fishers also increased to 357.1 km^2. The area of seasonally accessible ground was reduced to 90 km^2y^{-1}, continuing the general pattern of increasing exclusive access in exchange for reduced seasonal access for static gear fishers within the IPA.

The current IPA has operated since 1993, and covers 478.4 km^2, with 349.7 km^2 reserved for static gear use and 73.2 km^2y^{-1} retained for seasonal access. The majority of the loss of seasonal access area from 1984 to 1993 resulted from alterations to temporal rather than spatial access to seasonal zones.

Is the IPA a good system?

In response to the question “Is the Inshore Potting Agreement a good system?” all but one of the static gear fishers immediately responded positively (Table 3, Appendix 1). The exception was a fisher with gear positioned on the edge of the system (referred to as an ‘edge’ fisher in Tables 3-, Appendix 1) that stated that the IPA provided no personal benefit. This fisher reported that the IPA did little to stop towed gear fishers from working in static gear only zones, and that he was forced to co-operate with towed gear fishers by occasionally moving trap strings to allow them access to the ground he fished. Other static gear fishers, including those who operated on the interior of the system (i.e. had at least one other fisher’s gear between their gear and any edge of the IPA; ‘interior’ in Tables 3-7, Appendix 1) stated that although they received no personal benefit from the IPA, it had generally protected the ability of the static gear sector to operate. Six of the eight static gear fishers who said the IPA was a good agreement also said that the IPA was not good enough and that more protection should be afforded to the static sector.

Towed gear fishers were divided between those who thought the IPA was a good system, and those who thought it disadvantaged them unfairly. The general difference in opinion was due to some defending the right of the static sector to access fishery resources, while some objected to the overriding principle that static gear fishers had property rights to the ground governed by the IPA. All members of the towed gear sector raised the property rights issue, with particular reference to one static gear fisher who, on retiring, had advertised his boat for sale ‘with gear and ground’. Towed gear fishers objected strongly to the sale of fishing territories.

Gear protection

Almost all members of the static gear sector stated that the IPA afforded a degree of trap protection they would not have in the absence of an agreement (Table 4, Appendix 1). The two static gear fishers who felt that the IPA did not provide protection for their gear stated that, despite the agreement, the towed sector regularly fished in static gear only zones anyway, except in areas in which it was technically too difficult to operate.

Two towed gear fishers agreed that the IPA afforded static gear fishers some protection for their gear. However, other towed gear fishers claimed that the degree of loss that the static gear fishers suffered as a result of the activities of the towed sector was minimal, and was frequently exaggerated in order to create the maximum controversy. One towed gear fisher stated that if the IPA static gear only zones were opened to the towed gear sector, static gear fishers would benefit because any traps lost in the past would be quickly recovered.

There is also a gear protection aspect to the IPA for the towed sector, and in particular for those using otter trawls. Essentially, if traps are snagged while trawling then considerable damage may be done to the belly and cod-end of a trawl net. In this regard, two static gear fishers commented that the IPA benefited the towed sector considerably because the static sector operated only within the limits of the IPA. All towed gear fishers interviewed mentioned protection of trawl gear, but said that the IPA did not provide this service because even without a specific static gear area towed fishers would attempt to avoid trap strings.

Habitat protection

Six of the nine static gear fishers stated that the IPA functioned to protect benthic habitats within the IPA area. This was in contrast to interviewees from the towed sector, in which only one fisher indicated that the IPA functioned in this manner. With the notable exception of one scallop dredge fisher, interviewees from the towed sector generally accepted that towed gears caused damage to the seabed. However, they also said that the IPA did not protect benthic habitats because static gears also damaged the seabed, in particular when ropes are dragged across the seabed during hauling. Static gear fishers commonly considered these factors, but generally thought that the damage caused by static gears would be less significant than the damage caused by towed gears and so stated that the IPA functioned to protect the seabed.

Reserve function

There was almost uniform agreement amongst interviewees that the IPA functioned as a reserve for species targeted by the towed sector. Therefore it was felt that the IPA improved the long-term viability of the local fishing industry. Despite this view, towed gear fishers protested that static gear fishers used anchored gill and trammel nets to catch demersal fish species that could be protected by the existence of the IPA. Fishers from both sectors felt that the potential reserve benefits were therefore lessened.

Intra sector conflict

Most fishers from the static sector commented that they had conflict problems within their own sector, always as a result of competition for space (Table 5, Appendix 1). The majority of these problems were said to have occurred as a result of newcomers entering the fishery, or with vessels that were fishing a large number of traps. The most commonly reported periods for conflict interactions to occur were at the start of the static gear season in spring when additional traps were put out at sea after over-winter repair, and when seasonal zones were reopened after a period of towed gear use. At these times, territory boundaries between fishers were re-established, with the potential for ground to be acquired from neighbours.

Towed gear fishers less commonly stated that they suffered conflict within their own sector, but two commented that they were forced to be secretive when fishing within static gear only zones, in case other fishers noticed where they were working and began to operate in close proximity. Essentially, when towed gear fishers operated within static gear zones by finding vacant sites or by making personal agreements with static gear fishers, they tried to avoid competition from other towed gear fishers, or were worried that static gear damage would result, and their own agreement would suffer.

Inter sector conflict

All of the towed gear fishers interviewed admitted fishing inside the IPA static gear only zones, though accusations of static gear loss were also generally refuted. One scallop dredge fisher acknowledged that he regularly caught traps, but said that he replaced them whenever damage occurred.

A number of static gear fishers who used traps only stated that the use of anchored nets by static gear fishers represented a breach of the IPA. They commented that the IPA was established specifically to protect the right of trap fishers to operate, and that the use of nets was a considerable source of contention in dealings with the towed sector. All static gear fishers who mentioned this issue thought the towed sector would be more likely to respect the IPA if anchored nets were not used inside the limits of the system. Two towed gear fishers also commented that some static gear fishers positioned gear outside the limits of the IPA (Table 6, Appendix 1). One static gear fisher confirmed that some fishers did place traps outside the IPA area, and a number of trap strings from one fisher were consistently found located outside the IPA during the period of the study.

Most static gear fishers commented that they had experienced inter-sector conflict problems. The two exceptions were static gear fishers with territories within the IPA. Despite this, only half the interviewees from the static gear sector felt that towed gear fishers broke the spirit of the agreement by fishing in static gear zones. Three static gear fishers with conflict problems, including one who said he felt the other sector broke the IPA, still confirmed they worked with towed gear fishers to allow them temporary access to the ground over which they worked.

Among those fishers who expressed an opinion with regard to which sector caused most conflict problems, there was almost universal agreement that scallop dredgers were most at fault. The exception was one fisher who stated that he had most problems with anglers, as they frequently snagged ropes or traps while anchoring. Apart from dragging the traps away from their original location (which was said to reduce catches significantly), the interviewee claimed that the gear was almost inevitably cut off rather than untangled, thus making hauling the traps difficult and time consuming.

Can the IPA be improved?

Predictably, most members of the towed gear sector were opposed to any suggestion that static gear fishers should be given more ground (Table 7, Appendix 1). However, only one member of the static sector said this was a means to improve the IPA. There was consensus between respondents from both sectors when additional restrictions were considered for static gear fishers. Suggestions from them included limiting fishers to traps only and banning the use of non-return trap designs. Input controls such as limiting trap numbers according to size and power of the boat, or number of crew, were also mentioned by half the static gear fishers and all but one member of the towed sector. Output controls recommended by static gear fishers included a total allowable catch (TAC) system, a raised minimum landing size for male and female crabs or increased quality standards. However, it was accepted that crab buyers and processors would have to participate fully in any output control system.

Six of the nine members of the static sector interviewed, and one member of the South Western Fish Producers' Organisation (SWFPO) committee recommended that the IPA should be legalised to prevent towed gear fishers operating in static gear zones. All active fishing members of the towed sector rejected legislation however, as they claimed that it would do little or nothing to prevent towed fishers from breaking the IPA. In fact, fishers from both sectors commented that legislation could seriously harm the IPA, as towed fishers respected the agreement only because of its voluntary nature. It was considered that legislative intervention would be counter-productive.

Interviewees from the towed sector most commonly suggested the IPA should be altered by the introduction of corridors through static gear zones, or the implementation of further seasonal access arrangements in existing exclusive static gear zones. The exception was one fisher who operated a small trawler, and regularly towed in pockets of open ground within the static gear only zones. He said he preferred the existing system because he would lose his advantage if larger vessels from the towed sector were to be allowed into restricted zones. The towed gear fishers in favour of greater seasonal access commented that the static fishers commonly abandoned their gear at sea over winter to avoid losing the site to other static gear fishers, but that this prevented towed gear boats from operating in these areas. Essentially, the right of all fishers to go fishing was accepted by every interviewee, but the suggestion that static gear fishers held property rights over territories within the IPA was strongly condemned by every towed fisher. In contrast, one member of the SWFPO committee and one towed gear fisher commented that the area of ground within the IPA was tiny in comparison to the area available to towed fishers that work in the English Channel.

DISCUSSION

Fishery benefits

Fishers perceived the Inshore Potting Agreement to serve a number of functions, primarily the limitation of conflict between the towed and static gear sectors. Although almost all fishers stated that they suffered conflict interactions, it was commonly considered that inter-sector conflict would be worse without the IPA. A typical comment was "It works 90% of the time. It isn't perfect, but whatever is done isn't going to be perfect".

By limiting conflict, it is likely that the IPA has served to protect a large portion of the trap fishing industry of south Devon, and enabled fishers from the static and towed gear sectors to operate effectively and profitably in relative harmony. In comparison, fishers from both sectors described a trap fishery that historically operated in the 'Exeter Roughs', a nearby area to the east of the IPA, which disappeared after scallops (*Pecten maximus*) were discovered there by dredge fishers in the mid 1980s. The substratum was composed of biogenic, coralline reef, but within a short period it was reported that the seabed had been flattened and the trap fishery ended. It was also reported that the scallop fishery had been very short lived, and that there was little sign of a recovery in the substratum, or crab or scallop fisheries.

Scallop dredges are considered to be among the most damaging towed bottom fishing gears (Dayton *et al.* 1995; Collie *et al.* 2000), though the use of other towed gears may also lead to long term changes in benthic community structure (Bradstock and Gordon 1983; Kaiser and Spencer 1996; Collie *et al.* 1997; Jennings and Kaiser 1998; Kaiser *et al.* 1998; Norse and Watling 1999). In this study, even towed gear fishers generally accepted that damage occurred as a result of their fishing activities. However, the argument that the IPA does not protect benthic habitats because static gears also cause damage to the seabed is difficult to support. Studies by Kinnear *et al.* (1996) and Eno *et al.* (1996) indicated that trapping caused little incidental damage to epibenthic fauna. A study by Kaiser *et al.* (2000) also determined that the species diversity within IPA static gear only zones was higher than in seasonal access zones, which in turn was higher than in areas outside the IPA system where towed gear fishers were able to operate year-round. Importantly, biogenic fauna such as soft corals and hydrozoans were also more prevalent in exclusive use areas within the IPA.

Larvae of *Cancer pagurus* tend to be less selective of seabed characteristics at settlement than those of crustacean species of lower fecundity (Robinson and Tully 2000). However, other studies have shown that post-settlement survival of some sub-tidal crustacean species is higher in more complex habitats (e.g. Pile *et al.* 1996; Palma *et al.* 1998; Stevens and Kittaka 1998; Robinson and Tully 2000). Crustaceans are also physically damaged by towed bottom fishing gears (Kaiser et al. 1994; Hill *et al.* 1996; Kaiser and Spencer 1996), and a number of studies determined that crustacean densities decreased with increased towed gear use (Eleftheriou and Robertson 1992; Veale *et al.* 2000). Trap fishers commonly maintained that if towed gears were occasionally worked near but not alongside or over their gear, then catch rates could increase, as crabs were attracted to dead or dying by-caught animals. The rapid attraction of scavenging megafauna, including *C. pagurus*, to dredge tracks has been well documented (Caddy 1973; Kaiser and Spencer 1994). However, trap fishers also stated that it took several months for catch rates to recover if towed gear boats had worked repeatedly around their gear, and concluded that this was because the seabed had been damaged extensively. However, there is no published evidence to support this.

Of the species targeted by towed bottom fishing gears, scallops in particular may benefit from increased benthic heterogeneity within the IPA system. The presence of filamentous flora and fauna was identified as a critical factor that determines spat settlement in the scallop, *Pecten maximus* (Dare and Bannister 1987; Minchin 1992), giant scallop, *Placopecten magellanicus* (Stokesbury and Himmelman 1995) and Iceland scallop, *Chlamys islandica* (Harvey *et al.* 1993). As sessile emergent epifauna are at risk from towed gears (Collie *et al.* 1997; Sainsbury *et al.* 1998; Moran and Stephenson 2000), limits on towed gear use within the IPA may have important implications for spat settlement and later recruitment of adults to nearby fisheries. In addition, spat or undersized scallops may be damaged when in direct contact with towed gears (Caddy 1973; Brand 1980).

Spat may preferentially settle on structures to avoid being smothered by sediment (Brand 1980; Thouzeau 1991; Harvey *et al.* 1993), and high concentrations of suspended silt caused mortality in larvae and spat of different scallop species (Naidu and Scaplen 1979; Stevens 1987). Trawling may be a significant contributing factor to sediment re-suspension in shelf seas (Churchill 1989; Pilskaln *et al.* 1998; Auster and Langton 1999; Hall 1999), and consequently the reduction in sediment re-suspension by trawlers inside the IPA may also benefit scallop recruitment**.** Furthermore, the possibility exists that some commercially important scallop beds are self-seeding, with only occasional spatfalls originating in other areas (Sinclair *et al.* 1985; Darby and Durance 1989; Brand 1991; Young *et al.* 1992). For example, Buestal *et al.* (1979) determined that the scallop (*P. maximus*) spat settlement in the Bay of Saint-Brieuc reflected the status of the local parent stock. Therefore, if a scallop bed is fished to commercial extinction, there may only be limited potential for its resettlement and rejuvenation, and a reserve of mature scallops within the IPA could be vital to the continuation of the local scallop-fishing industry. Moreover, significant increases in scallop biomass have been clearly demonstrated in other closed area systems (e.g. Turner *et al.* 1996; Brocken and Kenchington 1999; Murawski *et al.* 2000).

Most interviewees thought the IPA had functioned to improve the long-term viability of the towed gear sector, though it was almost always in regard of protecting populations of demersal fish species rather than scallops. The possibility that the IPA may act as a reserve for fish species is uncertain. Fishery benefits in areas adjacent to reserves have been demonstrated infrequently, and it has been questioned whether a limited access system of only 480km^2 would protect a population of mobile demersal fish such that any net benefits would result (Horwood 2000). However, much smaller reserves have proved to be beneficial for some relatively sedentary species (Roberts and Hawkins 1997, Roberts *et al.* 2001). Regardless of any benefits of limited towed gear fishing, fish are taken within the IPA system in anchored nets and by recreational anglers. However, most fishers in the towed sector wanted access to the restricted ground within the IPA, and believed that the system protected valuable and scarce target species. For example, fishers reported that unusually large ray (*Raja* spp.) are caught on banks within the IPA by both anglers and commercial netters.

Development of the IPA

The establishment of the IPA, and subsequent changes to its shape and size over time resulted from proposals originating from users of the inshore system. Though fishers were driven to form the IPA, the system has worked effectively. However, the diamond shaped seasonal access zone outside the six-mile United Kingdom territorial limit was less likely to have functioned successfully because there are few access restrictions for fishers from the European Union to waters beyond the six-mile limit. In the absence of statutory protection, or without enforcement of fishery regulations, any part of the IPA that operated outside the six-mile limit could only function with the consent of other fishers within the European Union. This consent would be open to accidental abuse through lack of knowledge of the system, or deliberate abuse. Healthy fish stocks are a collective good, and in most common property situations it is difficult to exclude people from such goods (Jentoft et al. 1998). Hence, without conventional fishery management measures such as the six-mile territorial limit, or power and effort limitations on towed gear use within six miles of the coastline where the bulk of the IPA exists, it is unlikely that the IPA would have survived.

Property rights refer to the entire range of rules, regulations, customs and laws that define rights over appropriation, use and transfer of goods and services (Kula 1992). Acheson *et al.* (1998) and Walters (1998) suggested that property rights must be established before any other fishery management regulation can be successfully applied. Towed gear fishers vehemently opposed an official system of territory ownership within the IPA, and maintained that access should be equal for all fishers. However, informal ownership arrangements do exist between static gear fishers. These arrangements have allowed static gear fishers to reduce the risk of operating in an open-access system, though ensuring access to seasonal grounds is problematic. One informant maintained that traps were historically fished close inshore early in the season, when male crabs were targeted on rough ground. During this period, towed gear vessels would cover ground further offshore. Over the summer and autumn, traps were moved further offshore onto softer ground to target female crabs, enabling the towed gear fleet to fish any suitable ground inshore. The informant stated that the system operated successfully because it allowed both sectors to cover all areas. In addition, when the traps degraded or were removed from the water over the winter period, towed boats were further able to target areas normally fished with static gear.

The movement of traps between sites probably worked in the past because effort was limited. It is likely that the reduction in the amount of seasonal access ground from 1978 to 1993 resulted from two factors, the difficulty that static gear fishers have in re-acquiring ground when areas are seasonally re-opened, and the difficulty of ensuring regulatory compliance in seasonal access zones. Not only is it logistically difficult to move a large number of trap strings from one place to another, there is also little to prevent a fisher from positioning gear in a site occupied by another the previous season. Occupying a territory continually prevents an annual race to position gear at the start of the season. It is also easier to manage and enforce a single use system than a multiple use, seasonally changing, system. Enforcement is a key factor leading to successful fishery enhancement from reserves (Roberts *et al.* 2001).

As a voluntary agreement, the IPA is based on goodwill. The use of anchored nets by static gear fishers to target demersal fish species has the potential to adversely affect the long-term viability of the IPA. Towed gear fishers stated that they did not feel trawl protection was achieved through the IPA, and beam trawls and scallop dredges were not damaged when they came into contact with traps. Further, because static gear and towed gear fishers do not generally use the same ports, the IPA does little to reduce social conflict for fishers when they are in port, a factor that has been credited with helping to maintain management systems in other areas (e.g. Acheson 1988). However, towed gear fishers stated that the benefit of adhering to the IPA was that the area acted as a reserve for the fish species they targeted. When static gear fishers used anchored nets within the area, towed gear fishers felt that this reduced the benefit to them of respecting the IPA, but without this benefit, goodwill alone may not be enough to preserve the system in the future.

WIDER APPLICATION

A number of authors have proposed that rather than attempt to manage a fishery or fish stock in isolation, managers should take into consideration the ecosystem within which the fishery exists. Proponents suggest that if an ecosystem is sustainably managed as a whole, the individuals within will also be sustainably managed (Sherman, 1991; Botsford *et al.* 1997; Langton and Haedrich 1997; McGlade *et al.* 1997; Jennings and Kaiser 1998; Hofmann and Powell 1998; Pitcher and Pauly 1998). Essentially, it may be that the maximum long-term fishery production will be more easily achieved by controlling 'how' fishing is undertaken, rather than 'how much' is caught. The shift in emphasis towards non-technical fishery management measures stems in part from the failure of existing management programmes to meet biological goals (Murawski *et al.* 2000).

The IPA represents an interesting example of how fishing should be undertaken. Probably the most noteworthy features are that it was conceived relatively recently and has the general backing of both fishery sectors, but has protected the traditional practices of the local fishing industry. The IPA has evolved in modern society, despite the increasing pressures of lower catches but higher expectations of earnings and living standards. Because of this, fishers should be commended for the creation and function of the IPA, and features of the system that may be successfully adopted in other locations may be noted. These are:-

1. Management may be more successful if all existing uses of the managed area are taken into account. The IPA is an agreement over ground that historically had been used for the same purposes.
2. Management may be more successful if all existing users of the managed area are taken into account. The IPA has reduced in size to lie mostly within the six-mile territorial limit of the United Kingdom, thus reducing potential conflict issues concerning non-local fishers not party to the management system.
3. When existing use of the seabed permits, exclusive use zones have the greatest potential for management success. It is easier to enforce exclusive use systems, and reallocating seasonal territories has the potential to create conflict within sectors. Further, exclusive use zones may allow the effects of management strategies to be more easily quantified and related to changes in fishery use.
4. Seasonal limitations on gear types have the potential to work effectively, as different fishing sectors may wish to target the same areas at different times of the year. However, seasonal changes in use should not be overly complex in time or space. Care may also be required to ensure that on re-opening, fishers are able to return to previously occupied sites.
5. Within a management zone, long-term regulatory compliance may be more likely if users are restricted in their ability to switch methods to take advantage of increases in abundance of species targeted by other fishing sectors but protected and enhanced by the change in management. The use of anchored nets by static gear fishers has reduced the potential for long term viability in the IPA.
6. If gear types and effective effort can be limited at the inception of a new system, conflict between users is less likely to develop. Conventional fishery management regulations exist such that within six miles of the United Kingdom coast, towed gear fishers are limited to 12 dredges and power of no greater than 300hp. This has prevented large or non-United Kingdom vessels from fishing inside the IPA.
7. Regulatory compliance may be more likely to result when managers are able to meet regularly to discuss events occurring in a fishery, and when management is flexible and adaptable. When features of the IPA were found to be unworkable, changes were quickly made.
8. Conflict avoidance and regulatory compliance may be more likely if negotiation can be between bodies that represent fishers en masse. Two fishers' associations represent all of the static gear fishers and most of the towed gear fishers operating in the IPA. Information is rapidly disseminated within associations and peer group control may be applied.

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References

Acheson, J.M. (1988); The lobster gangs of Maine. University Press of New England, Hannover: 181pp

Acheson, J. M., Wilson, J.A. and Steneck, R.S. (1998); Managing chaotic fisheries. *In* Linking social and ecological systems: management practices and social mechanisms for building resilience. F. Berkes and Folke, C. (Eds.). Cambridge University Press, Cambridge: 390-413

Auster, P. J. and Langton, R.W. (1999); The effects of fishing on fish habitat. *In* Fish habitat: essential fish habitat and rehabilitation. American Fisheries Society V.22, Connecticut: 150-187

Auster, P. J. and Shackell, N.L. (1997); Fishery reserves. *In* Northwest Atlantic groundfish: perspectives on a fishery collapse. J. Boreman, Nakashima, B.S., Wilson, J.A. and Kendall, R.L. (Eds.). American Fisheries Society. Bethesda, Maryland: 159-166

Botsford, L. W., Castilla, J.-C. and Peterson, C.H. (1997); The management of fisheries and marine ecosystems. *Science* 277: 509-515

Bradstock, M. and Gordon, D.P. (1983); Coral-like bryozoan growths in Tasman Bay, and their protection to conserve commercial fish stocks. *New Zealand Journal of Marine and Freshwater Research* 17: 159-163

Brand, A. R., Paul, J.D. and Hoogesteger, J.N. (1980); Spat settlement of the scallops *Chlamys opercularis* (L.) and *Pecten maximus* (L.) on artificial collectors. *Journal of the Marine Biological Association of the United Kingdom* 60: 379-390.

Brand, A. R. (1991); Scallop ecology: distributions and behaviour. *In* Scallops: biology, ecology and aquaculture. S. E. Shumway (Ed.), Elsevier Science Publishers B.V., Amsterdam: 517-584.

Brocken, F. and Kenchington, E. (1999); A comparison of scallop (*Placopecten magellanicus*) population and community characteristics between fished and unfished areas in Lunenburg County, N.S., Canada. Department of Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, Nova Scotia: 33pp

Buestal, D., Dao, J.C. and Lemaire, G. (1979); Collecte de naissain de pectinidés en Bretagne. Rapports et Procés-Verbaux des Réunions. Conseil International pour l'Exploration de la Mer 175: 80-84

Caddy, J. F. (1973); Underwater observations on tracks of dredges and trawls and some effects of dredging on a scallop ground. *Journal of the Fisheries Research Board of Canada* 30: 173-180.

Chadwick, M., Soussan, J., Mallick, D. and Alam, S. (1998); Understanding indigenous knowledge: its role and potential in water resource management in Bangladesh. Environment Centre, University of Leeds, Leeds: 46pp

Charles, A. T. (1998); Beyond the status quo: rethinking fishery management. *In* Reinventing fisheries management. T. J. Pitcher, Hart, P.J.B. and Pauly, D. (Eds.), Kluwer Academic Publishers. London: 101-111.

Churchill, J. H. (1989); The effect of commercial trawling on sediment resuspension and transport over the Middle Atlantic Bight continental shelf. *Continental Shelf Research* 9 (9): 841-864.

Collie, J. S., Escanero, G.A. and Valentine, P.C. (1997); Effects of bottom fishing on benthic megafauna of Georges Bank. *Marine Ecology Progress Series* 155: 159-172.

Collie, J. S., Escanero, G.A. and Valentine, P.C. (2000); Photographic evaluation of the impacts of bottom fishing on benthic epifauna. *ICES Journal of Marine Science* 57 (4): 987-1001.

Darby, C. D. and Durance, J.A. (1989); Use of the North Sea water parcel following model (NORSWAP) to investigate the relationship of source to recruitment for scallop (*Pecten maximus*) stocks of England and Wales. ICES CM.1989/K:18 1-19.

Dare, P. J. and Bannister, R.C.A. (1987); Settlement of scallop, *Pecten maximus*, spat on natural substrates off south-west England: the hydroid connection (Abstract only). *In* The Sixth International Pectinid Workshop, Menai Bridge, Wales, ICES.

Dayton, P. K., Thrush, S.F., Agardy, M.T. and Hofman, R.J. (1995); Environmental effects of marine fishing. *Aquatic Conservation: Marine and Freshwater Ecosystems* 5 (3): 205-232.

Eleftheriou, A. and Robertson, M.R. (1992); The effects of experimental scallop dredging on the fauna and physical environment of a shallow sandy community. *Netherlands Journal of Sea Research* 30: 289-299.

Eno, N. C., MacDonald, D. and Amos, S.C. (1996); A study on the effects of fish (Crustacea/Mollusc) traps on benthic habitats and species.

FAO (2000); The state of world fisheries and aquaculture (SOFIA) 2000. FAO, Rome: 142pp

Fox, H. (2001). The evolution of the fishing village: landscape and society along the south Devon coast, 1086-1550. Leopard's Head Press, Oxford: 208pp

Hall, S. J. (1999). The effects of fishing on marine ecosystems and communities. *In* Fisheries Biology and Aquatic Resources Series 1, T. Pitcher (Ed.). Blackwell Science Ltd, Oxford: 274pp

Hanna, S. (1998); Institutions for marine ecosystems: economic incentives and fishery management. *Ecological Applications* 8 (1, Supplement): 170-174.

Hart, P. J. B. (1998); Enlarging the shadow of the future: avoiding conflict and conserving fish. *In* Reinventing fisheries management. T. J. Pitcher, Hart, P.J.B. and Pauly, D. (Eds.). Kluwer Academic Publishers. London: 227-238.

Harvey, M., Bourget, E. and Miron, G. (1993); Settlement of Iceland scallop *Chlamys islandica* spat in response to hydroids and filamentous red algae: field observations and laboratory experiments. *Marine Ecology Progress Series* 99: 283-292.

Hill, A.S., Brand, A.R., Wilson, U.A.W., Veale, L.O. and Hawkins, S.J. (1996); Estimation of by-catch composition and the numbers of by-catch animals killed annually on Manx scallop fishing grounds. *In* Aquatic Predators and their Prey. S.P.R. Greenstreet and M.L. Tasker (Eds.). Fishing News Books, Oxford: 111-115

Hofmann, E. E. and Powell, T.M. (1998); Environmental variability effects on marine fisheries: four case histories. *Ecological Applications* 8 (1, Supplement): 23-32.

Horwood, J. W. (2000); No-take zones: a management context. *In* Effects of fishing on non-target species and habitats- biological, conservation and socio-economic issues. M. J. Kaiser and S. J. de Groot (Eds.), Blackwell Science Ltd. Oxford: 302-312.

Jennings, S. and Kaiser, M.J. (1998); The effects of fishing on marine ecosystems. *In* Advances in Marine Biology V.34. J. H. S. Blaxter, Southward, A.J. and Tyler, P.A. (Eds.). Academic Press. London: 203-354.

Jentoft, S., McCay, B. and Wilson, D.C. (1998); Social theory and fisheries co-management. *Marine Policy* 22 (4-5): 423-436

Kaiser, M. J., Edwards, D.B., Armstrong, P.J., Radford, K., Lough, N.E.L., Flatt, R.P. and Jones, H.D. (1998); Changes in megafaunal benthic communities in different habitats after trawling distrubance. *ICES Journal of Marine Science* 55: 353-361

Kaiser, M. J., Spence, F.E. and Hart, P.J.B. (2000); Fishing-gear restrictions and conservation of benthic habitat complexity. *Conservation Biology* 14 (5): 1515-1525

Kaiser, M. J. and Spencer, B.E. (1994); Fish scavenging behaviour in recently trawled areas. *Marine Ecology Progress Series* 112: 41-49

Kaiser, M. J. and Spencer, B.E. (1996); The effects of beam trawl disturbance on infaunal communities in different habitats. *Journal of Animal Ecology* 65: 348-358

Kinnear, J. A. M., Barkel, P.J., Mojsiewicz, W.R., Chapman, C.J., Holbrow, A.J., Barnes, C. and Greathead, C.F.F. (1996); Effects of Nephrops creels on the environment. Fisheries Research Services Report 2/96, Agriculture, Environment and Fisheries Department, Scottish Office, Aberdeen

Knudson, E. a. M., D. (2000); Sustainable fisheries: Are we up to the challenge? *Fisheries* 25 (12): 4 and 43.

Kula, E. (1992). Economics of natural resources and the environment. Chapman and Hall, London: 287pp

Langton, R. W. and Haedrich, R.L. (1997); Ecosystem-based management. *In* Northwest Atlantic groundfish: perspectives on a fishery collapse. J. Boreman, Nakashima, B.S., Wilson J.A. and Kendall, R.L. (Eds.), American Fisheries Society. Bethesda, Maryland: 151-156

Lauck, T., Clark, C.W., Mangel, M. and Munro, G.R. (1998); Implementing the precautionary principle in fisheries management through marine reserves. *Ecological Applications* 8 (1, Supplement): 72-78

MacKay, K. T. (1992); User participation in aquaculture research and development. *World Aquaculture* 23 (1): 20-24

McGlade, J., Price, A., Klaus, R. and Metuzals, K. (1997); Recovery plans for the North Sea ecosystem, with special reference to cod, haddock and plaice. University of Warwick, Warwick: 41pp

Minchin, D. (1992); Biological observations on young scallops, *Pecten maximus*. *Journal of the Marine Biological Association of the United Kingdom* 72: 807-819

Moran, M. J. and Stephenson, P.C. (2000); Effects of otter trawling on macrobenthos and management of demersal scalefish fisheries on the continental shelf of north-western Australia. *ICES Journal of Marine Science* 57: 510-516

Murawski, S. A. (2000); Definitions of overfishing from an ecosystem perspective. *ICES Journal of Marine Science* 57: 649-658

Murawski, S. A., Brown, R., Lai, H.-L., Rago, P.J. and Hendrickson, L. (2000); Large-scale closed areas as a fishery-management tool in temperate marine systems: the Georges Bank experience. *Bulletin of Marine Science* 66 (3): 775-798

Murray, S. N., Ambrose, R.F., Bohnsack, J.A., Botsford, L.W., Carr, M.H., Davis, G.E., Dayton, P.K., Gotshall, D., Gunderson, D.R., Hixon, M.A., Lubchenko, J., Mangel, M., MacCall, A., McArdle, D.A., Ogden, J.C., Roughgarden, J., Starr, R.M., Tegner, M.J. and Yoklavich, (1999); No-take reserve networks: sustaining fishery populations and marine ecosystems. *Fisheries* 24 (11): 11-25

Naidu, K.S. and Scaplen, R. (1979); Settlement and survival of giant scallop *Placopecten magellanicus* larvae, on enclosed polyethylene film collectors. *In* Advances in Aquaculture. T.V.R.Pillay and W.A. Pill (Eds.). FishingNews Books, London: 379-381

Neis, B., Schneider, D.C., Felt, L., Haedrich, R.L., Fischer, J. and Hutchings, J.A. (1999); Fisheries assessment: what can be learned from interviewing resource users? *Canadian Journal of Fisheries and Aquatic Science* 56: 1949-1963

Norse, E. A. and Watling, L. (1999); Impacts of mobile fishing gear: the biodiversity perspective. *In* Fish habitat: essential fish habitat and rehabilitation, American Fisheries Society V.22, Hartford, Connecticut: 31-40

Palma, A. T., Wahle, R.A. and Steneck, R.S. (1998); Different early post-settlement strategies between American lobsters *Homarus americanus* and rock crabs *Cancer irroratus* in the Gulf of Maine. *Marine Ecology Progress Series* 162: 215-225

Pile, A. J., Lipicius, R.N., van Montfrans, J. and Orth, R.J. (1996); Density-dependent settler-recruit-juvenile relationships in blue crabs. *Ecological Monographs* 66 (3): 277-300

Pitcher, T. J. a. P., D. (1998); Rebuilding ecosystems, not sustainability, as the proper goal of fishery management. *In* Reinventing fisheries management. T. J. Pitcher, Hart, P.J.B. and Pauly, D. (Eds.), Kluwer Academic Publishers. London: 311-329

Piskaln, C.H., Churchill, J.H. and Mayer, L.M. (1998); Resuspension of sediment by bottom trawling in the Gulf of Maine and potential geochemical consequences. *Conservation Biology* 12 (6): 1223-1229

Roberts, C. M., Bohnsack, J.A., Gell, F., Hawkins, J. and Goodridge, R. (2001); Effects of marine reserves on adjacent fisheries. *Science* 294: 1920-1923

Roberts, C. M. and Hawkins, J.P. (1997); How small can a marine reserve be and still be effective? *Coral Reefs* 16: 150

Robinson, M. and Tully, O. (2000); Spatial variability in decapod community structure and recruitment in sub-tidal habitats. *Marine Ecology Progress Series* 194: 133-141

Sainsbury, K. J., Campbell, R.A., Lindholm, R. and Whitelaw, A.W. (1998); Experimental management of an Australian multispecies fishery: examining the possibility of trawl-induced habitat modification. *In* Global trends: fisheries management. E. K. Pikitch, Huppert, D.D., Sissenwine, M.P. (Eds.), American Fisheries Society V.20. Bethesda, Maryland:107-112

Sherman, K. (1991); The large marine ecosystem concept: research and management strategy for living marine resources. *Ecological Applications* 1 (4): 349-360

Sillitoe, P. (1998); The development of indigenous knowledge. *Current Anthropology* 39 (2): 223-251

Sinclair, M., Mohn, R.K., Robert, G. and Roddick, D.L. (1985); Considerations for the effective management of Atlantic scallops. Canadian Technical Report on Fisheries and Aquatic Science: 113

Stevens, B. G. and Kittaka, J. (1998); Postlarval settling behaviour, substrate preference, and time to metamorphosis for red king crab *Paralithodes camtschaticus*. *Marine Ecology Progress Series* 167: 197-206

Stevens, P. M. (1987); Response to excised gill tissue from the New Zealand scallop *Pecten novaezelandiae* to suspended silt. *New Zealand Journal of Marine and Freshwater Research* 21: 605-614

Stokesbury, K. D. E. and Himmelman, J.H. (1995); Biological and physical variables associated with aggregations of the giant scallop *Placopecten magellanicus*. *Canadian Journal of Fisheries and Aquatic Sciences* 52: 743-753

Thouzeau, G. (1991); Experimental collection of postlarvae of *Pecten maximus* (L.) and other benthic macrofaunal species in the BAy of Saint-Brieuc, France.I. Settlement patterns and biotic interactions among the species collected. *Journal of Experimental Marine Biology and Ecology*. 148: 159-179

Turner, W. H., Tammi, K.A. and Rice, M.A. (1996); "Bags to drags," the story of the bay scallop restoration project. *Journal of Shellfish Research* 16 (1): 276

Veale, L. O., Hill, A.S., Hawkins, S.J. and Brand, A.R. (2000); Effects of long-term physical disturbances by commercial scallop fishing on subtidal epifaunal assemblages and habitats. *Marine Biology* 137: 325-337

Walters, C. (1998); Designing fisheries management systems that do not depend upon accurate stock assessment. *In* Reinventing fisheries management. T. J. Pitcher, Hart, P.J.B. and Pauly, D. (Eds.), Kluwer Academic Publishers. London: 279-288

Woodhatch, L. and Crean, K. (1999); The gentleman's agreement: a fisheries management case from the Southwest of England. *Marine Policy* 23 (1): 25-35

Young, P. C., McLoughlin, R.J. and Martin, R.B. (1992); Scallop (*Pecten fumatus*) settlement in Bass Strait, Australia. *Journal of Shellfish Research* 11 (2): 315-323.

