Challenging coasts: transdisciplinary excursions into integrated coastal zone development

Visser, Leontine E. (Ed.)

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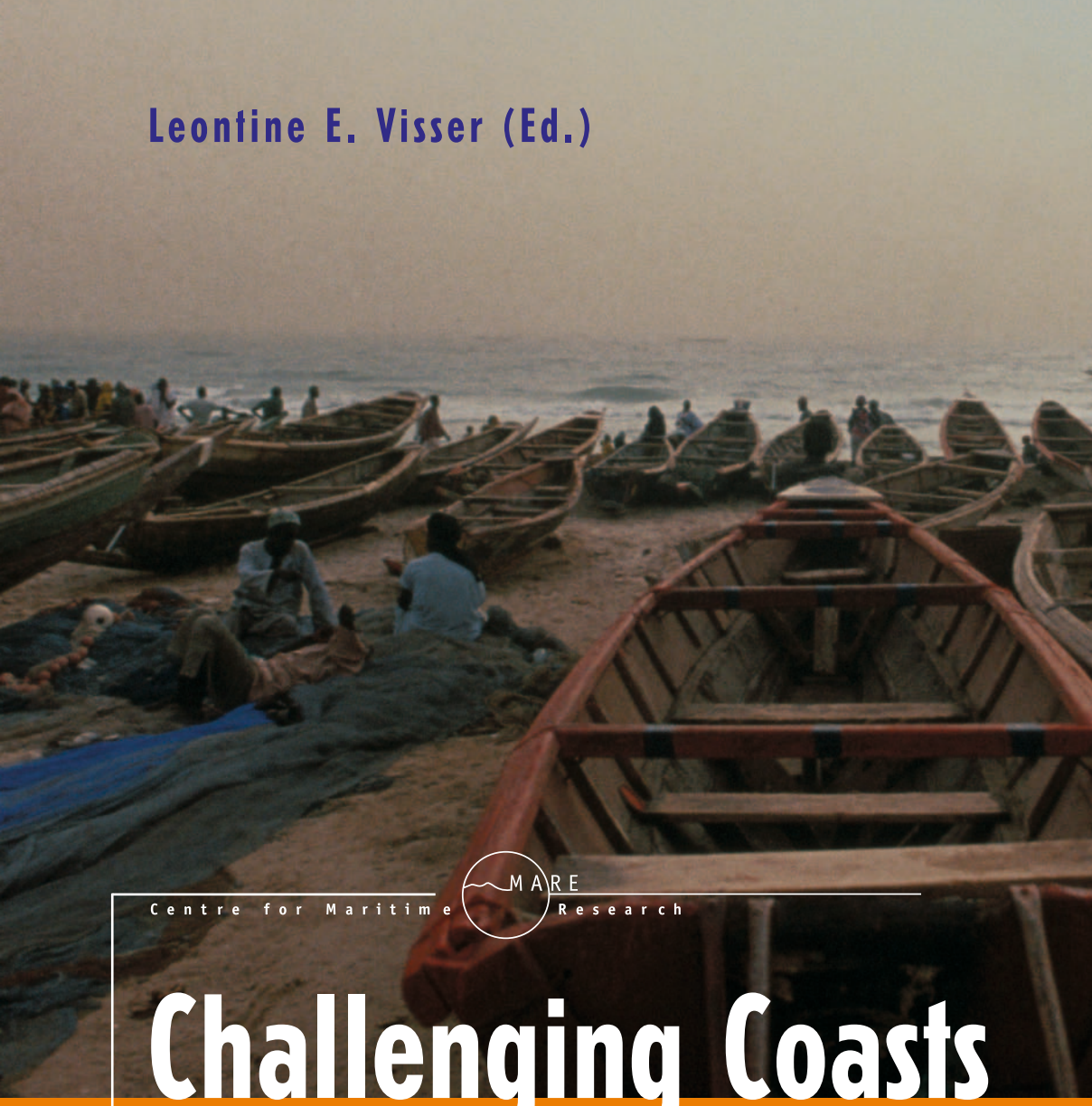

MARE
Centre for Maritime Research

Challenging Coasts

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Transdisciplinary Excursions into Integrated Coastal Zone Development

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Transdisciplinary Excursions into Integrated Coastal Zone Development

Leontine E. Visser (Ed.)

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Series Foreword

This is the first volume of the *MARE Publication Series*, and a cause for celebration. The initiating agency, the Centre for Maritime Research (MARE), is an interdisciplinary social-science organisation based in the Netherlands, whose aim is to provide a platform for the development and exchange of scientific knowledge on the use of marine and coastal resources. Its mission is to be a European research centre that is also explicitly concerned with maritime issues in the South. Its activities include the publication of the refereed journal *Maritime Studies/MAST* and, on a regular basis, the organisation of conferences on maritime and coastal topics.

We, the editors, are striving to create a series that addresses topics of contemporary relevance in the wide field of people and the sea. Our intention is to ensure the highest academic standards, through the involvement of specialists in the field and through the instrument of peer review. While allowing for diversity, we also, however, aim for coherence, if only in purpose.

Social scientists in the marine and coastal fields are a dispersed bunch. This is certainly true of those in Europe and the South. Our interaction is impeded not only by our geographical spread across departments and universities, but also by language barriers. The series thus aims to make visible, in the language with the greatest global reach, the excellent intellectual work that is being done by scholars on and from the various regions. Our concern is to ensure that scholarly work on coastal issues is disseminated widely, including to low-income countries, so we aim to keep the price of our publications as low as possible.

Coastal zones the world over are facing a range of challenges, and the scholarly debate is currently tending to concentrate on the concerns of management and governance. While these topics will also figure in this series, we have no intention of producing policy handbooks. Our objective is rather to reflect critically – on contemporary fashions, too – and to explore new avenues of thought.

The present volume is a case in point. While co-operation between natural and social scientists is frequently paid lip service, the results of co-operation efforts are still limited. Exploring the direction in which transdisciplinary research might proceed, the editor has brought together cases from different disciplines and parts of the world that together contribute to an identification of the potential for coastal zone development. This is a provocative exercise, and extremely fitting for the series' inception.

Readers can look forward to this series covering a variety of topics, such as fisheries, coastal tourism, mineral extraction, demographic growth, policy analysis, and multiple-use conflicts. In fact, in the course of time we hope to present a rich and diverse catch of coastal topics.

The publication of the series is in the safe and competent hands of the Amsterdam University Press.

Svein Jentoft (University of Tromsø, Norway;
e-mail: sveinje@nfh.uit.no)

Maarten Bavinck (University of Amsterdam, the Netherlands;
e-mail: mbavinck@marecentre.nl)

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Acknowledgements

Most of the chapters of this volume were first presented in two panels chaired by the editor at the international conference *People and the Sea: Conflicts, Threats and Opportunities* organised by the Centre for Maritime Research (MARE) in Amsterdam in August 2001. Putting together the papers from different fields of the social sciences, the natural sciences, and law has been a new and positive experience to which several people have contributed. I wish to thank the staff of MARE and its co-ordinator, Maarten Bavinck, who organised the conference. I also wish to acknowledge Derek Johnson who, as the copy editor, did a wonderful job in reshaping the texts, thus contributing to the overall cohesion of the book. Linda Emmelkamp, the editorial manager of MARE, played an important role in seeing the book through to publication.

Leontine Visser
Wageningen, the Netherlands

I

Introduction

Leontine E. Visser

This book is the first volume of the new MARE Publication Series. It brings together several papers showing different disciplinary perspectives on the complex and dynamic interface between people and the sea. *People and the Sea* was the title of the first International Conference organised by the newly established Netherlands Centre for Maritime Research. MARE[1] was formally established in 2000 upon the initiative of social scientists at the University of Amsterdam, who were mostly involved in fisheries research in Europe and in Asia. During the first three years of its existence MARE has rapidly expanded both in scope and in size in close collaboration with the Department of Cultural Anthropology and Sociology and the Department of Human Geography of the University of Amsterdam (UvA), SISWO/Netherlands Institute of the Social Sciences, and the Chairgroup of Rural Development Sociology of Wageningen University (WUR). It now includes Ph.D. research and advisory research on marine anthropology and integrated coastal development topics ranging from sustainable fisheries and co-management issues to the transnationalisation of artisanal fisheries and the complex realities of marine park management in Europe, Asia, Africa, and Latin America.

