CHAPTER 1 The value of anecdote

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ABSTRACT

The knowledge that indigenous, artisanal and commercial fishers and marine hunters accumulate over the course of their fishing careers can be invaluable to marine researchers despite its low scientific repute among methodological purists. Over the past several decades, and in tropical, temperate and Arctic fisheries, it has cast considerable light on important subjects such as stock structure, interannual variability in stock abundance, migrations, the behaviour of larval/post-larval fish, currents and the nature of island wakes, nesting site fidelity in sea turtles, spawning aggregations and locations, local trends in abundance and local extinctions. It has also cast light on the dynamics of fisheries and their relationship to scientific understanding. This chapter draws on a series of examples from indigenous, artisanal and commercial fisheries to explore ways in which the knowledge of fishers and fisheries scientists can complement each other and, in the process, drive forward not only our knowledge about fisheries' resources but also our capacity to manage our degraded marine ecosystems to recovery.

INTRODUCTION

Providing more relevant and timely scientific data and gaining better understanding of interactions between human societies and their marine environments are very high priorities in tackling our planet's marine environmental problems.[1] But the quest for more funds for these purposes tends to inhibit researchers from making an important admission: these problems have become far too big, too many and too complex for there ever to be enough time, money and qualified people to address them all effectively (e.g. Johannes, l998a). Related to this is the mounting evidence

1. As a fisheries biologist, Bob Johannes worked primarily with artisanal fishers and fisheries science in tropical contexts (Johannes, 1981, 1993, 1998a, b). Barb Neis is a social scientist who has done similar work with commercial fishers in Newfoundland and Labrador, Canada, and with temperate fisheries researchers (Neis and Felt, 2000). Before his untimely death in 2003, Bob asked Barb to contribute to his 'The value of anecdote' paper. Unfortunately, she did not get a chance to work on the paper while he was alive. She hopes he would approve of her contributions to the work.

that fisheries scientists are often just following fisheries around, providing advice that is more likely to document resource decline than to inform sustainable management (Haedrich et al., 2001; Neis and Kean, 2003).[2] Support for these claims comes from indications of continuing decline in many of the world's marine seafood stocks and ecosystems (Pauly and Maclean, 2003), coupled with ongoing increases in the efficiency of fishing fleets.

Fisheries scientists and managers, but perhaps particularly fisheries-dependent communities, are confronting major challenges. The changes happening all over the world are so numerous, dynamic and multifaceted that the physical–chemical environment, the estuaries and benthic environments, the population and species diversity and, more generally, the marine ecosystems we see today are not the same as those that existed even in the recent past. If we are to stop the degradation, understand the productive capacity of these environments and begin the long, hard process of achieving recovery, we need to understand what was there in the past (Jackson et al., 2001; Pitcher et al., in press), the interactive social–ecological processes that are driving the decline (Frank et al., 2005), what is left, and how these altered ecosystems work.

It is now critical that we do everything possible to improve our marine environmental information base and share our expanded knowledge with those interacting with marine ecosystems to increase our collective capacity for stewardship and enhancement. Fishers' knowledge may often be the only source of information on the history of changes in local ecosystems and on their contemporary state that is of sufficiently fine scale to help us design ways to protect stock remnants and critical habitats.

'Anecdote-gathering' from fishers is one approach to broadening the information available to science; another is to treat fishers' knowledge, fisheries natural science and fisheries social science as different knowledge systems that have interacted over time and space to influence the history of fish and fisheries (Murray et al., in press). A third approach is to involve fishers, natural scientists and social scientists in the design, conduct and review of research that seeks to collect their knowledge in a systematic fashion (Davis and Wagner, 2003) and in a form that makes it commensurate with other knowledge forms (Neis et al., 1999a, b).

The word 'anecdote' comes from the medieval Latin *anecdota*: unpublished items or narratives. However, its more common meaning today is 'a short, usually amusing account of an incident, especially a personal or biographical one', or 'a particular or detached incident or fact of an interesting nature … a single passage of private life'.[3] Certainly, fishers' knowledge is largely unpublished, a feature that

2. In a 1992 meeting with the Canada's Department of Fisheries and Oceans (DFO), Percy Walkus, an elder of the Wuikinuxv Nation on the Central Coast of British Columbia, said, 'All DFO are doing is managing the rate of decline' (cited in Haggan, 1998).
3. www.wordreference.com Dictionary.