APPENDIX 1

Table 1: Summary of the principle developments in the south Devon static gear fishery.

Year	Developments
Pre-1930	Wooden sailing and rowing boats of 5-6m length. 60-100 withy traps and two or three fishers per boat. Traps in strings of up to five below each marker buoy. Beach boats hauled ashore by hand.
1930-1950	Inboard motors introduced early 1930s. Some larger boats (up to 10m) with motorised capstans operated from deep-water ports by 1950. Beach boats hauled ashore using motorised capstans.
1950-1960	Beach fishers began to move to larger deep-water port boats. Up to 200 cherry and wire traps operated from each boat, though more from port boats. Remaining beach boats equipped with motorised capstans.
1960-1970	Beach boats disappear. Typical boat size 10-12m.
1970-1980	Plastic traps introduced. 300 traps in strings of up to 30 used. Inshore Potting Agreement (IPA) established 1978.
1980-1990	More traps operated from each boat. Seasonal movement of traps within static gear only zones abandoned mid 1980s.
post-1990	Typical boat size 10-15m. Pot-locks and rubber skirts introduced early 1990s. Up to 1600 traps operated from each boat, though average 6-700. Traps used in strings of 40-80.

Table 2: Area of the IPA and static gear zones 1978-1993.

	1978	1982	1984	1993
Total IPA Area (km^2)	527.3	470.7	479.9	478.4
Static Gear Only Zones (km^2)	291.0	330.7	357.1	349.7
Seasonal Static Gear Zones [Area x % of year] (km^2y^{-1})	135.7	113.6	90.0	73.2
Total Static Gear Area [Static Only + Seasonal] (km^2y^{-1})	426.7	444.2	447.0	422.9

Table 3: General function of the IPA. Absence of a remark indicates either no strong opinion expressed or no comment.

Gear Type	Area	Person	Generations of fishers in family	The IPA Is a Good System	The IPA Is Not Good Enough	The IPA Has No Personal Benefit
Static	Interior	1	4+	Agree	Agree	Agree
		2	1	Agree		
		3	3+	Agree	Agree	
		4	3+	Agree	Agree	
	Edge	5	2	Agree	Agree	
		6	1	Disagree		Agree
		7	1	Agree		
		8	3+	Agree	Agree	
		9	No data	Agree	Agree	Agree
	Committee	10	1	Agree	Agree	
Towed	Inshore	11	1	Agree		
		12	1	Agree		Agree
		13	1	Agree		
		14	1	Disagree		
		15	No data	Disagree		
	Committee	16	No data			
		17	No data	Agree		

Table 4: Benefits of the IPA to fishers. Absence of a remark indicates either no strong opinion expressed or no comment.

Gear Type	Area	Person	The IPA Provides Trap Protection	The IPA Provides Trawl Protection	The IPA Protects Benthic Habitats	The IPA Acts as a Reserve for Target Species
Static	Interior	1	Agree	Agree	Agree	Agree
		2	Agree		Agree	Agree
		3	Agree			Agree
		4	Agree		Agree	Agree
	Edge	5	Agree		Agree	Agree
		6				
		7	Agree		Agree	Agree
		8	Agree			Agree
		9	Agree		Agree	Agree
	Committee	10	Agree	Agree	Agree	Agree
Towed	Inshore	11			Agree	Agree
		12	Agree	Disagree	Disagree	Agree
		13	Agree	Disagree		Agree
		14		Disagree	Disagree	Agree
		15		Disagree	Disagree	
	Committee	16	Agree	Disagree	Disagree	Agree
		17	Agree	Disagree		Agree

Table 5: Interactions between fishers of the same sector. Absence of a remark indicates either no strong opinion expressed or no comment.

Gear Type	Area	Person	Have Had Conflict Within Own Sector	Our Sector Break IPA 'Rules'
Static	Interior	1	Agree	
		2	Agree	
		3	Agree	
		4		
	Edge	5	Agree	Agree
		6	Agree	
		7	Agree	
		8	Agree	Agree
		9	Agree	Agree
	Committee	10	N/a	
Towed	Inshore	11		Agree
		12	Agree	Agree
		13		Agree
		14	Agree	Agree
		15		Agree
	Committee	16	N/a	Agree
		17	N/a	Agree

Table 6: Interactions between fishers of different sectors. Absence of a remark indicates either no strong opinion expressed or no comment.

Gear Type	Fishing Area	Person	Other Sector Violate the IPA	Cooperate with the other sector	Have had Inter Sector Conflict	Worst sector
Static	Interior	1				
		2			Agree	Scallops
		3	Agree		Agree	Scallops
		4	Agree			Scallops
	Edge	5	Agree		Agree	
		6	Agree	Agree	Agree	Angling
		7		Agree	Agree	Scallops
		8	Agree		Agree	Scallops
		9		Agree	Agree	
	Committee	10	Agree	Agree		
Towed	Inshore	11		Agree		
		12	Agree	Agree	Agree	Scallops
		13	Agree	Agree	Agree	
		14	Agree	Agree		
		15				
	Committee	16	Agree			
		17	Agree		Agree	

Table 7: How can the IPA be improved? Absence of a remark indicates either no strong opinion expressed or no comment.

Gear Type	Area	Person	Should Give Static Gear Fishers More Ground	Should Limit Static Gear Fishers to Traps Only	Should Put in Corridors or Seasonal Areas	Should Legalise the IPA
Static	Interior	1	Agree	Agree		
		2		Disagree		Agree
		3				Agree
		4				Agree
	Edge	5		Agree		Agree
		6				
		7			Agree	Agree
		8		Agree		
		9		Agree		
	Committee	10		Disagree	Agree	Agree
Towed	Inshore	11				Disagree
		12	Disagree	Agree	Agree	Disagree
		13	Disagree	Agree		Disagree
		14	Disagree	Agree	Agree	Disagree
		15	Disagree	Agree	Agree	Disagree
	Committee	16	Disagree	Agree	Agree	
		17		Agree	Agree	Agree

INTEGRATING SCIENTIFIC AND LOCAL ECOLOGICAL KNOWLEDGE (LEK) IN STUDIES OF COMMON EIDERS IN SOUTHERN LABRADOR, CANADA

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ABSTRACT

Research on the history and status of Eider Ducks in Labrador and Newfoundland is needed. These ducks are an important part of the subsistence and traditional diet of coastal Labradorians. Two subspecies of Common Eider, a northern one (*Somateria mollissima borealis*) and a southern one (*S. m. dresseri*), occur in southeastern Labrador. Little is known about the non-breeding behavioural ecology and abundance of these subspecies. By working with hunters [by means of Local Ecological Knowledge (LEK) interviews and collecting duck heads], analyzing existing scientific data and collecting new scientific data, we are assessing the seasonal occurrences and distributions of these subspecies in southeastern Labrador. LEK data is also used to reconstruct the history of shifts in and intensity of local hunting and egg-harvesting pressures on the eiders in St. Peter's Bay, Labrador. We hypothesize that with the decline in the commercial cod and salmon fisheries in St. Peter's Bay and as a result of technological innovation, harvesting pressure has shifted from the nesting population (*Somateria mollissima dresseri)* to the wintering population (*S. m. borealis)* in this area. The history of local hunting pressures and technological and fisheries changes are explored.

INTRODUCTION

This project is being carried out under the auspices of a national interdisciplinary research program, Coasts Under Stress (CUS). CUS is a 5-year Major Collaborative Research Initiative, funded by SSHRC (Social Sciences and Humanities Research Council) and NSERC (Natural Science and Engineering Research Council). CUS study areas are in coastal communities in Newfoundland and Labrador and British Columbia. A major goal of CUS is to reconstruct ecosystem change by identifying how changes in the environment and society have affected human, community and environmental health. In order to do this, Local Ecological Knowledge (LEK) is collected and documented and combined with information collected using more 'traditional' natural and social science methods. The LEK referred to in this paper is hunters' LEK. When they hunt in the same areas for years, and sometimes generations, hunters acquire detailed knowledge of their environments, local resources and local hunting practices. This knowledge has a relatively large temporal and a small spatial scale (Fisher 2000).

Obtaining good quality LEK to combine with science depends on the systematic collection of qualitative data from a reasonably large sample of experienced or "expert" hunters. Because most existing scientific data tends to be collected at larger spatial scales and shorter time scales than those that inform LEK, it is wise to combine LEK with linked scientific research. When scientific research is linked to what harvesters know and have experience about, both scientists and harvesters can share their expertise. This sharing of information produces a more comprehensive research design, potentially improved data collection and contributes to a better understanding of natural processes and human interactions with nature. In a study on the harvesting of lobster populations Gendron et al. (2000) concluded, "the incorporation of the information given to us by fishers increased the credibility of the scientific conclusions concerning the harvesting of lobster populations."

In our study, we integrate LEK about Common Eiders from hunters in southern Labrador and scientific research to examine:

1. Seasonal distributions of two subspecies of Common Eider.
2. Decadal level changes in spatial distributions and abundance of these two subspecies.
3. Changes in human impacts on eiders.

This research is being carried out on the southern coast of Labrador with an emphasis on St. Peters Bay. This bay was established as a federal migratory bird reserve in 1949 at the request of the Newfoundland government to protect the eiders that were breeding there. According to records obtained from the Battle Harbour Regional Development Association, Dr. Les Tuck visited the area in June 1950 and reported very few nesting eiders. In 1959 after having no increase in colony size reported by local sources, Tuck suggested the sanctuary status be cancelled, as it was serving no useful purpose. This cancellation however was deferred for several years because St. Peters Bay was the only federal migratory bird reserve in Newfoundland and Labrador at that time. In 1980, after an assessment by the Canadian Wildlife Service that found fewer than 40 nests during an incomplete survey, the decision to cancel the reserve status was implemented.

The Common Eider

The Common Eider, *Somateria mollissima,* has been traditionally used as a local source of meat, eggs and feathers by coastal Labradorians. Two primary subspecies of Common Eider occur in Labrador - a southern Eider (subspecies *dresseri*) that mostly breeds in southern Labrador, Quebec, Newfoundland, the Maritime Provinces and Maine, and a northern Eider (subspeceis *borealis*) that breeds in northern Labrador and Arctic Canada and over-winters in southern Labrador and Newfoundland.

The two subspecies are very similar. The main distinguishing characteristic is the shape of their bills. The size of the eider and color of plumage are harder to use as distinguishing characteristics, however, the southern eider usually has a slightly bigger head and greenish plumage under the eye whereas the northern eider does not (Figure 1).

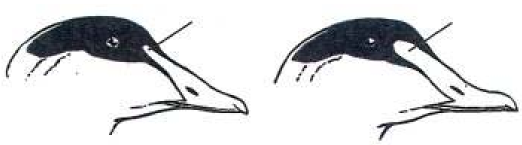

Figure 1. The northern eider, (*S. m. borealis*, left) has a bill that elongates into a narrow point at its base and the southern eider, (*S. m. dresseri*, right) has a bill that is more rounded at the base (from Peters and Burleigh, 1951).

Questions

The central questions in this research are:

1. Have local hunters living on the south coast of Labrador developed valuable LEK about eiders?
2. Can this LEK be collected in a systematic fashion and combined with scientific data?
3. Have distributions and population sizes of the nesting and over-wintering eiders changed over time?
4. Are these changes related to shifts in local human pressure?

Methods

Collecting LEK in a Systematic Fashion

In order to collect LEK in a systematic fashion a protocol has to be followed. The main tool used to collect LEK in this study is a semi-structured in depth interview schedule with a map component. Before the interviewing process began, the section of the project involving human participants had to be approved by the Interdisciplinary Committee on Ethics in Human Research (ICEHR) at Memorial University of Newfoundland. Consent forms that described the risks and benefits of being interviewed, confidentiality agreements and semi-structured interview schedules, were submitted to the ICEHR. This committee approved these documents and then the process of selecting interviewees began.

The first interviews were conducted in December 2000 in Mary's Harbour, Fox Harbour, Port Hope Simpson, Charlottetown and Cartwright (Figure 2). These were background interviews conducted to support several CUS projects. Information on local terms for various birds and fish and information on local observations of these different species as well as local uses for them were gathered. These interviews were conducted to help us design our interview schedule, to ensure we used appropriate terms in our interview, and to identify the hunters in these communities. The people who were selected for these interviews were all retired fishermen.

A second set of interviews, which concentrated on hunters, was conducted from May to August 2001 in Forteau, Red Bay, Lodge Bay, Mary's Harbour and Fox Harbour (Figure 2). A method called snowball sampling was used to select experienced hunters living in the area who had hunted in St. Peters Bay. Using the sampling method of snowballing local leaders in the community were asked to identify experienced hunters in the area and then these experienced hunters were asked to provide additional names of others whom they thought would be appropriate to interview. Thus, those interviewed were among the most experienced Eider hunters in their communities with the best knowledge of the history of hunting and Eider behaviour and distributions in St. Peter's Bay. Neis et al. (1999), used snowball sampling to identify local fisher "experts". By using snowball sampling the people who have the most knowledge of the topic in question are interviewed.

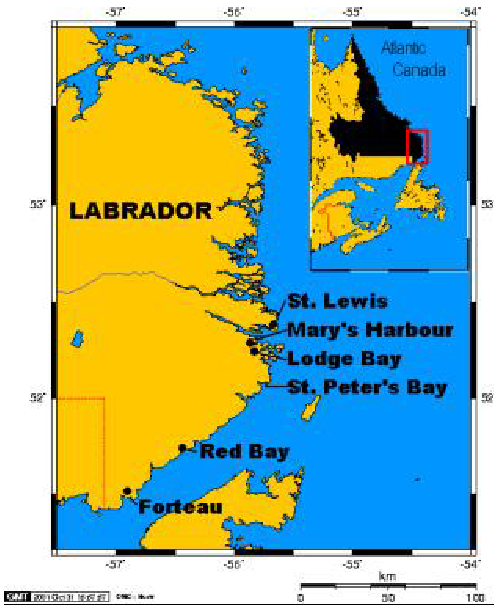

Figure 2. Study area on the south Labrador coast.

Conducting Interviews

At the beginning of an interview the hunters signed a consent form, which they read or had read to them. They also filled out an archival deposit form that enabled them to decide what they wanted to be done with the transcripts, maps and cassette tapes that were used to record the information in their interview. Interviewees were given a choice whether to be taped or not. They also had the option to decline to answer a question or stop the interview at any time. The semi-structured interview schedule provided hunters with a chance to elaborate on questions and introduce information if they desired. In this way the interview was guided by the interviewer but had the freedom to add information they believed was relevant and important as well as answering the questions being asked. Each interview included approximately 100 questions and lasted an average of 1.5 hours. The subject areas included asking hunters for information on the abundance of eiders in St. Peter's Bay, the location of breeding areas, over-wintering distributions and migration patterns. They were also asked to describe changes in these factors and changes in their hunting practices over their careers as hunters. They were asked if these changes in their hunting practices might have affected the breeding and over-wintering populations of eiders. Hunters' opinions of hunting regulations, conservation and about the establishment, disestablishment and possible reestablishment of a federal migratory bird sanctuary in St. Peters Bay were sought as was hunter awareness of Eider subspecies' morphological and behavioural differences.

Information that could be mapped such as the hunters' boat routes when hunting, the most popular hunting locations, eider migration routes, nesting locations, brood rearing areas and wintering distributions were recorded on a 1:60,000 (L/C 5030) nautical chart that covered the area from Battle Harbour south to Green Bay (Figure 3). Hunters used different colors to map different things on the chart. Aqua was used for the boat route while hunting, brown for the best hunting areas, red for migration routes of the eiders, blue for nesting areas, orange for eider brood rearing (or crèching) areas, and purple for wintering locations. Hunters were shown pictures and mounted heads of the two subspecies to demonstrate the difference between the shapes of bills of the southern and northern subspecies of Common Eider that breed and over-winter in Labrador and Newfoundland.

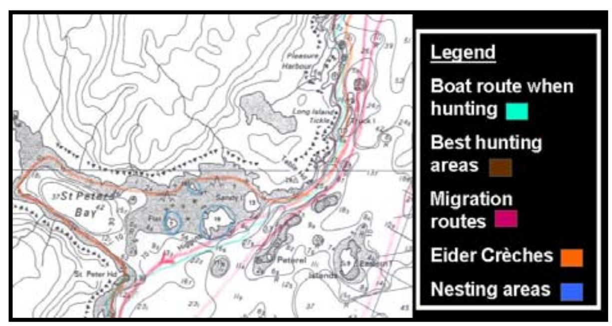

Figure 3. Scanned image of a chart that was used to record hunters' local ecological knowledge.

Interviewees

In the initial set of background interviews that was conducted in December 2000, interviewees' ages ranged from men in their 40s to their 80s. Most of these fishers were retired. In the second set of detailed species-specific interviews that were conducted in May to August 2001, interviewees' ages ranged between 27 and 84 (Figure 4). The majority of hunters were between 40 and 60. All of the hunters had been hunting for at least 12 years in the St. Peters Bay area and 50% of them had hunted for 30 years or more in this area. All hunters had been hunting since they were around 14 years old. A majority of the hunters were fishers. Twenty-eight percent of hunters were current fishers and 39% of hunters were former fishers.

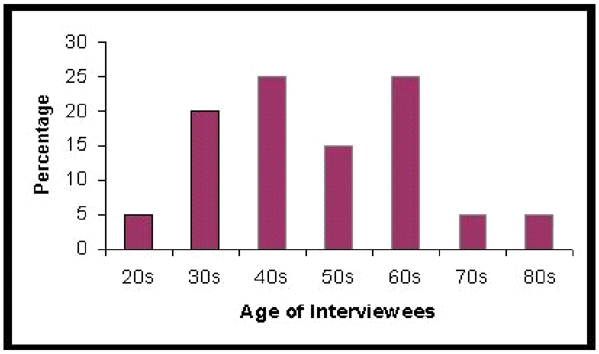

Figure 4. Age range of 20 interviewees

Eider Head Collection

Eider heads were collected from hunters in winters of 2001 and 2002 to determine the ratio of hunted southern to northern Common Eider subspecies during the over-wintering season in various places along the southern Labrador coast.

Surveys for Common Eiders

Estimates of the current nesting population of Common Eider in St. Peter's Bay (52°04' / 55°46'), Labrador, were made on the basis of systematic surveys that commenced on 29 May 2001. Prior to this, pack ice prevented boats from traveling along the coast and into St. Peter's Bay.

Surveys were divided into two time periods: 29 May to 12 June 2001 (pre-hatching) and 19 July to 4 August 2001 (post-hatching). Each survey was conducted from a 20-foot open boat that completely circumnavigated the islands in St. Peters Bay. The "inside" islands, Harbour, Higgins, Black and Goose Islands, were surveyed sequentially (Figure 5). On clear days when the wind was less than 20 knots (29 May, 11 and 12 June), the survey would continue to the "outside" islands, Double, Western, Eastern, Rock in the Run and Peterel Islands, that were surveyed sequentially (Figure 5). All islands were surveyed within 18 to 20 m of the shore at a speed of about 10 km/hr. When the tide was low the survey was carried out farther from the shore, the furthest distance being about 30 m, and at a slower speed of 3-5 km/hr because of dangerous shoals. This distance was still close enough to count birds.

St. Peter's Bay has many shoals, and weather conditions had to be very good to do a complete survey around all the islands in a single day. When winds increased to about 20 knots/hr the survey would be discontinued because it was not safe. St. Peter's Bay is also a very foggy place. On some days fog had lifted by late morning and on other days St. Peter's Bay was blanketed in thick fog for the entire day. On these days it was impossible to conduct research.

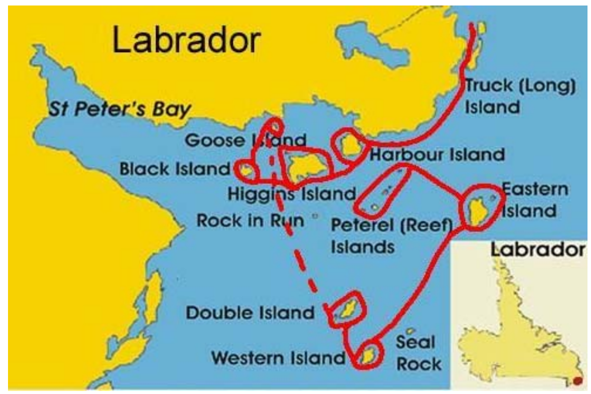

Figure 5. Survey route around islands in St. Peters Bay.

Pre-hatching population surveys

The objective of the first surveys in St. Peter's Bay was to conduct a Common Eider breeding male census in order to estimate the total breeding population in St. Peter's Bay. Five breeding male surveys were conducted on 29, 30 May, 5, 11 and 12 June 2001. Parameters measured on the first three surveys were: total number of male breeding eiders observed, their locations, time of day and weather. During the last two surveys the total number of adult males, juvenile males and pairs was also recorded.

Post-hatching population surveys

To determine how much of the breeding population and how many broods were still around by mid July to early August, and to determine how Eider broods occupy different areas and habitats, population surveys were conducted around the islands and along the shoreline of St. Peter's Bay. Surveys took place from 19 July to 4 August 2001. Parameters measured included: total number of birds, number of broods, brood sizes, ratio of ducklings: adult females, species (subspecies if possible), sex, activity, location, time of day and weather. Survey routes were the same as those carried out in May and June.

Subspecies Discrimination

Observations to determine subspecies were carried out in St. Peter's Bay to help determine the ratio of southern to northern Common Eider subspecies during the breeding season. On 5 June 2001, a 2-hour observation based on visual discrimination between subspecies was conducted on Higgins Island. When eiders came within 80 m on land or while swimming, the shape of their bill could be discriminated and birds could be identified to the subspecies level. On 10, 11, and 12 June 2001, observations to discriminate subspecies were conducted from the boat survey when eiders flew by within 5 to 10 m.

Pre-Hatch Nest Surveys

To compliment breeding male survey data and nest counts that were collected in St. Peter's Bay during June 1999 (K. Chaulk, CWS, unpublished data) nest surveys were conducted on 11 and 12 June 2001 on Long (Small), Long (Big), Higgins, Goose (Small) and Goose (Big) Islands. The number of eider nests on each island and the number of eggs in each nest were counted. The survey was conducted by a survey crew of 3 to 4 people who were evenly spaced along a survey line that ranged in length from 50 – 300 m. Surveyors would zig-zag back and forth making sure all suitable nesting areas were inspected. The survey line would traverse back and forth over the island until the entire surface was covered.

The age of some embryos inside the egg was determined using a technique called 'candling' (Resource Inventory Committee 1997). By holding the eider egg up to the sun and looking through a cardboard tube at the embryo the age of the embryo was estimated. When the relative ages of the eggs in the nest were determined hatching date was predicted.

Post-Hatch Nest Counts

A post-hatch nest survey, which could not be conducted in June, was completed on Black Island on 21 July, 2001. The procedure was the same as the previous nest surveys.

Brood Surveys

Brood surveys were conducted on 20, 28, 29 and 30 July 2001, in order to help determine the distribution of eider broods that left St. Peter's Bay soon after they hatched. The coastline, including all coves and bays from St. Peters Bay to Henley Harbour, was surveyed for Common Eider broods (Figure 6). Data collected included total number of birds, number of broods, brood sizes, ratio of ducklings/adult females, activity, time of day and weather. Their location was mapped and the size of the ducklings relative to the adult hens that were with them was estimated.

Figure 6. Eider brood survey route, from St. Peters Bay to Henley Harbour.

Results and Discussion

Seasonal Distribution of Subspecies

When hunters were shown heads of the two different subspecies of Common Eider, *dresseri* (southern) and *borealis* (northern), most hunters could remember seeing eiders with different shaped bills but did not realize they were different subspecies. Some hunters had noticed the differences in size and shape of the bills but thought that these differences were due to age: *borealis* with the smaller, more pointy bill being a young eider and *dresseri*, with the larger more rounded bill, being an old eider.

Hunters recognized *dresseri* to be the most common eider during the breeding season. After having being shown a *dresseri* head one hunter said:

> "*I can identify the green with the birds, yep, in the spring of the year we'd see them.*"

Nesting eiders in St. Peter's Bay on the south coast of Labrador were visually observed to be 97% *dresseri*. A majority of *dresseri* nesting in this area is consistent with records in previous scientific documents.

Most hunters noted that *borealis* were the eiders they would see mostly during over-wintering. After having being shown a *borealis* head one hunter said:

> *" Usually this is the one you would see mostly staying around in the winter time".*

Over-wintering Eiders (borealis)

Eiders occur on the south Labrador coast throughout winter. These over-wintering populations have been hunted intensively for decades. Individual hunters, however, report taking fewer per year now than 40 and even 20 years ago. Some hunters noted that over-wintering populations have declined and/or changed location. One hunter said:

> *"In winter there's still some around but its not like it used to be."*

Some hunters speculated that the decline and/or changed location in the over-wintering population is most likely due to the use of speed boats and semi-automatic rifles to hunt eiders. One hunter remarked:

> *"After speedboats came around it didn't seem like there were as many birds. The boats kept them drove out."*

Most hunters noted that the location of eiders in the winter has not changed at least in the past 20 years. The eiders still frequent the same places, along the shoreline, bays, coves and islands. Where the eiders can be found on a particular day however, has much to do with the weather and the ice.

Nesting Eiders (dresseri)

Hunters mapped the locations of nesting eiders between Cape St. Lewis and Bad Bay. They noted that during the late 1990s, new nesting sites were established between Bad Bay and Henley Harbour, where nesting sites had not been observed previously. Some hunters said that eiders nested on all islands in St. Peters Bay. Other hunters said that only some of the islands have nesting eiders on them. Most hunters said that Black, Higgins, Double and Western Islands have nests on them (Figure 7).

Eider nesting surveys indicate that nesting eider numbers have been increasing recently in St. Peter's Bay. Nest counts conducted in 2001 were compared with previous ones carried out by the Canadian Wildlife Service (CWS) in 1999. Five islands in St. Peter's Bay that were surveyed in 1999 were re-surveyed in 2001. Two of these islands had no nests in 1999 and in 2001. The other three islands showed an increase in nests (Figure 8).

During the summer cod fishery, before 1992, eiders were hunted during summer. Fishers would be at their summer homes on the headlands and some would take the opportunity to hunt. Hunters who did kill eiders during the summer in the past say that during the last 10 years regulations have been enforced more and the consequences of getting caught poaching are so great that they do not want to take the risk. Some hunters report that eggs are harvested but this practice has diminished greatly over the last 30 years.

Reduced human pressure could give these birds a chance to recover. As one hunter noted:

> *"There are more pairs of ducks now than there were 25 years ago."*

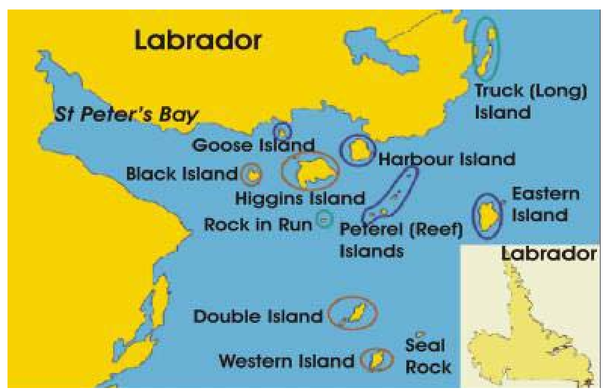

Figure 7. Eider nesting islands in St. Peters Bay

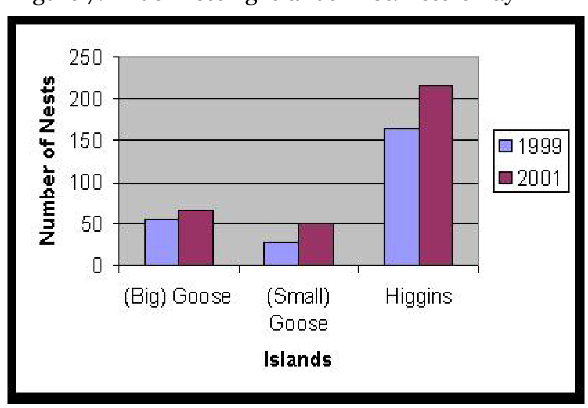

Figure 8. Nest counts for three islands in St. Peters Bay during 1999 and 2001.

Migraton and Movements

While mapping movement patterns, hunters noted that during fall migration most eiders flew south in November. During spring migration, the greatest number flew north between 1 and 15 May. During fieldwork commencing 18 May 2001, it was observed that all nesting eiders appeared to have already arrived. Hunters reported that during the last 10 years, fewer eiders have been observed migrating in fall than during spring. Most hunters reported that spring and fall migrants are now flying further from the land.

Conservation

Most hunters agreed that eiders need more protection, including enforcement during the breeding season. There were many differences of opinion, however, as to whether St. Peters Bay should be re-established as a migratory bird reserve. Most hunters thought the seasons and bag limits were sufficient as long as people obeyed them. One hunter noted,

"Y*ou wouldn't want the season opened earlier because you would like to see the older birds fly back*."

CONCLUSIONS

Local Ecological Knowledge (LEK) collected and analyzed in a systematic fashion can be a key tool in biological studies. Where it exists, it can be of great benefit to both researcher and harvester to work together to share information so that a more complete understanding of nature is achieved. In our study, we have shown that scientific data and LEK point to local changes in Scientific evidence and LEK suggest that breeding populations in St. Peter's Bay have increased in recent years, and harvester observations suggesting that nests are located in areas uninhabited at least since the 1950s indicate that this population may be at a 50-year peak. The reduced egging and hunting during the breeding season could be contributing to the growth of the eider breeding population (southern subspecies, *dresseri*). Overall, during the period 1960-2000, there appears to have been a marked shift in hunting mortality on breeding to wintering eider populations, and hence from southern (*dresseri*) to northern (*borealis*) subspecies.

ACKNOWLEDGEMENTS

We thank the Social Sciences and Humanities Research Council of Canada (SSHRC), and the Natural Sciences and Engineering Research Council of Canada (NSERC) for supporting our research through the "Coasts Under Stress" Project in the SSHRC Major Collaborative Research Initiatives (MCRI) program. Funding has also been provided by Memorial University of Newfoundland, Northern Studies Training Grants (NSTP), Student Work and Scholastic Placements (SWASP) and the Women in Science and Engineering (WISE) Program of Newfoundland and Labrador. Special thanks to the 20 hunters who participated in the interviews.

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REFERENCES

Fischer, J. 2000. Participatory research in ecological fieldwork: a Nicaraguan study, in, B. Neis, L. Felt, eds., *Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management*. ISER Books, Memorial University of Newfoundland. St. John's. 41-54.