The three-day conference *People and the Sea* was held in Amsterdam from August 30 to September 1, 2001. It was opened by the Netherlands State Secretary of Transport, Public Works and Water Management, and hosted a total number of 165 scientists who presented their work in many parallel sessions. Although MARE primarily consists of social scientists, research and training activities are often undertaken in a transdisciplinary context. The importance of transdisciplinary research was underlined by the organisation of two panels on the topic during this first international conference of 2001.

Why have the coastal zone and marine resources been recently receiving attention? Three parallel developments seem to be taking place at different scales and time perspectives. Changes in the bio-

sphere and sea level rise, the increased economic valuation of marine resources, and demographic transformations in the coastal zone are processes that to a large extent run parallel to each other. But in the present-day political-economic discourse they often reinforce each other, and potential sea level rise becomes a perceived risk that needs to be controlled.

Scientists have become concerned with changes in the biosphere and the risks of sea level rise. This has drawn attention to the need for a scientifically and technologically integrated coastal zone management. Meanwhile, since the 1980s widespread ecological concern has stepped up research on marine biodiversity. Ecologists and biologists are able, through more precise instruments and methodologies, to measure the occurrence, diversity, and dynamics of marine life. A general concern with sustainability is supported by a better ecosystematic understanding of marine life, revealing the great complexity and richness of the latter to a wider public.

Parallel and often contrasting with a concern for biodiversity and sustainability is the economic value of the sea in terms of 'resources'. Although the high seas have been increasingly exploited over the course of the last two centuries, confrontations over resources in these areas have become increasingly frequent since the 1950s.

Moreover, rapid demographic transformations are taking place. It has been predicted that by 2025 about 75% of the world's population will live in coastal areas, which will include the majority of the world's cities, and especially the southern megacities.

As a result of these diverse developments, marine resources are now contested not only within, but also between states and transnational institutions, and business networks and organisations. Oil companies, fish or coral traders, urban fish consumers, nature conservationists from around the world, coastal tourists, and more localised industrial and artisanal fisher households are all interested parties or 'stakeholders' who access coastal waters and use natural resources like fish, oil, sand, corals, and water. Although they still constitute a sizeable group in coastal areas, small-scale and artisanal fishers will increasingly have to share access to marine resources with other users.

Finally, it is likely that when the land-based search for new forms of food is exhausted, the sea will be turned to. Already the increased interest in aquaculture in coastal areas points in this direction. In

other words, the sea, and more particularly the coastal zones, have become matters of public interest.

From Coastal Zone Management to Coastal Development Research

Due to the complexities of scale, there are no single governance bodies that enable the management of these various interests simultaneously at international, national, subnational, and local levels. Legal instruments and management organisations at different levels of society are being developed to this purpose, but their implementation is fraught with practical difficulties and political contestation. This approach and its dilemmas are an analytical parallel to political interests that in the 1950s-1960s stressed the need for instititutional development and control (Heady 1991). In this vein, integrated coastal zone management or ICZM has become known as a policy instrument for intervention by states or international organisations in order to control coastal zone risks, like sea level rise, the loss of marine biodiversity, and demographic pressure. But ICZM as a tool of governance necessarily simplifies and standardises factual diversity and diversification, because it serves the need of a specific form of knowledge and control by the state. Scott (1998) has called this the state's 'tunnel vision'.

Integrated coastal zone management itself can be the subject of research. This is the focus of the present volume. When ICZM becomes a research theme, different units of analysis are chosen. Sea level rise, for example, is less appropriate as a unit of analysis because of the difficulty of finding causal relationships with the ways people interact with the sea through time and space, or with observable ecological and social changes. Research on coastal zones may constitute the basis of coastal zone management, but it also contrasts with coastal zone management as a policy tool because the research will inevitably show social and ecological variability, diversification, and difference through time and space. Ecological and biological studies highlight the complexities of marine ecosystems and biodiversity. Sociological, anthropological, and geographical studies focus on the various ways in which individuals, households, or classes of people obtain access to, and use marine resources, or are excluded from them. They include the study of a wide range of social forms of organisation that deal with resource management in partic-

ular social, economic, cultural, and political contexts. The environmental, social, cultural, economic, political, legal, and administrative conditions show important commonalities, but also important differences between coastal areas within and between the North and the South.

Furthermore, coastal zone management itself can also be studied as a social, administrative, and political process. Management practices appear to be far from standardised and homogeneous procedures. They often include the contestation of values and conflicts between a variety of stakeholders in different power positions, including scientists.

Coastal zone management as an instrument for government intervention is closely linked to the particular objective of safeguarding. It can be seen as a means to safeguard the land from the sea, or to safeguard marine biodiversity from adverse human intervention. During the last decade, poverty alleviation has been added to the agenda of sustainable resource use and biodiversity, and thus also to the agenda of marine biodiversity. Consequently, the meaning and purpose of coastal zone management have been broadened: such management is now seen as a tool for the sustainable development of human and natural resources in coastal areas.

What is actually happening here is the conflation of – hence the confusion of – the two different objectives of management and development. The management focus is on the safeguarding of the land from the sea, while the development objective is directed at poverty alleviation through alternative social and economic development of particular segments of society living in the coastal zone. Policy documents regarding development co-operation in particular focus primarily on the social-economic objective of coastal zone *development*, but they misuse the instrumental and technological concept of coastal zone *management* by linking a social, economic, and political agenda to the sustainable use of coastal resources. This lack of clarity poses difficulties when researchers from the natural, technical, and social sciences actually sit down together to develop an integrative approach to coastal development, especially with regard to developing countries.

The complexity and range of coastal issues indicated here make it unrealistic to try to keep the analyses within a monodisciplinary framework, and demand some form of integrative approach. But a true integration of social scientific analyses and data with natural sci-

entific analyses and data is only just starting. Multidisciplinary or interdisciplinary research objectives often appear to result merely in the use of social science data as a 'background' or 'context' to natural scientific findings, but the conceptual assumptions and both sets of data are not really compared as equals in order to reveal their contradictions and incongruences. Integrated research on the topic of coastal zone management is still at an early stage of development, and scholars from various social sciences and natural sciences are only just coming together to discover the commonalities and the differences between their scientific epistemologies and methodologies, and the potential to integrate and expand their bodies of knowledge.

This volume presents research cases in the fields of anthropology, human geography, economy, law, biology, and ecology that together contribute to the identification of problems in coastal areas and the potential for coastal zone development in Europe, Southeast Asia, the Pacific, Africa, and Latin America. The integration of natural and social scientific forms of knowledge with practitioners' knowledge is becoming more important in an era when globalisation appears to be dominating political agendas, at the expense of the necessary attention to societal and natural diversity and diversification. The cases discussed in this book may provide new insights into the different approaches to complex and often conflicting issues ranging from the sustainability of marine biodiversity and the parallel need for poverty alleviation of artisanal fishers' societies, to the conflicting directives of supra-national legal bodies and their implementation by nation-states in the cases of resource exploitation and pollution.

A Note on Transdisciplinary Excursions

The aim of this book is ambitious, for two reasons. First, because its composition is seen as a first start toward what I define as *transdisciplinary* research rather than interdisciplinary[2] research. In order to understand the complex interface between marine ecosystems and social systems in coastal areas new questions have to be formulated. The challenge of transdisciplinary research lies in the oscillation between disciplinary domains, and the feedback from partner disciplines. The added value of transdisciplinary research is that it challenges (mono)disciplinary assumptions and concepts, and triggers cutting-edge questions.

Transdisciplinarity contains a paradox: the more one starts thinking along transdisciplinary lines, the more this trajectory provides an incentive for, or even demands the reconsideration of one's own disciplinary assumptions and concepts. This is why I am using the image of an *excursion* into transdisciplinarity. Because an excursion is a journey that is undertaken with the intention of coming back to one's starting point. But, as after every true journey, whether physical or imagined, one is not the same after one's return. The excursion has provided new knowledge that consequently confronts the existing body of knowledge. These new insights and experiences may be contingent and become integrated, or they may contest and challenge the existing knowledge.

In addition, I want to engage the audience in an endeavour to develop and improve transdisciplinary ways of seeing coastal *development* as a process, as an interface between people and the sea, rather than looking at coastal zone management as a policy instrument. This book is intended to reach an audience of professionals, policymakers, and students or scholars who are interested or active in the field of development, and in coastal development in particular.

Introducing the Contributions to This Book

This book brings together a number of papers written by social scientists and by natural scientists. Most of the contributions for *Challenging Coasts* have been selected on the basis of their authors' presentations at two transdisciplinary panels that were chaired by the book's editor, and have been rewritten. Two papers that were presented at other panels (Owen; Seixas and Berkes) have been included because they serve our purpose of showing a range of development in coastal areas. Likewise, the paper by Van Duijn has been included, although he was unable to participate at the conference. Unfortunately, some of the other participants at the transdisciplinary conference panels who gave PowerPoint presentations were unable to prepare a paper for this volume.