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distinguishes it from science. Fishers often convey information in the form of story-telling about a particular biographical event, another feature of their knowledge that tends to distinguish it from scientific knowledge. However, it is often the 'detached', 'amusing' and 'biographical' features that those inclined to devalue fishers' knowledge are referring to when they think of it as anecdotal. This approach ignores the potential for systematic research involving fishers and their knowledge that pays attention to its social, ecological and historical context (Neis and Felt, 2000; Neis et al., 1999a). It also conveniently overlooks the frequency with which scientific research is 'detached' from highly significant historical and local contexts (Neis, 1998) and the extent to which science is 'biographical' in that it reflects the training, experience and prejudices of scientists as well as the institutional structures within which they are embedded (Finlayson, 1994).

Information obtained from natural resource users has been variously described as 'pre-scientific' or 'natural history', or as 'inductive' if one is being especially polite (Fuller, 1997). But if we can lay aside our graduate school prejudices long enough to examine the facts, it is impossible not to acknowledge that fishers' and marine hunters' knowledge about the sea has sometimes proven a fast and inexpensive shortcut to information essential to our scientific understanding of the marine environment, even when that knowledge is from the distant past (Spens, this volume). Juxtaposing their observations and interpretations with the results of scientific work can provide important insights for scientists and managers, as well as for fishers themselves. As with science, concerns that fishers' interpretations of observations may be mistaken should not preclude paying attention to the observations themselves.

Some of the information possessed by fishers in developing and developed countries may well never become available to science if we depend solely on conventional research to obtain it. Conversely, if natural and social scientists and fishers do not begin working together more effectively, we are unlikely to protect the fish that remain, let alone enhance the potential for recovery. The remainder of this chapter presents some established examples of the practical scientific value of the 'anecdotal' information of indigenous and artisanal fishers and marine hunters, and the different purposes it can serve.

FISHERS AND 'EXCUSES' FOR POOR CATCHES

How many times have we heard fishers explain poor catches by saying 'they've just gone somewhere else; they'll be back'? And how many times have scientists thought to themselves 'Yeah sure; you just don't want to admit that catch reductions are needed because of overfishing'? Although such suspicions are sometimes warranted, they are not always correct. In the Torres Strait, hunters caught roughly a fifth as many dugong (*Dugong dugon*) with essentially the same hunting effort during a survey made in 1983–4 as they had during the previous survey in l976–8 (Johannes and MacFarlane, l991). Many hunters expressed no concern about this change, saying that the animals had simply gone somewhere else and that sooner or later they would return. We and some other biologists were sceptical (Johannes and MacFarlane, 1991). However, aerial surveys of dugong in the Strait subsequently revealed great interannual variation in numbers and dugong catch per unit effort did subsequently rebound. Hunters predicted both outcomes (Marsh et al., 2002).

Research also supports a related claim made by the hunters, that great interannual variation occurs in the extent and location of the seagrass upon which the dugong feed, a pattern that may well influence their distribution significantly (Marsh et al., 2002). Whether or not overhunting is occurring in the Strait is still unknown because of difficulties associated with getting reliable stock estimates. However, the hunters' claims about the scale of natural interannual variability in both the number of dugong and their seagrass food were undoubtedly correct (Marsh et al., 2002).

As scientific awareness of the natural interannual variation in stock sizes has grown in the past fifteen years, so has the realization that stocks can sometimes recover in the absence of more stringent management. Awareness has also grown that social and technological dynamisms, as well as persistent problems with bycatch, discarding and under-reporting, are all contributing to sustained catch rates in the context of resource decline and to problems in estimating fish mortality. Not surprisingly, precautionary concerns may motivate scientists to support conservation initiatives on the basis of less than adequate data – as when they think stocks are overfished but cannot prove it. Conflict is the inevitable consequence of management actions based on scientific assumptions that run counter to biological information held by fishers. But fishers too need to consider the spatial, temporal and ecological dynamics of their fisheries and the ways these could be influencing their observations and related perceptions about stock health (Murray et al., 2006). Respect, collaboration and the successful application of knowledge require both fishers and scientists to understand not only the strengths but also the weaknesses of their *own* knowledge systems.