Gendron, L., R. Camirand and J. Archambault 2000. Knowledge-sharing between fishers and scientists: towards a better understanding of the status of lobster stocks in the Magdalen Islands, in, B. Neis, L. Felt, eds., *Finding Our Sea Legs: Linking Fishery People and Their Knowledge with Science and Management*. ISER Books, Memorial University of Newfoundland. St. John's. 56-71.

Neis, B., D.C. Schneider, L. Felt, R.L. Haedrich, J. Fischer and J.A. Hutchings 1999. Fisheries assessment: what can be learned from interviewing resource users? Canadian Journal of Fisheries and Aquatic Sciences 56, 1949-1963.

Peters, H.S. and Burleigh, T.D. 1951. The Birds of Newfoundland. Department of Natural Resources. St. John's. Resource Inventory Committee Publications, 1997. Live Animal Capture and Handling Guidelines for Wild Mammals, birds, Amphibians and Reptiles. Copyright © 1997 Province of British Columbia. Html created March 1998.

How Fishers' Endeavors and Information Help in Managing the Fisheries Resources of the Sundarban Mangrove Forest of Bangladesh

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Abstract
The aquatic resources of the Sundarban Mangrove Forest (SMF) are an important component of its biodiversity and are an important source of food and income for human populations. The SMF is the biggest mangrove forest in the world and covers an area of 6,017 km^2. Over 200 species of fish identified in the SMF are harvested by between 110,000 and 291,000 fishermen using approximately 25,000 registered small fishing boats. The water body inside the SMF, i.e. inshore fishing area, covers an area of 1,874 km^2 , and the estimated annual production of finfish and crustaceans is about 3,054 t, equivalent to a yield of 16.3 kg/ha. In addition, about 215 million tiger shrimp fry (Post Larvae-PL) are caught to supply shrimp farms. The Sundarbans also includes a 20 km wide marine zone, i.e. offshore fishing area, which covers 1,603 km^2. A seasonal winter fishery of Dubla Island operates in this zone, consisting of about 30,000 fishermen and associated people. The annual production of the marine zone is estimated at 8,733 metric tonnes, or 54.5 kg/ha. Apart from the obvious structural complexity of this fishing area, the fishing area is strongly influenced by climate: fishing in the offshore area is very hazardous from May to August due to severe weather conditions.

There are 14 different fishing methods and gears used by the fisherman inside the Sundarbans. These may be clustered into three major groups based on target species and fishing gear. Shrimp fry fishing in particular is considered to be very destructive. This paper attempts to describe fishing practices and issues arising in the SMF and adjacent 20 km marine zone of the Bay of Bengal. Bycatch of turtles is a significant issue and 90% die in the net. Large sharks of 200-240 kg. are sometimes caught, sawfish and rays are also frequently caught in the fishers' net. Molluscs may be of some ecological importance for converting mangrove leaf litter into detritus. Hence, over-harvesting of molluscs may undermine the trophic pyramid. The use of Sundri and other trees as stakes and anchors by the fishers damages the forest. Regulation of fishing methods, mesh size, and participation of fishers in the current fisheries management systems is essential for sustainable fisheries development in the Sundarban Mangrove Forest.

Introduction
The Sundarban Mangrove Forest (SMF) contains the most diverse and rich natural resources of Bangladesh. It is located at the great delta of the Ganges, Brahmaputra and Meghna rivers at the edge of Bay of Bengal, and constitutes the largest contiguous single-tract mangrove ecosystem in the world (Figure 1, Appendix 1). This forest is also an important nursery and breeding ground for many species of shrimp, crab and finfish, and provides habitat for diverse aquatic wildlife e.g.: Estuarine crocodile (*Crocodylus porosus*), Turtles (*Lepidochelys olevacea*), Dolphins (*Platanista gangetica* and *Peponocephala electra*), and molluscs like the Giant oyster (*Crassostrea gigas*) etc.

The SMF covers 6,017 Km^{-2}, of which 1,874 Km^{-2} or 31% is comprised of waterbodies, lakes, rivers, canals and creeks. The Sundarbans include a 20km wide Marine Zone in the Bay of Bengal, which covers an additional 1,603 Km^{-2}. The hydrology of Sundarban mangrove forests is influenced by the tides in the Bay of Bengal.

Over 200 species of fish identified in this forest are harvested by 110,000 to 291,000 fishers using approximately 25,000 small and motorized boats. The Sundarban Mangrove Forest fishery has been managed by the Bangladesh Forest Department since 1897. Fisheries management is limited to issuing permits for economic reasons, regulations for conservation reasons. Conservation science is almost totally lacking. Research on aquatic fauna, finfish, and fisheries is sporadic at best.

The Fishers and their Gear
There are 14 different fishing methods and gears used by the fisherman in and around Sundarban. These are grouped as:

Single species-single gear fisheries
A single primary type of fishing gear takes most of the total catch of a single target species. Other gears take only small quantities of the target species. Bycatch of other species by primary gears tends to be minor. Examples include the gillnet fishery for hilsha (*Tenualosa ilisha*), longlines for mud crab, longlines for prawns, and pull, push and set bagnets for shrimp post larvae and oyster fisheries.

Single species-multi gear fisheries
A particular gear generally targets a single species, but significant quantities of these target species are also taken by other gear. Examples include gillnet fisheries for fatty cat fish and sea bass.

Multi species-Single gear fisheries
Single gears tend to be nonselective, and take many species, e.g. set bagnet, cast net, long line, gill net, shore net, canal gill net, shore seine, otter fisheries etc. Fishing gears fall into 4 classes on the basis of whether they are used in the inshore or offshore fishery and the group of fish or crustaceans they are used to capture.

Class-A: Used in the inshore fishery to catch adult fish and crustaceans. The estimated total catch from these gears in 2000 was 3,038 t. The gears are as follows: (1) Gillnets (2) Cast nets (3) Canal gill nets (4) Shore nets (5) Long line (6) Crab long line (7) Angling rod (8) Otter gill net (9) Otter lift nets etc.

Class-B: Used in the offshore fishery for adult fish and crustaceans. The estimated total catch from these gears in 2000 was 8,710 t. The gears are as follows: (1) Set bagnets (2) Beach seine nets (3) Gillnets etc.

Class-C: Used in the inshore fishery to catch crustacean larvae. The estimated total catch for these gears in 2000 was about 215 million. The gears are: (1) Fine meshed pull nets (2) Fine meshed push nets and (3) Fine meshed set bagnets etc.

Class D: Besides, without using gear, some Sundarban fisher used to collect live and dead molluscs shell by hand from the forest floor and giant oyster from the colonies in the mud. Types, number of gears, number of fishers, and boats in Sundarban are shown in Table 1 (Appendix 1).

How Fishers' Information Helps in Managing the Fishery

A new era for fisheries management dawned in 1999 with the launch of the Sundarban Biodiversity Conservation Project. A new Aquatic Resources Division was formed to deal with the conservation of aquatic biodiversity and sustainable development of fisheries resources within the Sundarban Mangrove Forest.

Under this program, fishery research and stock assessment has been started in the SMF. Fishers are being interviewed and asked to provide information on the status problems and prospects of their fisheries. A lot of information and issues have come up and are being taken into consideration for fisheries management. The fishery information and issues that came out are as follows:

1. The offshore set bagnet fishery often catches turtles *(Lepidochelys olevacea)* which are not desired. Turtles are slow swimmers and can be passively swept into nets by the tide. They cannot find their way out and 90% of them drown and die in the net. The remaining 10% are sometimes returned to the water alive. Two to four species of large sharks of 100-240kgs, and big sawfishes are sometimes caught in the set bagnet as bycatch. Stingrays are frequently caught.

2. During the interview, one complete set of articulated jaws of a large shark was received from a fisher, who reported it as having a large head, 100 kg of weight and about 3m in length. The appearance of the jaw and the fisher's description indicates a rare species of the genus *Glyphis* of Sundarban.

3. Fatty catfish (*Pangasius pangasius*) are very famous for their taste and can fetch much money. However, they are now rarely caught, so fishers who used to target them are now switching to other fisheries for their subsistence.

4. Onboard and port storage facilities are poor due to the lack of ice in the fishing area. Set bagnet fishers land daily at Dubla fish drying yard after 12-16 hours of fishing. As a result, most catches start to rot unsorted. Fishers must therefore dry the fish rather than selling it fresh. The quality of the final product is generally low, and fresh fish gives more cash income for the fishers and more revenue for the forest department. So there is a loss of production and revenue.

5. Dubla fisherman hut is famous in the Sundarban offshore fishery and consists of about 11 fishing and fish landing centres. Fishers from some of these centres catch large quantities of small shrimp by small meshed set bagnet. But this is not very lucrative as prices are poor for small shrimp.

6. Offshore set bagnet fishers catch a lot of juveniles, sub-adults, small shrimps and fish, which is destructive to recruitment and the food chains. This catch does not provide much opportunity for added value after processing.

7. Some fishers use long gill and seine nets of 1.5-2.5 inch stretch mesh in the marine zone between November and early April, when it is easy to catch large number of juvenile hilsha. As a result, hilsha stocks have been depleted abnormally in the rainy season during recent years. Hilsha fishers and fish traders are suffering as a result and thinking of switching over to other fisheries.

8. Shore seine and canal gillnet fisheries in the inshore area can block long area of shore and the mouths of small canals. These gears are capable of catching virtually all fish (juvenile / adults and small fishes) present, resulting in overfishing and depletion of fish stocks in recent years.

9. During September to December, when rainfall is over and tides are lower, some very dishonest fishers illegally use poison in the small canals at low tide to catch almost all kinds and size of species, causing pollution and depletion of fish stocks.

10. Set bagnets and pull and push nets for shrimp post larvae in the inshore area, rivers and canals, also catch enormous numbers of eggs, larvae and fry of many fishes, shrimps, prawn, crabs, and molluscs. Thus, the shrimp fry collection fishery has a high bycatch mortality causing heavy depletion of all kind of fish stocks. Genuine and commercial fishers want to halt the shrimp post larvae fishery to allow fish stocks to recover.

11. Snails, clams and giant oyster are of ecological importance for converting mangrove leaf litter into detritus. Excessive collection for lime, shrimp feed and chicken feed, damages the trophic pyramid of the ecosystem.

12. Local fishers for inshore and offshore fishery using enormous Sundri (*Heretiera fomes*) timber as pole to anchor the net and the boat to the sea and river bed and using enormous Goran (*Ceriops decadra*) and Gewa (*Excoecaria agalocha)* sticks to act as fish drying racks and Nypa leaf for thatching the fishers boats for sleeping and fish drying sheds put additional pressure on forest resources.

Discussion and Recommendation

The bycatch of turtles in set bagnets seems to be of great concern for the conservation of aquatic bio-diversity. Nobody eats turtle meat, or uses any parts of a turtle in this region. The introduction of turtle exclusion devices may address this problem, but needs a lot of trial, training and motivation. Present fishery management will look into developing and implementing turtle bycatch mitigation.

We were fortunate to able to contact Dr. Leonard J.V. Compagno, a leading shark taxonomist of the Shark Research Center, South African Museum, who has been able to examine Glyphis type material. The findings to date are very preliminary and leave many questions unanswered about the taxonomic status and biology of these rare animals. More observations and research will be conducted in future in this regard.

Fatty catfish (*Pangasius pangasius*) in Sundarban have been severely overfished due to their excellent flavour and high value. As a result, they were listed as critically endangered in the 2000 IUCN red list. People are highly motivated to restore stocks and a minimum 5-year ban on by gillnet and long line fisheries is under consideration.

Some traditional artisanal fishers in the Dubla area catch small shrimp *Metapaneus brevicornis, Parapenaeus stylifera, Acetes indicus* and *Nematopalaemon tenuipes* by small meshed set bagnet. Only 10% is sold fresh, the remaining 90% is sun dried for making poultry feed. There is a high bycatch of juveniles of other finfish species. These small shrimps are also an important food for other fishes. The closure of three fishing and landing centers is under consideration to protect juveniles and improve the stock of the food for other fishes.

There is considerable scope for enhancement of the production and value of the catch from the Dubla offshore fishery by improved handling and processing. This would require a number of changes in current fishing practices. The aim is to improve handling and transporting a large part of the catch as fresh, high quality, fish to either processing factories or the consumer market, leading to increased production, higher prices and additional employment. The main products for processing are the shrimps and high value table fish: groupers, croakers, snappers, sea bass, pomfret, Grunts, Indian salmon and the like. These can be deep frozen, packed, and exported. Other alternatives to sun drying Dubla fish species include exportable products such as Sashimi, fish fingers, and fish balls from Ribbonfish and paste and filets from Anchovy. This additional product for export would have the following advantages: higher price, less drying area required, less wood needed, more income and employment through an extended processing plant operating seasons. With this in mind, new initiatives for motivation and negotiation among fish processing plant owners and fishers are being considered. Facilities for ice in Dubla and improved fish processing methods will be developed under the present management systems.

Sharks, sawfish and stingrays are not commonly used in the community other than their jaws, saw blade and tail, which are used as show items. The meat is used by some Indigenous people, but fetches an extremely low price. Measures planned to protect biodiversity include introduction of different devices or techniques in the net to avoid these species with fishers' participation in training and trials.

Offshore set bagnet fishers should be forced to refrain from catching juveniles, sub-adults, small shrimps and fish to improve recruitment and availability of food for other fishes. A bag end mesh size of at least 2.5 to 3.0 inch stretch mesh should solve this problem, but will have to be introduced in consultation with fishers and fish traders.

Shore nets and canal gill nets will be regulated by mesh size, riverbank zoning and season to improve recruitment by ensuring that only adults are taken in the fishery.

Catching of fish by poison is destructive, and induces health hazard and pollution. This practice is illegal and it needs close watch to stop it. So increased and regular patrolling inside the forest and motivating and engaging fishers against this is under way to stop this malpractice.

Hilsha stocks are dwindling every year, because of recruitment problems, primarily capture of juvenile hilsha. A ban on small mesh seine and gillnets from November to April is being considered to improve hilsha stocks.

Fine meshed set bagnets, and pull and push nets have been identified as the most destructive of all the fishing gears in the Sundarban. Bycatch mortality is very high. Data from 1994 reveal that in catching of 253 million shrimp fry about 90% of the larvae of many other species was destroyed as bycatch. (Chantarasri 1994). This destruction of juveniles is continuing, leading to serious annual depletion of fish stocks. Shrimp farmers prefer natural postlarvae, as they seem to be stronger and better survivors. This ensures continuing high demand for natural post larvae. Sufficient shrimp and prawn hatcheries and nurseries must be established to ensure supply of abundant and healthy shrimp post larvae to the shrimp farm. Alternative livelihood options must also be considered for the postlarvae collector to reduce and stop this destructive method of fishing. Integrated coordination between the Department of fisheries, shrimp farmers and Forest department is working to supplement natural shrimp post larvae to the shrimp farm. So efforts are underway to stop shrimp post larvae collection from Sundarban water to recover fish stocks and aquatic biodiversity. A recent government ban on post larvae collection is going to be enforced, but will take time.

The snails, clams and giant oyster are distributed on the forest floor and mud respectively inside Sundarban. These molluscs are used for preparing lime, shrimp and chicken feed. Live and dead shells are collected, but high collection rates are causing damage to the trophic pyramid of ecosystem. Data generation and restriction on live molluscs collection and on species, season and area is being considered to recover and improve the ecosystem.

Use of timber, wooden sticks and nypa leaf for making anchor for boat and nets, fish drying rack and thatching boat, temporary shed and fish depots respectively are also a significant cause of forest resource depletion. Motivating and teaching fishers about these destructive methods, increased patrolling and enforcing regulation, supplying alternate material for making anchor and fish drying rack, will be introduced to reduce the forest resources depletion.

New fisheries management pattern and systems with pragmatic regulations after consultation with fishers is underway to improve the Sundarban fishery in a sustainable way. To increase fish stocks and improve biodiversity, hence forth, rivers and canals within the wild life sanctuaries comprising an area of 1,39,000 ha and 18 other important canals inside Sundarban declared closed to fishing. Seasons are also declared closed for fishing of Mud crabs, Eeltail cat fish, Sea bass, Giant fresh water prawn, mullets during April to June.

References

Chantarasri 1994

APPENDIX 1

Table 1: Type of gears, number of gears, number of fishers and boats in Sundarban

SI no.	Type of gear / Method of fishing		No of gears	No. of Fishers	No of boats	Remarks
01	Gill nets	Fatty cat fish gill net	0 6	20	06	Operates in the inshore fishery area.
		Hilsha gill net	500	2,000	500	Operates both inshore and offshore area.
		Other gill nets	420	1500	420	For larger sea species e.g. Indian salmon, croakers, mackerels etc. and for small finfish e.g. ladyfish, mullet, catfish, paradise threadfins. Operates both in offshore and inshore fishery area.
02	Cast net		2505	5000	538	Operates from river bank and some from boats in inshore area for mixed fish.
03	Shore seine net		20	120	20	Operates in offshore area.
04	Pull net		85,000	1,20,00	....	Use no boats but pull the net along the bank of river of inshore area for shrimp/prawn fry.
05	Push net		25,000	37,000	...	-Do-
06	Long line		705	1410	705	Operates in the inshore area.
07	Crab long line		3000	6,000	3000	-Do-
08	Angling rod		500	1000	100	-Do-
09	Set bagnet (SBN)	For adult fish and crustaceans	2963	17,700	1902	Operates in the offshore area.
		For crustacean larvae	20,000	40,000	16,970	Operates in the inshore area for shrimp/ prawn fry only.
10	Shore net		385	1540	385	Operates in the inshore area
11	Canal gill net		250	800	250	-Do-
12	Otter gill net		3	11	3	-Do-
13	Otter lift net		6	20	6	-Do-
14	Oyster & gastropod collection.		-	1100	200	No gear is used but are collected by hand from inshore and offshore area.
	Total		**1,41,263**	**2,35,22 1**	**25,005**	

Shrimp fry means *Penaeus monodon* post larvae and prawn fry means *Macrobrachium rosenbergii* post larvae.
Source: Sundurban Fores Office 2000.

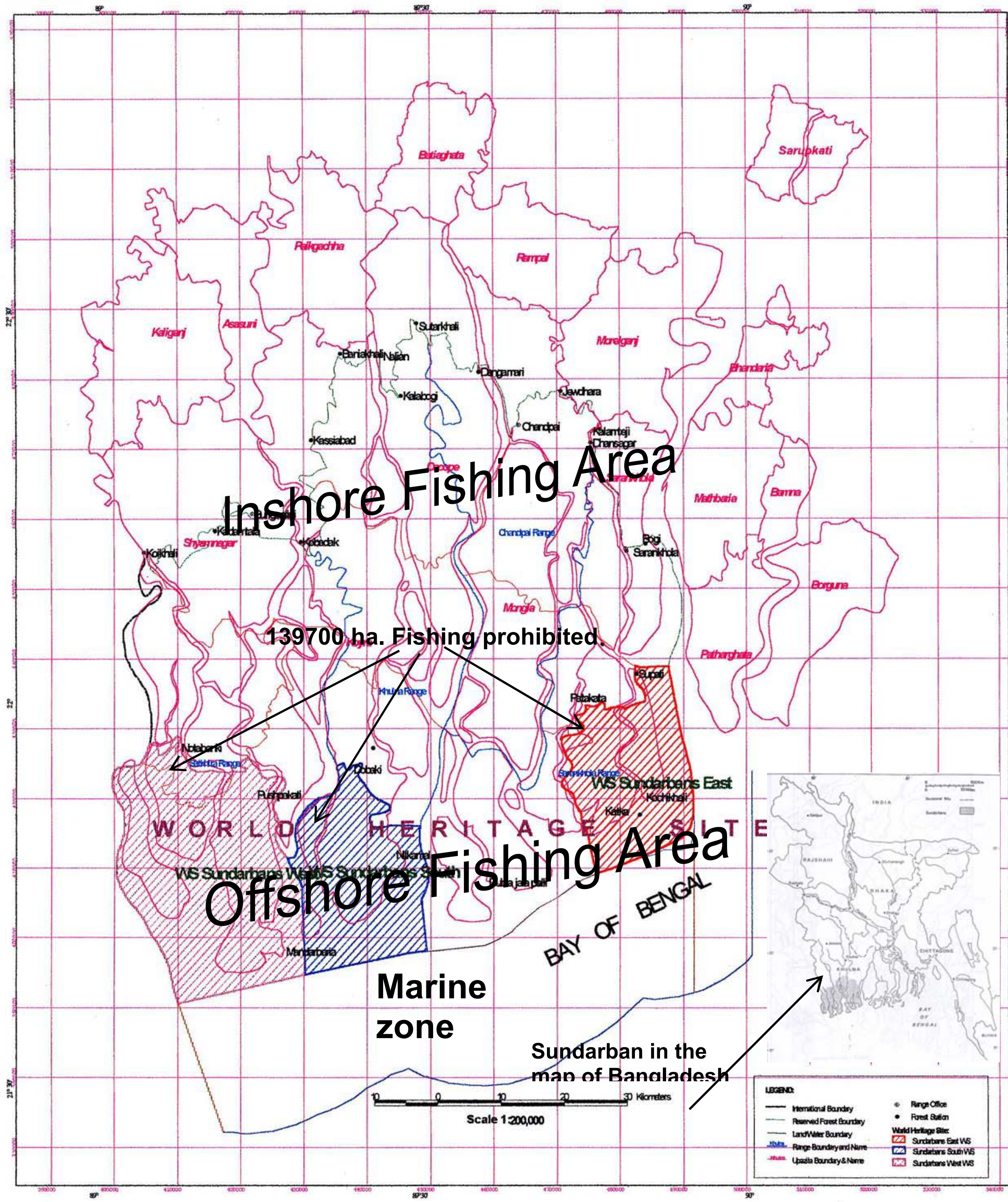

Figure 1: Map of Sundarban, showing Inshore, Offshore area, river systems, world heritage site, Wildlife sanctuary and fishing prohibited area.

WHAT'S IN THERE: COMMON NAMES OF BRAZILIAN MARINE FISHES

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ABSTRACT
The common names of plants and animals carry much of the information that humans have about these organisms. This is illustrated here for a sample of 537 fish species, representing 65% of the marine and brackish water fishes of Brazil, for which 3,012 common names were compiled and analyzed. Overall, 40% of the names originated from Latin (via Portuguese), and 24% from Amerindian languages (Tupi, Guarani). Languages from around the Mediterranean rim (Spanish, French, Greek, Arabic) also contributed numerous names, while names from African languages were relatively rare. The words used to name the Brazilian fishes are mainly primary lexemes, subsequently modified according to morphology, color patterns, non-fish animals and inanimate objects. Attributes earlier hypothesized to lead to fish being given specific common names (commonness, ease of observation, size in relation to humans, and striking appearance) were tested, and three found to apply. On the other hand, a hypothesis initially based on studies of Amazonian fishes and languages, and later corroborated for Austronesian languages, associating low frequency sounds [a] with large fishes, and conversely for high frequency sounds [i], led to ambiguous results. The diversity of Brazilian marine and brackish water fish names, while culturally and linguistically interesting, is a problem in terms of standardizing national fisheries statistics. Thus, the suggestion is made to initiate a consultative process that would extract from the wealth of names documented here a set of standard fish names that would perform for Brazil the same useful roles that the list of North American common names of fish does for Canada and the USA.

INTRODUCTION
Inconsistencies in common names of fishes between different places can cause a serious problem when dealing with the scientific literature, or with catch statistics, especially in tropical and developing regions where small-scale fisheries exploiting a wide array of species are very important. Before we can discuss how to incorporate traditional or local ecological knowledge into fisheries management, we must answer what may appear to be a trivial question: which species are we talking about? This is the reason why this work was initiated, later to evolve into an analysis of the way common names are attributed to Brazilian fishes.

There is an extensive literature on why and how organisms are named, constituting a discipline, ethnobiology, which deals with the study of the complex relationships people establish with plants and animals (Berlin 1992). The utilitarian reasons for naming organisms are obvious and long recognized, but have been complemented by Lévi-Strauss (1966), who argued that things are named as a result of an "intellectual need," i.e., because of an inherent striving for order. Indeed, according to this view, it is only after things have been named that they can be evaluated as being useful or not.

This contribution aims to show how fishers and other Brazilians perceive marine fishes and how this may have influenced how these species were named. As well, we re-evaluate the role of 'utility' in the naming process.

MATERIALS & METHODS
A database with 3,012 common names of marine fishes from Brazil was compiled based on the following ten sources: Brandão (1964), Carvalho and Branco (1977), Lima and Oliveira (1978), Santos (1982), Nomura (1984), Suzuki (1986), Godoy (1987), Soares (1988), Carvalho-Filho (1999), and Szpilman (2000). According to the detailed taxonomy in FishBase (Froese and Pauly, 2000), these names refer to a total of 537 species representing 65% of the marine and brackish water fishes of Brazil. The broadly asymptotic shape of our plot of cumulative number of names versus source suggests that our sample includes a substantial fraction of the existing names, and hence can be considered representative (Figure 1).

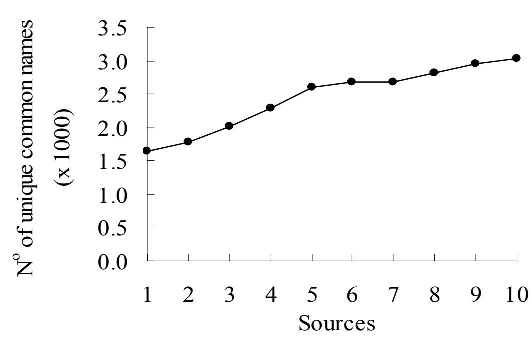

Figure 1. Cumulative number of common names of Brazilian marine fishes successively extracted from ten sources.

The common names of each species were complemented by translations (from Portuguese to English), and information on their gender (female, male or indeterminate), origin (language or language family), structure (multiple choice descriptors of the name's 'core' and theirs modifiers), and life stage (juveniles, adults or both). The origin of the common names was defined according to Tibiriçá (1984), Ferreira (1999) and Bueno (1998).

The four attributes required for fish to be named proposed by Berlin (1992), i.e., commonness, striking appearance, ease of observation and size in relation to humans, were tested using an approach developed by Palomares *et al.* (1999) and data available in FishBase (Froese and Pauly, 2000). The corresponding hypotheses are presented in the next section, along with the results. The influence of size in the naming process was also analyzed using the relationship between an index that represents the total salience of organisms, the 'specific species recognition ratio' (SSRR), and the (base 10) logarithm of the total length (Hunn, 1999). We applied the two methods suggested by this author to analyze this relationship; both are briefly described below:

(a) sampling unit method, where the sampling unit was family; SSRR is the ratio between the number of common names and the number of species included in each family (Hunn 1999). A total of 102 families was included in this analysis.

(b) single species point method, where the sampling unit was species (Hunn 1999). According to this author, "SSRR of a species … is 1 if it corresponds 1:1 to a basic folk taxon [common name], it is 0.5 if it is one of two species included within a single basic folk taxon; it is 0.33 if it is one of three such species; and it may be 2.0 if it is 'split' between two basic folk taxa; and so on". We introduced a variant to this method, wherein we simultaneously allow for: (i) the same common name to be used for more than one species, and (ii) for each species to have different common names. Then, we add partial SSRRs to obtain the total SSRR.

Sound-symbolism was tested according to Berlin (1992) and gender issues related to the naming process were analysed using maximum length data for each species and gender available in FishBase (Froese and Pauly 2000).

RESULTS & DISCUSSION

Diversity and origin of fish names

The first result of this analysis is the high nomenclatural diversity associated with Brazilian marine fishes. Although this is a locally well-known problem, it had not been previously quantified on a national scale. From the total of 537 species analyzed, about 130 have only one common name, while two or three names are available for 80 and 50 species, respectively (Figure 2 a, b). Conversely, we have the extreme cases of three species with 30 names each, *Cynoscion virescens, Macrodon ancylodon* and *Opisthonema oglinum*, which are widespread along the coast and commercially important (CEPENE, 2000; Godoy, 1987; Szpilman, 2000).

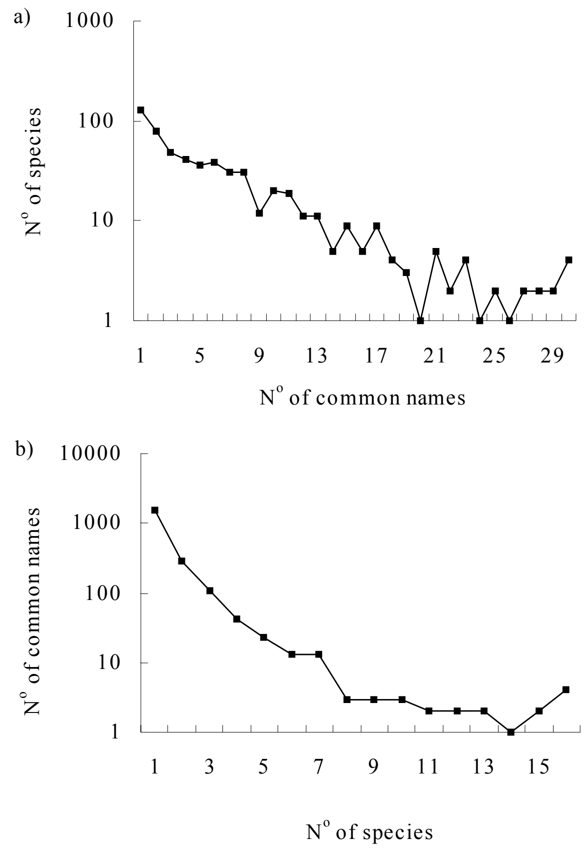

Figure 2. Nomenclatural diversity of Brazilian marine fishes: a) frequency of scientific species that have one to thirty common names; b) frequency of common names that correspond to one to sixteen scientific species.

Each of half of the 3,012 names pertains to only one species (Figure 2 a, b). The other extreme is three cases where the same common name is used for 16 different species, even from distinct families: "sardinha" (sardine) for species included within the families Clupeidae and Engraulidae, "manjuba" (silverside) for

Clupeidae, Engraulidae and Atherinidae, and "solha" (sole) for Achiridae, Bothidae and Paralichthyidae.

Forty percent of the common names of Brazilian marine fishes originated from Latin through Portuguese, followed by Amerindian languages (24%) and others (Greek, Arabic, French). The Amerindian languages represented in our sample names were mainly Tupi and Guarani, both closely related and forming the basis of the called "Língua Ge[ne]ral" encouraged by the Jesuit Order (Bueno 1998). The contribution from African languages is surprisingly low considering that African cultures had a strong impact on Brazilian culture since the late 18th century, (Freyre 2000), and people of African ancestry were predominant among Brazilian fishers in the mid 19th century (Figure 3). Castro (2001) suggests that Brazilian dictionaries frequently attribute words from African languages to Tupi, or do not identify them as such, for reasons that she identifies as "extra-linguistic". We found two examples of this: (a) the word "xangó" (a sardine), derived from a language of the (African) Bantu family, and labelled as a "Brasilianism" in the dictionary issued by Ferreira (1999), and the word "carimbamba" (a jack), also originated from a Bantu language, but attributed to Tupi by the same author.

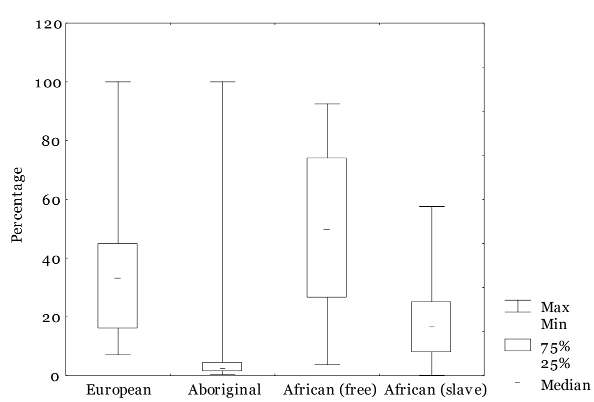

Figure 3. Origin (and status) of the fishers registered in

The core, first and second modifiers of common names of Brazilian fishes consist most frequently of primary lexemes (in 1,793 names or 38% of the total), followed by references to morphology, color pattern, non-fish animals, inanimate objects, size and others (Figure 4). Morphology and other descriptors of the fish body, such as colour patterns and size are quite important in naming fishes in Brazil, while habitat and economic value do not seem to influence this process as much as they do, e.g., in Haïti (Wiener, this volume).

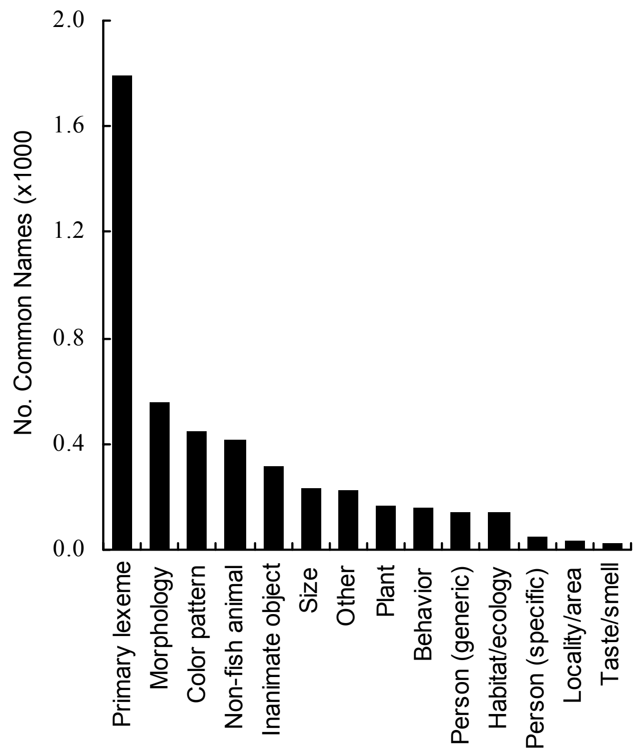

Figure 4. Descriptors used in the core, and in the first and second modifiers of the common names of Brazilian marine fishes.