The contributions are all based on extensive fieldwork resulting in case studies. The authors have in common that they encountered practical problems, and discovered theoretical and methodological shortcomings and biases through monodisciplinary approaches to coastal zone development, whether in the case of ocean or marine park management or in the case of safeguarding or improving

coastal people's livelihoods. This has resulted in a keen interest to move beyond the boundaries of their own disciplinary bodies of knowledge. We have clustered a number of papers around these issues, showing how most authors are using their practical experience and their own disciplinary background to raise new questions that demand more integrative approaches. Ecologists grapple with the difficulty of including the impact of people's fisheries activities into the ecosystem model. Social as well as natural scientific studies on marine park management acknowledge the need to address local economic demands, and the conflicting goals of human and natural sustainability. The cases clearly show the need to fully integrate social research, instead of using social data as subsidiary to natural research outcomes. This is a key point for the agenda of transdisciplinary research on coastal zone development.

There are both strengths and weaknesses in bringing together these papers in one book, related to their disparate epistemological foundations. Of course the big advantage is that the reader has the possibility of finding together within one volume a wide range of experiences and methodological approaches to coastal environmental and social issues. It certainly would be more difficult and time consuming to find such a range of articles otherwise, searching through a wide array of journals and books. On the other hand, readers are invited to make a serious effort to read papers that are written in a different style from what they are used to in their own disciplinary field. For example, anthropologists might argue that the contribution by the coral reef specialist (Chapter 3) is a rather state-of-the-art type of overview that would probably better fit in a kind of *Annual Review of Coastal Zone Development*. Unfortunately no such a volume exists – yet. Conversely, natural scientists often dislike the narrative style of the anthropologist's case study. Yet, the acknowledgement and registration of societal diversity is a condition for biodiversity management. Also, a lawyer may be used to referring to legal codes instead of to an extensive literature to support his case. Finally, terminological usage and levels of data aggregation and analysis will be different between the sciences. For example, geographers, economists, and biologists alike speak of populations and are interested primarily in regional or systematic phenomena whereas anthropologists prefer to speak of people and actors, and interview them as members of a household, community or institution. Also, the very notion of what constitutes a *case* appears to be dissimilar. For now, I am just making

these observations. But their consequences are part of a future transdisciplinary agenda.

During the process of compiling this book I became increasingly aware of the differences in presentation, methodology, and terminology, and discussed these with the authors. I have decided not to insist that authors with different epistemological backgrounds should reframe their papers into a format with which we are more familiar in the social sciences. I believe rather that the overt exposure of epistemological differences is an essential first step towards the discussion of possibly conflicting concepts and methodologies as a necessary starting point for theoretical and methodological comparison and progress. Together with the MARE editor we have tried to make the book as coherent and readable as is possible, given such a diverse range of contributions.

Transdisciplinarity precludes homogeneity and continuity. I am convinced that those who take the challenge to carefully read the contributions to this book will find a wealth of new food for thought.

Challenging coasts' second chapter is a theoretical and methodological examination of why a transdisciplinary approach is needed to understand the complex interface between people and the sea. Also, our scholarly understanding of social and ecological dynamics stretches beyond the more policy oriented, and politically inclined objective of integrated coastal zone management and aims at a concerted approach to coastal zone development. A clear land-bias can be observed in the development of conceptual tools, especially within the social sciences. Examples are notions of boundary, which relate to human territorial relationships, and acts of mapping and zoning, which relate to resource tenure. The transferability and the validity of these concepts need to be studied as part of a transdisciplinary approach, because of their methodological and conceptual consequences for coastal zone development research.

Chapters 3 to 6 form a cluster insofar as they all deal with marine ecology and the establishment of marine parks. Chapter 3 gives an overview of marine biodiversity in the Indo-Pacific area, especially on coral reefs. Sea cucumber, pearl oysters, giant clams, and corals have all become commodities on local and global markets. Biologists observe people's resource use as a threat to biodiversity, and an extensive literature indicates the need felt to establish marine protected areas as a form of integrated coastal management. This paper has

been included because it provides a shorthand overview of some important aspects of marine biodiversity that are necessary to make the reader understand the contestation of the need for the conservation of the coastal zone on the one hand, and, on the other hand, socio-economic development in coastal areas. This debate is more or less implicit in the following chapters.

Chapter 4 describes the interesting case of the shift towards a 'modern' form of integrated management of a marine protected area that was originally established in 1976 by the State as a bird sanctuary: the Parc National du Banc d'Arguin of Mauritania. At the time, occasional fishing by local Imraguen fishers-cum-herders did not pose a threat. Only certain specified economic activities were formally allowed within the park, like small-scale fishing, cattle herding, and the collection of firewood. By 1998, ecological deterioration and increased technological and socio-economic pressures on the Park's natural life demanded the reconsideration of the park's mandate. The management realised that a form of co-management together with the Imraguen was the only option. Development programmes were developed, including ways to improve the livelihood conditions of the local people. The paper does not describe the programme in detail, but focuses on the lessons learnt in the process of shifting the park's management objectives from wildlife conservation to coastal development, including livelihood improvement.

Chapter 5 follows with the analysis of the integration of biological and sociological considerations in the management of a marine park at the opposite side of the world, in Papua New Guinea. The Milne Bay conservation programme was set up by Conservation International with the objective of enhancing marine biodiversity in an area of about 46,800 square km. Restrictions on marine resource use would directly affect about 65,000 people. This paper shows how the programme managers, who were biologists, gradually became aware that they needed to involve the local people, and that the legal and institutional framework of the National Fisheries Authority also had to be taken into account because of the potential impact of their economic plans on the Milne Bay area. The conflicts of interest and of approach between nature-oriented and people-oriented managers concerning the scale and zoning of the Marine Park Area, and the time and approach needed to involve the local people have become characteristic of marine park management history in the last two decades. Together with Chapter 4, this Papuan case provides excellent material to reflect upon the question of whether, and why, the

feasibility and sustainability of marine park development depend on the involvement of local resource owners.

Chapter 6 swings the pendulum back from anthropology to ecology, zooming in on the development of an integrated ecological and fisheries research framework that can be used as a management tool. The authors have extensive comparative research experience on the coral reefs surrounding the atolls in the Pacific Ocean, like French Polynesia, Tonga, Fiji, and New Caledonia. These small island ecosystems differ in terms of species diversity and density, and they are subject to island-specific differences in terms of such factors as fish exploitation and consumption. At a regional scale, the relative isolation of the coral reefs disappears and other factors become relevant, such as the atoll's size and distance from the biodiversity centre (already mentioned in Chapter 3). Because the islands are ecologically rather isolated, it is assumed that fisheries and fish consumption are equally localised. Thus, fish consumption and biomass measurements can be used in a comparative framework of fisheries and ecology. Although this chapter raises many questions, this is also its value and appeal. Publications do not often show the *process* of development of a management tool, either because it is taken for granted or because the authors do not wish to stick out their necks. This case is a truly transdisciplinary excursion that challenges natural scientists and social scientists alike.

Chapter 7 uses a legal approach to question the political economy of the European Community in the case of coastal zone management. The study focuses on the legal incongruity between international and national jurisdiction in the case of the control and management of shipping routes and of oil exploration on continental shelves. The European Community provides legal instruments for the establishment by the Member States of special protection areas (SPAs) and special areas of conservation within its exclusive economic zone (EEZ). At the same time, foreign-flagged vessels enjoy the freedom of navigation through the EEZ of that coastal state. In other words, the individual (European) coastal states are confronted with conflicting directives and regulations by the European Commission. In effect their power is restricted to prevent the routeing of ships carrying products that are potentially polluting from passing through or near a marine protected area. The Member States can propose a Special Protection Area as 'an area to be avoided' to the International Maritime Organization (IMO) of the European Community. But, given the composition of the IMO and the political-eco-

nomic interests represented in it, it is likely that the IMO would restrain the proliferation of SPAs if this could have the effect of limiting the sea area available for navigation.

Chapter 8 takes us to the Ibiraquera Lagoon in Southern Brazil. Here, the State and subnational governmental institutions are involved in the co-management of the coastal fisheries. Multiple-use conflicts exist between fishers who use cast nets and those who use gill nets, between local fishers who fish for their living and outsider sport-fishers, and between members of the lagoon communities and outsiders. The authors propose the establishment of a lagoon-based forum to improve conflict resolution and fisheries management in the Lagoon. In the context of the highly centralised policymaking process and socio-political complexity in Brazil, this is an interesting approach to crosscut existing hierarchies.