We need to study fishers' knowledge of their resources as a matter of high priority so as to be able to understand it in all its complexity, test it (preferably in collaboration with fishers) as soon as possible, and thereby reduce the likelihood of such conflicts (many chapters, this volume). Similarly, fishers need help to understand that there are different paradigms within science and that science, like fishers' knowledge, is to some degree a socio-ecological product. Paying particular attention to areas of agreement and disagreement between scientific and fishers' knowledge can contribute significantly to improved understanding and to advancing the knowledge of both groups.

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FISHERS' KNOWLEDGE AND STOCK ASSESSMENT SCIENCE

PERSONAL interviews with fishers can elicit large amounts of information pertaining to the past and the present for both commercial and noncommercial species. This information can be very useful in scientific stock assessments. Local knowledge of the time and place fish are caught can indicate seasonal and directional fish movements. Fishers can also provide information on stock structure, spawning grounds and juvenile habitat. They can provide catch-rate data which may reflect local changes in abundance. In addition, they can provide information on spatial and other changes in effort and fishing practices that are critical for interpreting catch-rate data (Hutchings, 1996; Neis et al., 1999b).

On Canada's east coast and elsewhere in the North Atlantic, stock-assessment scientific data were largely derived from offshore areas from research vessel surveys and commercial trawlers. Cod (*Gadus morhua*) and other groundfish stock collapses in the 1990s have made it critically important to understand the stock structure and related behaviour so as to ensure that remnant populations are not overfished. In Newfoundland and Labrador, most of the remaining cod live in the coastal bays. In both Newfoundland and Norway, fishers' knowledge has been used to help identify actual and potential local stocks of cod in fjords and bays (Maurstad and Sundet, 1998; Wroblewski, 2000; Wroblewski et al.). In the Gulf of Maine, it has been used to identify coastal spawning areas for cod and haddock (*Melanogrammus aeglefinus*) (Ames et al., 2000; Ames, 2004; Ames, this volume). Careful management of remnant coastal cod and haddock stocks may be critical to the long-term recolonization of offshore areas (Wroblewski et al., in press).

In Newfoundland, scientists had a history of collecting data from commercial capelin (*Mallotus villosus*) fishers by means of a logbook programme and, since the 1990s, an annual phone survey. Interviews with some of these fishers indicated, however, that the index of relative capelin abundance based on the logbooks of inshore capelin trap fishers may have been positively biased. These fishers described significant changes in the design and size of their capelin traps, as well as other efficiency-related changes that should have been taken into account in interpreting data from the relative index of abundance that was based on the capelin trap catch rate (Neis and Morris, 2002). Similarly, detailed interviews with lobster (*Homarus americanus*) fishers in the Magdalen Islands of Quebec, Canada, helped document changes in fishing equipment, strategies and efficiency that were crucial to interpreting catch-rate data in their fishery (Gendron et al., 2000).

LARVAL BIOLOGY OF REEF FISH

CORAL reef fish larvae spend several weeks to several months in the oceanic plankton. Research has shown that once they are sufficiently well developed to take up demersal existence, they can detect reefs from distances of more than a kilometre and swim toward them (e.g. Leis et al., 1996; Stobutzki and Bellwood, 1998). Tobian fishers described this phenomenon clearly to Johannes in the mid-1970s. They named at least five species that they had commonly observed abandoning drifting logs with which they had been associated, and heading over deep water directly towards reefs 'many hundreds of yards away'. A Palauan master fisher later reiterated these observations (Johannes, l981). Until biologists got around to confirming that such behaviour occurred more than fifteen years later, they routinely assumed that reef fish larvae were entirely at the mercy of the currents (e.g. Roberts, l997). This incorrect assumption led to major errors in reef fish stock modelling and management (e.g. Leis and Carson-Ewart, 2000).

Such swimming control implies that reef fish larvae have some ability to determine where and when they settle out of the plankton. The way this ability is employed needs to be better understood if efforts to collect settling reef fish larvae for the purpose of aquaculture research are to be refined (e.g. Hair et al., 2002). The two collection devices most commonly used by researchers are light traps and specially designed plankton nets. Both are expensive. Neither has proven very effective in collecting groupers, the most important species among cultured reef food fish (e.g. Hair et al., 2002). Thousands of South East Asian fishers capture settling groupers for sale to aquaculturists. They use more than a dozen different methods and demonstrate considerable knowledge about precisely where and when to deploy them productively (Johannes and Ogburn, l999; Sadovy, 2001).