Test of Berlin's attributes

Attribute (1): Commonness

We tested the hypothesis that the common fish species that sustain fisheries should be named more frequently than those which do not. This is corroborated, as 78% of the species listed in FishBase as exploited by commercial or artisanal Brazilian fisheries have common names (Table 1). Conversely, species identified as "of no interest" were named in only 26% of the cases. Thus, this attribute applies to Brazilian fishes and seems to show the utilitarian influence on the naming process.

Attribute (2): Striking appearance

We followed Palomares *et al.* (1999) in linking striking appearance to monotypy, i.e., the fact that taxonomists tend to create extra families (or higher taxa) to accommodate single species with striking attributes. In general, sixty-two per cent of the monotypic families were named, which is slightly lower than the ratio of 67% for all species included in the analysis (Table 1). This attribute seems not to be pertinent. However, we should consider the confounding effect of the commercial importance, as monotypic families for the exploited category presented a naming ratio of 71%, while the non-exploited species were named in only 32% of the cases.

Attribute (3): Ease of observation
Ease of observation is an important attribute, as 73 to 75% of the more accessible species (reef-associated and pelagic) were named, while lower values were obtained for species that occur in deeper water (Table 2). Thus, this attribute also applies to Brazilian fishes.

Attribute (4): Size in relation to humans
Among the attributes of fishes, and other organisms for that matter, size is the most important. Notably, people cannot name what they cannot see. On the other hand, what they can see, at least with unaided eyes, is, according to May (1988), only the "tip of the biodiversity iceberg". Thus, the larger the specimens of a given species can be, the higher the probability is of that species having a common name (Table 3); this corroborates Berlin's fourth attribute. We also observed an increase of the number of common names per species with maximum length. JW Wiener (*pers. comm*) has found an opposite trend, and we think this is due to our last length classes being rather large (to account for the fact that large fishes vary more in size than small fishes). To evaluate this issue in a rigorous manner, we used the methodology proposed by Hunn (1999) and the results are presented in the next section.

Size again
Our plots of the scientific species recognition ratio (SSRR) against the logarithm of length at both family and species levels (Figure 5a and b) show a clear, dome-shaped pattern, very different from the linear relationships advocated by Hunn (1999) for mammals, birds and fishes. This pattern may be due in part, to our having counted what may be spelling variants of the same names as full common names. However, these results are consistent with our observations of few names in large species, notably for the largest extant fish, the whale shark, which has only one (exclusive) name in Brazil, "tubarão-baleia". In fact, three out of the seven graphs presented by Hunn (1999), all related to birds, show the same dome-shaped pattern, although he fitted them with a linear relationship. Actually, good linear adjusts occurred only in association with small sample sizes. Thus, we suggest that it is not "large" organisms that have many common names, but "middle-sized" ones, with the size with the most names varying among taxa.

Table 1. Analysis of the first and second of Berlin's attributes: the first is expressed by commercial importance, the second by monotypy (one species per family). Importance and monotypy data from FishBase (Froese and Pauly, 2000).

IMPORTANCE	All Brazilian species	Spp. with local names (%)	Monotypic spp.	Mono. spp. with common names (%)
Exploited[1]	466	78	80	71
Non-exploited[2]	336	26	25	32
TOTAL	802	67	105	62

1) This includes the following categories listed in FishBase: highly commercial, commercial, minor commercial, and artisanal fisheries. The last category also comprises subsistence fisheries; 2) Includes all categories not listed in 1.

Table 2. Analysis of the third of Berlin's attributes (ease of observation), as captured by habitat types. Habitat data from FishBase (Froese and Pauly, 2000).

HABITAT	All Brazilian species	Species with common names (%)
Pelagic	154	75
Reef-associated	162	73
Demersal	300	60
Benthopelagic	73	44
Bathydemersal	40	5
Bathypelagic	73	3
TOTAL	616	56

Table 3. Analysis of the fourth of Berlin's attributes, as expressed by fish size. Length data from FishBase (Froese and Pauly, 2000).

LENGTH (cm)	All Brazilian species	Species with common names (%)	Common names per species
Small (1-30)	204	50	2
Medium (31-70)	176	71	6
Large (71-2000)	179	79	8
TOTAL	559	66	5

'Fishness'
'Fishness' expresses a smooth, slow and continuous flow, and is related to the presence of low-frequency vowels such as [a] in common names (Berlin 1992), and contrasts with the high-frequency sounds of vowels such as [i], related to the rapid motion typical of birds. The common names of Brazilian fishes indicate 'fishness' rather well (Figure 6).

As well, sound-size symbolism implies that high-frequency vowel [i] should be related to small sizes and low-frequency vowels to larger sizes, as shown for frogs and toads, butterflies, and Amazonian fishes by Berlin (1992), and for Philippine fishes by Palomares *et al*. (1999). However, this does not appear to hold for Brazilian marine fishes (Table 4). Moreover, combinations of these vowels with the two most common consonants in the common names [c] and [p] did not show, either, any relationship with size (data not shown).

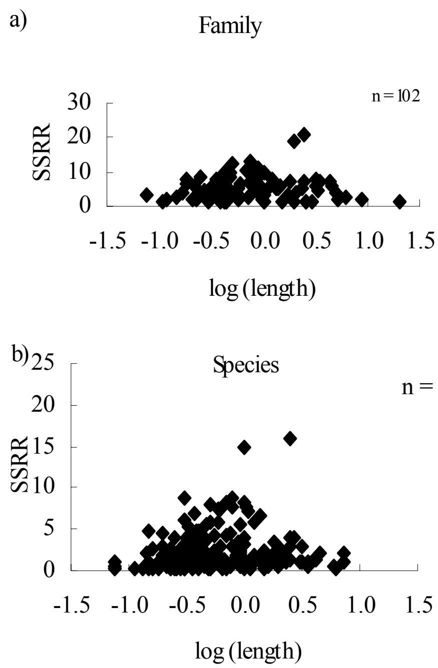

Figure 5. Relationship between the scientific species recognition ratio (SSRR) and the logarithm of length, in meters: a) Sampling unit method (Family level); b) Scientific species point method (Species level).

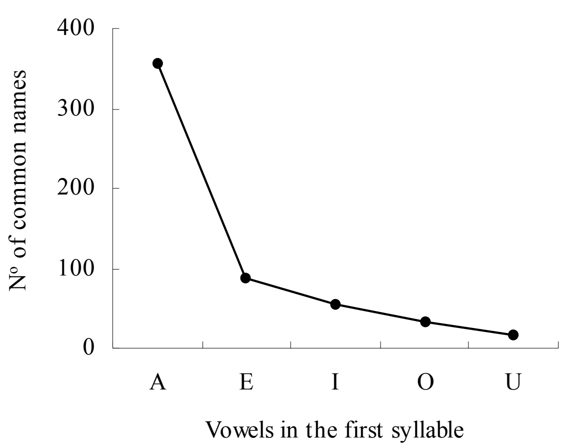

Figure 6. Vowels in the first syllable of the Amerindian names (Tupi and Guarani) of Brazilian fishes.

Table 4. Number of names with [a] or [i] as the first vowel in the common name for three classes of fish length.

LENGTH (cm)	[a]	[i]
Small (1-30)	73	20
Medium (31-70)	165	38
Large (71-2000)	117	29
TOTAL	355	87

Are fishers gender biased?

Fish common names of the masculine gender (in Portuguese) were mainly attributed to larger fish and feminine words to smaller fishes (Table 5). This can be interpreted as reflecting gender bias among the overwhelmingly male fishers, since the females of 64% of fish species reach maximum sizes in excess of those reached by the males (see Pauly 1994, who discusses a related bias among scientists).

Table 5. Mean length of fish species whose names are expressed by a word of masculine or feminine gender as identified by the ending letters.

GENDER (& ENDING)	Number	Length (cm)
Masculine (o)	404	175
Feminine (a)	527	98

Need for standardization

Brazil has longstanding problems with standardization. Thus, the first attempts to introduce the metric system to weights and measures was strongly opposed up to the late 1800s, notably by people who viewed diversity as one of Brazil's strengths (Marcílio and Lisanti 1973). The notion of standardizing the common names of fishes can thus be expected to meet much resistance, in spite of the advantages of such standardization, as evidenced by the wide official use, in the USA and Canada, of the list of common names of North American fishes (Robins *et al.* 1991).

Given this resistance, the success of such standardization demands a broad consultative process, including all parties directly or indirectly involved with fishes: universities, governmental institutions such as the Brazilian Institute for Environment and Renewable Natural Resources (IBAMA), the Ministry of Agriculture, non-governmental organizations, associations of recreational and commercial fishers, etc.

The principles to be used in this process may be based on those used since 1948 by the Committee on Names of Fishes for United States and Canada (Robins *et al.* 1991), with modifications as required by the Brazilian context. The main idea here is to have a unique common name for each species, which should be simple, descriptive (using color pattern, structural attributes, ecological characteristics or geographic distribution), and reflect the ethnic diversity of Brazil in terms of names' origins. Moreover, non-descriptive names, notably those honouring people should be avoided, along with the names of other organisms.

The final list would be made available by an appropriate national organization, and also through FishBase, a well-established international database on fishes. National fisheries statistics would be presented using this official list, which would avoid the problems due to the use of a multitude of ill-defined names.

Conclusions

Commonness, ease of observation and size are strongly related to the probability of Brazilian marine fishes having common names, and this can be interpreted from both utilitarian and non-utilitarian perspectives.

The nomenclatural diversity of Brazilian marine fishes poses a big problem in the standardization of national fisheries statistics. We recommend start of a consultative process that would extract a set of standard names from the >3,000 names documented here. These standard names would then perform for Brazil the same useful roles that the list of North American common names of fish does for the USA and Canada.

Acknowledgements

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References

Berlin, B. (1992). *Ethnobiological classification. Principle of categorization of plants and animals in traditional societies*, Princeton, New Jersey. 335 p.

Brandão, J. M. (1964). Glossário de nomes dos peixes: sistemático, português, inglês. *Boletim de Estudos de Pesca* 4 (6): 1-59.

Bueno, F. S. (1998). *Vocabulário Tupi-Guarani - Português*. Éfeta Editora, São Paulo, Brazil. 688 p.

Carvalho, V. A. and R. L. Branco (1977). Relação de espécies marinhas e estuarinas do nordeste brasileiro. *P.D.P. Documentos Técnicos* (25): 1-60.

Carvalho-Filho, A. (1999). *Peixes: costa brasileira*. Melro, São Paulo. 320 p.

Castro, Y. P. (2001). *Falares africanos na Bahia*. Topbooks Editora e Distribuidora de Livros, Rio de Janeiro. 366 p.

CEPENE (2000). Boletim estatístico da pesca marítima e estuarina do nordeste do Brasil - 1999. *Boletim estatístico da pesca marítima e estuarina do nordeste do Brasil*: 1-150.

Ferreira, A. B. H. (1999). Dicionário Aurélio Eletrônico - Século XXI. Lexicon Informática Ltda., Rio de Janeiro, Brasil.

Freyre, G. (2000). *Casa grande & senzala*. Record, Rio de Janeiro. 668 p.

Froese, R. and D. Pauly (2000). *FishBase 2000: concepts, design and data sources*. ICLARM, Los Baños, Laguna, Philipinnes. 344 p.

Godoy, M. P. (1987). *Peixes do estado de Santa Catarina*. Editora da UFSC, Florianópolis, Brazil. 571 p.

Hunn, E. (1999). Size as limiting the recognition of biodiversity in folkbiological classifications: one of four factors governing the cultural recognition of biological taxa. In: Folkbiology. D. L. Medin and S. Atran (eds.). Massacchusetts Institute of Technology, Cambridge, Mass.: 47-69.

Lévi-Strauss, C. (1966). *The savage mind*. The University of Chicago Press, Chicago. 290 p.

Lima, H. H. and A. M. Oliveira (1978). Segunda contribuição ao conhecimento dos nomes vulgares de peixes marinhos do nordeste brasileiro. *Boletim de Ciências do Mar* (29): 1-26.

Marcílio, M. L. and M. L. Lisanti (1973). Problèmes de l'histoire quantitative du Brésil: métrologie et démographie. *Colloques Internationaux du Centre National de la Recherche Scientifique* (543): 29-37.

May, R. M. (1988). How many species are there on Earth? *Science* 241 (4872): 1441-1449.

Nomura, H. (1984). Nomes científicos dos peixes e seus correspondentes nomes vulgares. In: (eds.). Editerra, Brasília, Brasil: 27-63.

Palomares, M. L., C. V. Garilao and D. Pauly (1999). *On the biological information content of common names: a quantitative case study of Philippine fishes*. Proceedings of the 5th Indo-Pacific Fish Conference, Nouméa. p.861-866. Société Française d'Ichtyologie & Institut de Recherche pour le Développement.

Pauly, D. (1994). *On the sex of fish and the gender of scientists*. Chapman & Hall, London. 250 p.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea and W. B. Scott (1991). Common and scientific names of fishes from the United States and Canada. *American Fisheries Society, Special publication* 20: 183 p.

Santos, E. (1982). *Nossos peixes marinhos (Vida e costume dos peixes do Brasil)*. Editora Itatiaia Limitada, Belo Horizonte, Brasil. 265 p.

Silva, L. G. (1988). *Os pescadores na história do Brasil*. Vozes, Recife. 222 p.

Soares, L. H. (1988). Catálogo dos peixes do litoral do Estado do Rio Grande do Norte. *Boletim do Departamento de Oceanografia e Limnologia do Centro de Biociências da Universidade Federal do Rio Grande do Norte* 7: 1-39.

Suzuki, C. R. (1986). *Guia de peixes do litoral brasileiro*. Edições Marítimas, Rio de Janeiro, Brazil. 394 p.

Szpilman, M. (2000). *Peixes marinhos do Brasil: Guia prático de identificação*. Instituto Ecológico Aqualung, Rio de Janeiro. 288 p.

Tibiriçá, L. C. (1984). *Dicionário Tupi-Português - Com esboço de gramática de tupi antigo*. Traço Editora, Santos, Brasil. 200 p.

Wiener, J. W. (this volume). Marine resource knowledge related to fish classification in Haïti. *Fisheries Centre Research Report*.

FISHERS' KNOWLEDGE ROLE IN THE CO-MANAGEMENT OF ARTISANAL FISHERIES IN THE ESTUARY OF PATOS LAGOON, SOUTHERN BRAZIL.

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ABSTRACT
This paper analyses the ecological knowledge of small-scale fishers in the estuary of Patos Lagoon, obtained from interviews and questionnaire surveys, and discusses its potential role in the local co-management of artisanal fisheries. This study demonstrates that fishers' knowledge can provide a valuable set of information about the characteristics of practices, tools and techniques that led a more sustainable pattern of resource use in the past. Such knowledge can contribute to the formulation of present management plans to better adapt rules to local social and environmental conditions. However, the use of fishers' knowledge in the co-management of artisanal fisheries was shown to be hampered by three identified factors: the low expectations among scientists and decision makers of the value of fishers' knowledge for management; the lack of incentives for fishers to act according to their ecological knowledge due to problems in the definition of property rights; and the contradictory paradigms in place about the role of scientific and local knowledge in the management of the estuarine ecosystem.

INTRODUCTION
Worldwide crises in fisheries management have triggered changes in the process of governance and in the approach to study of common property resources (CPRs). The co-management theory and the theory of the commons have played an important role in restructuring the field of fisheries CPRs management (Berkes 1989; Pinkerton 1989; Ostrom 1990). The essence of co-management, as defined by Pinkerton (1989), is the involvement of fisher's organizations and fishing communities in management decision-making through power sharing: sharing both between government and locally-based institutions, and among differently-situated fishers. It represents a way to decentralize decisions, delegate rights and roles to communities and move towards a joint decision-making process.

One of the strongest aspects of fisheries co-management that differentiates it from other models of participatory management is the knowledge of the environment and resources that fishers pursue. Fishers' knowledge is used here interchangeably with Local/Traditional Ecological knowledge (TEK) to refer to the cumulative body of knowledge, practice and beliefs, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings with one another and with their environment (Berkes 1999; Neis and Felt 2000). TEK contains empirical and conceptual aspects, is cumulative over generations, and is dynamic, in that it changes in response to socio-economic, technological and other changes (Berkes, 1999). It is well known that the knowledge held by fishers in many areas of the world, especially in small-scale traditional societies, may be extremely detailed and relevant for resource management (Berkes and Folke 1998). In fact studies have shown that it is the complimentary characteristics of local knowledge and scientific knowledge that make co-management stronger than either community-based management or government management (Pomeroy and Berkes 1997).

Artisanal fisheries in the estuary of the Patos Lagoon, located in the Southern Brazilian coastal zone, are going through a tragedy of the commons. Fisheries resources are decreasing sharply, compromising the livelihood of more than 10,000 small-scale fishers (Reis 1999). The failure of past historical institutions to manage these resources triggered the establishment of new institutional arrangements in 1996, redefining rules and rights by which to manage the resources (Reis and D'Incao 1998; Kalikoski *et al.* in press). A co-management forum (Forum of Patos Lagoon) composed of different stakeholders was established to (1) discuss and develop alternative actions to mitigate and/or resolve the problems of the fishers and the crisis in the artisanal fisheries sector, (2) recover the importance of artisanal fisheries and (3) share decisions to address problems more effectively. The role of small-scale fishers' knowledge in this new institutional arrangement has not yet received the required attention, and the exchange of knowledge between fishers and scientists has not yet been explored to its full potential.

The present scarcity of information raises the question if it is possible to identify an informal knowledge system used by small-scale fishers that could improve co-management in the estuary of Patos Lagoon and hence help in the maintenance of local ecosystem resilience. The assumption is that, in the context of the Patos Lagoon co-management Forum, such knowledge may contribute to developing or re-formulating local management plans to better adapt them to local social and environmental conditions. This paper aims to contribute to the subject by analysing two questions: 1) how has the local social system developed management practices based on ecological knowledge for dealing with the dynamics of the ecosystem in which it is located?; and 2) what are the current barriers and opportunities to using TEK in the Forum of Patos Lagoon co-management?

METHODS

Fieldwork in the estuary of Patos Lagoon was carried out from April 2000 to August 2001. Data were obtained from primary and secondary sources. The primary sources were (1) researcher observations of the Forum of Patos Lagoon meetings, (2) informal conversations, (3) in-depth semi-structured interviewing, and (4) a questionnaire survey. Details of interviews and survey procedures are described in Kalikoski *et al.* (in press) and in Kalikoski (in prep.). Supplementary data were obtained from secondary sources including analysis of scientific publications, local newspapers, meeting minutes, laws, decrees and policy statements from national profile sources such as: Federal Institute for the Environment (IBAMA) and the Federal Sub-Secretary for Fisheries Development (SUDEPE).

Interviews and questionnaires focused on four levels of analysis, consistent with the description of TEK as a *knowledge-practice-belief complex* as proposed by (Berkes 1999). Level one relates to the local knowledge of the animals and ecosystems, such as the behavior and habitat of fish, and the timing of fishing seasons. Such local knowledge may not, in itself, be sufficient to ensure the sustainable use of resources. Therefore, level two refers to the existence or sophistication of a resource management system that uses local environmental knowledge to devise an appropriate set of practices, tools and techniques for resource use. However for a group of fishers to manage resources effectively, appropriate institutions or a social organisation must exist for co-ordination, co-operation, rule making and rule enforcement (Ostrom 1995; Berkes 1999). Accordingly, the third level of analysis is about institutions – the set of rules in use to coordinate the management of the resources. Lastly, the forth "worldview" level represents the system of belief that "shapes human-nature relations and gives meaning to social interactions" (Berkes 1999). As put by the author distinctions between the levels of management systems and institutions are sometimes artificial, and although the four levels are hierarchically organised, there is often feedback between the knowledge levels such that worldviews may themselves be affected by changes occurring, for instance, with the collapse of a management system.

THE ESTUARY OF PATOS LAGOON ECOSYSTEM

With an area of approximately 10,000 km², Patos Lagoon is recognized as the world's largest choked lagoon, stretching from 30°30' to 32°12' S near the city of Rio Grande where the lagoon connects to the Atlantic Ocean (Figure 1). The estuarine region encompasses approximately 10% of the lagoon, and is occupied by diverse and abundant flora and fauna. The estuary is shallow, with variable temperature and salinity depending on local climatic and hydrological conditions (Castello 1985). The dynamics of estuarine waters are mainly driven by the wind and rain regime with only minor influence of tides. The Patos lagoon system communicates with the ocean via a channel between a pair of jetties, about 4 Km long and 740 m apart at the mouth. All the estuarine dependent marine organisms enter and leave the estuary through this channel for nursery, reproductive and feeding purposes. Of the more than 110 species of fish and shellfish species that occur in the estuary (Chao *et al.* 1985), four represent important fisheries resources, and have sustained artisanal fisheries for more than a century. Short descriptions of these species life-cycle and dynamics are provided in Table 1.

Different species' life history characteristics create a well defined seasonal variability in the diversity and abundance of resources in the estuary and also in the availability of resources to artisanal fisheries (Figure 2). Artisanal fisheries landings have declined steadily since the mid-1970s, to ca. 5,000 tonnes in the late 1990s, the lowest landings recorded in the last 50 years. Fisheries landings also present a marked interannual variability, with a period of approximately 6 years, which seem to be related to the occurrence of strong ENSO events. Figure 3 uses Holling's (1986; 1992) model to represent the dynamics of artisanal fisheries resources in the estuary of Patos lagoon by accounting for four major phases in resource life cycles in the estuary and coastal areas. The phases are: *exploitation*, in which fisheries resources enter the estuarine environment for growth or reproduction purposes, leading to the *conservation* phase in which resources increase in size and maturity. Adults leave the estuary in the *release* phase to spawn and recruit in the marine environment closing the cycle with the *renewal* phase. The influence of climatic conditions is conspicuous in the transition from the *renewal* to *exploitation* phases because of its effect on recruitment success and on the migration/dispersion of resources towards the estuarine environment.

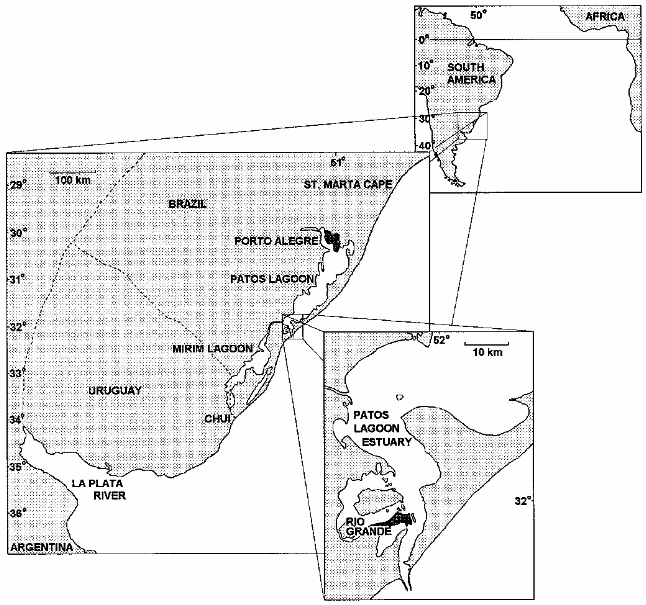

Figure 1. Location of the Patos Lagoon estuary in Southern Brazil (source Seeliger *et al.*, 1997).

Table 1. Summary of biology and life-cycle of main artisanal fisheries resources in the estuary of Patos lagoon (sources Reis, 1986; D' Incao, 1991; Vieira and Scalabrin, 1991Haimovici, 1997;).

Pink shrimp, *Farfantepenaeus paulensis*	Estuarine dependent species. Adults spawn in shelf waters below 50 m deep, producing demersal eggs that hatch into planktonic larvae. When approaching estuaries the larvae develops a benthic habit settling in shallow areas where they will grow for a few months until reaching the pre-adult phase when they migrate to the ocean reinitiating the cycle. The growing phase in the estuary may last between 4 and 10 months when they reach ca. 7 cm of length. Larvae enters with varying success into the estuary all year round but mainly in the spring and summer depending on environmental forcing of wind and freshwater outflow.
Marine catfish, *Netuma barba*	Slow-growing, anadromous species with a calculated life span of approximately 23 years, though adults may occasionally attain 36 years of age and a total length of 98 cm. At the end of the winter the species migrates into the Patos lagoon estuary. Reproduction takes place in early spring in the estuary followed by spawning in the coastal waters. *N. barba* has low fecundity and after the reproduction the males incubate the eggs for up to 2 months in the bucal cavity. Between spawning seasons, adults disperse over the entire shelf.
Croaker, *Micropogonias furnieri*	Species depends on the estuary of Patos lagoon as a nursery and feeding ground. Croackers spawn during spring and summer in coastal waters under the influence of freshwater runoff from the Patos lagoon. Adults normally migrate into the estuary in September-October and leave the area in December-January. Young and subadults croacker occur throughout the year near the coast and in the estuary of Patos lagoon. Adults are dispersed over the shelf and migrate from Uruguay to southern Brazil during the fall and winter and towards Uruguay in the summer.
Mullets (mainly represented by *Mugil platanus*	Mullets occur year round in the Patos lagoon and adjacent coastal waters. Juveniles are more abundant in the winter and spring in nursery areas of the lagoon. In the fall, adult mullets leave the estuary and initiate their reproductive migration. Spawning occurs in warmer offshore waters at about 27°S between the end of the fall and winter. Eggs and larvae are transported from spawning ground towards the surfzone, followed by long-shore migration to the estuary of Patos lagoon.

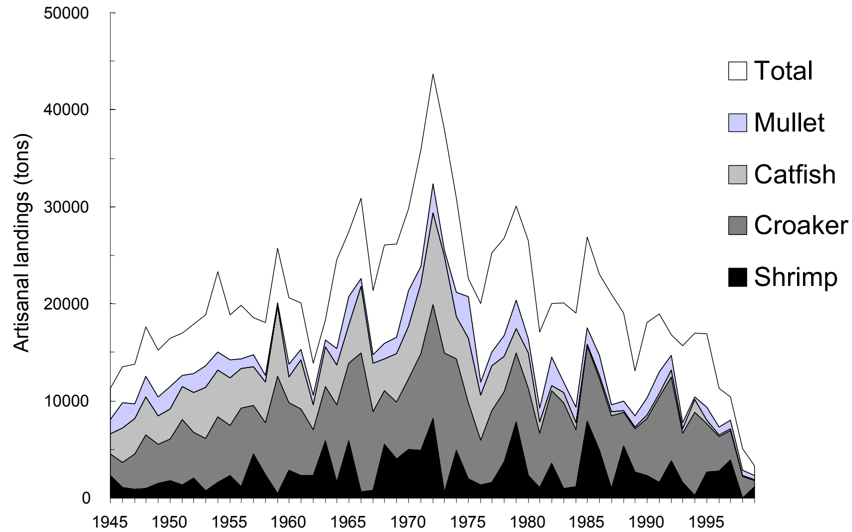

Figure 2. Artisanal fisheries landings in the estuary of Patos lagoon.

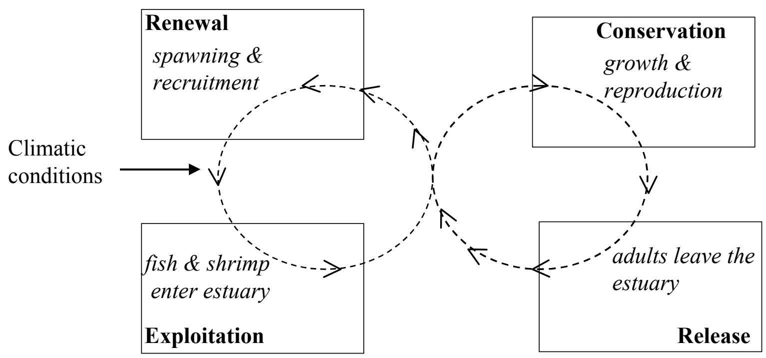

Figure 3. Four phase model of estuarine and coastal fisheries resource dynamics (adapted from Holling, 1986; 1992). During the cycle of exploitation, conservation, release and renewal, biological time flows unevenly. It is slow from the exploitation to the conservation phase, very rapid to the release, rapidly to renewal and back to the exploitation phase.

FISHING PRACTICE AND ECOSYSTEM RESILIENCE

The fishing calendar

One of the single most important characteristics of estuarine artisanal fisheries is the fishing calendar. Since the time when practically no formal rules existed for fisheries management (before 1960s), artisanal fisheries followed a calendar of activities (rules in use) determined by the abundance of different fisheries resources during the year and by the fishing technologies in use. The calendar was based on the experience of local fishers. As such it represents a form of traditional ecological knowledge with important consequences for the resilience of artisanal fisheries because it created natural limits to the exploitation of CPRs.

From January to May, fishers captured shrimp and mullets. Mullets were fished mainly in two periods: in January when the adults were returning from the spawning grounds in the sea, and during the spawning runs, which normally occur between the months of April and June. The catfish season normally began in July and lasted until early November. This fishery targeted the large catfish entering the Lagoon to reproduce and also on the spawning grounds in the upper estuary. The fishery during this period captured mostly fish of good weight and with well developed gonads. A less extensive fishery also occurred during the summer months, especially in February, when catfish migrate back to the sea and the males were incubating the young in their mouth. Few fishers were involved in this fishery because catfish was normally "thin" and did not have a high value, and also because other fisheries, such as shrimp and mullet, were more attractive at that time. The croaker season started in October or right after the catfish season and normally lasted until early summer.

According to fishers, the fishing calendar in the estuary of Patos Lagoon is strongly influenced by the strength of the intrusion of salt water and the rainfall regime. Many fishers consider saltwater to be the single most important factor controlling artisanal fisheries activities. This influence is particularly conspicuous in the shrimp fishery, as shrimp are thought to be more influenced by climate than other fisheries resources. A good fishing season usually occurs if the salinity of the estuary is ideal in the period from October to December; the earlier the estuary is replenished with saltwater the earlier will be the shrimp season. A similar relationship between rainfall regime and shrimp production was demonstrated by Castello and Moller (1978). Fishers also view a warm winter as beneficial for the shrimp season. The moon is also considered an important factor in determining the timing and success of a fishery. For instance, the full moon usually determines good catches of shrimp but it is not good to capture croaker, as explained by a fisher: "*When the moon is bright the croaker is more active and difficult to catch with gillnets*". The last quarter moon is considered excellent for mullets; normally, according to fishers, the last quarter moon of May triggers the schooling behavior of mullet spawners.

Resource use by small-scale fishers in the estuary of Patos Lagoon was and still is to a large extent conditioned by the availability of the resources in the estuarine environment which is in turn controlled seasonally by the influence of the weather and also affected by the influence of the moon on the behavior of the fish. As explained by a fisher:

> " *...nature makes its own fishing closure with the moon, the bad weather, and also the fish, because if it is too windy the fish don't move and you cannot catch them. For instance, if the mullet sees the net it does not enmesh. If it is not the right time, and the fish do not want to be captured, you cannot catch them*".

But, as will be shown in the next section, resource use practice changed markedly as new fishing technologies were introduced and as the industrialisation of fisheries brought exploitation beyond the limits of the carrying capacity of resources.

Changes in fishing practice and resource conditions

In the past 50 years, fisheries in the estuary of Patos Lagoon and coastal areas experienced changes in fishing technologies and materials that significantly altered resource exploitation and the sustainability of artisanal fisheries. Artisanal fisheries were initially based on a beach seine fishery at the mouth of the estuary and in other specific locations along the migratory route of the species inside the Lagoon (Barcellos 1966; Costa 2001). The nets were approximately 300 meters long and were utilised to encircle the fish schools of mullet, croaker, black drum, catfish, and even shrimp, close to shore. The mullet fishery was carried out in two main places in the mouth of estuary on either side of the channel. Each fisher had his turn on a specific day of the season, which was sorted out among fishers of each community. It was common to capture over 60,000 fishes (ca. 90 tonnes) in a single shot, and in order to handle the large catch volume, the fishery was often carried out by groups of 20 to 30 fishers.

Older fishers recall that the beach seine fishery remained important until approximately 1964 when gillnet fishing intensified (this is also confirmed by Barcellos 1966). Gillnets were the most appropriate type of technology to be used in the large areas of the lagoon where fish were naturally more dispersed than at the mouth of the estuary. The intensification of gillnet fishing in turn decreased the viability of the beach seine fishery.

The introduction of motors and the widespread use of gillnets allowed fishers to start fishing mullets in the lagoon as early as October. This gillnet fishery was considered unsustainable by elders who believe the lagoon functions as a nursery area. Unlike the beach seine fishery, which captured only adult fish during a short time window, the gillnet fishery targeted immature fish, and lasted for a longer time, over larger areas including those where the resource was vulnerable to exploitation. Today croakers and catfish as well as mullets are mainly fished using gillnets.

Many assume that the increase in the number of artisanal fishers and the changes in fishing practice and technologies in estuarine fisheries increased pressure on resources which became gradually less abundant to the point of collapse of some important fish resources of the past, e.g. catfish (Reis 1986; Rodrigues 1989). However, fishers and scientists agree that one of the main causes of decline of fisheries CPRs in southern Brazil is the intensification of industrial fisheries observed during the 1960s and 1970s (Haimovici *et al.* 1989; Haimovic, 1997). The fishing areas and technologies employed by industrial fisheries, as viewed by fishers, have a much greater impact of resources because of the amount of fish caught, and the fishing time. These fisheries operate in areas of the continental shelf that were before (and still are) inaccessible to artisanal fishers for most of the time. Fishers recall that since these industrial vessels started fishing, the fish that used to enter the lagoon are disappearing, and to balance the decrease in production, artisanal fishers, in turn, started to increase the amount of gear in the estuary and intensify their shallow coastal water fisheries (many stated that, when weather permits, the coastal area is visited regularly during the croaker fishing season, capturing the fish before they enter the lagoon). The end result has been an overall decrease in fisheries production.