Chapter 9 describes a case from Cat Hai Island in the Red River delta of Northern Vietnam. The collection of molluscs, crabs, and other aquatic organisms is a last resort for the poor and marginalised households of the island's communes. Collection, mainly by older women and children, is guided by the lunar calendar, local technology, seasonality, and the demands of local and international (Asian) markets. Local knowledge is rather site-specific, creating economic niches for the members of particular communes. Outsiders come to collect the coastal resources that are not targeted by the local people. However, residents are increasingly being excluded from the collection of these resources by government policy, and the gap between the relatively rich who have access to government agencies and the poor who do not, is widening.

Together, the chapters present a wide range of interesting case studies, written from disciplinary perspectives like ecology, anthropology, and law. Their focus oscillates between the international, national, regional, and community levels. Meanwhile, the focus on one level of analysis clearly shows the integration of other ecological, governmental, and societal 'levels' in dealing with the complex issues of coastal zone development.

Among the management issues addressed, the organisation and management of marine parks appear to be most important, including ways to involve local inhabitants of the park area. But, apart from the practical need for research and action in this field, we should also ask ourselves the following question: why would local people refrain

from the exploitation of marine species for their own socio-economic needs in favour of global food security or biodiversity conservation?

Notes

1. www.marecentre.nl. MARE's Research activities are registered with CERES, the Netherlands Research School for Resource Studies for Development, in particular with AGIDS (University of Amsterdam) and CERES-Wageningen.
2. Experiences with interdisciplinary research on development and the environment have been discussed in an interesting report by the Centre for Development and the Environment of the University of Oslo (McNeill et al. (Eds.) 2001).

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Reflections on Transdisciplinarity, Integrated Coastal Development, and Governance

Leontine E. Visser

Introduction

The past forty years have been a time of momentous change globally. An important part of that change has been an increasing awareness of and mounting concern for the erosion of the natural environment including, in particular, the world's coasts. This paper addresses the conceptual and methodological challenges that are increasingly apparent with regard to the dominant strategy that responds to degradation of the world's coasts: integrated coastal zone management (ICZM). One of the most important realisations within ICZM in recent years is that natural sciences alone cannot meet the current challenges posed by coasts. It is becoming increasingly apparent, as the papers in this volume show, that the analytical strength of the natural sciences in the study of ecosystem change has to be coupled with the social science study of social transformation. This paper argues for the value of a transdisciplinary approach to ICZM that learns from the critiques of the history of science that have been done within the social sciences and humanities. A transdisciplinary perspective highlights the current shortcomings of method and concepts in ICZM and points to ways in which those shortcomings may be addressed.

By the mid-1960s, the notion of continuous progress in both the social and the natural sciences was in jeopardy. The French historian and philosopher Michel Foucault became highly influential by critically reflecting upon the 'history of ideas', and his own ideas were embraced by a variety of people: scholars as well as individuals in the public and private sectors. This has helped pave the way for more interest in the human and the social sciences, and a scholarly interest in local or indigenous knowledges and social forms of environmen-

tal management. Three insights from these new interests are as follows. First, scholarly disciplines or 'bodies of knowledge' have a historical sequence but they are otherwise discontinuous instead of showing an evolutionary development (McHoul and Grace 1993:31). Secondly, disciplines are not regarded as conveying 'the' truth. But this does not mean that there is no truth. On the contrary, there can sometimes be many truths, each with its own rationality. But the question is: whose truth? Which of these, at a given period, became dominant and how? Thirdly, the power of certain disciplines produces other, subjugated or marginal knowledges that are dismissed by official histories as 'less scientific' and located at the bottom end of the hierarchy (ibid.:15). This position has triggered a renewed interest in local forms of knowledge since the 1970s. In the field of ecological modernisation Foucault's ideas have been widely adopted (Hajer 1997; Connelly and Smith 1999).

Meanwhile, environmental issues like global warming and climatic change, including the effect of sea level rise, became prominent public issues that were widely publicised by the media (Anderson 1997). Some have related this public and policy interest to an increased awareness of risk in contemporary society, including the industrial sector (Beck 1992), but the fact is that there is today a greater awareness of environmental hazards, and 'it would be foolish to think that science alone can provide the answer [to them]' (Drake 2000:243). In the same vein, Wilhusen et al. (2002) agree that scientific reasoning and solutions alone will not be enough to safeguard biodiversity. Put differently, one could say that science informs but on its own does not transform society. And the transformation of society is a necessary condition for sustaining biodiversity. Social transformation is one of the central topics of development sociology/anthropology (Booth 1994; Grillo and Stirrat 1997; Martinussen 1999; Long 2001). During the last forty years, successive theories have shown the dependency of peripheral areas and rural communities on more urbanised centres, the role of the state and of the market in development and, more recently, the role of different actors like farmers' co-operatives, NGOs, women's groups, et cetera who use their agency and organisational strengths to influence their livelihood conditions.

But the social sciences are still heavily biased towards the land, and developmental studies on coastal communities are lagging behind. Moreover, the image of socially, culturally, and economically homogeneous village communities still seems dominant. But in the

globalising world of today, coastal areas constitute a *frontier society*. A frontier society is defined (Van Lier 1971:7) as a peripheral area situated on the fringes of the world economy, as well as an area which lies on the edges of mighty jungles of an uncultivated interior, and whose population constantly finds itself in 'border-line situations' as a result of – as in the case of Surinam – slavery and life under colonial conditions. But, instead of this frontier characteristic being lost in the coastal areas of many independent states, it is being reinforced by poverty, administrative neglect, and, more recently, migration and violence. For a long time, coastal areas have been treated as the fringes of the world economy and of civilisation. Their inhabitants are, according to Ram (writing on the Mukkuvar fishers of Southern India), 'fringe dwellers' whose 'geographical location is a metaphor not only for social and economic marginality [...] but for the possibilities of an independent cultural identity which this marginality provides' (Ram 1991:xiii).

At the same time, coasts lie at the borders of a mighty and largely uncultivated exterior (cf. Corbin 1995). Thus, in a sense these 'wastelands' of the sea provide us with the mirror image of the 'wild interior' of the Surinamese jungles. Also, the inhabitants of the coasts are often uprooted migrants who have either come down to the coast from upland and hinterland areas, or from overseas. Although the image of homogeneous coastal communities of artisanal fishers is still strong, it has already been shown in the history of village formation in South and Southeast Asia that this image is very much a construct of the colonial state (Visser 2001; Breman et al. 1997) that did not, and does not mirror everyday practice.

Environmental change and social transformation are mostly analysed in isolation from each other, according to different epistemologies, and approached from different bodies of knowledge. But the mere juxtaposition of the social and the natural is not sufficient if we are to come to grips with the complex interactions between institutions, individual actors, technological development, physical geography, marine ecology, and the changes in all of these. Anthony Charles, in his recent book *Sustainable Fishery Systems* (2001), tries to integrate all these elements into what he calls the fishery system. In marine ecology, systems analysis is seen as an important improvement because it focuses on the relationships between the individual species or elements instead of on the elements themselves. In sociological terms, especially in view of the everyday practices of small-

scale fishermen who cannot afford to be choosy, an ecosystem approach also makes more sense than a focus on a single species. However, sociological theories that favour a systems orientation are regarded as problematic because of their functionalist flavour (Bavinck 2002). Sociological evidence shows that people's everyday practices do not fit a particular 'system' and yet are valuable to the social life of households and communities.

The Need for Transdisciplinarity

The ideas I am developing in this paper[1] have been triggered by a number of integrative research experiences over the past few years, among which the following is an example. As a member of the interdisciplinary programme for Sustainable Management of the Coastal Zone of Southwest Sulawesi, better known as the Buginesia research[2] in Sulawesi, Indonesia, I was involved with the integration of anthropological data into the integrated coastal zone management model that was being developed as an interactive management tool for regional government officials. The many discussions on the methodologies and concepts used by the different natural sciences and anthropology were highly instructive but frustrating. We tried to accommodate the very different aggregation levels and qualities of the data on fishers' access to and use of fish resources, their experiences with resource depletion (cf. Meereboer 1998) with the statistical measurements of the size of fish on local markets (cf. Pet 1999), the data gathered on sedimentation, and the location and quality of seagrass beds and coral reefs. The integration of quantitative and qualitative anthropological/sociological data into a model based on natural scientific assumptions on systems and rational human behaviour taught me a few lessons that I will discuss here.