Some of these methods are environmentally destructive and should be discouraged (Johannes and Ogburn, l999; Sadovy, 2001). Others, which focus on pre-settlement larvae, appear not to be destructive and are very inexpensive. In some cases, the gear consists of nothing more than small clumps of old netting, or of particular species of algae or terrestrial vegetation suspended from sticks or ropes at times and places that fishers have learned through trial and error are good for catching grouper larvae or post larvae. Learning from and, indeed, teaming up with some of these fishers offers researchers opportunities to develop the science needed to help increase catches while reducing costs and environmental damage.

SEA TURTLES

FOR many generations, tropical sea turtle hunters asserted that green turtles (*Chelonia mydas*) usually returned to the same beach to nest over many years.

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They believed this because they recognized individual turtles by distinguishing marks or wounds – things like chunks bitten out of their flippers or shells by sharks. If these fishers' claims are true, they are obviously of great importance in the design of useful scientific studies of turtle movements and population and reproductive trends – studies that are absolutely essential to enable researchers to understand turtle biology well enough to detect overharvesting and design useful conservation measures. However, biologists ignored or dismissed this knowledge for a long time before one of them finally decided to take it seriously and test it. The result was biologist Archie Carr's famous turtle-tagging experiments that demonstrated the truth of the turtle hunters' claims in the 1950s (see for example Carr, 1972). Research on sea turtles took a great leap forward after this discovery as scientists realized how much they could learn from turtle-tagging studies where they could usually rely on the turtles to return to the tagging site. Tens of thousand of turtles have since been tagged. A great deal has been learned about growth rates, longevity, reproductive rates and nesting frequency as a direct result of one scientist deciding to take turtle fishers' knowledge seriously (see also Küyük, this volume, for practical application of turtle fishers' knowledge).

BEING IN THE RIGHT PLACE AT THE RIGHT TIME

FISHERS and hunters everywhere focus on where and when to find ample prey. This means that marine fishers and hunters often know a lot about how the distribution and abundance of marine animals vary from year to year with type of habitat, season, weather, time of day, stage of tidal cycles, lunar phase and other factors. They can also often relate important observations about behaviours of marine animals that contribute to these changing distributions and abundances. Such subjects are key areas of focus in fisheries research, but scientific observations of them tend to be temporally and spatially limited (Fischer, 2000).

For example, at higher latitudes most scientific research is done in the summer months because, first, the university-based researchers can more easily get away from teaching, and second, summer is often the most comfortable time to be in the field. The Inuit,[4] in contrast, traditionally hunted on sea ice throughout the winter. As a result, they learned much about the biology of their prey that can only be learned in winter when most biologists are snug in their offices. Milton Freeman (in Johannes et al., 2000) describes what Inuit know about the winter biology of the whales they hunt. They were able to tell him where and how they move, and how they can navigate and migrate under the ice. Until recently, biologists had never seen this

4. The correct name for Arctic aboriginal people formerly and incorrectly referred to as 'Eskimos'.

ice-related behaviour and initially doubted the accuracy of these claims. Subsequent research showed that Inuit information was not only correct but also essential for developing better estimates of whale population sizes (Johannes et al., 2000).

Similarly, Nakashima's (1993) studies have shown the scientific value of Inuit knowledge about eider duck (*Somateria mollissima*) behaviour during the winter, a time when ice cover forces them to change their behaviour and distribution greatly from that of warmer months when most scientific field research is done. Nakashima states that, 'for many species of Arctic wildlife, [traditional ecological knowledge] far outstrips current scientific knowledge', and that natural resource managers 'make decisions and take actions based upon deficient scientific data, declaring that for the time being it is the only information available. In so doing they choose to ignore the traditional ecological knowledge of Native peoples' (Nakashima, l993, pp.108, 103). By tapping Inuit knowledge, Nakashima was able to show that the eider duck population of Hudson Bay was almost twice the size estimated by biologists, and reveal a host of interesting biological facts such as how substantial numbers of eiders can shelter on the water under ice domes of their own making. More recently, Labrador hunters' ecological knowledge about the history of interactions between eider duck (*Somateria* spp.) populations and hunting in St Peter's Bay, Labrador, has been combined with scientific research to enhance our understanding of long-term trends in eider abundance and the relationship between industrial and regulatory changes and shifts in mortality among eider populations (Chaffey et al., 2003).