The pink shrimp fishery has also experienced marked changes in fishing technologies and practice in the last few decades. The shrimp fishery was initially carried out along the Lagoon beaches and shallow areas using a manual trawl net dragged by two to four people, or beach seine nets. The manual trawling nets were later (in the mid-1950s) modified into fixed nets (bag nets). Bag nets were fixed around the channels, the mouth of the net placed facing the ebb currents of the estuary, so that shrimp were caught passively through the currents. Beginning in the 1960s, otter trawling from boats became widely used in the shrimp fishery. Most of the trawling was done in deeper waters of the estuary and in areas with "cleaner" bottom (although fishers acknowledge that many of them used to trawl also in shallow nursery areas). Stownets, introduced in the 1970s, are now the dominant type of gear used in the estuarine shrimp fishery. Stownets are fixed in shallow areas of the lagoon and operate by attracting shrimp to the net with light produced by gas lamps. The fishing operation with stownets has changed over the years. The nets were initially placed close to small inlets, because *"shrimp was initially caught in the currents*". Now the nets are placed mostly in the shallows where according to fishers, the young/smaller shrimp are caught before migrating from the nursery areas.

Fishers maintain that the introduction and widespread adoption of stownets impacted negatively on the operation of other types of fishing technologies (such as bag nets and trawling) because a large proportion of the shrimp is caught before they are able to migrate to the channel areas and lower parts of the estuary. It also triggered an intensification of trawling in the estuary to compensate for the decreasing yield of shrimp. The end result has been an increase in fishing effort and the over-exploitation of shrimp in the estuary. D'Incao (1991) estimated that the intensity of the stownet shrimp fishery in the estuary of Patos Lagoon is so high that few shrimp leave the Lagoon to complete the species life cycle.

Fishers interviewed cited stownets and trawling as fisheries that frequently produce high bycatch rates. According to them, artisanal trawling can produce little bycatch depending on the area of the estuary and also on the characteristics of the otter board and the height of the net – the higher the net in the water column the higher the bycatch. Fishers have found ways to reduce the amount of bycatch (if not for conservation reasons, for practical reasons since bycatch increases the handling time on the catch on board) by decreasing the height of the net, and also avoiding trawling in areas with high bycatch rates, such as shallow estuarine waters and specific locations off the coast which are known as nursery areas. Despite fishers' knowledge of trawling methods with low bycatch, since the introduction of stownets in the estuary, all types of trawl fisheries became forbidden without any scientific evaluation of potential impacts on the ecosystem.

MANAGEMENT LESSONS FROM TRADITIONAL PRACTICES

What can be learned from the above forms of resource use? When resources were still abundant, the fishing calendar worked in a way that allowed fishers to benefit from the most abundant resources in a season while limiting the amount of fishing pressure (time) over a particular species and/or a critical period. For instance, fishing for catfish was normally discouraged during the summer months when the males are incubating the young. It was also unnecessary, given the availability of other resources such as croacker and shrimp. Similarly, the capture of large amounts of shrimp below the optimal size (between late spring and early summer) was in part prevented by the type of fishing technology in use, and also by the existence of alternative fishing resources. A failure of a fishing season, normally due to low shrimp abundance, resulted in a re-distribution of fishing effort to the other resources available in the period, but never to the point of over-exploitation because the characteristics of the fishing practice were more compatible with the carrying capacity of the system and a smaller number of people was involved in the activity.

An informal fishing calendar was still in place until the mid-1990s, but to a much lesser extent than in the past. Figure 4 shows the changes in fishing calendars of the main artisanal fisheries resources between the 1960s and the early 1990s. Species such as mullets, that were fished mostly in late fall (April to June) during the spawning run, in the early 1990s were fished almost equally throughout the year. For other resources, such as catfish, the collapse of the stock brought a change in the fishing calendar from spring to winter months when the few remaining catfish sustain a smaller-scale fishery in the upper estuary. The change in technology (from beach seines to gillnets) also made fishers capture croakers during the same period as mullets, since both species are present in the estuary at different life stages throughout the year and are vulnerable to the same gear.

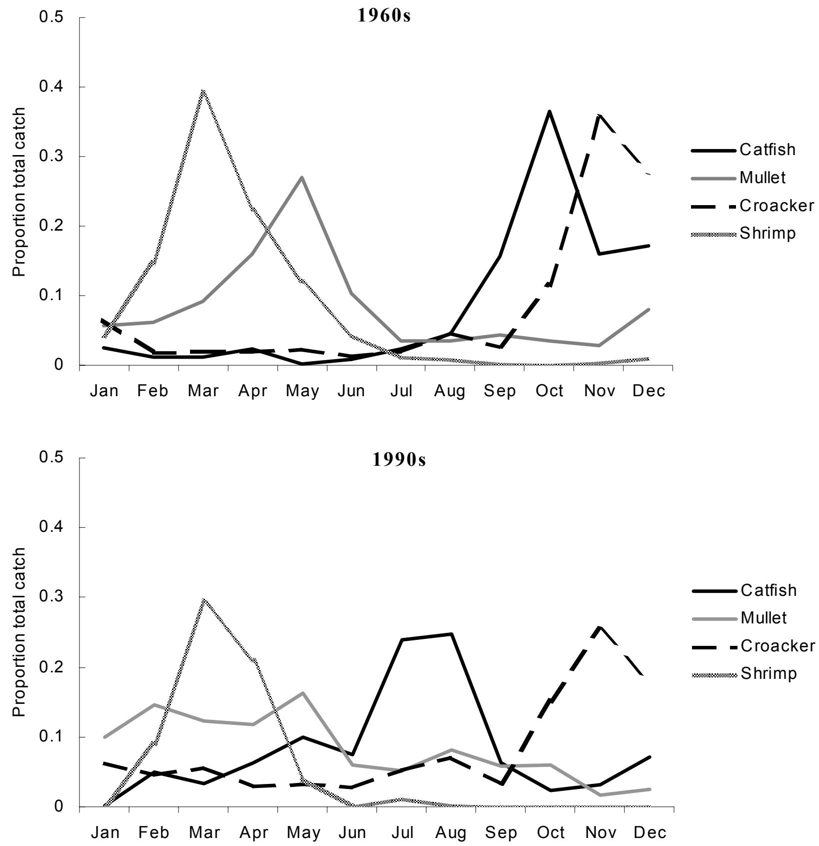

Figure 4. Fishing calendar of artisanal fisheries in the estuary of Patos lagoon and coastal waters during the 1960s and 1990s. The lines represent the proportion of the total annual catch of each species obtained in a single month.

Also, before the advent of industrial fisheries, a large proportion of the species habitat in the Patos lagoon and in the southern Brazilian shelf worked as *de facto* spatial refugia, since artisanal fisheries were limited to specific areas of the estuary of Patos lagoon and adjacent coastal shallow waters. Thus, the increasing competition between artisanal and industrial fisheries and the technological improvements in resource location and capture undermined important factors that made artisanal fisheries resilient in the past, i.e., the limited time and areas of resource exploitation**.** The fishing technologies and resource use practice in the past were intrinsically dependent upon nature, through the influence of the moon, the behavior of the fish, and weather conditions, which created natural mechanisms for limiting excess exploitation by artisanal fisheries. Referring back to Holling's 4 phases model (Figure 3), artisanal fisheries were practically limited to two phases in the resources dynamics: the *exploitation* phase, when resources such as croaker, catfish and mullets were entering the estuary, and the *release* phase, when all these species and pink shrimp were leaving the estuary to the shelf waters. The other two phases (*renewal* and *conservation*) were not targeted by fishers until technological advances and the industrialisation of the fisheries which in turn made the resources available to be exploited at any time and area. In conclusion, the hypothesis put forward here is that up to a certain point in time, the pattern of resource use by artisanal fisheries in the estuary of Patos

Lagoon served conservation purposes because it made resources less vulnerable to over-exploitation while helping maintain the cycle of resource renewal. Besides serving conservation purposes, the fishing practices adopted by artisanal fishers sustained a very productive fishery from the early 1900s until practically the late 1980s (Reis 1999). For instance, in 1960 artisanal fisheries were responsible for over 80% of the total fisheries landings in southern Brazil (ca. 27,000 tonnes/year; IBAMA).

The above analysis of the fishing practices adopted by artisanal fishers in the estuary of Patos Lagoon showed that indeed there was an informal knowledge system used by fishers to deal with the dynamics of the resources. These fishing practices were part of an informal resource management system that helped maintain a productive and resilient small-scale fishery. Resource use practice in the estuary of Patos Lagoon has been changing over time in response to changes in technology, increasing fishing pressure and influences from internal and external (mostly from government agencies) institutional transformations that shifted the management of fisheries CPRs from informal community-based, to central government-based, and to the present situation of co-management (Kalikoski *et al.* in press).

The Patos Lagoon estuary experience has shown failures in both decentralised (community-based) and centralised (government-based) forms of resource management due, to a large extent, to the mismatch between local knowledge and social institutions (Kalikoski *et al.*, in press). The local, informal, decentralised management system present until the 1960s failed because it was never formally institutionalised. Therefore the attempts to control access and attenuate the over-harvesting problem with locally devised rules never reached higher levels of decision making. This system was easily eroded by the external influence of economic development policies aimed at the industrialisation of local fisheries and by a centralised management model adopted by the federal government after the late 1960s (Kalikoski *et al.*, in press). By relying on a system of economically driven policies, this centralised management disregarded the sustainable resource use practices by small-scale fishers and drove many resources to over-exploitation and collapse.

The artisanal fisheries management situation in the estuary of Patos Lagoon called for a cross-scale linkage between local institutions and government. Steps towards a co-management arrangement were taken in 1996 with the creation of the Forum of Patos Lagoon (Reis and D'Incao 1998). This study demonstrates that fishers' knowledge can provide a valuable set of information about the relationship between fishers and the local environment, and about the characteristics of practices, tools and techniques that led a more sustainable pattern of resource use in the past. Local knowledge can broaden the knowledge base needed for management and hence improve institutions that mediate the interaction between communities and their use of the resources. However, the co-management of fisheries CPRs in the estuary of Patos Lagoon is still at its infancy. There are barriers to be overcome before fishers can play a significant role in management decisions.

It is possible to identify 3 inter-related factors influencing the use of local knowledge in the co-management of estuarine resources:

1) *Illiteracy and socio-economic marginalization create low expectations of the management value of fishers' knowledge among scientists and decision makers*. There are many myths about artisanal fishers that still haunt management arenas and hinder a more productive interaction between scientific and local knowledge. Diegues (1995) paraphrased some of the most common myths about artisanal fishers in Brazil:

> *"artisanal fishers are beach beggars, they are a social problem that needs to be treated by social aid programs"; "artisanal fisheries are in transition to industrial, capitalist fisheries, and therefore are doomed to disappear"; "artisanal fishers are unintelligent and resist the technological innovations"; "artisanal fishers are predators, individualists and are not able to organise themselves"*.

Over time, these myths helped to exclude fishers from decision-making and consequently made them more vulnerable to the management process. As put by Pauly (1997) the marginalization of fishers and their limited formal education have often blinded managers and scientists to their ecological knowledge which is used in many successful common property systems as basis for traditional community-based management.

Despite their limited formal education, artisanal fishers developed resource use practices that maintained a productive fishery in the estuary of Patos lagoon until the late 1960s when their informal systems of management practices were eroded by formal top-down management procedures. Fishers' knowledge of sustainable fishing practices were also identified during interviews and meetings of the Forum of Patos lagoon in the form of requests for changes in local fisheries management. Fishers' requirements mirror many of the principles one can read in higher level environmental institutions, such as the FAO Code of Conduct for Responsible Fisheries (Table 2).

2) *Misfit between institutions and the characteristics of common property resources hinders fishers' stewardship of resources and the use of their knowledge to that effect*. Although they recognise the need for management, fishers still do not comply with the management rules in place in the estuary (such as the fishing closure in the winter months and the banning of trawling). In a condition of scarcity and competition, fishers' stewardship of resources is an important yet difficult aim to achieve. Where stewardship of resources exists it is in the best interests of those who control it not to overfish. As put by Johannes (1981) in this case "self-interest thus dictates conservation". Users' interest in working towards the sustainability of the particular resource is conditioned to the benefits they expect to achieve (Ostrom *et al.* 1999). However, solving fisheries CPR problems involves two distinct elements that are important to the husbandry of the resources: restricting access and creating incentives for users to invest in the resource rather than overexploit it.

Limiting access alone can fail if resource users compete for shares, the resource can become depleted unless incentives or regulations prevent over-exploitation (Ostrom *et al.* 1999). Besides, as can be observed in Table 2, traditional users of the estuary of Patos Lagoon feel threatened by sharing access rights with the more recent industrial users group. Resources outside the mouth of the estuary are still open to be freely caught by industrial purse-seiners as there are no rules regulating this activity in the coast, despite the damage it may cause. This creates a dilemma inside the estuary as small-scale fishers complain that the resources they do not catch today will not be available to them in the future but rather will be fished by industrial fishers outside the estuary. Efforts to exercise stewardship in such circumstances are unlikely to succeed.

Examples of CPR management worldwide has shown that although the development of local ecological knowledge is a necessary condition, it is usually insufficient in itself to achieve sustainability if it does not become accepted and legitimized by management institutions (Johannes 1981; Berkes 1999; Castro 2000; Seixas 2000).

Table 2 Comparison between selected principles of the Code of Conduct for Responsible Fisheries (FAO, 1997) and adjustments to local fisheries management suggested by small-scale fishers during interviews and Forum of Patos Lagoon meetings.

Principles of Responsible Fisheries (FAO)	Adjustments to fisheries management according to fishers knowledge in the estuary ofPatos Lagoon
• *Control of gears that are damaging to the ecosystem*:	- Stop industrial trawling in the coast because it kills large quantities of fish that are discarded. - Switch trawling nets by gillnets with large mesh sizes, which are more selective and less damaging. - Forbid or reduce artisanal fisheries in the nursery shallow waters of the estuary (such as stownets and trawling) because they capture large quantities of juvenile fish and shrimp. - Adapt artisanal otter trawling nets to reduce bycatch (implementing by-catch reduction devices) and restrict the use of artisanal trawling only in the channel areas of the lagoon;
• *Monitoring and enforcement*	- Increase enforcement in the estuary all year round and not only during the shrimp season; - Increase enforcement in the 3 miles zone along the coast, where many industrial trawlers operate illegally.
• *Marine protected areas*	- Close the inshore area around the mouth of the lagoon (specially to industrial purse seiners). This is an area that according to fishers fish concentrate before entering the lagoon. By turning it into a protected area fishers believe that more fish will make their way to nursery and reproduction areas in the lagoon. The establishment of marine protected areas is also congruent with a precautionary approach to fisheries management.
• *Adaptive management*	- Adjust fishing calendars according to the environmental conditions and resource abundance. An intricate system of time/area openings has been suggested by fishers as a way to accommodate management rules to the characteristics of the shrimp fishery.

A fundamental incentive to conserve relies on the definition of property rights to common property resources (Ostrom 1990). As long as property rights to resources remain open, no one knows what is being managed or for whom, and any incentive to conserve will disappear because there is no guarantee that the benefits of any management action will be accrued by the same individual or group that practice conservation.

3) *The difficult transition to a "civic science" in the management of coastal resources.*
Two types of paradigms about the role of science and local knowledge are evident in local environmental management institutions. The first, which has been the dominant, is based on the idea that scientific knowledge is objective and factual, and provides the 'truth' on which decisions should be made (Holling *et al.* 1998). This paradigm has no room for local traditional knowledge, for uncertainties, or for a systemic view of the problems. This conventional way of conducting science has been shown to act against sensitive and precautionary environmental management by drawing decision makers to examine only those phenomena where cause and effect can be either proven or shown to be reasonably unambiguous (O'Riordan 2000).

The second paradigm is based on the recognition that conventional science is value-laden, and that information and decisions can be manipulated by powerful vested interests. It acknowledges that knowledge about the ecosystem is incomplete, therefore uncertainties are high and surprises (when actions produce results different to those intended) are inevitable (Holling *et al.* 1998). It calls for the integration of different forms of knowledge (scientific and local) in order to better understand the nature of complex problems and to reduce uncertainties, where possible. More importantly, this paradigm recognises that management of CPRs should not rely merely on science but on a *civic science* (Lee 1993), that is "deliberative, inclusive, participatory, revelatory and designed to minimise losers" (O'Riordan 2000).

By stimulating the exchange of information and knowledge between scientists and fishers, the Forum of Patos lagoon is creating the conditions for a transition towards a civic science in the co-management of artisanal fisheries. One important indicator of this move is the process of defining and revising rules to regulate the fisheries of the Patos Lagoon estuary from the bottom-up, with inputs from small-scale fishers (the rules devised locally were legitimised by the federal government as decrees IBAMA 171/98 and 144/01). However, while Forum decisions that relate to small-scale fisheries management are triggering the transition towards a civic science paradigm, the overall process of governance of other resources and activities within the coastal zone of the Patos Lagoon is not. Instead, the overall coastal zone governance system is still locked into a top-down management system based on a conventional scientific approach (*sensu* Holling *et al.* 1998) (Asmus *et al.* 1999). An example of this approach is seen in the Environmental Impact Assessment of the enlargement of the jetties in the mouth of the estuary of Patos Lagoon (FURG 2000). The EIA study had many uncertainties which were not made explicit or communicated. The project had many outcomes that are not well defined and there are many questions that still remain unanswered, such as the ones raised within the Forum:

> "*will the project impact the amount of shrimp entering the Lagoon? What will be the impact of the project on the behavior of the fish that migrate through the channel of Rio Grande? What will be the impact of the project on the estuarine ecosystem? How will the project affect navigation conditions for small-scale fishing boats off the mouth of the estuary?*"

As defined by O'Riordan (2000), the above characteristics create a mix of uncertainties and ignorance about the possible consequences of the project which calls for a civic science approach. Contrary to civic science's principles of inclusivity and participatory research, neither the small-scale fishers' communities of the estuary of Patos Lagoon directly affected by the project nor the Forum of Patos Lagoon were consulted during the EIA.

Therefore, although the Forum is moving slowly towards a civic science approach to artisanal fisheries management inside Patos lagoon, activities in the estuary, with a direct effect on artisanal fisheries, are not taking into account bottom-up or participatory approaches. However, because many of the 21 institutions that participate of the Forum represent interests beyond fisheries (e.g. Public Ministry, Environmental Agency), opportunities are being created for the Forum to challenge decisions which impact artisanal fisheries, thus empowering local institutions and fishers' communities to call for better governance of the natural resources in the region. In this sense this study put forward that small-scale fishers and their knowledge – including the set of practices, tools, techniques and appropriate informal institutions embedded in a different world view system – may represent a future oriented concept for sustainable resource management in the estuary of Patos Lagoon.

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References

Asmus, M. L.; Calliari, L.; Tagliani, P.R. and Kalikoski, D.C. 1999. Ecosystem Based Integrated Coastal Zone Management in the Estuary of the Patos Lagoon: Opportunities and Constrains. Proceedings of the Workshop Ecosystem Based Integrated Coastal Zone Management, UBC, Vancouver, Canada. 10 p.

Barcellos, B. N. 1966. Informe geral sobre a pesca no Rio Grande do Sul. BRDE-CODESUL. Porto Alegre, Rio Grande do Sul. 115 p.

Berkes, F., ed. 1989. Common property resources: ecology and community-based sustainable development. Belhaven, London, UK.

Berkes, F. 1999. Sacred Ecology. Traditional ecological knowledge and resource management. Philadelphia. Taylor and Francis. 209 p.

Berkes, F. and C. Folke. 1998. Linking Social and Ecological Systems. Management practices and social mechanisms for building resilience. Cambridge University Press, UK, 459 p.

Castello, J. P. 1985. The ecology of consumers from dos Patos Lagoon estuary, Brasil. Chap. 17:383-406 In A. Yañez-Arancibia (Ed.) Fish community ecology in estuaries and coastal lagoons: Towards an ecosystem integration. 654 p.

Castello, J. P. and O. O. Moller. 1978. On the relationship between rainfall and shrimp production in the estuary of the Patos Lagoon (Rio Grande do Sul, Brazil). Atlântica, Rio Grande, 3:67-74.

Castro, F. 2000. Adjusting to change: the crafting of community lake management systems in the Brazilian Amazon. The Eighth Annual Conference of the International Association for the Study of Common Property, Bloomington, Indiana, US, May 31- June 4th, 2000.

Chao, L. N.; Pereira, L. E. and J. P. Vieira. 1985. Estuarine fish community of the Patos lagoon, Brazil. A baseline study. Chap. 20, 429-450 In A. Yañez-Arancibia (Ed.) Fish community ecology in estuaries and coastal lagoons: Towards an ecosystem integration. 654 p.

Costa, J. S. 2001. Navegadores da Lagoa dos Patos. Asaga náutica de São Lourenço do Sul. Hofstatter. 212 p.

Diegues, A. C. S. 1995. Povos e Mares: Leituras em sócio-antropologia marítma. NUPAUB, University of São Paulo, Brazil, 260 p.

D'Incao, F. 1991. Pesca e biologia de Penaeus paulensis na Lagoa dos Patos, RS. Atlântica (Rio Grande) 13(1): 159-169.

FAO. 1997. Fisheries management. FAO Technical Guidelines for Responsible Fisheries, 4, Rome, 82 p.

FURG, 2000. Relatório de Impacto Ambiental: Ampliação dos molhes do porto de Rio Grande. University of Rio Grande, Rio Grande, Brazil.

Haimovici, M. 1997. Recursos pesqueiros demersais da região sul. Programa REVIZEE. Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal. FEMAR. 80 p.

Haimovici, M.; Pereira S. D. and P. C. Vieira. 1989. La pesca demersal en el sur de Brasil en el periodo 1975-1985. Frente Maritmo 5:151-163.

Holling, C. S. 1986. Resilience of ecosystems; local surprise and global change. p. 292 - 317. In Clarck, W. C. and R. E. Munn (Eds.). Sustainable development of the biosphere, Cambridge University Press, Cambridge, Mass.

Holling, C. S. 1992. Cross-scale morphology, geometry and dynamics of ecosystems. Ecological Monographs 62(4): 447-502.

Holling, C.S.; Berkes, F. and C. Folke. 1998. Science, sustainability and resource management. In: Berkes, F. and Folke (eds). Linking Social and Ecological Systems. Management practices and social mechanisms for building resilience. Cambridge University Press, UK, 342-362.

Johannes, R. E. 1981. Words of the Lagoon. Fishing and Marine lore in the Palau district of Micronesia. University of California Press. 245 p.

Kalikoski, D. C. in prep. The Forum of Patos Lagoon: an analysis of institutional arrangements for conservation of coastal resources in southern Brazil. Ph.D. Dissertation. University of British Columbia, Canada.

Kalikoski, D. C.; Vasconcellos, M. and L. Lavkulich. In press. Fitting institutions to ecosystems: the case of artisanal fisheries management in the estuary of Patos Lagoon. Marine Policy.

Neis, B. and L. Felt. 2000. Finding our sea legs: linking fishery people and their knowledge with science and management. Institute of Social and Economic Research. 318 p.

O'Riordan, T. 2000 (Ed.). Environmental science for environmental management. Second Edition. Prentice Hall. 520 p.

Ostrom, E. 1990. Governing the commons. The evolution of institutions for collective action. Cambridge University Press, Cambridge, UK.

Ostrom, E. 1995. Designing complexity to govern complexity. P. 36-46. In S. Hanna and M. Munasinghe (Eds.) Property Rights and the Environment. Beijer International Institute of Ecological Economics. 141 p.

Ostrom, E.; Burger, J. Field, C.B., Norgaard. R.B. & D. Policansky. 1999. Revisiting the commons: local lessons, global challenges. Science 284: 278-282

Pauly, D. 1997. Small-scale fisheries in the tropics: marginality, marginalization and some implication for fisheries management. p. 40-49. In: E.K. Pikitch, D.D. Huppert, and M.P. Sissenwine, eds., Global trends: Fisheries Management. Bethesda, Md.: American Fisheries Society.

Pinkerton, E., (ed.). 1989. Co-operative management of local fisheries: new directions for improved management and community development. Vancouver: University of British Columbia Press.

Pomeroy, R.S. and F. Berkes. 1997. Two to tango: the role of government in fisheries co-management. Marine policy, 21: 465-480.

Reis, E. G. 1986. Reproduction and feeding habits of the marine catfish Netuma barba (Siluriformes, Ariidae) in the estuary of Lagoa dos Patos, Brazil. Atlântica, Rio Grande, 8:35-55.

Reis, E. G. 1999. Pesca artesanal na Lagoa dos Patos. História e administração pesqueira. P. 81 – 84 in Alves, F. N. (ed.) Por uma história multidisciplinar do Rio Grande. Fundação Universidade Federal do Rio Grande. 241 p.

Reis, E. G. and F. D'Incao, The present status of artisanal fisheries of extreme southern Brazil: an effort towards community based management. Ocean & Coastal Management, 43 (7), 2000, 18pp

Rodrigues, G. 1989. A atividade pesqueira no estuário da Lagoa dos Patos. Subprojeto A pesca artesanal na Lagoa dos Patos. Projeto Lagoa dos Patos. University of Rio Grande, Rio Grande, 27 p.

Seixas, C.S. 2000. The Ibiriquera lagoon, Brazil: a resilient social-ecological system? Papers of the International Association for the Study of Common Property, June 2000, Bloomington, Indiana, USA. http://www.indiana.edu/~iascp2000.htm.

Seeliger, U.; Odebrecht, C. and J. P. Castello. 1997. Subtropical Convergence Environments. The coast and sea in the Southwest Atlantic. Berlin, Springer, 308 p.

Vieira, J. P. and C. Scalabrin. 1991. Migração reprodutiva da tainha (Mugil platanus, Gunther, 1980) no sul do Brasil. Atlântica (Rio Grande) 13(1):131-141.

Cognitive Maps: Cartography and Concepts for an Ecosystem-based Fisheries Policy

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The bellman himself they praised to the skies –
Such a carriage, such ease and such grace!
Such solemnity too! One could see he was wise,
The moment one looked in his face!

He had brought a large map representing the sea,
Without the least vestige of land:
And the crew were much pleased when they found it to be
A map they could all understand.

"What's the good of Mercator's North Poles and Equators,
Tropics, Zones, and Meridian Lines?"
So the Bellman would cry: and the crew would reply,
"They are merely conventional signs!"

"Other maps are such shapes with their islands and capes!
But we've got our Captain to thank"
(So the crew would protest) "that he's brought us the best –
A perfect and absolute blank!"

From Fit the Second in "The Hunting of the Snark: An Agony in Eight Fits" by Lewis Caroll, 1876. Illustration by Quentin Blake, Folio Society Edition, 1976.

Abstract
Mental concepts of the health of a marine ecosystem and its fisheries can influence the goals and design of management policies. We discuss how such cognitive maps, held by individual humans, and deriving from an interplay of science, traditional and local knowledge, are fostered by the *Back to the Future* approach to fisheries policy. *Back to the Future* seeks to use the structure and abundance of past ecosystems to guide restoration policy, and engages all sectors in positive and remedial action.

A blank map is ideal for hunting a beast that no-one knows the form or whereabouts of. Lewis Carroll's Bellman and crew of snark-hunters neither needed nor desired much idea of where they were going. Later in the poem, the blank map seems to be there for them to sketch their own futures.

Henri Poincaré said that we all carry a map of the world in our heads (Figure 1), but our maps are not a perfect representation of the reality that surrounds us. Illusory and mistaken elements of the map may prompt erroneous behaviour, giving rise to all kinds of shocks and surprises. Using our mental map of the present to guide our steps to a better future is therefore an uncertain process. Present maps can at least be checked for errors against what we see in front of us now, but our mental maps of past times are subject to greater error from omissions, misconceptions, misinformation, and even disinformation from those who seek to rewrite history. Nevertheless, mental maps of the present and past are at least grounded in some kind of reality. In contrast, our mental maps of where the future might lead are imbued with dream, myth and wishful thinking. Such dreams of the future are the very stuff of humanity, but whilst they are pivotal to our spirituality and ethics, they rarely offer us much practical help in dealing with impacts on the natural world of which we are an integral, and in the case of marine ecosystems, very damaging, part.

The term 'cognitive map' was first defined by Tolman (1948) and used to denote a mental map of the actual spatial relationships in a rat's view of escaping from a maze. Since then the term has been used in a broader way to indicate mental maps of sets of conceptual relationships about environment, society, institutions, governance and human impacts on the natural world (Lazlo *et al.* 1996). In political science, cognitive maps have been used as a qualitative reasoning tool to try to analyse, predict and understand decisions, especially in the context of conflict and games theory (Axelrod 1976; Levi and Tetlock 1980). Mathematicians have taken the rather

Figure 1. Mathematician Henri Poincaré (1854-1912) said we all had maps of the world in our heads. Poincaré's mental world, however, was likely very different from yours and mine, populated as it was with the arcane equations of the Diophantine proposition and with Poincaré's conjecture, that has baffled all-comers since he died. Appropriately for someone concerned with maps, Poincaré invented topology.

inconsistent and imprecise concepts in the political science literature and formalised a theory of cognitive maps using algebra (e.g. Chaib-draa and Desharnais 1998), computational science (e.g. Park 1995) and fuzzy logic (e.g. Kosko 1986). Recently, fuzzy cognitive maps have become a part of artificial intelligence research in designing functional ways to represent human knowledge and causal inference, a way of programming the actors in a virtual world (e.g. Miao and Liu 2000). The overall success of these ventures in forecasting human social behaviour remains to be demonstrated.

In this paper we use the term 'cognitive map' in the broader sense to describe the totality of the way in which humans envisage natural marine ecosystems, with all their constituent organisms, fisheries, physical environment and modes of human intervention such as management, or lack of it. In fact, the term ecosystem itself implies a cognitive map of humans embedded in a natural world.

COGNITIVE MAPS OF ECOSYSTEMS AND *BACK TO THE FUTURE*

Before it reaches an 'adoption of policy' stage, our *Back to the Future* ecosystem modelling entails two stages: first, the construction of ecosystem models of past and present; and secondly, the choice of a desirable management goal from comparing the benefits and costs of restoring each past ecosystem from the present state. The scientific modelling of past ecosystems can help us improve our maps of the past. The design and analysis of sustainable and responsible future fisheries improves our perception of how a restored future might come to look like the past. So cognitive maps of marine ecosystems and the dynamics of how their status might be changed are integral to the Back to the Future policy agenda.

What might a cognitive map of an ecosystem look like? What elements are captured in the mind? Major features are the species, like valleys, coasts, lakes and rivers. We may imagine that the relative abundance and food web of animals and plants is captured in mountain chains, lake regions, watersheds and plains. Fisheries are perhaps like villages, town and cities. Clearly these representations of the features of natural ecosystems may take many different forms in different individuals, but given our recent evolutionary heritage as humans, it is reasonable to assume that we all have the ability to capture similar map features of the natural world in our heads. This forms the basis of the concept of human biophilia (Wilson 1984). To assume the contrary, that all cognitive maps are arbitrary and unrelated is at best solipsist, and at worst, postmodern.

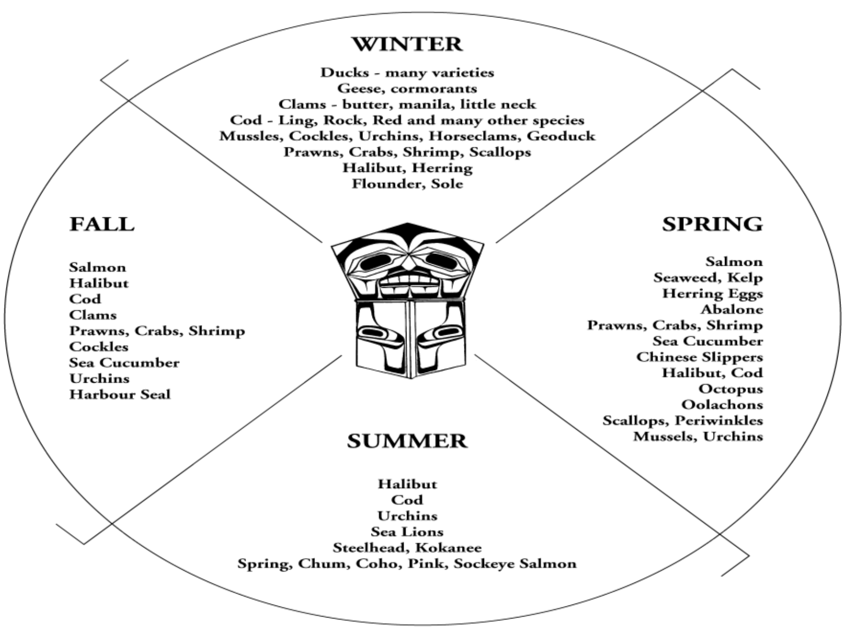

Figure 2: A seasonal cognitive map of traditional food gathering in the Heiltsuk Nation in central British Columbia. In Winter 19 items are named; spring 17; Summer 11; Fall 11 items (Brown *et al.* 1997). Chart prepared with the assistance of Cameron Brown, Beverly E. Brown and Cyril Carpenter.