The most important lesson is that an integrative approach demands that in project development the social sciences be treated on an equal footing with the natural sciences. In the Buginesia case, the same mistake was made as in many development projects during the 1980s, namely that the social scientist was added on to the already designed natural science project. Social data are apparently regarded as mere 'contextual support' for natural and technical data: supplementary but not vital.

Secondly, projects aiming at policy development and projects developed by natural scientists or technologists already hold certain as-

sumptions about the people of the coastal zone, particularly fishers. Their 'virtual' fisher[3] appears to be an individual man on a boat who makes rational choices about the number of times he will go to sea, and the fish he expects to catch. However, anyone who has taken the time and interest to stay in a fishers' village will know that in actual practice the fishers' wives, members of extended families, and village co-residents participate in the decision-making process. Moreover, the highly mobile and variable qualities of the fish resources, together with environmental uncertainties, demand a high level of flexibility in resource use through time and space. This means that, as opposed to what is assumed in teleological rational choice modelling, fishers do not and cannot predict their activities and catches.

The third lesson is that an integrative approach to coastal zone management requires one to take a critical look at one's own disciplinary 'toolbox' of theories, methodologies, concepts, and assumptions, and their value in an integrated approach with other disciplines, especially the natural sciences. In order to understand the complex interface between marine ecosystems and social practices with regard to coastal resources, new questions may have to be formulated or concepts developed.

What I think is needed is a concerted interaction between the social sciences and the natural sciences, in which epistemological differences and conceptual incongruences become transparent in order to be overcome. I propose calling such an integrative approach to coastal zone research, based on an equal partnership between the social and the natural sciences, a transdisciplinary approach. In my view, transdisciplinarity differs from multidisciplinarity, as in the latter the different disciplines are merely juxtaposed and not integrated. I prefer also to differentiate transdisciplinarity from interdisciplinarity on the basis of the following criteria:

1. The transdisciplinary paradox

The challenge of transdisciplinary research lies in translating the insights that arise from the oscillation between disciplinary domains into disciplinary lessons. Transdisciplinary research challenges disciplinary assumptions and concepts, and triggers new disciplinary questions. Transdisciplinarity contains a paradox: the more one starts thinking along transdisciplinary lines, the more this trajectory provides an incentive to or even demands that one reconsiders one's

own disciplinary assumptions and concepts. Transdisciplinarity only works if the partners from the different disciplines are strong.

2. Transparency
Transdisciplinarity invites us to critically examine the assumptions that underlie our own disciplines. It thus reveals rather than conceals conceptual continuities and congruences, or disjunctures (Appadurai 1992) and conflicts within and between the participating disciplines, and their impact on data gathering and analysis. This transparency is in itself a condition for the following characteristic of realism.

3. Realism
Transdisciplinarity is a gradual process of conceptual and methodological articulation. It may appear to be impossible or senseless to accommodate approaches, levels of data gathering or concepts. Such apparent disjunctures should be acknowledged because they can nevertheless have an impact on integrative coastal management. This is why I believe transdisciplinarity is more realistic than interdisciplinarity. The latter term seems to promise only positive outcomes, whereas transdisciplinarity provides room for disjunctures or the acknowledgement of the possibility of failure of the integrative experiment. For example, sedimentation data on a large historical scale have no direct bearing on present-day fisheries activities. Yet, the sedimentation process itself may indeed have an impact on future access to resources. Or, the same concept may be used by different disciplines, and its formal characteristics may be agreed upon, as in the case of the concept of the system. However, in actual practice, different values are attached to that concept. For example, in marine ecology the systems approach may be supported because it invites a consideration of the relationships between individual species. In anthropology, in contrast, the concept of system is often regarded as too functionalist and determinist. It gives the misleading impression that all elements within the system are in harmony with each other and contribute to the functioning of the system.

Apart from theoretical discrepancies, there are differences 'on the ground'. For example, the interaction between public administrators and environmental scientists may reveal that their 'system' boundaries are disparate, and that both administrative and ecological boundary markings are relevant to integrated coastal management. Thus, the administrative borders of a coastal area may exclude and

hence make 'invisible' the pollution that originates outside them, but that pollution may nonetheless have an important impact on the coastal ecosystem.

4. Transdisciplinarity moves beyond boundaries
It aims at the discovery of cutting edge issues and the formulation of new research questions and concepts that *move beyond* the partner disciplines, although positive or negative links could be established. Moreover, such questions or concepts are not easily generated, nor necessarily recognised by the individual disciplines. For example, in coastal zone research this implies that transdisciplinary research has to move beyond an ecosystem approach that assumes certain causal linkages and levels of aggregation on temporal and spatial scales. Neither biological or ecological data nor social, economic, or political data *alone* can determine the boundaries of a research area. Hence, different coastal issues may need the recognition and involvement of different system boundaries, or even the contestation of boundaries.

Practical Implications of Transdisciplinarity

Transdisciplinarity is not merely a newly invented term; it also sets a new agenda in the sense of the criteria mentioned above. Interdisciplinarity has been on the policy agenda for almost two decades, as the public awareness and the recognition of the intricate relationships between natural and social phenomena have become widespread. But there is still an enormous gap between the recognition of complex interfaces and the implementation of an integrative approach to the kind, size, and contents of these interrelationships.

Maybe the present project is more modest, as it is more realistic about the difficulties of the practical implementation of such a transdisciplinary approach, its uncertain outcomes, and its time- and energy-consuming character. The implementation of an integrated approach to the sustainable development of a marine park area is a case in point. It shows that conflicts can be generated that appear to be about practicalities but in fact result from the different epistemological histories of marine biology and anthropology. The conceptual differences about the size of a territory become in practice almost a kind of ideological conflict between the biologists and the anthropologists involved in the establishment of a marine park (Osseweijer 1999; Van Helden 2001).

A second, but closely related implementation problem is institutional. Most government officials and practitioners have been trained along sectoral or disciplinary lines, and have little experience with *trans-sectoral* project implementation. Moreover, an integrative approach to coastal development issues needs the institutional support of an integrated, trans-sectoral institutional body. But even if such a body exists, it might conflict with the hierarchy of the sectoral organisation of most government administrations. Consequently, practitioners and government officials often experience trans-sectoral co-ordinating bodies as a threat to their sectorally defined positions. This is a serious practical issue to be considered, for example, in co-management projects.

Yet, the relevance of a transdisciplinary, and thus necessarily a trans-sectoral, approach is that it tries to move beyond the boundaries, knowledge, and assumptions of government institutions. Such an approach necessarily involves other segments and groups of society, with different and not sectorally determined bodies of knowledge, ranging from coastal communities and fishers' unions, to NGOs together with central and decentralised government institutions and international organisations.

An ecosystem differs from a social system, and, as anthropological studies on local or indigenous knowledge from around the world have shown, the species diversity known by a fisheries expert is not identical to the species diversity known by a fisher. Knowledge includes cultural practice, skill, and technology. The effectiveness of catching fish may depend on a person's access to sonar or tracking devices, or on the skipper's ability to find and catch fish (Pálsson and Durrenberger 1992). Likewise, people's knowledge of marine biodiversity and collecting practices may be highly variable because of their personal histories, and the different histories between households of the same village, let alone between villages and regions.

Sociologists and anthropologists, and often also geographers, have an in-depth knowledge of and experience with the diversity, variability, and differentiation through time and place of local practices that are vital to the successful implementation of coastal development or co-management projects. But they still seem to be rather hesitant to acknowledge the need to upscale and integrate their data on the diversification of coastal livelihoods with biological and technical data on marine biodiversity and to move beyond the small niche of the coastal community. I am convinced that they have a lot to add

methodologically and conceptually, and that they should become more vocal and self-confident about the transdisciplinary relevance of their knowledge about people's conceptualisations, practices, knowledge, societal institutions, and networks, precisely because these are unsystematic, fluid, and unpredictable phenomena.

The anthropologists' methodological approach to the complex and multi-layered social networks, institutional and organisational arrangements has become indispensable for a proper understanding of the effectiveness and efficiency of project implementation. This is especially the case in an era of globalisation when the transnational mobility of people and commodities, including users of marine resources often stretches far beyond national and ecosystemic boundaries, as in the cases of transnational fisheries (Stacey 1999) and international sand mining (Osseweijer 2002).