FISHERS' KNOWLEDGE, MARINE PROTECTED AREAS AND ENVIRONMENTAL IMPACT ASSESSMENTS

The value of fishers' knowledge extends beyond stock assessment science and management. For example, recording the spatial and temporal distribution of coastal marine plants and animals is fundamental both to environmental impact assessments (EIAs) (Johannes, l993) and to the design of marine protected areas (MPAs). Here, the relevant knowledge possessed by fishers can be invaluable. The locations of rare or endangered species are more likely to be pointed out by local resource users than they are to be identified by outside researchers doing site inventories on their own over limited time periods. The same is true of the timing and location of animal migrations and aggregations (see, for example, Wroblewski, 2000).

An important body of fishers' knowledge in tropical nearshore waters that relates to the siting of MPAs concerns reef fish spawning aggregations. Groupers, snappers, jacks, emperors, mullets, bonefish, rabbitfish, surgeonfish and other species of coral reef food fish aggregate to spawn at the same location, season and moon phase each year. More than thirty researchers or research groups have acknowledged in their

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publications that it was fishers who first led them to the spawning aggregations that they subsequently studied (for a list of twenty-three of these see Johannes et al., l999). There are, in fact, very few published examples of biologists locating important spawning aggregations of reef food fish without such aid. Although this subject has often been discussed in print, it deserves continuing emphasis because fisheries managers in many tropical regions have proven incomprehensibly resistant to obtaining fishers' knowledge on spawning aggregations and using it for better reef fish management. Like other small, local stocks, many of these aggregations are highly vulnerable to rapid depletion or complete elimination (reviewed by Johannes et al., 1999). Although supporters of MPAs routinely assert that their most important function is to protect spawning stock biomass, disappointingly few MPA planners make the effort to locate spawning aggregations or to incorporate them into MPAs.

The trade in live reef food fish, in which cyanide is often used to stun the fish, is depleting grouper spawning aggregations and the stocks they represent at unprecedented rates in South-East Asia (e.g. Johannes and Riepen, l995; Pet-Soede and Erdmann, l998; Bentley, 1999). Yet there is nothing in the scientific literature in the region on the timing or location of these aggregations. The fishers who are depleting them clearly know more about them than fisheries biologists, illustrating the fact that knowledgeable fishers are by no means always environmentally sound fishers. Just as tomb-robbers make outstanding guides for archaeologists, so too live reef fish operators might prove useful in helping reef fish researchers locate spawning aggregations. So devastated are grouper stocks in South East Asia that such drastic measures may be called for.

CURRENTS

The inhabitants of the tiny isolated oceanic island of Tobi south of Palau were intimately familiar with a form of island wake that strongly influenced where and for what they fished (Johannes, 1981). Johannes was unable to find any such form of wake described in the oceanographic literature, but eventually stumbled across it in the experimental hydrographic literature where it was known as a stable eddy pair (Johannes, l981). At that time, this basic oceanographic feature had never been observed by oceanographers, yet Tobians had known about it for generations if not centuries.

Trochus (Trochidae) are large, commercially valuable, tropical gastropods found in the western and central tropical Pacific. Although they have an unusually short pelagic larval life, local villagers can reap the benefits of local trochus reproduction when protective breeding sites are located within their waters and the currents retain the larvae in the area until they settle. Surveying the currents on the fishing grounds of many small fishing villages for the essential information to site the trochus reserves would be prohibitively expensive. Local canoe fishers, however, are usually very familiar with these currents, and government fisheries personnel in Vanuatu therefore use this local knowledge to help villagers determine where best to locate their trochus reserves (M. Amos quoted in Johannes, 1998b).