Cognitive maps exist at different scales and units. That of an Aboriginal or traditional harvester links many species and natural assemblages, those sought and those associated to place, season, weather, ocean conditions and past experience (e.g. Figure 2). At a conceptual or spiritual level, the Canadian First Nation's ecosystem concept is of an ecological, environmental, human and spiritual whole. At the other extreme, the cognitive map of a stock assessment scientist tracks one or a very few fished species and their immediate ecosystem linkages over relatively vast distances. In the first case, the map relates species and abundance to geographic location. In the second, the primary 'geography' is a graph showing change in abundance over time. Figure 3 shows the catastrophic decline in abundance of Rivers Inlet, BC, sockeye salmon, representing an annual loss of $12 million to fishers and $65million in retail value, a foregone future for the Oweekeno Nation and serious consequences for forest and wildlife through the cutoff of marine phosphorous and nitrogen deriving form salmon carcasses. The graph tells us nothing about where or why the decline occurred, issues that would be an integral part of the equivalent cognitive map of the people concerned. There are good reasons to assume a large role for changed ocean conditions in the decline. However, 97% of the salmon fishing occurs in the Rivers Inlet watershed, even though looking at the watershed to the exclusion of the ocean is like looking beside the campfire for something you lost in the forest- it is easier to see, but there's little hope of finding what you seek (Haig-Brown and Archibald 1996).

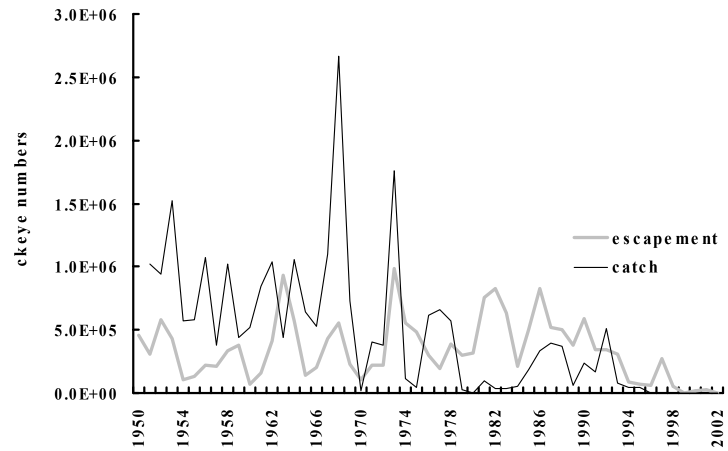

Figure 3. Estimated numbers of Rivers Inlet Sockeye caught and allowed to spawn (escapement) since 1980. Vertical axis in millions (Source: R&SPG 2003).

Most scientific representations of ecosystems do not provide something equivalent to the powerful ownership and 'stewardship' relationship expressed in Aboriginal food gathering and illustrated in Figure 2. The concept of the adjacency principle (Pitcher and Power 2000; Coward *et al.* 2000; Pauly 1999) is embodied in this diagram. Traditional place-based economies have used traditional and local knowledge (T/LEK) and, from the early to mid 20th century, government agencies often employed local managers who used semi-quantitative ecological and locally-based management. This era has been replaced by large-scale corporate fisheries managed with highly quantitative single-species techniques run by a bureaucracy perceived as remote with no local roots. So a person in a local

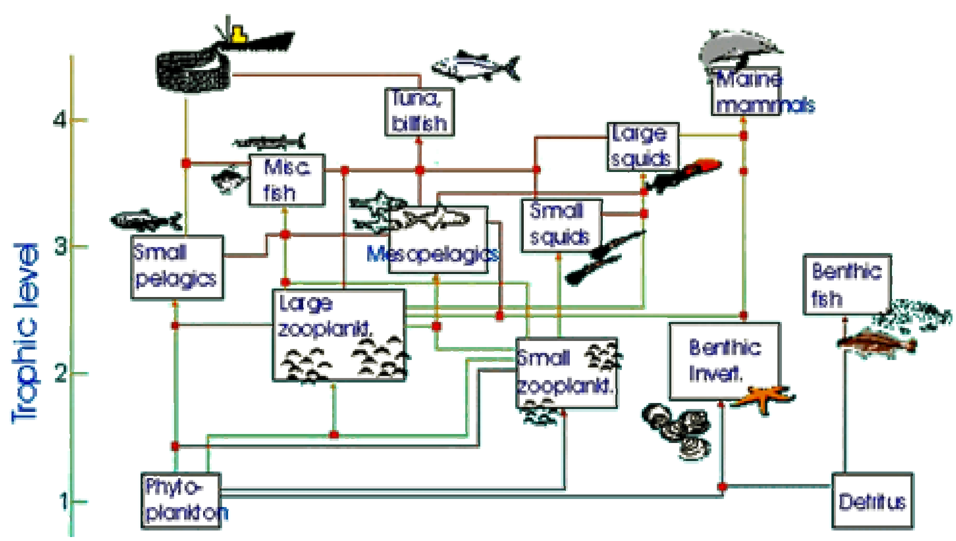

Figure 4. Schematic of a generic Ecopath mass-balance model of an ocean ecosystem showing trophic linkages against trophic level (plants are defined as trophic level 1). Actual models today often have over 50 compartments and many different fisheries (diagram courtesy V. Christensen).

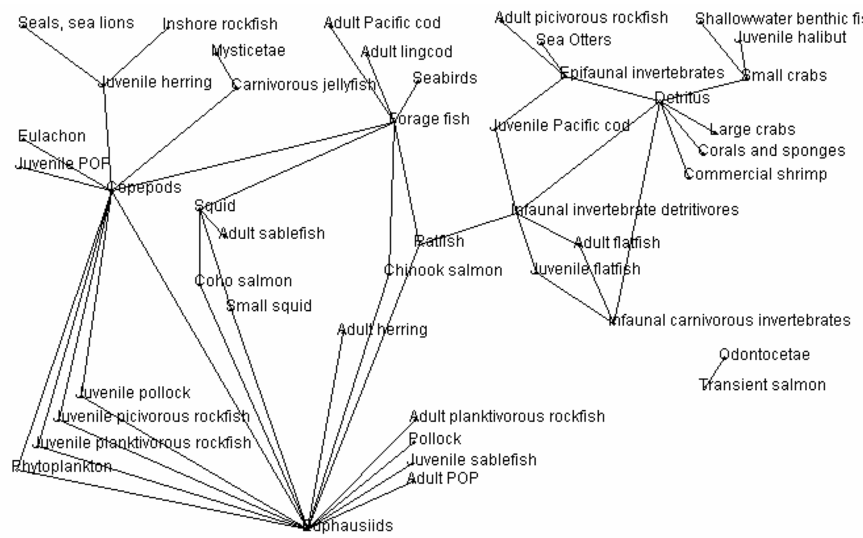

Figure 5. Important food web linkages (links >25% of diet) in the Northern British Columbia ecosystem, as drawn up by a mass-balance Ecopath model. (Ainsworth et al. 2002). The ecosystem scientist's cognitive map of the system is based on diagrams like this.

fishing community in the 1950s would have a very different cognitive map of the same fishery today. These trends have led to a fragmentation of knowledge (Haggan 2000).

The first challenge in creating a common cognitive map of the entire ecosystem is to make disparate maps mutually comprehensible. The progression from the holistic ecosystem knowledge of First Nations, through a stage of studying the bits and then trying to put them back together is, in the worst case, like Humpty Dumpty. At best, it is a 'Blake's progress', leading from the innocence of fisheries scientists in the 1950s and 60s, helping fishers to increase their catch, through the bitter experience of the failure of single species management epitomized by the Newfoundland cod, to, today an emerging informed knowledge of the whole, (Blake 1795, Haggan 2000).

The 'new ecosystem science' began with the development of a system to relate individual quantitative and scientific studies to each other using the 'Ecopath' mass balance approach (Christensen and Pauly 1992), an approach that tracks the trophic flows between predators and prey (Figure 4). This re-linking of separated components opened the door to the use of T/LEK information on presence /absence, relative abundance and trends to improve the models built by scientists (Pitcher 1998). The resulting new cognitive map has come a long way from the single species concept, in that it shows the relationship between species (Figure 4), but is imprecise, in that it smears biomass over the entire ecosystem in tonnes per square kilometre.

Ecosim, the dynamic version of Ecopath (Walters *et al.* 1997), allows modelers to explore the ecological and economic impacts of different fisheries, conservation and management strategies over time. The valuation methodology has been substantially expanded to include social benefits to present and future generations (Sumaila 2001, Sumaila *et al.* 2001) and to look for fisheries allocations that optimise specified objectives. Moreover, the spatial version, Ecospace (Walters *et al.* 1998), enables the assignation of species to their preferred habitat, thus opening the door to the possibility of transferring detailed spatial knowledge of species from scientific surveys,

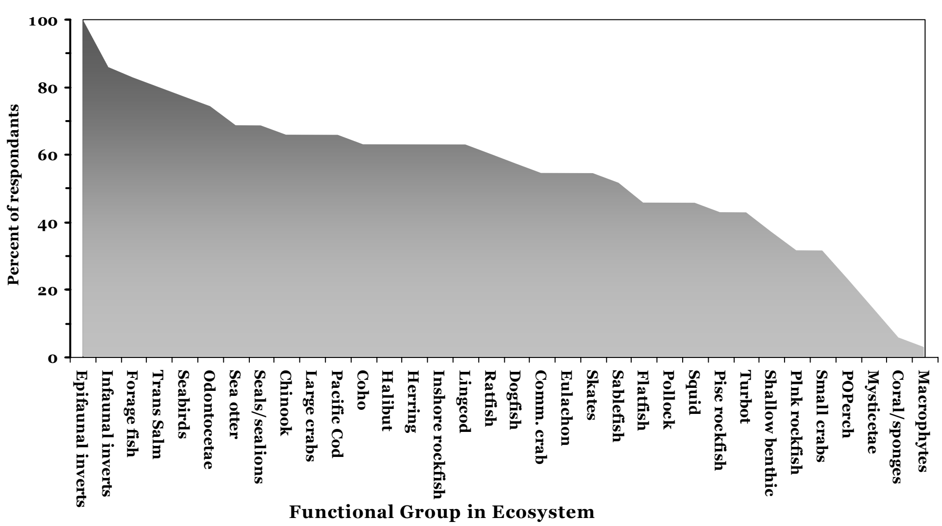

Figure 6. Diagram showing the percentage of respondents (total 35) mentioning as important each of the functional groups included in the mass-balance ecosystem model shown in Figure 5 (sorted from most-mentioned group the to the least). Respondents were from Prince Rupert, Northern British Columbia. Individual cognitive maps may contain only shadows for organisms held in full focus by scientists.

T/LEK, bathymetry and other sources. Spatial management plans, such as zones restricted to some fishing gears, or fully no-take areas, can also be explored and optimal fisheries searched for. The cognitive map delivered by Ecospace actually behaves rather like a real ecosystem and hence may engage the maritime community.

Alternative scientific representations of food web relationships, such as Multi-Species Virtual Population Analysis (MSVPA: Magnusson 1995) cover mainly the fishy portions of an ecosystem with greater rigour than ecosystem models. But MSVPA does not include most invertebrate, mammal and bird species, and does not address spatial distribution. Although these, and allied, models may be useful in fishery management, the MSVPA cognitive map is partial and is likely only to be understood by expert practitioners.

Figure 5 illustrates one aspect of the cognitive map of a scientist working on a trophic model of an ecosystem. The *Back to the Future* concept enhances this map by including perceptions of change in each of the main trophic linkages – change both from the past and for what might yet be. The cognitive map of the whole ecosystem implicit in Ecopath and *Back to the Future* analysis is perhaps closest to the concepts used in former times by pioneering ecologist/ naturalists such as Aldo Leopold (1933), Charles Elton (1926) and Alistair Hardy (1956). It reflects the classic division of ecology in autecology and synecology made in ecology textbooks (e.g. Krebs 2002).

whales and kelp received unexpectedly low scores. The cognitive map of the ecosystem scientist, on the other hand, covers all organisms equally but weights organisms by the relative importance of trophic linkages as shown previously on Figure 5.

Differences in cognitive maps were also found among the interviewees. Figure 7 shows the percentage responses for ecosystem groups in four categories of respondent: commercial, recreational and aboriginal fishers, and conservationists. It is evident that conservationists put consistently high values on a patchy set of organisms, while they tend to almost ignore others. In contrast to our ecosystem scientist and naturalist mentioned above, a survey of a random set of traditional single-species ecologists, might be similar to this conservationist profile. Recreational and Aboriginal fishers have similar shaped profiles to each other, but recognize different organisms, while, at least in this data, commercial fishers have the most balanced set of scores.

It has to be emphasised that the conclusions made here are very preliminary, since the interviews were carried out by the snowball technique and were neither random, nor stratified by category. Some fishery sectors may be been missed from the survey. Moreover, the effects of scale and changes in fishing gear locations were not covered in the survey.

Unsurprisingly, community members interviewed in Prince Rupert, a fishing town in northern British Columbia in the summer of 2000 (Pitcher *et al.* 2002b), revealed cognitive maps that differ from those of scientists. Figure 6 summarises an indication of those differences as reflected in the number and type of organisms mentioned as being important for the food web. Whilst high scores for salmon, crabs, seabirds and killer whales and low scores for small crabs and sponges are not surprising, baleen

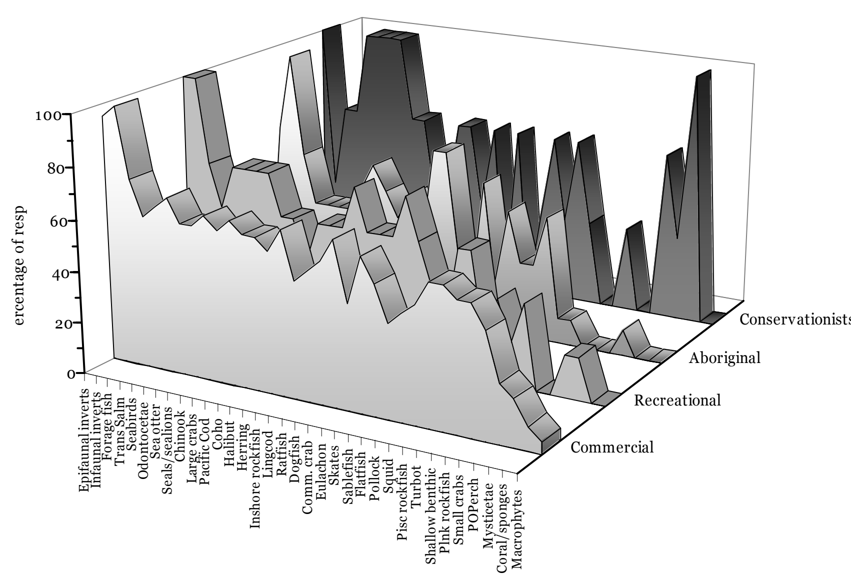

Figure 7. Diagram showing the percentage of respondents in four categories mentioning each of the functional groups included in the mass-balance ecosystem model shown in Figure 4. Respondents were from Prince Rupert, Northern British Columbia.

“THOSE WHO CANNOT REMEMBER THE PAST ARE CONDEMNED TO REPEAT IT”

(*George Santayana (1863-1952)*

The temporal dimension of a journey from TEK through single-species fishery science to an ecosystem science that *includes* T/LEK overlays the history of serial depletion of fisheries (Pauly *et al.* 1998). For example, recent work on the North Atlantic has demonstrated a ninefold reduction in table fish species between 1900 and the present (Christensen *et al.* 2003). Depletion like this has been driven by three ratchet-like processes (Pitcher 2001) that adversely affect ecology (Odum’s ratchet), economics (Ludwig’s ratchet), and the cognitive map of the system (Pauly’s ratchet, = ‘shifting baseline’, Pauly 1995), the latter expressing how successive generations perceive abundance at the start of their careers as what ‘ought’ to be there. In response to this rather deep problem, the authors conceived the *Back To the Future* approach (Pitcher 1998, Pitcher *et al.* 1999) where different knowledge systems, history, archaeology and other sources are combined to reconstruct past abundance as a way to set restoration goals that relate to productive potential rather than present scarcity. The *Back To the Future* process draws up a set of cognitive maps of the entire system as it was, as it is, and what it might become if the wit and wisdom of the scientific and maritime community could be harnessed to restoration.

Back To the Future, is, in fact, a deliberate ‘cognitive intervention’ designed to expand knowledge of the system and the potential for restoration. The political drivers of change are intended to be public awareness of the extent of ecosystem depletion in relation to the past, coupled with re-kindled belief in the potential for restoration. The latter has been sadly eroded since Peter Larkin’s ‘stained-glass cathedral’ era of the 1960s by a series of unexpected collapses, failures or fish stocks to rebuild and by a deep pessimism on the part of fisheries agencies, who these days are wont to portray themselves as helpless in the face of climate changes.

However, the future is not all black, since large area closures in US waters have shown that biomass of commercial fish stocks can rebuild, and that there is a future for fisheries provided that action is taken (Mace, pers comm.). Seeing positive results on their catches, artisanal fishers in the tropics have begun to ask for protected areas to be set up (Roberts *et al.* 2001). At the ecosystem scale, spatial models developed for marine protected areas in Hong Kong have shown the potential for restoring depleted fisheries through no-take areas, artificial reefs and other measures (Pitcher *et al.* 2002a). Cognitive maps engendered by these simulation models, coupled with consultations with fishers government and marine industry (e.g. Pitcher *et al.* 2002b), contribute to a better collective understanding of the marine ecosystem, the potential for restoration and the obstacles that have to be overcome. Such wide support, driven by a cognitive map that includes the past and the potential for restoration, encourages participation and commitment from all sectors (Pitcher 2000).

CONCLUSIONS

Is fisheries science drawn on a blank cognitive map, like Lewis Caroll’s snark hunters, as some scientific practitioners would have you believe? We don’t think that this has ever been the case. For example, Finlayson (1994) describes convincingly how misplaced confidence in models (Walters and Maguire 1966) and policies (Hutchings *et al.* 1997a, 1997b) led to the collapse of the Newfoundland cod stocks. Finlayson interprets this unhappy saga in terms of failed institutions, but underlying this in turn are the flawed mental maps of individuals who dealt with fisheries management policies.

Back to the Future encourages much more complete cognitive maps than hithertofore used in attempting to set goals for management. First, it embodies the widespread call for ecosystem-based management, or for an ecosystem approach to management (Cochrane FAO 2003). Questions that may appear purely the realm of policy using single species ecology, such as ‘what is an acceptable degree of restriction on harvest?’ (Healey 1997), turn out to have clearer answers if one evaluates the consequences for the rest of the ecosystem under a rebuilding policy.

Secondly, in *Back to the Future* the baseline relationship of the map’s structure with the perceptions of the present state are integral, but changes in ecosystem structure may be rendered easier to conceive because the map already contains comparative elements of ‘then and now’ – rather like the geomorphological shadows of past coastlines or river beds on a landscape map. And major changes in peoples cognitive maps of ecosystems may be more easily accommodated than might at first sight be thought. For example, the dissonant image of a drowned landscape is conjured up by archaeologists retrieving stone tools from the present day sea bed, as has happened in Hecate Strait Northern British Columbia (Fedje and Christensen 1999). Hence, we think that the cognitive maps of humans are profound, subtle, complex and malleable enough to accommodate the possibility of major changes for the better, despite everyday miserable evidence to the contrary. At one extreme, the world's great religions would not work if this were not so, but in our case, BTF expresses a hope that a future may see healthier fisheries and ecosystems, in sharp contrast to the pessimism surrounding fisheries policy both globally and in Canada.

Modelling is imperfect, even when uncertainty is accounted for as explicitly as possible. The *Back to the Future* cognitive map, based on a linked series of past and future model representations, is only a representation of reality: "The map is not the territory" (Korzybski 1995). So we may ask what of our policy goal for the future, derived from modelling that is imperfect and flawed? Another saying by the originator of the cognitive map concept, Henri Poincaré is relevant here "It is far better to foresee even without certainty than not to foresee at all."

References

Ainsworth, C., Heymans, J.J., Pitcher, T.J. and Vasconcellos, M. (2002) Ecosystem Models of Northern British Columbia For The Time Periods 2000, 1950, 1900 and 1750. Fisheries Centre Research Reports 10(4), 41pp.

Axelrod, R. (1976) Structure of Decisions: the Cognitive Maps of Political Elites. Princeton Univ. Press.

Blake, W. (1795) Songs of Innocence and of Experience. London.

Brown, C.R., Brown, B.E. and Carpenter, C. (1997) Some of the traditional food gathering of the Heiltsuk Nation. BC Ministry of Education, Skills and Training.

Chaib-draa, B. and Desharnais, J. (1998) A Relational Model of Cognitive Maps. Intl J. Human-Computer Studies 49: 181-200.

Christensen, V. and Pauly, D. (1992) ECOPATH II: A system for balancing steady-state ecosystem models and calculating network characteristics. Ecol. Modeling 61: 169-185.

Christensen, V., Guénnette, S., Heymans, S., Walters, C., Watson, R., Zeller, D. and Pauly, D. (2003) Hundred year decline of North Atlantic predatory fishes. Fish and Fisheries 4: 1-24.

Cochrane, K.L. (2003) The use of scientific information in the design of management strategies. Pages in FAO Technical Report 424: 95-127.

Elton, C.S. (1927) Animal Ecology. 296 p

Fedje, D.W. and Christensen, T. (1999) Modelling Paleoshorelines and Locating Early Holocene Coastal Sites in Haida Gwaii. American Antiquity 64(4).

Finlayson, A.C. (1994) Fishing for Truth. Institute of Social and Economic Research, Memorial University, Newfoundland, 176pp.

Haggan, N. (1998) Reinventing the Tree: reflections on the organic growth and creative pruning of fisheries management structures. Pages 19-30 in Pitcher, T.J., Hart, P.J.B. and Pauly, D. (eds) Reinventing Fisheries Management. London, Chapman and Hall, 435pp.

Haggan, N. (2000) Back to the Future and Creative Justice: Recalling and Restoring Forgotten Abundance in Canada's Marine Ecosystems. Pages 83-99 in Coward, H., Ommer, R. and Pitcher, T. (eds) Just Fish: Ethics in the Canadian Coastal Fisheries. ISER Books, St. Johns, Newfoundland. 304 pp.

Haig-Brown, C. and Archibald, J-A. (1996) Transforming First Nations research with respect and power. Qualitative Studies in Education. Vol. 9 (3) 245-267.

Hardy, A. C. (1956-59). The Open Sea: its Natural History. Parts I and 2. London, Collins.

Healey, M.C. (1997) Comment: The interplay of policy, politics, and science. Can. J. Fish. Aquat. Sci. 54: 1427-1429.

Hutchings, J.A., Headrich, R.L. and Walters, C. (1997a) Reply: scientific inquiry and fish stock assessment in the Canadian Department of Fisheries and Oceans, and, Reply: The interplay of policy, politics, and science. Can. J. Fish. Aquat. Sci. 54: 1430-1431.

Hutchings, J.A., Walters, C. and Haedrich, R.L. (1997b) Is scientific inquiry incompatible with government information control? Can. J. Fish. Aquat Sci. 54: 1198-1210.

Krebs, C. (2002) Ecology: The Experimental Analysis of Distribution and Abundance. Prentice Hall, 608 pp.

Korzybski, A. (1995) Science and Sanity: an Introduction to Non-Aristotelian Systems and General Semantics. Institute of General Semantics, New York. 927pp.

Kosko, B. (1986) Fuzzy Cognitive Maps. Intl J. Man-Machine Studies 24: 65-75.

Lazlo, E,. Artigiani, R., Combs, A. and Csanyi, V. (1996) Changing Visions. Human Cognitive Maps: Past, Present and Future. Praeger, Westport, Connecticut, USA, 133pp.

Leopold, A. (1933) The Conservation Ethic. J. Forestry 31: 634-643.

Levi, A. and Tetlock, P.E. (1980) A Cognitive Analysis of Japan's Decision for War. J. Conflict Resolution 24: 195-211.

Magnusson, K.G. (1995) An overview of the multispecies VPA: theory and applications. Rev. Fish Biol. Fish. 5: 195-212.

Miao, Y. and Liu, Z-Q (2000) On Causal Inference in Fuzzy Cognitive Maps. IEEE Transactions on Fuzzy Systems 8(1): 107-1119.

Pauly, D. (1995) Anecdotes and the shifting baseline syndrome of fisheries. Trends Ecol. Evol. 10: 430.

Pauly, D. (1999) Fisheries Management: Putting our future in places. Pages 355-362 in Newell, D. and Ommer, R. (eds) Fishing Places, Fishing People: tradition and issues in Canadian small-scale fisheries. University of Toronto Press, 374pp.

Pitcher, T.J. (1998) "Back To The Future": a Novel Methodology and Policy Goal in Fisheries. Pages 4-7 in Pauly, D., Pitcher, T.J. and Preikshot, D. (Eds) Back to the Future: Reconstructing the Strait of Georgia Ecosystem. Fisheries Centre Research Reports 6(5): 99pp.

Pitcher, T.J. (2000) Fisheries management that aims to rebuild resources can help resolve disputes, reinvigorate fisheries science and encourage public support. Fish and Fisheries 1(1): 99-103.

Pitcher T.J. (2001) Fisheries Managed to Rebuild Ecosystems: Reconstructing the Past to Salvage The Future. Ecological Applications 11(2): 601-617.

Pitcher, T.J., Haggan, N., Preikshot D. and Pauly, D. (1999) 'Back to the Future': a method employing ecosystem modelling to maximise the sustainable benefits from fisheries. Pages 447-466 in Ecosystem Approaches for Fisheries Management, Alaska Sea Grant, Anchorage, USA, 738pp.

Pitcher, T.J. and Power, M.P. (2000) Fish Figures: Quantifying the Ethical Status of Canadian Fisheries, East and West. Pages 225-253 in Coward, H., Ommer, R. and Pitcher, T.J. (Eds) Just Fish: the ethics of Canadian fisheries. Institute of Social and Economic Research Press, St John's, Newfoundland, 304 pp.

Pitcher, T.J., Buchary, E.A. and Hutton. T. (2002a) Forecasting the Benefits of No-take Human-made Reefs Using Spatial Ecosystem Simulation. ICES J. Mar. Sci. 59: S17-S26.

Pitcher, T.J., Power, M. and Wood, L. (eds) (2002b) Restoring the Past to Salvage the Future: Report on a Community Participation Workshop in Prince Rupert, BC. Fisheries

Centre Research Reports 10(7): 55 pp.
Roberts, C.M.; Bohnsack, J.A.; Gell, F; Hawkins, J.P. and Goodridge, R (2001) Effects of Marine Reserves on Adjacent Fisheries. Science 294: 920-1923.
Sumaila, U.R. (2001) Generational cost benefit analysis for evaluating marine ecosystem restoration In Pitcher, T.J., Sumaila, R. and Pauly, D. (eds) Fisheries Impacts on North Atlantic Ecosystems: Evaluations and Policy Exploration. Fisheries Centre Research Reports 9(5). 94 pp.
Sumaila, R.S., Pitcher, T.J., Haggan, N. and Jones, R. (2001) Evaluating the Benefits from Restored Ecosystems: A Back to the Future Approach. Pages 1-7, Chapter 18, in Shriver, A.L. and Johnston, R.S. (eds) Proceedings of the 10th International Conference of the International Institute of Fisheries Economics and Trade, Corvallis, Oregon, USA, July, 2000. (on CD-ROM)
Tolman, E.C. (1948) Cognitive Maps in Rats and Men. Psychological Review 55(4): 189-208.
Walters, C.J. and Maguire, J. J. (1996) Lessons for stock assessment from the northern cod collapse. Rev. Fish Biol. Fish. 6: 125-137.
Walters, C., Pauly, D. and Christensen, V. (1999) Ecospace: prediction of mesoscale spatial patterns in trophic relationships of exploited ecosystems, with emphasis on the impacts of marine protected areas. Ecosystems 2: 539-554.
Walters, C., Christensen, V. and Pauly, D. (1997) Structuring dynamic models of exploited ecosystems from trophic mass-balance assessments. Reviews in Fish Biology and Fisheries 7: 139-172.
Watson, R. and Pauly, D. (2001) Systematic distortions in world fisheries catch trends. Nature 424: 534-536.
Wilson, E.O. (1984) Biophilia: The Human Bond with other Species. Harvard Univ Press. 176pp.

Papers in Abstract

This section reports the abstracts of papers, and their discussion, which were delivered at the conference, but which were not submitted as papers for this publication.

CHANGES IN TECHNOLOGIES, MARKET CONDITIONS, AND SOCIAL RELATIONS: THEIR LINKAGES WITH FISHERS' TRADITIONAL ECOLOGICAL KNOWLEDGE (NEW BRUNSWICK'S INSHORE FISHING FLEET IN THE SOUTHERN GULF OF ST. LAWRENCE).

Omer Chouinard and Jean-Paul Vanderlinden
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New-Brunswick's inshore fleet is, by tradition, practising a multi-species fishery. Nevertheless, technological changes as well as market conditions have increasingly led this fleet to specialize towards one (lobster) or a few species (lobster, scallop, herring). While the extent of this specialization is small in comparison to the specialization of midshore and offshore fishing fleets, it did have consequences in terms of fishers-resource interactions.

Using New-Brunswick's southern Gulf of St. Lawrence inshore fleet as a case study, the purpose of this presentation is to show how fishers' traditional ecological knowledge may have evolved in the face of technological changes, institutional changes and market conditions. Surveys were conducted with fishers between 1997 and 1999; these surveys were targeted at acquiring data on technological changes, changes in fishing strategy, changes in social relations, and changes in fishing territories. Analysis of these data allowed the identification of fishing territories as a key indicator of the inshore fishery's sustainability. From this indicator it is possible (1) to derive the evolution of fisher-resource interaction, and (2) to analyse the impact of this evolution on inshore fishers' ecological knowledge.

Fishers' ecological knowledge evolved in concert with the evolution of their knowledge of institutional and economic conditions. This knowledge contextualizes recent changes in terms of access to the resource (e.g., development of a native fishery) and in terms of management (e.g., bottom seeding of scallop beds). This allows a better understanding of the role that fishers' ecological knowledge may play in the future of fishery management.

DISCUSSION

Eduardo Espinoza
How is the information from fishermen evaluated?

Omer Chouinard
Fishermen asked for a wider space for both lobsters and crabs and were given the go-ahead in 1996, twenty years after they asked for it. There is a lot of waiting before regulation is implemented because the way of thinking is that fishermen have to solve the problems by themselves. But they can only do a certain amount on their own. They need assistance from the state.

Cyril Carpenter
I am from British Columbia and I am a retired fisherman. I worked in Newfoundland, New Brunswick, and Quebec. We overfished herring in British Columbia. We bought our boats in Panama and worked in your country. While we were there, the Canadian government allowed mid-water trawlers to harvest miles and miles of herring. When herrings were spawning, we asked the company to stop fishing but that didn't happen. There were circumstances beyond the power of fishermen that controlled the rules. We asked the company why they wouldn't let us stop fishing during spawning season when it is detrimental to the herring. When did the federal and provincial governments in the East support protection of the resources?

Omer Chouinard
As I mentioned before, it took a long time for the government to react. We know that the herring is in trouble and now they are more cautious with the resource. The problem is that fishermen tend to work where the herring spawn.

FISHING AT KOMODAH, KITKATLA TERRITORY: RETURNING TO SELECTIVITY

Charles R. Menzies and Caroline F. Butler
Department of Anthropology and Sociology, University of British Columbia, Vancouver, British Columbia, Canada

In response to a perceived decline in fish stocks, the Department of Fisheries and Oceans (DFO) has implemented a policy of selective harvesting in the Pacific fisheries of British Columbia, requiring avoidance or live-release of non-target species. DFO sponsored test fisheries have prioritized non-Indigenous fishing gears and technologies (such as fish wheels and mobile traps) and have seemingly ignored the ecological and technological knowledge of First Nations. In order for selective fishing strategies to be both ecologically sound and commercially viable, gear and fishing methods need to be site specific in design. In this paper we describe a pilot project that explores the conservation potential of traditional Tsimshian fishing methods (primarily stone wall traps and beach seines). We have identified key elements of local ecological understandings and historical practices through working with Tsimshian fishers. This knowledge is critical for creating locally relevant and ecologically sound fishing technology.

DISCUSSION

Cyril Carpenter

I want to add more information on fish traps. We were active members in maintaining them. Contrary to what the fisheries are doing, what we did was take the small and weak for our food, open the gates when we had enough, and chased them out of the traps, and let them out when they were ready. We have archaeological evidence of fish traps over 400 years old with gates to chase the salmon out when we had enough to process for one day. It enhanced the stock in that it allowed the strongest of the species to go upstream. In Bella Bella and other places this has been going on for over 5000 (is this right?) years. Now we take the biggest and most vibrant out of the stock because we are using big mesh gear.

Saudiel Ramirez-Sanchez

How do you approach the problem of the technology when you only look at that aspect? When First Nations use their knowledge, there are values attached to it that you didn't mention. If you want to use their traditional knowledge again, how would you reattach the values to them?

Charles Menzies

I have to confess to being a materialist in that I see knowledge emerging out of the utilization of the resource. We have different cultural frames, but the day-to-day interactions, if you listen to elders, entail very detailed information. I think that it's important for people to remember the values, but knowledge is not necessarily structured by a cultural framework. I start from the directly observable.

THE LEADERSHIP ROLE OF CALIFORNIA FISHING MEN AND WOMEN PROMOTING SCIENCE IN FISHERIES POLICY AND FISH RECOVERY

Natasha Benjamin[1], Paul Siri[2] and Zeke Grader[3]
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Organizations representing commercial fishing men and women have played a key leadership role for over quarter of a century in California bringing science to bear on fishery policy and efforts to restore fish habitats and populations. Programs initiated by the fishing industry for the restoration and management of a number of fisheries, and support for legislation to tax themselves, include, among others: research into the cause of the decline in Dungeness crab populations, research into spawning herring populations, and research into the biology of market squid. In addition to incorporating a role for science in the policies they initiated, California fishing men and women also became engaged in lending their knowledge, skills and assistance to marine scientists including: albacore research, collecting information on watersheds on salmon populations and also on rockfish in nearshore waters.