Integration of anthropological knowledge into transdisciplinary research may also demand critical (self)reflection on the usefulness and applicability of disciplinary concepts at more integrative levels of data aggregation and explanation. What knowledge about social interaction should be transmitted to natural and technical scientists and practitioners? Which sociological concepts are most appropriate for the purpose? On the one hand we have to acknowledge the need for more inclusive labels indicating the transformation processes and relationships between actors and institutions (compare with earlier discussions by Long 1989:226; Booth 1994:10). Today, terms like networks, transnationalism, hybridisation, and governance may serve this purpose. But their usage becomes meaningless if we do not at the same time show the social content and context of such general terms. There will be an ongoing need to link these to concepts closer to the realities of everyday life in the coastal areas, such as people's agency, kinship and patronage relationships, and livelihood strategies.

In the case of the Buginesia project mentioned earlier, the anthropological data had to be integrated into a model that was already designed on a scale appropriate for physical geography data. This caused the dilemma of upscaling concepts to a level beyond which they had no meaning. For instance, the concept of patronage, which indicates the socio-economic dependency of a client from his patron, cannot easily be converted into a variable at the level of the village, the coastal zone, or the ecosystem. Such relationships transcend

physical boundaries. Patronage is nonetheless pertinent for the analysis of resource use. Patron – client dependencies imply unequal access to resources, as well as to decision-making about their uses. It is thus highly relevant to include in an ICZM model the fact that not every fisherman has equal rights and access to marine resources or participates equally in decision-making processes (Meereboer 1998). Moreover, it is impossible and meaningless to attach a numerical value to this kind of inequity. Consequently, statistically extrapolating socially undifferentiated samples of fishers' catches without taking account of the fishers' social and economic position could seriously bias conclusions about fish catches and human impact on marine biodiversity.

This implies that marine biodiversity conservation through ICZM, and through co-management in particular, presupposes a detailed knowledge of social difference and differentiation, and their impact upon the use of nature. In other words, social diversity is conditional for the sustainability of biodiversity.

Transdisciplinarity and the Shift from ICZM to Integrated Coastal Development (ICD)

In the dominant discourse on coasts and seas, integrated coastal zone management (ICZM) is a keyword. The concept is of recent origin, having been put on the map by the Intergovernmental Panel on Climate Change (IPCC) and the Earth Summit in Rio de Janeiro in 1992. IPCC's concern was with sea level rise and the possible threat to low-lying coastal regions. Its recommendations 'endorsed integrated coastal management as the appropriate framework [...] to reduce vulnerability to accelerated sea level rise' (Cicin-Sain and Knecht 1998:36). ICZM is primarily seen as a means to control salt water – especially in countries like the Netherlands, where people have a long history of fighting against the sea. This is why technical agencies and technical sciences still dominate the discourse on developments in the coastal areas. ICZM should safeguard humankind from the sea, from hazards such as flooding, and from marine disasters such as environmental degradation and pollution.

Two main biases or restrictions of this 'traditional' approach to ICZM deserve attention. Firstly, ICZM primarily serves land-related technical and macro-economic goals. Apart from the physical safe-

guarding of the land, its major concerns are the large-scale demographic, urban, and macro-economic developments in the coastal zone. The less populated coastal areas, and the existing social and environmental differentiation of fishers' communities and their access to coastal resources are mostly ignored.

Secondly, ICZM is a government tool. The dominant approach to resource management views ICZM as an instrument enabling governing bodies to intervene by means of rules and regulations. This approach is inherently biased towards politico-economic and administrative goals. Moreover, the technological and infrastructural policies and project interventions demand a standardised description of the coast in terms of administrative borders and system boundaries (cf. Scott 1998).

Recently, marine ecologists and biologists have added a new perspective on ICZM. Biodiversity depletion (for example, of mangroves) is threatening the health and reproduction of fish populations. ICZM is thus becoming a strategy for the conservation or sustainable use of coastal biodiversity. Social scientists too have increasingly become involved in projects concerning sustainable resource use and poverty alleviation in coastal areas. But government- and NGO-driven projects and programmes still use the top-down term 'coastal zone management' to cover a rather different practice: bottom-up coastal development. This confusion is partly due to the conflation of the political agendas of ICZM of physical safeguarding and of poverty alleviation. Thus, social scientists studying or bringing about the socio-economic development of the poorer members of the coastal communities find themselves at the opposite end of spectrum from those natural and technical scientists who regard the coastal population as a burden or a threat to government control over a coastal area with high economic potential. It is important for such epistemological (and sometimes emotional) differences to become transparent if we wish to engage in a transdisciplinary approach to integrated coastal development. I see integrated coastal development as a condition for integrated coastal management.

Therefore, I propose that we move away from the instrumentalist, intervention-oriented focus on the management of the sea and the coastal resources. Like all managerial tools, ICZM was originally designed to serve the purpose of control by means of a simplifying and standardising model *for* coastal zone management. It has not been designed to serve as a model *of* coastal social-economic development

and governance. Such a model is highly desirable, but still needs to be developed.

A transdisciplinary approach addresses the ICZM biases through revealing two sets of challenges that an integrated approach to coastal development must address:

1. ICZM needs to be based on a better understanding of the natural *and social* complexities of the coastal zone. Here we look at the problematic concepts of zone and territory in relation to coasts. Moreover, the integration of social and economic aspects necessarily implies that ICZM is looked at from a marine perspective as well as from a land-oriented perspective. In other words, ICZM is about the interaction between salt water *and* fresh water systems and resource uses.
2. ICZM needs to formulate more appropriate governance strategies. Three challenges for coastal governance are examined: the narrow focus of mainstream ICZM on control and regulation; issues of valuation; and issues of participation.

The integration of social and natural factors allows ICZM to better grasp the transformations that are actually taking place in coastal areas in different places around the world, hence in different ecological, physical geography, political, economic, and socio-cultural conditions. It may thus make sense to move from integrated coastal zone management or ICZM to integrated coastal development (ICD).

The Problematic Concepts of Zone and Territory

Notions of the coast are man-made constructs that develop and change over time. The mainstream definition of the coastal zone is highly restrictive. Geomorphological and ecosystem characteristics appear to define the boundaries of a coastal zone as the area where the interaction between marine and land-based processes interfere in observable and measurable ways. This conceptualisation of the coastal *zone* is primarily an instrumental device based on technical and institutional needs for fixed boundaries. Recently, politico-economic interests have strengthened the governmental need for the coastal zone to be fixed as if it were 'an industrial zone'. The in-

creased value of coastal areas for aquaculture, fisheries, sand mining, and other economic activities has also triggered claim-making movements by governments and private entrepreneurs to control these areas, including their human and natural resources. Also, oil pollution of the national (coastal) waters by foreign-flagged ships and the incongruences between legal orders (see Owen, *this volume*) reinforces the conceptualisation of a fixed and bounded area: the coastal zone.

But in the everyday resource uses of fishers' households, there is no real thing like a coastal zone. The following may serve as an example. When I last visited the coastal villages of Northeast Kalimantan, Indonesia, the fishers were complaining about the SARS pneumonic crisis. It was May 2003 and the restaurants in Hong Kong were closed. The trawlers from Hong Kong had stopped coming, and the fishers could not sell their live reef fish. Consequently, within weeks they had to look for alternative sources of income and activities. Some went fishing for tuna, others tended their culture of sea cucumbers, whereas still others went inland to sell logs to the sawmills. This diversity of livelihood activities implies that the resources are appropriated from a similar variety of ecosystems that often lie beyond administrative, even state boundaries.

Secondly, trade networks and product chains based on coastal resources stretch far beyond a predefined geomorphological or ecological coastal 'zone'. Traders, as in the above-mentioned case, may cross national borders, and often they carry fresh fish inland from the coast daily, to be sold. Likewise, vegetables may be carried into the coastal villages, where gardening is less common.

The governance of sustainable coastal development precludes zoning, as the decision-making processes involve actors, organisations and institutions at higher levels up to, and beyond, the national capital. Government officials often still regard users of coastal resources as sedentary people who live in territorially fixed settlements, because this suits the governmental 'tunnel vision' that enables development policy and politico-administrative control to be standardised (Scott 1998). This governmental view contrasts with present-day and historical evidence. For example, in West Africa the translocality of fishers communities has been the rule rather than the exception (Jul-Larsen 1994; Overå 2001). Also, people like the Sea Nomads or the Orang Suku Laut of Southeast Asia never lived on the mainland until recently (Chou 2003).

The second problematic concept in ICZM is territory. Several studies question the universal validity of the phenomenon of 'territorialisation', as it belongs to a state discourse of Western European origin that has been expanded through the project of colonisation and adapted in particular cases by post-colonial and post-socialist modern states (Corbin 1995; Peluso forthcoming; Sundar 2001).