HABITAT ISN'T EVERYTHING

There are countless examples of shallow-water spawners that characteristically choose particular types of bottom habitat on or over which to spawn. For example, many seahorses give birth in seagrass beds, where rabbitfish (Siganidae) also lay their eggs, and grunion (*Leuresthes tenuis*) spawn in the sand on the beach on high spring tides. Johannes had always assumed that nearshore species consistently chose a particular spawning habitat, until he learned a lesson from the aboriginal fishers of northern Australia about the spawning habits of barramundi (*Lates calcarifer*). Barramundi are an important food and sportfish in Australia, but in the 1970s little was known about their biology. There had been a long-running argument among marine biologists about where barramundi spawned. Some insisted that they migrated from the ocean into rivers to spawn, while others argued just the opposite – that they migrated from rivers into coastal waters at spawning time – but there were no scientific data available to settle the issue.

The question appeared to have been solved conclusively when research demonstrated that barramundi in the Fly River system in Papua New Guinea migrate out of the river and as much as 100 kilometres along the coast to spawn (Moore, 1982). However, shortly after this discovery and several hundred miles away in northern Australia, Johannes interviewed aboriginal fishers who claimed that barramundi in their waters migrated from the ocean into rivers, sometimes tens of kilometres upstream before spawning. Johannes told some of them about Moore's work and they all responded in the same way saying, in essence, 'With all due respect to your friend Mr Moore, where we live, barramundi migrate into some rivers to spawn.' Eventually, their assertions that barrramundi move upstream to spawn in this region were confirmed (Davis, 1985).

How can the same fish have such conflicting spawning habits in different parts of its range? Further research revealed that fertilized eggs of barramundi survive best in water with a salinity of around 30 parts per thousand. The Fly River, where Moore did his research, has a very large discharge of freshwater that dilutes the seawater for many tens of kilometres out to sea. For this reason, Fly River barramundi have to migrate around 100 kilometres along the coast from the Fly River mouth in order to find water of high enough salinity to spawn. In northern Australia, however, most rivers are relatively small and slope very gently to the sea. The very big tides in this area push seawater many tens of kilometres upstream into some of the rivers, forcing

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the barramundi to leave the sea and swim inland to find water of low enough salinity. We biologists had assumed that barramundi were choosing a special bottom type in order to spawn, just like most other shallow-water spawners we were familiar with. It had simply never occurred to us that some other environmental factor could be more important. For centuries, the Aborigines knew the barramundi spawning movements in their waters that were determined by this need, even if they didn't know the reason for it.

FISHERS' MISTAKES

LIKE other resource users and like scientists, fishers sometimes draw false conclusions from accurate observations (Gunn et al., 1988 and similar researchers). We should think twice before discounting a fisher's conclusion even when we are positive it is wrong, because the observation on which it is based may be right – and valuable. For example, fishers in Belize told a group of marine biologists they had periodically seen a large group of whale sharks (*Rhincodon typus*) swimming through milky clouds of water. They said, 'We figured they must be spawning.' As biologists, we knew this was wrong because whale sharks do not release eggs; they are viviparous. However, these were good fishers whose knowledge had proven reliable and valuable in the past. What was going on here? Some days later we discovered the answer. In the same area, we saw a group of whale sharks swimming through a large cloud of very milky water. Its milkiness, we discovered, was due to spawn produced by a large aggregation of snappers. The whale sharks were there because they were feeding on this spawn. The fishers' 'mistake' had helped lead us to an important discovery: nobody had ever recorded this event before, nor had biologists known that the largest shark in the world could feed on eggs smaller than the head of a pin (Heyman et al., 2001).

FISHERS' KNOWLEDGE AS LONG-TERM DATABASES

FISHERS' knowledge was recently used to document inshore spawning areas for cod and haddock in the Gulf of Maine. In some cases, these spawning areas were fished out decades ago, making fishers' knowledge the only potential source of information on their location (Ames et al., 2000 and this volume). Similarly, Dulvy and Polunin (2004) mention a large food fish, the bumphead parrotfish (*Bolbometapon muricatus*) that was once common in waters around some Fijian villages but which some village men under 25 have never seen because of overfishing. This species, they discovered, can be considered locally extinct at six islands where the last date of capture was prior to the 1990s, and stocks are severely depleted around other islands in the group.