Several fisheries restoration projects began as concepts initiated by the fishing industry, which integrated science with agency managers, and resulted in the development of new tools for stock assessment and management. Currently in its eighth year, the Sacramento River Winter Run Chinook Captive Broodstock Program is providing groundwork for recent interagency proposals to preserve endangered coho salmon using similar science-based intervention rules and technologies. This success facilitated the formation of additional partnerships with recreational anglers, thereby gaining national attention in the role of Non-Government Organizations (NGOs) working with scientific institutions in coastal salmon recovery efforts. More recent examples of academic-industry partnerships are fishery supplementation initiatives to enhance San Francisco Bay ecosystem function and environmental services, in particular for native herring and oysters.

New large scale coastal observations have been proposed using fixed platforms and biological sampling together with the local knowledge of fishing men and women underpinning the development of the science necessary to create marine protected areas. Active participation of fisherfolk in the measurements necessary to reduce uncertainty in marine and aquatic systems is essential for creating information and social equity – THIS MAKES NO SENSE. Potential benefits of academic-industry partnerships will need to expand to embrace other issues such as invasive species, which are as large a threat to ecosystem function as the collapse of fisheries. Active participation in science by well-informed industry and NGOs helps to increase the flexibility of bureaucratic decision-making systems that traditionally resist change and ignore the biological consequences of inaction.

DISCUSSION

Eduardo Espinoza
We have the same situation in the Galapagos. How do you get fishermen's participation?

Natasha Benjamin
The fishermen are coming to us when they see a problem with the resource.

Eduardo Espinoza
Do you have any salaries for them? We have a participatory process with the fishermen and they want a salary because they lose days out at sea when they attend meetings.

Natasha Benjamin
A lot of these are volunteers. We try to use fishermen in those projects and we try to give them money when we can.

Eduardo Espinosa
That is a cost for the participatory process because then in the future you need to pay them every time.

Natasha Benjamin
We have incorporated them in our research program, and they get compensated for them.

Ed Burton
Is that getting serious play in DC?

Natasha Benjamin
There are quite a few co-sponsors. They have just been introduced.

Unknown
Does the federation represent all fishermen and species?

Natasha Benjamin
It is definitely focused on salmon and albacore.

Sheila Heymans
I don't know about First Nations in California. Did they catch these species as well, and do they still participate in the fishery?

Natasha Benjamin
I don't know about the First Nations in California.

Sheila Heymans
Can they be part of the federation if they want?

Natasha Benjamin
Yes, but membership mainly comes from the commercial fishery.

Burton Ayles
What is an urban commercial fishery?

Natasha Benjamin
It is the fishery which takes place in San Francisco bay in the middle of the city.

Kathy Scar
In the PCFFA, is there mandatory participation? Is it a volunteer organization? Is there funding that goes towards research?

Natasha Benjamin
Participation is for people who want to participate and get involved with the legislation. Once the bill is passed, it covers the entire fishery. The California Fish and Game controls the funds.

INCORPORATING INDIGENOUS INTERESTS AND KNOWLEDGE INTO MANAGEMENT OF THE GREAT BARRIER REEF MARINE PARK

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The Great Barrier Reef Marine Park was established in 1975 and covers an area of more than 346 000 square kilometers. It is the largest World Heritage Site in the world, and the largest multiple use Marine Protected Area. It includes the maritime estates of over 40 coastal indigenous groups of Australia.

In the mid-1990's the Great Barrier Reef Marine Park Authority (GBRMPA) embarked on a review of management of the Far Northern Section of the Marine Park which covers an area of approximately 85 000 square kilometers. The Far Northern Section lies adjacent to Cape York Peninsula, a remote region which is often stated to be an indigenous domain where indigenous peoples represent the majority of the population and have an ongoing cultural relationship with the land and sea. Indigenous people with connections to the Far Northern Section of the Great Barrier Reef Marine Park engage in turtle, dugong, finfish, crayfish, and shellfish fisheries, and have historically been involved in pearl, beche-de-mer and trochus fisheries.

The review of the Far Northern Section was primarily aimed at meaningfully involving indigenous groups in marine planning and management, whilst reviewing the conservation requirements of important marine habitats and species. The review is the largest marine planning exercise of its type conducted in Australia to date. Negotiations took place with over 12 indigenous groups between 1995 and 1999, and involved GBRMPA, Queensland Fisheries Service, Queensland Parks and Wildlife Service, the commercial fishing industry, recreational fishers, non-government conservation organizations, and the general public.

Indigenous knowledge of marine species and habitats, in conjunction with cultural values, have been incorporated into a package of proposed plans and strategies for management of the Far Northern Section, including: a new Zoning Plan which is due to come into force late in 2001, formal agreements regarding the development and implementation of more detailed Marine Park management strategies, and roles in day-to-day management.

However, as time passes, indigenous aspirations have shifted from desiring high levels of marine protection towards improved fisheries management and economic advancement, and there is an increasing focus on the requirement to incorporate indigenous fisheries interests into the wider fisheries management framework, and to recognize the special interests of indigenous groups with custodial obligations to care for 'sea country' in fisheries management. The debate over the existence of Native Title in the marine environment continues, and political priorities of governments also change over time.

USING FISHERS TRADITIONAL KNOWLEDGE TO IDENTIFY PRIORITY AREAS FOR CONSERVATION IN THE PACIFIC OCEAN

Lance Morgan
Marine Conservation Biology Institute, Redmond, WA, USA

In some ways, conservation in the sea is no different from conservation on land; protecting places is a more comprehensive, robust, cost-effective and politically viable strategy than imposing separate regulatory regimes on each species. Interest in marine protected areas (**MPAs**) as a new paradigm for conserving marine biodiversity and strengthening fishery management has increased dramatically in the last few years because the dominant paradigm–command-and-control regulation–has failed to stop biodiversity loss and fisheries collapse. In the sea, as on land, successful place-based strategies require identifying conservation targets, so the first step of a rational MPA strategy is producing a map of the most important places to protect.

A credible map of delineated and named priority areas would catalyze progress in marine conservation by making them tangible in the minds of people. The conventional approach to priority area designation is by means of a workshop of scientific experts. While this results in the production of a map it remains lacking due to several key reasons. Priority designation is first and foremost a subjective term and needs to be clearly defined. Second, place-based knowledge in the sea is patchy at best among scientists and little information is available that has significant temporal resolution. Thus the opportunity to use fisher's knowledge in these efforts has high potential for assisting in documenting priority areas. Accessing and interpreting this information however remains an outstanding challenge. Here I describe our approach to delineating priority areas in the Northeast Pacific Ocean and the role for fishers' knowledge in the process. As the interest in MPAs increases many groups are initiating efforts that could contribute to a map of priority areas, and everyone involved—scientists, managers, NGO staff—would benefit by incorporating traditional knowledge of fishers.

DISCUSSION

Bob Johannes
Did you have any experts on marine TEK in your group?

Lance Morgan
Not specifically. There were a few people who were involved in it. One of the tasks was to talk about it.

Chad Paul
In Canada, the fish stock is prioritised in the following way: the first priority is for conservation, then for aboriginal use, then for recreational use and what they term other stakeholders. 9% of British Columbia is not under a treaty. If you want to consult in my area you should not use "stakeholders".

Lance Morgan
I apologise for that.

Ted Ames
On the issue of fishermen versus scientists, you mentioned that scientists focus more on species and fishermen focus more on family and self. I take exception to that because fishermen are saying that they're a part of the system too. They are not severed from the fishery.

Lance Morgan
I agree. Part of it is trying to reflect the conversation that we had. It's not perfect. The other part is that, as I said, it's a generality that we're trying to fix.

Simon Lucas
I come from the Hesquiat Peninsula. I know what you're trying to achieve, but what made our Hesquiat nation whole is that about 20 years ago, there used to be a commercial seine fishery in our area and the elders said "No, it's against our philosophy" so we got rid of it. Most of the communities you showed are First Nations people. In British Columbia, you say that you will have marine parks and you will consult with environmental groups. You have to make sure that you consult across the board. Consult with the First Nations too, and not just grab some Indian off the street to ask his opinion.

Lance Morgan
What will happen is that large regions will be selected and there will be intensive effort within a smaller region.

Simon Lucas
One of the problems in Nuu-chah-nulth is the overpopulation of sea otters. We have to talk to lots of people to get rid of them. Our neighbours have no more clams or sea urchins because of them. One of the things you have to remember is that one of the most endangered species on the coastline is our people.

THE NOVA SCOTIA LEATHERBACK TURTLE WORKING GROUP: A MODEL FOR SUCCESSFUL COLLABORATION BETWEEN FISHERS AND SCIENTISTS

Michael C. James[1] and Kathleen E. Martin[2]
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The leatherback turtle (*Dermochelys coriacea*) is a highly pelagic marine reptile. Therefore, working with this species anywhere but on nesting beaches is challenging. When we began studying the distribution of the leatherback in Atlantic Canada, we addressed this difficulty by turning to commercial fishers for help. Fishers have some of the best opportunities to observe leatherback turtles at sea, although their observations of this species are traditionally unreported. In 1998, we enlisted the assistance of more than 200 volunteer fishers in reporting turtle sightings. In just one season, we collected 171 geo-referenced sightings of leatherback turtles—more than twice the extant number of published records of this species in Atlantic Canada. Our findings served to further substantiate an earlier claim (Bleakney, 1965) that these animals are seasonal migrants to Canadian waters. As important as the data that we collected, is what made that data collection possible: developing and maintaining our relationship with the volunteer fishers. Our current level of knowledge of the movements and distribution of this critically endangered species could not have been possible without journeying first into the heart of one Nova Scotia's most vital cultures, the fishing community, complete with its brand of politics, family structure, and vernacular.

DISCUSSION

Ian Baird
You mentioned that fishers were not likely to be willing to contact you if you were associated with environmental groups, yet one of your posters says that you receive funds from the World Wildlife Foundation.

Kathleen Martin
That's one of the first posters that we made. Fishers did call with concerns over it. They were not necessarily interested in being involved

because they were wary of the World Wildlife Foundation.

Shauna Rheiswitz
Did you get any historical sense from the fishers about changes in the population? Are the leatherbacks less abundant or more abundant?

Kathleen Martin
They appear to be just as abundant, which is exciting when you're working with endangered species. However, we cannot be sure because we may be surveying in an important foraging ground. When we talked to the fishermen, they said that their grandparents saw them and had photos. They knew when the turtle season began. There are years that appear to be bumper years, like 1997, when 25-30 turtles appeared in St. Arliss Bay.

Shauna Rheiswitz
Are those bumper years related to El Nino?

Kathleen Martin
I don't know – it could be. We just started, so we cannot say at this stage. There could be a cycle that we aren't aware of yet, like a two-year nesting cycle.

TRADITIONAL ECOLOGICAL KNOWLEDGE IN OCEAN AND COASTAL MANAGEMENT: A SURVEY OF RECENT EXPERIENCE IN ATLANTIC CANADA

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In Canada's Atlantic Provinces, scientific researchers and community development practitioners have long worked with organizations and individuals to collect and apply traditional ecological knowledge. In this paper we review several recent projects supported by Fisheries and Oceans Canada. Since the early 1990s, ocean and coastal planning staff of the Department have worked with a range of indigenous and non-indigenous communities to document traditional knowledge. Most of these projects have involved semi-structured interviews, mapping, some level of verification and digital treatment with geographic information systems. Community participants have volunteered information on ecology and patterns of use as well as local perspectives, such as attachment to place. The precise collection methodologies have varied somewhat between projects and regions, but the results are generally comparable. Valued coastal resources and medicinal plants have been inventoried through a collaborative project with Bras d'Or Lakes Mi'kmaq. Inshore fishing grounds have been mapped for most areas of Atlantic Canada. Observations of spawning and juvenile fish have been documented in the Bay of Fundy, on the Scotian Shelf and in eastern New Brunswick. Other sensitive areas, including the locations of deep-sea coral, have also been described. Applications fall into several broad categories. Traditional knowledge has been used to supplement scientific data for environmental assessments in aquaculture and hydrocarbon exploration. In a planning context, traditional knowledge has been used for search and rescue, marine protected area selection, oil spill response planning, education and communication. Cartographic portrayals of different activities in space and time have supported conflict resolution in fisheries management and in multiple use ocean environments. In a final application, we describe how fishers' knowledge was used in the planning stages of a multibeam survey and later, a scientific survey of coral habitat. The paper concludes with a discussion of successes, failures, and lessons learned.

DISCUSSION

Vivian Barrier
I work with a Salish tribe in Puget Sound. How do you carry across the knowledge to the table without losing all the details, especially if the information can only be used for conservation and fisheries management?

Paul Macnab
That's not something the government will take to the table ever. The knowledge resides in the community, and it is up to the community to decide whether they want to bring it to the table or not. Some of the comments on the last few slides don't apply to the Mi'kmaq.

THE TULALIP TRIBES CULTURAL STORIES PROJECT: RECORDING AND USING TRADITIONAL KNOWLEDGE FOR CULTURAL LANDSCAPE RECOVERY, WATERSHED MANAGEMENT AND SALMON PROTECTION

Terry Williams, Julia Gold and Preston Hardison
Tulalip Natural Resources, Marysville, WA, USA

Over the past two centuries, the ancestors of the Tulalip Tribes have witnessed great changes to the health of their homelands – the salmon return in fewer numbers to spawn, many of their traditional relationships to the land have been

broken, and many culturally important species and habitats have dwindled. Over the past two decades, the Tulalip Tribes have embarked on a program to manage and restore their watersheds and protect and recover habitat for salmon. For indigenous peoples, any environmental restoration involves biocultural restoration, since the culture cannot be separated from the land. The Cultural Stories Project has been developed to complement the biophysical models the Tulalip developed for watershed management. The project uses interviews with elders and other tribal members to document the cultural and traditional uses of resources and their importance to Tulalip Tribal members, whose stories are used to characterize historical cultural landscapes and resources, the perceived current state of these landscapes and resources, and the future desired states. This information is correlated against historical accounts from the literature and scientific documentation, and these are then integrated into the biophysical watershed models to establish a vision for restoration efforts. We describe the methodology for this process, some of the software tools developed, and issues concerning privacy, indigenous knowledge protection, and the use of indigenous knowledge in interaction with external federal, state and municipal agencies involved in watershed management and Pacific salmon endangered species protection. Finally, we explore the importance of this process for the cultural health and well being of the Tulalip Tribes and their homeland.

ENVIRONMENTAL SENTINELS: REFRAMING COMMERCIAL FISHING IN PURSUIT OF VALUE, INTEGRITY AND SUSTAINABILITY

Bryan Price
SARDI Aquatic Sciences, Henley Beach, SA, Australia

The traditional western model of fisheries science emphasized the importance of "independent", high quality scientific advice – which is most commonly utilized to support the power of the relevant political authority /management organization. Regardless of purported institutional aims, actual incentives for fisheries scientists to effectively service stakeholder or resource needs are usually minimal or negative.

Fisheries science may at times have high explanatory value; but is also commonly very expensive, involves small sample sizes relative to environmental variability, and has been prone to overlook factors that are "common knowledge" to grass-roots fishermen. Societal environmental expectations (and impacts) require an increasing burden of monitoring and research on aquatic environments – all of which are necessarily parasitic on the same limited (usually decreasing) revenue stream.

South Australia's River Murray Fishery and Lakes and Coorong Fishery have grasped environmental and resource monitoring as an opportunity to dramatically change the perception and profitability or their small-scale fisheries. Specific voluntary, self-funded initiatives they have working now include:

- A daily resolution, location-specific environmental data collection system (inclusive of habitat, pollution, human use and icon species quantification);
- A GIS-based model linking habitat data to location-specific daily catch-effort data that quantifies the impacts of management on fish abundance and health;
- A cooperative stock assessment system whereby industry research is "benchmarked" by independent, cost—effective fisheries science

Resulting data already have high management value (e.g. Coorong National Park now uses data on tourist use in operational management and future planning). In the River Murray Fishery, the replacement value of core data actually exceeds the annual production value of the fishery. Perceived integrity of fishers, especially with environmental groups, has increased beyond any expectations. Knowledge is power, and these fishers now express increased control over their own fishery's destiny, as well as greater ownership of the sustainability of the aquatic systems on which their futures depend.

DISCUSSION

Saudiel Ramirez-Sanchez
I think your typology for power is interesting. You say that information is power, but information by itself isn't power unless you structure it in different ways. By presenting information in a certain way, you also exercise power.

Bryan Pierce
Yes, that's true, but I argue that's principle-based power because we are expressing what we believe.

DEVELOPING A SET OF INDICATORS FOR EVALUATING THE CONDITION OF A RESOURCE. CASE: FRESHWATER FISHERIES IN LAOS PDR.

Niels Jepsen1, Douglas Wilson2 & Sommano Phounsavath3
1Danish Institute for Fisheries Research, Dept. of Inland Fisheries, Silkeborg, Denmark; 2Institute for Fisheries Management and Coastal Community Development, Hirtshals, Denmark; 3Living Aquatic Resource Research Centre, Vientiane, Lao PDR

Indicators of ecosystem health have emerged as a popular concept among fisheries management professionals who think they have the potential to provide useful information to managers that can be clearly communicated to stakeholders. Through a project involving several case studies in Asia and Africa, we tried to define a list of parameters or indicators that are simple, robust and make sense to the local people. These indicators can be evaluated through the knowledge of both fishers and fisheries science professionals and thus provide a biologically valid base for management actions. The relevant indicators will vary between areas and types of fisheries, but we hope that the approach and the methods will have global relevance.

Through interviews with fishers along the Xe Don River, a Mekong tributary in Laos, we have attempted to learn the ways that local people understand the condition of the resource and what information they believe indicates changes in this condition. Our main purpose is to explore how the "indicator approach" can be helpful in making statements about the condition of the resource, which can be utilized in management. We have identified a list of candidate indicators, which may prove to be a valuable tool in the management of the fisheries. The indicators are currently being evaluated for both sociological and biological validity by a cross-disciplinary team through collected data as well as literature reviews. The final evaluation of the indicator-approach will be performed after six additional case studies have been carried out.

DISCUSSION

Richard Hamilton
From all the talks that we've heard, it looks like there is a lot of emphasis on Laos and the Mekong River. What is the objective? Is it to help the people there and improve the fisheries?

Niels Jepsen
There are different objectives, but when we choose our case studies, it is to reduce cost. We go into places that already have things going on and build on top of the projects. That's part of the reason. Another part of it is that the Mekong is very important and has had problems in its fisheries, so there is need to do some kind of management there. There are also case studies of coastal fisheries and different types of fisheries. We are trying to spread this out and learn from all these case studies.

Ian Baird
I also thought that your project had something to do with discourse analysis between government and people, but you don't mention much about it in your talk.

Niels Jepsen
That's because we haven't done it yet. We will do it next month.

A METHOD TO ESTIMATE THE ABUNDANCE OF ARAPAIMA GIGAS (CUVIER 1817)

Leandro Castello
Instituto de Desenvolvimento Sustentável Mamirauá, Tefé-Amazonas; Brasil

Arapaima gigas is an over-exploited commercial fish species in the Amazon. This work aims to develop and test a method to assess *Arapaima* wild populations. A team of 8 local fishermen made direct counts of *Arapaima* individuals (juveniles and adults) in closed lakes. The validity of the counts was tested through the comparison of its estimates with mark and recapture abundance estimates for the same populations. The applicability of the counting method was tested surveying 105 lakes. The replicability of the method was tested through a series of experiments aiming the method's dissemination- THIS DOESN'T MAKE SENSE.

The correlation between the counts and the mark and recapture estimates is high (r^2=0.99). The size-classes estimation is also considered reliable (juveniles: r^2=0.95; adults: r^2=0.96). 987 adults and 2963 juveniles were counted in 105 lakes. Higher densities of adults were found in unfished lakes. The dissemination of the method was confirmed by a series of high correlation indices (r^2=0.87; r^2=0.92; r^2=0.79).

The counting method is accurate, precise and cheap. The higher abundance of older individuals found in the unfished lakes suggests site-fidelity. The method can be taught from one fisherman to another without the use of mark and recapture abundance estimates. The methodology proposed is considered ideal for community based fishery management programs. Particularly this work shows that fishermen's empirical knowledge may be the best tool for management of *Arapaima*.

DISCUSSION

Christina Soto
If you didn't have abundance of the fish, on what basis was the fishery closed?

Leandro Castello
That's a problem in the Amazon. Decisions are made based on nothing or on biased reports. We don't have good studies on the status.

Christina Soto
Were any fisheries reopened as a result of this technique?

Leandro Castello
Yes. An extension team applied this research within these communities. We had special permits from the government to do this legal harvesting.

Kathy Scar
I'm really impressed with the work done here. One of the reasons why it was so different is that the focus isn't on how to get villagers to give data to scientists and let them go off and use it. Rather, the focus is on how to maintain fishers' knowledge and share that knowledge within a community, particularly at a point in time when fisheries all around the world are being shut down and there is no information transfer between generations. You've taken that information and demonstrated that there is value in it, and allowed fishermen to help fishermen. This isn't about how to get information when I already have a lot of knowledge. I'm really impressed and I was wondering whether or not that concept of fishermen training fishermen is adopted anywhere else.

Leandro Castello
This knowledge only exists in populations where the population is healthy, so there is interdependence between the fish and the knowledge. Both fish and knowledge have to exist so they can both be managed. Today there are only 4 communities using this method and they are getting very good results. We have 30 communities that are implementing this strategy and hopefully in a couple of years, we will have 34 communities using it. Although this method may seem ideal, do take into consideration that the Amazon has over 1000 communities. We can't ever reach them all.

USING FISHERS' KNOWLEDGE TO EVALUATE GREAT LAKES FISHERY MANAGEMENT POLICY

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Fisheries management in the Laurentian Great Lakes remains a challenge due to the low abundance of native lake trout stocks (*Salvelinus namaycush*), the introduction of invasive aquatic species, lack of cooperative management between tribal and state regulatory agencies, and social conflict between treaty-right Native commercial fishers and non-Native state-licensed, recreational sport fishers. Since 1985, fisheries management in the Great Lakes has been governed by a court-imposed fisheries management policy—the 1985 Consent Decree/Order. This policy utilized unique management provisions to promote: 1) conservation and rehabilitation of lake trout, 2) reduction of violence and discord between treaty-right Native commercial fishers and state-licensed sport fishers, 3) equitable fishery allocation, and 4) more collaborative management between state and tribal regulatory agencies. To assess the effectiveness of the 1985 Consent Decree/Order at achieving these goals, individual, in-depth interviews were conducted with tribal commercial fishers and state-licensed sport fishers, as well as biologists and representatives. Exploration of fishers' knowledge provided fundamental insight into how this fishery management policy impacted the Great Lakes fishery and critical socioeconomic variables—such as social conflict, economics of the fishery and fishing opportunities—that previous assessments have not provided. Furthermore, their knowledge offered a rich context for understanding changes to the fishery over time, such as the movement of fish stocks with warming water temperatures and diminishment of fishing opportunities for Native small-boat commercial fishers.

DISCUSSION

Christine Dyer
How does your evaluation affect policy?

Laura Cimo
During the negotiations for the recent agreement, the Court put a gag order on the parties so we could not talk to them about policy. The result was that they did not use this information and the fishers were not consulted, as happened in 1985. We are hoping that there is

an opportunity to present this information in the upcoming discussions for inland fishing treaty rights.

Saudiel Ramirez-Sanchez
The previous presentation argued that knowledge is shifting. If you bring in the voice of people into policy, how do you deal with the shifting knowledge? Policy cannot predict how knowledge is changing.

Laura Cimo
Knowledge is flexible, but the policy is structured so that you could not change it and so people keep going to court. We would like to have more flexible agreements. I think the latest 2000 agreement is more flexible. Hopefully we will have better dispute mechanisms, but I don't know if that will work. There is a real power differential – the state has power.

THE FISHERMEN AND SCIENTISTS RESEARCH SOCIETY: COLLABORATIVE IMPROVEMENT OF THE KNOWLEDGE BASE FOR MODERN FISHERIES MANAGEMENT

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The collapse of the eastern Scotian Shelf cod fishery in the early 1990s was the catalyst for development of the Fishermen and Scientists Research Society (FSRS). Fishermen were faced with devastating declines in incomes while the Department of Fisheries and Oceans (DFO) suffered staff and budget reductions and a deteriorating relationship with its clients and the general public. A new model, which would improve the scientific basis of stock assessments and re-build trust between scientists and fishermen, was needed. The FSRS was established in 1994 to bring fishermen and scientists together to share information and conduct collaborative research in support of long-term sustainability of fisheries. The project was designed to obtain more accurate indicators of fish stock health and establish viable methods of co-operation and collaboration. At present the Society has over 200 members throughout Atlantic Canada, manages a comprehensive annual survey of fishes, and is involved in a wide range of research project in collaboration with DFO, NGO's and Universities. We trace the development of the Society from the early steps of developing a common language and overcoming mistrust, to the present organization, which brings fishermen's knowledge into the scientific arena and provides an effective forum for deliberation of issues germane to the long-term viability of fisheries. We also review results of a number of major co-operative research initiatives of the Society.

DISCUSSION

Kathleen Martin
You said that the projects were generating revenue for themselves. What do you do to raise funds?

Paul Fanning
The government funds them and any overhead is retained by the society. When lobster biologists wanted to do a study, they were able to take money from the DFO to contract scientists. It was fairly cheap because we made the fishermen buy the traps themselves. It still requires coordination, but we are only talking about small amounts of money, on the order of $1500 or so. Fishermen can't do these things on the water for free, so there has to be some amount of money. At the very least, we have to cover their expenses.

Chad Paul
You were saying that your organization involves vested interests. What about Mi'kmaq? Are they involved?

Paul Fanning
They aren't yet because the background of the organization is groundfish and they haven't taken an interest in it. Their interest is mainly in lobsters and the gulf area, neither of which is in the organization. The society is of limited geographical scope and does not take representative membership. Members come into the society if they wish. Some scientists from DFO are involved and some are not. Sometimes they start out with projects that work with the organization, and end up joining it. There are members of the society that come from a Mi'kmaq background, but they don't represent the Mi'kmaq.

FISHERIES IN THE GALÁPAGOS ISLANDS: THE PARTICIPATION OF FISHERS IN FISHERY MANAGEMENT

E. Espinoza, J.C. Murillo, M.V.Toral, R.H. Bustamante, F. Nicolaides, G.J. Edgar, J. Moreno, C. Chasiluisa, M. Yépez, J.C. Barreno, S. A. Shepherd, J. Viscaino, M. Villalta,R. Andrade, A.F. Born, L. Figueroa1, P. Guerrero1 y M. Piu1
Área de Investigación y Conservación Marina, Estación Científica Charles Darwin
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Exploitation of marine resources within the Galapagos Archipelago has passed through several phases in which whales, fur seals and lobster were exploited. Recently, with the commencement of a sea cucumber fishery in 1992, fishing capacity increased greatly. In order to reduce threats to the natural values of unique Galapagos marine ecosystems and provide a scientific basis for sustainable management of Galapagos fishery resources, a joint fisheries monitoring program (Programa de Monitoreo de Pesqueria - PMP) involving the Charles Darwin Research Station, the Marine Resources Unit of Galapagos National Parks and the four Galapagos fishing cooperatives has been operating since January 1997.

Within the framework of the PMP, monitoring of fishing activity and catches now occurs cooperatively on a daily basis. Management decisions are made on the basis of the fisheries knowledge existing in the fishers' community. This process is institutionalized in a participatory process that involves the local users of the Galapagos Marine Reserve and the results are directly utilized by the decision-making bodies.

The present paper summarizes the state of the development of the participatory process and the implementation into sustainable fishery management procedures.

DISCUSSION

Laura Cimo
A few years back there were real problems between fishers and the marine park service. The fishers started to protest and destroy the homes.

Eduardo Espinoza
Yes, that's true. We are trying to build new relationships.

Laura Cimo
Do you think relations are regrouping?

Eduardo Espinoza
All relations are better than they were two years ago but rebuilding is a long process.

Achutosh Sarhur
You distinguished between fishers' knowledge and scientific knowledge - is fishers' knowledge not scientific?

Eduardo Espinoza
By scientific knowledge I mean the information that scientists are getting without the fishermen. The data we get from the fishermen is fishers' knowledge.

HOW CAN WE HAVE MORE PARTICIPATION BY THE FISHERMEN IN FISHERIES SCIENCE?

Virginia Boudreau
Guysborough County Inshore Fishermen's Association, Canso, Nova Scotia, Canada and Social Research for Sustainable Fisheries, Community Research Coordinator Social, St. Francis Xavier University, Antigonish, Nova Scotia, Canada

There has been a change in view on research and what research is by the fishermen since this partnership "Social Research for Sustainable Fisheries" has started. Before the fishermen engaged in research it was thought of as something to use to change something that DFO had decided to do. Since this project, research is now regarded as something that will answer the issues and concerns that are important to them, the fishermen, to understand what is going on in their ecosystem – to enable them to do something about it or to stop doing something harmful, regardless of DFO decisions. This has resulted in a change in perception of the fishermen as to what fisheries science is.

Discussions of the challenges, services and benefits to engaging fish harvesters in fisheries science from the perspective of a fishermen's association are: volunteer base; contact (regular) with the membership; administrative /managerial base to work from; finding a way to pass on information and skills. The fishermen want to have a role in policy changes because such changes affect the very lives of the fishermen and their families. The big question is how to go about this.

There are also many challenges to community-based research – we are trying to gather information, to "research" the local fisheries in a way that is defensible, credible and transparent – in a manner that will stand up to inspection at all levels to be considered "fisheries science". The impacts of having a community-based, directed and conducted research carried out by familiar people within the identified community are undetermined. This is a question that has arisen within our own project – are we compromising the credibility of this work by carrying it out ourselves? Should we disengage ourselves from the information gathering process to minimize potential bias and invisible influences? Can research carried out at a truly grass-roots level be considered valid and stand up to rigorous inspection in a fisheries science environment?

DISCUSSION

Bryan Pierce
How has the academic community embraced being approached by fishermen who are initiating these projects?

Virginia Boudreau
It is extremely receptive. Most of the issues that fishermen identify are not just personal issues. They may be specific to the area, but there are commonalities as well, so academics are welcoming the initiatives.

Denise McCullough
I would like to know what sort of research the fishermen do.

Virginia Boudreau
For this particular project it is social science.

Robert Blyth
What percentage of fishermen in the county are involved in your association?

Virginia Boudreau
Approximately 85% belong to the inshore association. There is a Halifax county groundfish association that the others are involved with, and some are involved in both.

Robert Blyth
Why aren't the remaining 15% involved?

Virginia Boudreau
They are not involved because we don't have a groundfish management board. Although there are fishermen with groundfish licenses, they are not active. They belong to the Halifax county association.

THE LEGAL AND INSTITUTIONAL CONTEXT OF INCORPORATING INDIGENOUS KNOWLEDGE INTO FISHERIES MANAGEMENT

Terry Williams and Preston Hardison
Tulalip Natural Resources, Marysville, WA, USA

In the last two decades, indigenous knowledge has increasingly become an object of national and international law and policy. An increasing number of international processes are beginning to address legal and ethical issues surrounding the use of traditional knowledge, such as formal United Nations conventions, intergovernmental agreements and standards of practice, non-governmental organization policies, and academic society ethical guidelines. Indigenous peoples themselves are increasing their involvement in these processes, but their involvement at the international level is problematic and uneven. Here we review the evolving context of indigenous standing in international conventions such as the Convention on Biological Diversity (CBD), the United Nations Human Rights fora, (the International Labor Organization (ILO) 169, the Draft Declaration on the Rights of Indigenous Peoples, the Working Group on Indigenous Populations and the Permanent Forum for Indigenous Peoples), and the conventions administered by the World Intellectual Property Organization (WIPO). We then review some of the major policy and guideline documents from inter-governmental organizations (IGOs) and non-governmental organizations (NGOs), focusing on those related to fisheries management. We then review the significant barriers to the development and implementation of these laws and guidelines in national law and standards of practice. Foremost among these are 1) the lack of substantial indigenous participation in the drafting of these norms; 2) the related problem of communication between these international processes and indigenous and local communities; 3) the issue of tribal sovereignty and government-to-government relations; 4) the limitations of contract law; 5) the difficulties of defining and obtaining "prior informed consent" for the use of traditional knowledge, and 6) the existence of indigenous social movements to block the "biopiracy" of indigenous knowledge. We suggest policies to surmount some of these barriers.

FISHING IN MURKY WATERS ETHICS AND POLITICS OF RESEARCH ON FISHER KNOWLEDGE

Anita Maurstad
Associate Professor, Norwegian College of Fishery Science/University of Tromsoe, Tromsoe, Norway

Fisher knowledge is increasingly seen as an important source of information for the management of fisheries and natural resources. Many academics and managers are involved in projects with the purpose of documenting and gathering this knowledge. With reference to my own experiences with interviewing Norwegian fishers on local knowledge I will discuss problematic ethical and methodological aspects of such documentation. Fisher knowledge is embedded in a social and cultural context and transfer of knowledge is relational. Fisher knowledge is also a professional asset, and contains information that is often known only to a small group of local people. Transferring fisher knowledge to science puts fisher knowledge in a completely new setting and the question is what it implies for fishers to have their knowledge moved beyond its traditional borders.

DISCUSSION

Colin Scott
One of the big differences between the situation you are describing and the indigenous cultures that I have worked with is that there is an assumption within these cultures that knowledge belongs to the community and that it is not safe to share knowledge into a centralized control. This is different from what you have been describing. It seems that the Norwegian fishers have the cultural assumption that the state is still the central authority. Perhaps that is what makes the fishers think that sharing of this knowledge is dangerous.