The issue of de-terriorialisation is particularly relevant for our understanding of the coastal areas. Firstly because of the mobility of maritime species, and the fact that ecosystem boundaries cut across administrative borders. Secondly, because of the fluidity of the coastal resources on regional and global markets. Thirdly, the particular social, economic, and political conditions of the coastal population, who are among the least 'residential' members of civil society. It would be interesting to investigate whether, or to what extent, social theories and concepts developed with reference to a fixed land environment have similar contents and meanings when applied to a fluid or non-fixed environment like the sea. In the cultural and political history of Northwest Europe, development projects presuppose territorialisation: territory as an identifiable and identified and fixed reality, as a piece of land with known and recognised borders. Anyone who has travelled across continents knows from practical experience that borders, hence territory, are not necessarily biophysical or ecological divides, but conceptual tools of state formation imposed on a physical environment. Politico-administrative devices such as mapping and planning likewise presuppose territory and zoning.

Territory is a form of property control (McCarthy 2002). Like resource tenure, territory is decreed through rules and regulations of a plurality of institutions and organisations. Both in the North and in the South, official discourse often starts from the point of view that management problems could be remedied by a more thorough implementation of the law, or by the implementation of co-management bodies involving 'local participants'. Meanwhile, the discourse of the state and of transnational institutions and organisations hides the fact that individual representatives of the same state institutions hold different views on territory and property. For example, government officials and the military in post-independent or post-socialist states are often themselves involved in what is called 'illegal' resource exploitation, together with entrepreneurs and people living near the exploitation area. Here again, as in the qualification of the coastal area as a frontier (see above), comparison with forestry cases

may prove revealing (McCarthy 2002; Obidzinski 2003; Van den Top 1998).

A systematic study on the 'illegality of the sea' still needs to be done. I do not mean to say that we do not know of individual cases of illegal actions like blast fishing or poaching. What is necessary are in-depth case studies of people's actual practices that contest the official discourse that calls such activities 'illegal'. Such studies may show that activities like poaching and smuggling are often necessary strategies of coastal people to counter poverty and to improve their livelihoods. But they will also show that networks of individuals, including members of government institutions, will be involved in these so-called illegal activities; a social fact that demands reconsideration of what is legal and illegal in the everyday practice of coastal zone development.

The Instrumental Management Focus of ICZM

The second set of challenges mentioned above concerns the fact that mainstream ICZM does not adequately address the complexity of the transformations taking place in coastal areas, including changing governance priorities (that is to say the new focus on poverty). In this information age, the apparent structures of the established institutions of society are being challenged by networks, and by flows: of people, goods, and information (Castells 1996) and of contested idea(l)s and values. Yet, none of these developments appears to have been incorporated into government policies.

The Earth Summit in Rio de Janeiro in 1992 stressed the need to relate sustainable development to poverty alleviation. During the last decade this concern permeated policies and projects throughout the world (Woodhouse 2000:141-162). National development programmes have made a political shortcut by integrating the dual policy objectives of sustainable use of biodiversity and poverty reduction. This is exemplified by the following text from the Policy Programme on International Biodiversity of the Netherlands government: 'The spiral of degradation and impoverishment can be broken by stimulating the participatory and sustainable management of natural resources'. Although the general policy objective explicitly relates biodiversity, sustainable use of natural resources and poverty, in the document (par.3.2) on 'Seas, coasts, and marine wetlands' no link is formulated between people and coastal biodiversity. Coastal systems are exclu-

sively and entirely viewed as natural ecosystems, without any human interference.[4]

The concern with the control over salt water is now shifting towards the control over marine resources. But the ecosystem approaches by the government still exclude people and the impact of human action in the coastal zone.

Rethinking Valuation within ICZM

Present-day politico-economic views somewhat obscure other contemporaneous and historical valuations of the sea and the coast. Of course, coasts and the sea have been, and still are, the subjects of political, economic, and social discourses, but they are also the subject of forms of art, such as painting and poetry.

In his book *Le territoire du vide*, on the discovery of the seaside, Alain Corbin cites a seventeenth-century poem to show how the enjoyment of the seaside is in keeping with the Baroque poets' taste for motion; it is further nourished by their longing for surprise.[5] The Enlightenment initiated a fundamental break with the classical negative image of the sea, in which the endless movement of the seas suggested the possibility of a new Flood. An image, too, in which the ocean was a chaotic and damned world, and coastal dwellers were the constituents of this interface with the dark and demonic sides of human life (ibid.:6-9). Picturing the coast has, since the seventeenth century, been closely linked with the territorial desires of state rulers. French and British rulers wanted to know the true face of their kingdom, and special attention was paid to the delineating of marine boundaries (ibid.:199). By their exploration of sea trade routes to the West and East Indies, Dutch and Iberian seafarers were already engaged in the mapping of the seas in order to link distant lands. The power of the map in the formation of our world view cannot be underestimated, as B. Anderson has indicated. The map, together with the census and the museum, are 'the three institutions ... [that] together ... profoundly shaped the way in which the colonial state imagined its dominion – the nature of the human beings it ruled, the geography of its domain, and the legitimacy of its ancestry' (Anderson 1991:163-164).

The sea became a state concern firstly as political space or as a territorial marker, especially after the capitalist expansion of Western Europe (Wolf 1982; McCarthy 2002). In the last two hundred years it is the economic value of the sea, including in particular the conversion of marine biodiversity into marine resources that has become a major concern. Today, marine resources are heavily contested by states, transnational institutions, business networks, and other actors such as oil companies, coral traders, fish consumers, artisanal and industrial fishers, coastal tourists, and nature conservationists. Thanks to increasingly precise instruments and technologies, scientists are able to measure the occurrence, diversity, and dynamics of marine life. The detailed analysis of the qualities and numbers of species and individuals per species may contribute to a better scientific understanding of marine biodiversity and ecology. But this type of knowledge is insufficient to understand human impact on marine life, whether direct or indirect, and the different values and meanings people attach to the sea and the coast.

Also, we should be conscious of the fact that social actors count and measure in different ways and for different purposes in different contexts. The concern with sea level rise that is at the base of policy-oriented accounting differs from ecological and social science measurements. Governmental and industrial organisations often employ formal statistics as a tool or technique to prove a certain 'truth' about the natural or ecosystem conditions of the sea or the status of marine resources, which supports their assumptions about reality. Politico-economic interests and policy goals also produce inconsistent or even contradictory 'truths' between sectoral departments of the same government administration, as a result of their different targets, such as land, water, fish, or oil.

On the basis of their measurements and counting of numbers of fish in particular spacial contexts, biologists may defend another 'truth' about the state of marine biodiversity in that area. Their data may be used – or contested – by a fisheries department for policy or political purposes. Both forms of knowledge often contrast with the more practical and locally conditioned 'truths' of the fishers who have access to the marine resources 'out there'. They count the occurrence of fish stocks on the basis of locally differentiated and specialist knowledge, integrating environmental, technical, and social conditions. Social scientists who usually take more interest in fishers' real-life diversities may act as mediators of the 'local' or 'indigenous' knowledge and experience of the fishers. Marine resource users, sci-

entists, and government officials thus possess and use different bodies of knowledge of marine diversity and human impact, but the assumptions or valuations underlying these different bodies of knowledge often remain implicit. Each set of implicit valuations of marine life, the status of the sea as a political or an art object, as a commodity or as nature, serves different purposes and produces different and conflicting forms of knowledge and practices.

Rethinking Participation in ICZM

Most readers are now familiar with terms like co-management and stakeholders. They usually bear a positive connotation in the context of what Hajer (1997) calls the global environmental discourse-coalition of national governments, international environmental NGOs, the media, powerful scientific organisations, and the public. In this context, the stakeholder concept serves particular administrative and politico-economic demands.

Since the 1990s, the concept of co-management in fisheries has been embraced by practitioners and governments as well as by scholars (Pinkerton 1989; Sen and Nielsen 1996). Co-management of natural resources together with local communities is seen by national or decentralised government agencies and international organisations like the World Bank as a politically correct management solution to counter resource depletion, but also to increase local people's participation and institutional organisation. Anthropologists, biologists, and geographers have documented the widespread existence of community-based customary systems of marine tenure which regulate the access to and the use of fisheries resources. More recent studies (Adhuri 2002; Bavinck 2001; Osseweijer 2001) show that these tenure systems are being eroded by translocal migration, the commoditisation of fish, and the globalisation of the fish trade. Inter- and intra-village conflicts are erupting between fisher households. Also, government participation in the co-management of local resources is a threat rather than a support for development, as in the case of the Indonesian province of Papua (Visser 2001). There, the shrimp fishers mistrust the 'participation' of the regional fisheries department that owns the trawler that collects (and sells) their produce. The fishers are very well aware of the mismatch between the expressed goal of production increase and the government's practice of selling the shrimps to the regional mar-

ket at a higher price than offered to them, instead of allowing them to sell the shrimps themselves. They experience this practice as a transgression of what they see as their human rights, namely their autonomous right to the land and waters of their place of origin.