These scenarios of depletion would never have been discovered if researchers had not canvassed the knowledge of older fishers. Their findings demonstrate that interviews with older fishers can be used to identify declining species and confirm the disappearance of exploited fishes, potentially in time for conservation action. They also suggest that fishers' knowledge, like the knowledge of scientists, is vulnerable to the 'shifting baseline syndrome' in that their sense of an ecosystem and its potential tends to be based on what they encounter when they enter the system and, as a system degrades, successive generations may come to expect less and less in terms of abundance and diversity (Pauly, 1995; Neis and Kean, 2003). In the case of Dulvy and Polunin (2004), their concurrent underwater censuses and subsequent statistical analyses suggest that, compared with surveying fishers' knowledge, conventional ecological censusing is far more expensive and has relatively little power to detect extinctions of large, vulnerable fishes. It took two to three weeks to determine the status of the fish stocks with the aid of fishers' knowledge, whereas it took between a year and eighteen months to do the same by means of ecological censusing (see also Spens, this volume). Dulvy and Polunin's (2004) findings dramatize the fact that in remote areas where few written records are kept, important knowledge about natural resources may die with each generation unless someone records it. Later, conventional biological field research is unlikely to recover this information. The only long-term databases that exist for such areas may reside in the heads of the elders (See Johannes and Yeeting, 200l, for another example).

FISHERS' KNOWLEDGE: A PRICELESS BUT FRAGILE OPPORTUNITY

VAST areas of marine habitat have never been studied scientifically in any detail. Most will remain unstudied because there simply are not enough dollars and scientific personnel to do the job (Johannes, l998a; Prince, 2003). In addition, our marine ecosystems are changing rapidly in response to the effects of overfishing, climate change and other anthropogenic and natural forces. Vital knowledge about local areas and about the history of fish and fisheries in these areas – knowledge that is critical to the recovery of our marine ecosystems and the communities that depend upon them – resides in the heads of indigenous, artisanal and commercial fishers and hunters around the world. When given the opportunity, fishing experts from these groups have made researchers aware not only of ecological processes but also of customary tenure and local management systems that have been eroded through the interactive effects of external management interventions and resource degradation. In some areas, these insights have fuelled the development of innovative, community-based management initiatives that have helped local fishers and their communities bring about the recovery of marine ecosystems. The 'renaissance of community-based marine resource management in Oceania' described in one of Bob Johannes'

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last publications contains important examples of success stories that have global relevance (Johannes, 2002). He argued at the Putting Fishers' Knowledge to Work Conference that:

> 'Biologists are much better trained to ask useful questions about local ecological knowledge, put the answers into broader biological context and help restrain social scientists from framing management recommendations that ignore critical biological realities. Social scientists are better skilled in achieving good collaboration and rapport with local people, in interviewing, and in restraining biologists from drawing management conclusions that ignore equally critical cultural realities. The two types of researchers should be working in teams (Johannes, 2003).'

His reflections on the presentations based on indigenous, artisanal and commercial fisheries led him to argue that social and natural scientists working in both venues could learn from each other, but great care needed to be taken with generalizations from temperate to tropical and from commercial to artisanal and indigenous fisheries. In his concluding remarks to the conference, he emphasized that there were some thirty-eight institutions in the world dedicated to the study of indigenous knowledge of the terrestrial environment, but none for aquatic ecosystems. He challenged both natural and social scientists to set one up as a matter of urgency.

> 'Fishers have knowledge that often exists nowhere else. They need to be involved in the careful and systematic collection and evaluation of that knowledge, as well as in decisions about where, when and how it is put to use. The planet loses something precious every time one of these people dies without having had an opportunity to have this knowledge recorded. One Palauan fishing expert who taught Bob Johannes his knowledge recognized this. He told him, "Through you I can leave my footprints in this world before I move on to the next" (Johannes, 1981).'

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Fishers rely on an in-depth knowledge of the natural milieu for their livelihood. This volume focuses on how and where fishers' knowledge – indigenous and artisanal, as well as large and small-scale commercial – is being put to work in collaboration with scientists, government managers and non-governmental organizations.

Case studies from around the globe show clearly that it is time to move beyond debates about the utility of fishers' knowledge to focus on establishing frameworks that best allow fishers and their knowledge to become effective and appropriate counterparts in fisheries science and management.

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