Anita Maurstad
There is a very ambiguous relationship between Norwegian fishers and scientists. In a way they collaborate and are very close – the scientist does the data collection and fishers contribute. But on the other hand there is distrust when the fishers feel that they do not get a voice. In an institutional context, trust can be defined according to how the knowledge is used. Today there are many interests who can access and use local knowledge for their purposes – there are many new actors now such as the tourist industry and other parties that can access this knowledge. Up to now there has not been a sharing kind of relationship.

BUILDING NETWORKS FOR INDIGENOUS KNOWLEDGE AND ENVIRONMENTAL MANAGEMENT

Preston Hardison
Tulalip Natural Resources, Marysville, WA, USA

Indigenous knowledge presents many complexities for information management. Focusing on indigenous knowledge itself, developing norms suggest that much of what has been considered in the public domain should be protected, either through laws or through ethical guidelines for traditional publishing or use. Other difficulties arise from the use of telecommunications, databases and working in networked environments. Some of these are in common with the development of any communications network, while others are particular to traditional knowledge. Tackling these problems will require much more formal discussion among tribes, natural resource managers, scientists, and other organizations on networked information policy. Building from experience in developing international biodiversity information networks such as the Clearinghouse Mechanism of the Convention on Biological Diversity, the Inter-American Biodiversity Information Network and the Indigenous Biodiversity Information Network, I suggest some of the elements that should be addressed in developing communications policy. These include addressing: 1) Participation; 2) Obtaining consent; 3) Privacy; 4) Security; 5) Repatriation of information; 6) Data custodianship; 7) Oversight and monitoring information flow; 9) Documentation and indexing standards; 9) Open network protocols and metadata standards; and 10) Open database standards. I note some of the limitations of using technology to store and transmit traditional knowledge, review some of the failures of current practices to address the policy issues above. Building cooperative networks is vastly different from building databases and websites on the Internet, and will require a substantial investment of time, resources and will to make them happen.

DISCUSSION

Kathleen Martin
What is the best place to look for information on this?

Preston Hardison
I am not sure in the Canadian context but there are good books by the National Research Council published in 1998 and 1999.

Marcel Shepherd
Referring to your initial presentation, don't you feel we are in a race against time? Laws are there to slow things further. Genetic and drug companies are patenting traditional knowledge. You talk about mutual benefit, but I don't see that happening.

Preston Hardison
We are all here because we are living off Pleistocene indigenous capital. The legal approach is not a pretty one and all these things have a cost. Most indigenous folks I work with realized there are real things they can get out of the projects, but there is also a long history of exploitation and as a result there's frustration. There are also cases where sharing knowledge has created more problems than it has helped solve. What we are trying to do is to steer the parties to understand that the economics are not the issue. What they are looking at is a trust-fund to pay a whole region. But now the real thing is to get those kids learning and that knowledge transmitted.

Marcel Shepherd
I do a lot of work on the Fraser and I put things in context for myself. If we move our management system to a more conservation-oriented structure rather than production-oriented, there will be a lot more willingness to share knowledge. Under the current regime, First Nations have the right to hold back their information until they see things change.

Tony Pitcher
There is one database out there, www.fishbase.org, which is completely free to use. It was set up in the Philippines and not in North America. All scientists who have collaborated to this database agreed to the sharing of all the data. A part of the project is to record native and indigenous names of fish. That was a part of an agreement with aboriginals.

Ian Baird
That is not quite true. I'm a collaborator and I have photos in there. Fishbase says that you have to contact the contributor before you use the photos.

Preston Hardison
Everyone can make his or her own copyright protocols. Copyright is not a bad thing – it is just how you write it.

Ron Hamilton
There is a terrible history in my community that has made people reluctant to share. How many people are aware of the bad blood scandal? Some fifteen years ago, a gentleman came and collected blood samples from our community. There was a piece of paper that we had to sign – a kind of informed consent. The gentleman went out of the country and sold that blood to European scientists. The blood is now used in studies that we never consented to.

Another thing. I am a singer. Twenty years ago I wanted to make an album of songs to share our songs with the larger community. I wanted to find someone who knows their business, and I phoned a Haida helper, who recorded the elders singing - that album is in the Smithsonian. She said that the songs will belong to her. That is upsetting because the songs do not belong to her.

The third incident: I was here during 1988 to 1992 and I often lectured. I often shared things that my people would say were very, very delicate to be talked about and would yell at me for sharing with non-native. One time I talked about large format royal paintings, and these were unknown in this country. An art student drew sketches of the paintings while I was talking and then claimed that he owned them. I was being generous and I feel now that I have been robbed.

I want to tell the people here who call themselves scientists and academics that I am capable of giving informed consent, but to have a PhD candidate say "I'm a post-modernist, I won these" is insulting. That kind of arrogance can be masked in a lot of ways. That kind of mentality gets in the way of people who truly have things to say.

SOCIAL RESEARCH FOR SUSTAINABLE FISHERIES

Christie Dyer and Jessica Paterson
Project Officers, Social Research for Sustainable Fisheries,
St. Francis Xavier University, Nova Scotia, Canada

Social Research for Sustainable Fisheries (SRSF) is a collaborative project in Nova Scotia between St. Francis Xavier University and three community partner organizations: Guysborough County Inshore Fishermen's Association, Afton First Nation, Gulf Nova Scotia Bonafide Fishermen's Association. This is one of the 37 Community-University Research Alliance (CURA) projects throughout the country aimed at creating and developing community-based research capacity.

This project focuses on building and enhancing Mi'Kmaq and non-native fish harvester organizations' capacities by increasing and developing their ability to conduct and carry out social research. The communities themselves have identified the research issues they want to address. This partnership enables the transfer of skills and capacity from the university to the partner organizations through: customized workshops, student internship placements from the university's Interdisciplinary Studies in Aquatic Resources (ISAR) program, guidance from social science researchers and core research staff who are dedicated full-time to the partner projects. The development of skills through this process serves as the basis for the organizations to carry out their own research that will enable them in the future to assume greater governance of marine ecosystems and resource harvesting.

The process of SRSF is focused on research and education. The partnerships between the fish harvesters and the social science researchers work to develop and deliver 'action' research, while contributing to the building of community organizations' research capacity. Currently we are developing research expertise in: collecting and using traditional ecological knowledge; documenting family and community histories in fishing; developing skills in the design and conduct of research, interviewing skills and survey design.

ICONS: A Software System for Integrating Traditional Knowledge and Natural Resources Management

Preston Hardison and Terry Williams
Tulalip Natural Resources, Marysville, WA, USA

ICONS in presented as a tool for information management, for integrating some aspects of indigenous knowledge into natural resources management, and a model for developing networking standards and protocols. ICONS has a number of modules for managing different categories of information: 1. Organizations; 2. Persons (staff, members, experts); 3. Sources (bibliographic citations); 4. Peoples (indigenous and local communities); 5. Projects; 6. Events; 7. Geographic Areas; 8. Species (with subsystems for observation/specimen-level information, and for common names); 9. Stories (for traditional Stories and case studies); 10) Practices (technologies and traditional practices); 11. Internet Sites; 12. Databases; 13. Acronyms; 14. Encyclopedia (user-defined definitions and discussion forum for concepts and terms). The modules can be linked to form relationships: e.g. the Stories can be linked to places (Geographic Areas), species used (Species) and practices performed (Practices). The data can be linked to other databases, such as geographic information systems (GIS). ICONS incorporates existing standards and protocols, and is open to adopting others where they are proposed. It is available freely, and the code is open for use by others. The use of ICONS within the Tulalip Tribes Cultural Stories Project is presented.

Assembly of Map-Based Stream Narratives to Facilitate Stakeholder Involvement in Watershed Management

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Watershed stewardship activities throughout North America have evolved into a process that requires more involvement in planning and decision-making by community stakeholders. Active involvement of all stakeholders in the process of watershed stewardship is dependent on effective exchange of information among participants, and active involvement of a wide range of stakeholders from "communities of place" as well as those from "communities of interest." We developed a map-based stream narrative tool as a means to (a) assemble a wealth of incompletely documented, "traditional" ecological or natural history observations for the rivers or streams, and (b) to promote a higher level of active involvement by community stakeholders in contributing to information-based, watershed management. Creation of stream narratives is intended for use as a tool to actively engage local stakeholders in the development of a more comprehensive information system to improve management for multiple stewardship objectives in watersheds. Completion of map-based stream narrative atlases provides a valuable supplement to other independent efforts to assemble observations and knowledge about land-based natural resources covering entire watersheds. We are confident that completion of stream narrative projects will make a valuable addition to the information and decision making tools that are currently available to the public and resource agencies interested in advancing the cause of community-based approaches to watershed and ecosystem management.

MIGRATION PATTERNS AND SPAWNING HABITS OF AN IMPORTANT FISH, HELIGOPHAGUS WAANDERSI, OF THE PANGASIIDAE FAMILY IN THE MEKONG RIVER BASIN

Sintavong Viravong
AMFC/LARReC, Vientiane, Lap PDR

The use of local ecological knowledge to investigate migration patterns and spawning habits of fishes in the Mekong River was discussed in the previous paper. In this paper, the migration pattern and spawning habits of *Heligophagus waandersii* is presented. Its distribution has been reported from the Mekong Delta to Bokeo, even to Luang Namtha Province in northern Lao PDR.

The Khone Falls at the border between Cambodia and Lao PDR constitute a barrier between two migration patterns for this species. Below the Falls, *H. waandersii* migrate upstream during October to February, whereas from May to July, the species migrates downstream. This migration system appears to be a movement between important flood-season floodplain habitat in the south and dry-season refuge habitats associated with deep pools within the Mekong River in the north (i.e. *H. waandersi* was one of the species most often reported to be associated with deep pools during this survey). Above the Khone Falls, two upstream movements were identified, one during the beginning of dry season (i.e. from November to February) and one during the early flood season (May to August). Based on reports on the occurrence of eggs in the abdomen of the fish, spawning appears to occur early into the wet season, i.e. May-June. One report from the Mekong Delta in Vietnam suggests the species spawns all year round. Juveniles (with sizes between 2 and 16 cm) of the species were reported from many sites both north and south of the Khone Falls. Based on this survey, it can be hypothesized that *H. waandersi* consists of several sub-populations within the Mekong Basin.

INSHORE GROUNDFSH SPAWNING AND NURSERY GROUNDS IN THE BAY OF FUNDY: LEARNING WITH AND FROM FISHERMEN

Jennifer Graham
Center for Community-based Management, St. Andrews, New-Brunswick, Canada

This project builds on Trippel and Benham's 1997-1998 report (currently under review) on spawning and nursery areas as identified by fishermen around the Bay of Fundy. Identifying areas of importance for the reproductive life of groundfish is crucial for management. An emphasis on local spawning and nursery areas can also help identify local stocks that may have historically formed the bulk of coastal fisheries.

This poster explores some of the challenges and opportunities of using a community-based research approach with inshore fishing associations to validate, define and rank areas identified in the earlier study.

The historic coastal fisheries of the Bay of Fundy are in serious decline. This gives a sense of urgency to the task of learning as much as possible about coastal stocks; it also makes it difficult to locate active fishermen still fishing some of the areas in question. Random samples of fishermen are not an appropriate means to collect local information; rather it is essential to determine what layers of information are required and who holds this information. This requires thinking about the kinds of fish that particular vessels target, the areas in which they operate presently and in the past, as well as what seasons they are on the water.

The fixed gear sector in particular may hold information that is extremely specific – both geographically and temporally. A genuine community-based research process requires developing tools, such as appropriately scaled maps, with which to present information at the level of detail which fishermen possess. It also requires creating venues for fishermen to jointly assess their own distinct pieces of information to consolidate a larger body of knowledge over which they have ultimate ownership and control. In this way, a local knowledge project presents opportunities to learn from and with inshore fishermen.

THE CONTRIBUTION OF FISHERS TO THE MANAGEMENT OF SEA-URCHIN FISHERIES IN BARBADOS AND ST. LUCIA

Christopher Parker[1], Patrick McConney[2] and Allan Smith[3]
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Fisheries for the roe of the white sea-urchin *(Tripneustes ventricosus)*, known as the sea egg, are important in Barbados and St. Lucia. In Barbados, the resource has a history of fluctuation leading to the first conservation legislation in 1879. In the 1970s and 1980s the abundance of sea urchins declined dramatically, and by the late 1980s the fishery had collapsed in Barbados. Likewise, St. Lucia also experienced collapse of the fishery with over-exploitation being a major contributing factor in both cases. In the 1980s and 1990s the fisheries authorities of both countries instituted multi-year closed seasons to facilitate recovery of the fisheries and establish new management arrangements in which fishers participated. A project was instituted in Barbados, using formal participatory methodology, to elicit from fishers their knowledge about the biology and ecology of the resource, fishing practices, and how the interaction of these may have contributed to the decline. Participatory methods were also employed to bring fishers from 17 communities together to plan their involvement in the recovery and management of the fishery. These methods and their results are examined. In St. Lucia a formal co management arrangement was instituted, based on a period of research and consultation. The agreement involved fishers in all stages of management, including monitoring urchin size and population density, determining when and where fishing would be allowed, and otherwise regulating the fishery to the extent that fisher knowledge and observations are shown to be the main inputs to management. Both cases demonstrate the use of fisher knowledge in managing the sea urchin fisheries, but with important differences in how the information was obtained and used. The roles of social and cultural factors in access to and use of fisher knowledge are illustrated. How fishers perceive the value and use of their knowledge is also explored.

GENERAL DISCUSSION

27th August 2001

Ron Hamilton
This is a question to Leanne Sommer. When you were presenting, you were talking about protecting the interests of various aboriginal groups in the area. Whenever the notion of protecting aboriginal rights happens here, the ugly head of racism rears up. What is your experience in your area?

Leanne Sommer
There is an expression of racism. In the most remote part of the marine park, the management agencies were able to argue with the recreational and commercial fishery sectors that there were several legitimate reasons why they were taking aboriginal concerns over everyone else's. One is that Cape York is still aboriginal land, had ongoing cultural relationships, and was mostly populated by aboriginal people. Also, more recently, there has been a targeted effort to get native titles to come to the negotiating table. When it comes, we need legislation in place to take people's interests seriously. Thirdly, the management agency is prepared to support indigenous groups in resolving conflicts between sectors of the community. For example, the management upholds fishing closures wanted by the indigenous people because it is good conservation and other sectors did not have better arguments to keep the area open. There are also meetings to see if a compromise can be reached.

Ron Hamilton
You used the word "subsistence use". I wondered if your definition includes subsistence if it is based on commercial exploitation. When I use a resource and sell it to provide for my family, I call it subsistence, but that's not seen as subsistence. In Australia, does the definition of subsistence include commercial use?

Leanne Sommer
In the context that I gave, it's purely fishing for family use. It's a fine line and it's untested whether fishing beyond family use and involving some sort of trade will be recognized as a native title right. On the whole, in Queensland, there are no indigenous people involved in commercial fishing. You can draw a line between indigenous and commercial fishing, and they don't cross at all.

Bob Johannes
In your community, Ron, I guess in the old days, the community caught fish and kept it within the community. In a lot of communities now, fish is sold within the community as well as outside the community. Is it still subsistence fishing?

Ron Hamilton
It's interesting, because within my community there's a long history of people from my community catching fish in super abundance so they supply the community with food and still have some for trade. Captain James Cook, in April of 1778, documents in detail people trading everything for the buttons on his uniform. He writes, "Nowhere in the world have I seen such a highly developed sense of ownership. Every blade of grass belongs to one man or another." Somehow or another, our concept of ownership gets lost when we become the minority, and we end up with people outside our community defining what subsistence is for us. So we have ridiculous situations where people have to go to court for 20 years to prove that we had a concept of ownership. When the Mckenna-Mcbride commission went to re-map, they set territories. In 1914 to 1916, they had another commission to decrease the size of Indian reserves. Early on, when they were forcing us into postage-sized stamps, they justified it by saying that we don't use the land anyway, we use the sea. But when I was a boy, we were arrested for taking herring eggs. It was okay for the Japanese to do that. There are no aboriginal sea otters on the island. We saw the near extinction of whales. Twenty years ago, my uncle and I chased what we thought was a northern fur seal for a better part of the day because I had never seen one before and I was begging him to take us closer so I can see it. I still haven't seen one. Today I'm a criminal because I catch a salmon and sell it because it's not subsistence fishing. It's okay for you to make millions of dollars selling fish, but if I catch and sell fish to support my family, I'm a criminal. Somewhere between Cook and today, rights have been redefined, because someone defined subsistence for me.

Cyril Carpenter
This morning there was mention of 37 organisations around the world that study indigenous knowledge but very few study marine resources. In BC, Alaska, Washington, Oregon, and California, there's certainly much documentation about First Nations' knowledge and the way they enhance the resources that should be available to the public and not collecting dust. If it's going to international conferences like this, the way we enhance the

resources should be documented for the benefit of the community. We have always said that we don't want to be looking in after we have been driven out and driven to a poverty level beyond imagination. When you read the paper about Matthew Coomb's statement on genocide, he's not exaggerating. The BC experience is so dark. It throws western civilisation history into darkness when you review the First Nations experience. We have research in our area; we have worked with universities, with a lot of people, to be a part of society.

Nigel Haggan
Many nations such as the Heiltsuk have done in-depth studies. There is a great body of knowledge of information out there. The suggestion that Bob made is that it's time that there is a centre for this knowledge. It will not be just a centre for putting information together. It's not that the information doesn't exist, but there's a lack of a focus for it. We can dwell on the bad treatment of the First Nations in BC. In Canada, there is some fairly enlightened legislation in aboriginal rights and titles. What's missing is the means to implement that legislation. In the Sparrow case, which dealt with the aboriginal right for food and ceremonial purposes, the court spoke of the importance of using a loose interpretation of the word, but in practise, the Government of Canada has taken the narrowest interpretation of the word. Percy Star, from the Kitasoo, said of salmon for ceremonial use: "I don't know when someone's going to get married or someone's going to die. I need to prepare for that." They say that people should have enough for food, ceremonial and social use but what it is has never been defined. There's room to define it, but is there will?

Saudiel Ramirez-Sanchez
Another thing we overlooked is that we as researchers ignore categories that exclude power politics. How much do we as researchers contribute to categories? There's only a part of knowledge that we use. There are others that we can take into account.

Ian Baird
In 1998, I returned to BC for a conference called Coastal Zone Canada. They invited lots of people from different countries, and there was section on co-management. A lot of people showing up in Canada expected to see an advanced country on the topic of co-management, what they realised is that there's really little to get. They realised that they were not there to learn from Canadian experts, but to convince the government how far behind it is. Compared to the rest of the world, DFO hasn't really done any real giving away of power. There's no real co-management in this country yet. We should look at countries such as the Philippines that have made the effort. Canada should not get away with this forever. We should be embarrassed with this situation.

Bob Johannes
There's nothing I would disagree with there.

Nigel Haggan
No, but I think the focus of such a centre would not be exclusively Canadian, but international.

Ian Baird
Right. But it should be clear that the centre isn't placed here because Canada is the best example of co-management.

Chad Paul
There is a lot of focus on all the tributaries in this conference but my people live in the headwaters. We have to make deals with our brothers and sisters to access the fish. That should be addressed.

Eduardo Espinoza
There is a lot of talk about participation of fishermen, but the big question is how to put a value on different sources of knowledge be it fisheries, science, or socio-economic. It is important to put it in a balance for sustainable fisheries and to include it in their management.

Pascale Baelde
When you compare the value of the knowledge, what we can forget is that we tend to see knowledge as a commodity. The value of knowledge is what we make of it and the collective decision. If not, we will keep bouncing against each other's knowledge and arguing whose knowledge is better.

Nigel Haggan
We work with the First Nations House of Learning on campus and the past director, Joanne Archibald, has a saying: "knowledge has power when it's shared." And what this gentleman is saying is that we need to share all the knowledge – not get one type of knowledge at the expense of others.

Pascale Baelde
Many of the talks today referred to taking fishers' knowledge and transforming it to the benefit of science. We should accept their knowledge without having to fix it until it fits with our knowledge.

Nigel Haggan
When you open a can of worms, the only way to put it back is to use a bigger can. We need a bigger can. We need a bigger context.

Bob Johannes
In the context that I was talking about this morning, we sat down with people in villages and swapped information. We put the information together and told them, "You are faced with modern problems that you weren't faced with before; this is what we suggest you do." Then we left. It wasn't just taking their knowledge and leaving.

Pascale Baelde
I was saying the opposite. I meant that we take the fishers' knowledge, but only when it fits.

Simon Lucas
There's an assumption that all Indians think alike. I'll use an example. In my territory, they made a marine park but they didn't talk to us. They used the name Maquinna Marine Park, which doesn't have any relevance to us, but has relevance to the tribes on either side of us. The brightest minds in our tribe didn't speak English. One of them, Alice Paul, would say, "life is enormous" and the ocean "is where our life line is". There's another elder who would say that we have never seen where the first raindrop drops but the first raindrops contain life. It's a benefit to the fish where we eat. What we are dumping into things these days, all these bright minds allow it. We don't want the things we dump into the water but we allow our fish to swim through it. We have to address the contradictions that we and the country and the world make. They say go with the flow, but we're worried about home. Our people left some resources alone and we supported the government when they shut down the herring fishery for eight years because we thought it was important to save it. Our whole lives centred on the ocean and the mountains. The hereditary system in our nations allows us to know what parts of the oceans our chiefs owned and that's connected to the land. But some smart guy came along and said we're going to call it Maquinna Marine Park when we had been using our own names for 20,000 years.

AUGUST 28TH, 2001; NO DISCUSSION

AUGUST 29TH, 2001

Melita Samoilys
I have a question for Francis. Are there any enclosures for spawning aggregations of groupers and has the trade in live reef-fish moved in?

Francis Hickey
The government just started to bring in the live reef-fish trade, but it basically self-destructed in about three months. They were not happy with the way things were going. In another area, there was a conflict with a tourist development because they brought in barracuda and sharks and the tourists weren't into it. They eventually realized that they were not getting as much fish as they needed. To get fish to Hong Kong and to come back requires high overhead so they eventually backed off. They spent 100,000 Australian dollars for it in a few months and did not get anything back. We asked them to stand down until they have a management plan in place.

Melita Samoilys
Do they have enclosures on spawning aggregations?

Francis Hickey
Yes. Most communities don't identify spawning aggregations in the area, but when they do, they have some rules against fishing during the aggregations, like not setting nets.

Nigel Haggan
Bob said that the fishers of Palao had an intimate knowledge of spawning aggregations and identified them. Why do you think they did not in this case?

Francis Hickey
They are less inclined to fish than they are in Laos. They are more into gardening. Most of the fishing was traditionally near the inshore region.

Melita Samoilys
In Palao and the Solomon Islands where they have knowledge of spawning aggregations, they have large aggregations. Perhaps where Francis is describing, the fish are not near the reefs.

Brent Peacock
I have a question on turtles. You mentioned that most of the natives were harvesting turtles. Were they part of a cooperative?

Kristin Bird
Most were in small cooperatives having from 10 to 50 fishers, but they are very fragmented.

Brent Peacock
Are these cooperatives financially viable?

Kristin Bird
Not really. The cooperatives are trying to come together more and that is why delegates from different cooperatives went to different communities and saw that coming together brings more success. They want to learn techniques to use in their own communities.

THURSDAY, 30TH AUGUST

Barbara Neis

A lot of issues that I was going to discuss have already been brought up today, including gender issues, ethics, management of information, who you talk to and the fact that knowledge is collective and not individual; the issue that if you want to understand the knowledge of the fishery often you need the woman who manages the books; the points that Jerry made - do we actually have a crisis of science or of management? Can we deal with the crisis of management in isolation? Can we pursue and gather knowledge from fishery workers and not address the management problem arising from attracting interest? There is so much commercial interest in Laos now where there was no interest before.

I was very struck by Ron's image yesterday of the boat people who are drifting around. Are we the latest drifters? Think of the legacy of those drifting people. They know nothing about the fisheries, then they learnt about it from the local people and then they destroyed those people. We have to be very careful of what we are doing. One of the Projects in Memorial looks at the relationship between fishers and science over time. We see a pattern emerging – scientists works with fishers, learn from them and then move away and the science becomes free standing. Then in a crisis, we have a new interest in fishers' knowledge. We are precisely at that point in fisheries now. Where will this go and what role will we play in directing where all this will go? Will we move fisheries in the direction of recovery or in the direction of depletion?

I want to propose that we talk about the new center and how to move towards a more mature research ethic and work collectively within our community. We have benefited enormously from the presence of the First Nations. They have been patient and tolerant as we went through our own research projects. The people I've worked with are not always so patient. How can we have a center that doesn't involve moving researchers around the world and separating them from their communities? It is very easy to get funds to move us around. It is harder to move fisheries people around.

Cyril Carpenter

I'll give you an example of what we are doing to fund some of our own programs. The salmon needs to be addressed – what is the future of the salmon fishery in our area? We need to negotiate. We have recorded two hundred and forty fish traps in our area and we only got the tip of the iceberg. Our people were managing all these salmon. The fish traps were designed to coral salmon and we took only the small and the weak as a whole community effort. We had trade. Our canoes were 70 feet with two sails on them to have ballast.

Going back to the marine resources, we have negotiated with the DFO to manage the fisheries ourselves, but they are not willing to do that. They are not willing to let the First Nations manage their own resources, to enhance it and to benefit from it. We have rivers on our central coast. We have tributaries that spawn salmon. We are involved with the sport fishery and logging. The only way we are going to manage our fish resources is if we join the industry and stakeholders. We are the largest stakeholders. We have 57 villages in our area and 7 provinces. We organized ourselves into that form of government and we managed whole valleys. We now see small reserves established in 1915 by the Mckenna-Macbride Commission. Now they are realizing that the history we are putting to the public tells us a lot more about management skills. We were really good at it. We had enhanced the resources and that model is what we want back. We want a kind of resolution coming from an international conference like this. We all feel helpless unless we have a plan for the future.

Ron Hamilton

You began this wrap-up by saying that we should talk about the possibility of having a research center. I have in my home several thousand slides. I have a bunch of songs in my own head that I can sing. The slides show people in feasts, utilizing sea cucumbers, seal meat and blubber from way back. I am willing to give copies of all that material and much more as a way to contribute something. We are always pushed aside when people are making decisions. We are much more than stakeholders because we are in a relationship with that resource that goes much deeper than a stakeholder.

Cristina Soto

As feedback for future conferences, I think we needed more free time for discussion. It has been a great conference but there have been many times that people have been excited about talks and didn't have enough time for discussion. Marcel Shepherd had an interesting idea about a small panel that can be set up, where you have a central theme. We did not get into some deeper issues like confidentiality and power.

Ian Baird
Small group discussions are often a very good tool that is used a lot in international workshops.

Bruce Burrows
We could have used some time in smaller groups or in workshops. I agree on the marginalization of traditional knowledge. I think it has been laid at the feet of scientists, but very often, local knowledge is suppressed because of power relations in the society. If they speak against the interests of powerful people, they get suppressed.

Bryan Pierce
My view is that this group is relatively unusual relative to the fisheries science community in general. I can't think of any of my colleagues that will think the same way as the First Nations. I'm happy to have the institution be a center of a network, but local knowledge should remain with the people.

Jeremy Prince
Yes, nodal networks would be good. It should be a place where people can train and then go back to their communities.

Nigel Haggan
An International Center is a paradox anyway; it has got to be a network.

Pascale Baelde
We still have not defined the role of the center. Is it for researchers to do new research or is it to empower people with knowledge to act in their interests?

Simon Lucas
Having a place to talk about world issues right now is a good dream but there are things we have not talked about. In Canada we had people die when the water went bad. The rest of Canada did not talk about it. When a human being dies, we get all excited. When an animal or fish die, they don't get that exposure. When disaster happens, like that oil spill that ended up on our beaches – and we were the ones to clean it up because nobody would take responsibility – there should be no borders. Disasters need to be tackled immediately. There are more oil tanks and tour boats traveling through our waters. While we talk about resources, these things are happening.

Tony Pitcher
I want to reflect on what we academics have done to ourselves when we say that research does not empower local communities. If we go back to the Victorian era, we see how science empowered communities, from engineering to medicine improving the quality of life. A century and a half later, we are saying that we should not do research. I hope that if the center becomes established, it will be an international center and hopefully we can bring in some stock assessment people. It will not only be relevant to BC and Canada, but also to the entire world.

Adam Faulkner
Indigenous knowledge is practical knowledge. A lot of fisheries management really stifles aboriginal people because it makes it a crime for aboriginal people to practice their culture. When that happens, the knowledge is gone.

Arnie Narcisse
In 1911 my great grandfather was signatory to a statement of declaration that the people made of their territory. In the letter he questioned the need for hatcheries in that territory. The industrial fishery on the Fraser River started around 1888. This points out the decimation in 23 short years of the greatest run of salmon in the world. If his question had been given more attention we won't be in the situation that we are now. 90 years later we are now fighting against fishfarms, another incursion. I sense a very real defeatist mentality creeping in Government minds. All stocks have gone to hell, habitats have gone to hell, but we are lucky because we got all these fishfarms. The problem is that the fish are not native to this territory and they transport all sorts of problem over here. This is analogous to the small pox when the Europeans came here. We got to begin to adhere to the advise of the elders. My whole world is 10 miles long. All sorts of things have happened to reduce my ability to catch fish in that 10-mile stretch. There is a place for academia - they can put these things together. All we want is the same as yesterday.

Maria Manghans
I agree with the comments about the lack of discussion in the conference and I think that breaking up into smaller groups would be a good idea. As for the center, I think that a number of localized centers of knowledge will be better. Maybe the knowledge should stay in the territory that it belongs to. Another thing: I came here because I thought there would be an exhibit on fisheries knowledge and I really wanted to see that. Maybe that is something you can do for the center – you can have little exhibits not for the world to see the community but for the community to remember their knowledge. Bring the world to the communities not the communities to the world.

Michael Phelan
Will a center be just another beurocracy?

Ian Baird
What a center should really consider is the issue of traditional knowledge and power. There should be a strong ethical code associated with the center so that any information that goes into it is approved by the people who retain copyright to that information, and they can pull it out if they no longer want it there. It should have a mission statement, which should view local ecological knowledge as a way to empower local people. The explicit objective should be to empower the local people.

Stephanie Henry
There has not been much mention of the central and north coast. We average around ninety people. We have seen a decline in sockeye. We have all these commercial fishers from the province out in the river, making income in our territories and we feel like outsiders there. A few days ago we were digging clams and an RCMP told us to bring our status cards. We had to prove that we lived there. A speaker here said that we were reluctant to share information. We are not reluctant. We are cautious about handing out information about of our resources, such as the location of spawning areas. There are a lot of reasons why we are loosing sockeye but we need more communication. People from the Fishery Center should come over. This is a good beginning of the dialogue.

Brent Peacock
I am from the Okanagan nation and my background is in Education. A UBC center should also be an educational center. Part of being a scholar is to share knowledge with the people who require it – that is the only way people will learn. It is the responsibility of academics to share their knowledge.

Preston Hardison
Having a center is fine, but there is an issue on how it presents itself and what is its scope. Two years ago, Daryl Posey published a book about spiritual and cultural values of biodiversity. Every author in the book was non-indigenous. There is a capacity out there in the indigenous peoples who want to form networks but don't have the resources. It is hard for them to get money or support. It is great that there's a need for the center and to pull in resources from the University, but it should not be a global center. Indigenous folks need support to build their capacity to build their own network. If initiatives come along and indigenous folk want the network, facilitate it. If they want to own it, they can. The problem with centers is that they take on a life of their own.

Pascale Baelde
We need to make sure that the motives and interests of the center are agreed from both sides. Arnie said that all they want is the same as yesterday. Researchers want to restore the ecosystem. These are two groups of people talking about different things. Are we sure these things fit together? There is a cultural dimension that was mentioned, that we should not miss.

Arnie Narcisse
That is basically why we are participating in the Back to the Future modeling. We are interested to reconstruct the past abundance. That is also what the DFO is trying to do, to rebuild the resource. We have to have some idea of what there was before.

Saudiel Ramirez-Sanchez
What is knowledge? Are we assuming it is an inventory, like we do with species? How are we to educate people about the knowledge that they already have?

Barbara Neis
My own view is that it would be more than an inventory of knowledge.

Jeremy Pierce
A lot of people are not convinced that there should be a database. It should be a local thing and there should be some universal links, with an emphasis to integrate everybody together.

Bill Montevecchi
There has been a lot of good focus and good support in this conference. People are talking and that is the most important part of this process. I have really benefited a lot from the presence of the First Nations. Their respect for the environment is overwhelmingly impressive. Research in its purest form is just that – re-search or look again – essentially a process of renewal. I agree about the comments on education – it is fundamental.

Bryan Pierce
We can decide when to gather again and discuss management systems. The only way to change is to support the people on the water, add value on them and become their symbionts and friends.

Nigel Haggan
As I said previously, an international center is a contradiction. We have a memorandum of understanding on our web site that encapsulates a lot of these elements. We would like to have feedback on that.

Barbara Neis
Anita left me her comments on the center in which she says that she supports the center, but the Fisheries Center is not the place for it. It will need to have a socio-geographic base.

Saudiel Ramirez-Sanchez
There is an ethical problem when we are dealing with science. We can get to a point where science is neutral. Can scientific work really be apolitical? Can it be really outside of social relations?

Barbara Neis
We live in a world that is structured around power relations. Even when you think you're neutral, you are aware of whom you're working for. I think Anita's paper was very important. Fisheries scientists are focused on how to get the traditional knowledge into the stock assessment. But the point is that if you don't understand the management system than you are not doing good science and you will not be aware of the consequences of using the information on the fishermen themselves and on the government. That is the reason why we need interdisciplinary research and why we need social scientists, and not just training biologists to do interviews.

We are a community of people who are working together and we share concerns and issues. I am wondering how we can, as a community work together with other communities. Rather than creating something new, I think we should look for other organizations that are already out there.

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