Alternative roads to development have been proposed along the lines of 'stakeholder participation' as an instrument for co-management (Ostrom et al. 2002). Debates about 'sustainability' are often also about who may legitimately access, use, and manage natural resources (Woodhouse 2000:162). A growing number of case studies from all over the world indicate that co-management serves to strengthen social-economic control over local 'stakeholders' rather than giving them equal shares in development (Adhuri 2002; Jentoft 2000; Osseweijer 2001). Moreover, to label all participants as stakeholders mainly serves the purpose of the planner, and is discursively naive. It gives a false image of reality by implying that these actors all have equal shares in the social, economic, and political assets of coastal development. Many people, and often those in the South, have no alternative but to become 'partners' in the exploitation of their land, rivers, and resources after these have been sold to outsiders. Sport fishers who enjoy a weekend in the coastal waters experience the coastal area differently from the resident fishermen with whom they may be competing for the same fish resource. But they are also part of an urban network and probably have a stronger power position when it comes to defending their goals in coastal development. Again, other stakeholders, such as fish traders or an international conservation organisation, who have extensive networks and access to financial resources, have a different 'stake' from resident coastal fishermen, let alone the landless labourers who seek seasonal jobs on trawlers. The idea(l) of co-management should give way to a more realistic recognition and study of competing claims over resources that often have a political flavour implying unequal positions of power and access to resources and decision-making (Hirsch and Warren 1998).

Conclusion

Emotionally or conceptually – still from a land-side view – the coast and its inhabitants constitute the borderline between the land and what is known and knowable, safe, and civilised on the one hand, and the sea and the unknown, the uncivilised 'other', the dark and 'empty' world, on the other hand. This image is still held by many people, in-

cluding government officials who also publicly declare that coastal communities are 'backward', or 'uncivilised' and 'unruly'.[6] Today, when most forest dwellers have settled or have been settled, it seems that it is now the turn of the last frontier: the communities of marine fishers. Interestingly, this popular image of backward fishers in their 'closed' society is mainly applied to an imaginary category of 'fisheries communities' and it has little to do with their actual differentiation and mobility. Neither is it applied to the inhabitants of the megacities on the coasts, despite their rapidly developing slum areas in which live labour migrants who have been attracted by the new coastal economies and immigrant fishers and traders who are near the markets.

In fact, this negative image of coastal communities is aggravated by the fact that local resource users, especially in the South, are often economically and politically dependent on a network of powerful non-local entrepreneurial networks including government officials, the military and transnational corporations. The different categories of users can thus be seen as both local and non-local, 'top' and 'bottom'. In addition to these dependency relationships, we see the development of new international dependencies between national and international NGOs and their local partners; for example, a fishers co-operative. All these actors and institutions are engaged in what Ferguson (1998) describes as a transnational 'topography of power' in which there are no clearly distinguishable 'top' and 'bottom' levels of society, and where it makes little sense to separate the state from civil society. Following this line of thinking, we may have to look differently at something like the Maximum Sustainable Yield (MSY). This has been developed as a tool for the regulation of the unequal distribution of fish catches between appropriators at a time when the national sustainability of the species is already threatened. MSY seems to serve the purpose of a particular politico-economic resource distribution mechanism rather than the purpose of species maintenance (see Kulbicki et al., *this volume*).

In this paper I have pleaded for a transdisciplinary approach to coastal development. An appropriate governance of the coast should be supported by and profit from the kind of integrative research that is able to improve our understanding of the complexity and diversity of social action and biodiversity in coastal areas around the world. Instrumental notions of ecological zoning and administrative bound-

aries appear less relevant and may even obstruct a proper insight in translocal movements of people and resources.

I have also dealt with the various interpretations and goals of ICZM. Originally, integrated coastal zone management was formulated in 1992 as a technological and governance framework to reduce the risks for the land and the people of sea level rise. Ecological concerns have added another meaning to ICZM. Integrated coastal management may be a government technique for the conservation or sustainable use of coastal biodiversity. Recently, concerns about the depletion of biodiversity have been linked with a political agenda concerning poverty alleviation. Thus, the original approach to ICZM as a means 'to fight the sea' is presently contested by an ecological 'support for the sea' and a politico-economic and social concern for the development of the coastal population. Under these conditions it makes sense to shift from the narrow technological approach to ICZM to a more integrative approach to integrated coastal development or ICD.

To conclude, the following problems can be listed as relevant issues for future research within integrated coastal development: Firstly, existing institutional structures are ineffective and sometimes irrelevant in cases like oil pollution, over-exploitation of marine biodiversity, 'illegal' fishing, and international tourism. Secondly, legal/administrative boundaries do not coincide with ecosystem boundaries; the governance of marine resource uses needs to address transnational and translocal movements of both human and natural resources. Finally, the necessary transdisciplinary research into integrated coastal development is hampered by sector-specific approaches and regulations.

Notes

1. This chapter and the Introduction have greatly benefited from comments on earlier drafts made by Alberto Arce, Maarten Bavinck, Derek Johnson, and John Kleinen.
2. The interdisciplinary Programme for Sustainable Management of the Coastal Zone of Southwest Sulawesi or the Buginesia research programme was funded by the Netherlands Organisation for Tropical Research (WOTRO 1994-1998; W 01.60) and carried out in the Spermonde archipelago of Southwest Sulawesi, Indonesia by a joint team of Ph.D. students and senior researchers in the fields of biophysics, human geography, marine ecology, fisheries, and anthropology. The CD-ROM was developed by Jean-Luc de Kok of Twente University (see Augustinus 1999).

3. I refer to the concept of the *virtual farmer* developed by J.D. van der Ploeg (2001). The virtual farmer stands for our image or model of agrarian entrepreneurs in Western Europe, their wives, history, work, environment, etc. The real farmers are ever more distanced from this image. This becomes problematic when we realise that policies based on this image of the virtual farmer are being formulated and implemented. Policies are thus likewise distanced from the real lives of farmers.
4. Dutch Ministry of Agriculture, Nature and Fisheries (LNV). Website accessed 18 July 2003 (www.minlnv.nl/infomart/parlement/2002/par02203.pdf:6).
5. Published in France (Paris: Aubier) in 1988, the book by Alain Corbin has been translated and published in English as *The Lure of the Sea* (Policy Press, 1994; Penguin Books 1995). The poem was written in the seventeenth century by Tristan l'Hermite (Corbin 1995:20, 295).
6. Qualifications like these were for a long time attributed to upland shifting cultivators and other forest dwellers, especially by the technical departments and sectoral officers of the colonial administration, and they have lived on after independence.

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3

Biodiversity and the Natural Resource Management of Coral Reefs in Southeast Asia

Bert W. Hoeksema[1]

Introduction

Biological diversity (or biodiversity) concerns the richness of life at three levels: genetic, species, and ecosystem (Norse 1993; Heywood 1995). These three aspects are interrelated, since an area with a high environmental variability most likely contains many species, and many species represent a high genetic variation. Within a species, isolated or distant populations may also show genetic diversity. Species richness is the most obvious form of biodiversity.

Concern with regard to the loss of global biodiversity has increased during recent decades (McNeely et al. 1990; Courrier 1992; Groombridge 1992; Dobson 1995; Heywood 1995). Few people realise that the seas and oceans contain more animal phyla and probably also more species than the land (Ray 1988; Grassle and Maciolek 1992; Briggs 1995; Williamson 1997). Perhaps this is why protection of marine biodiversity is several decades behind the conservation of terrestrial biodiversity (Thorne-Miller and Catena 1991; Norse 1993; Agardy 1994).

The present study introduces the centre of maximum marine biodiversity, which is predominantly determined by the abundant life on its coral reefs. The study identifies the major threats to the ecology of the area including, in particular, human exploitation of its living resources.

The Centre of Marine Biodiversity

Species of reef coral, mangrove, and seagrass are important for shaping and protecting sea shores. Their populations cover large portions of

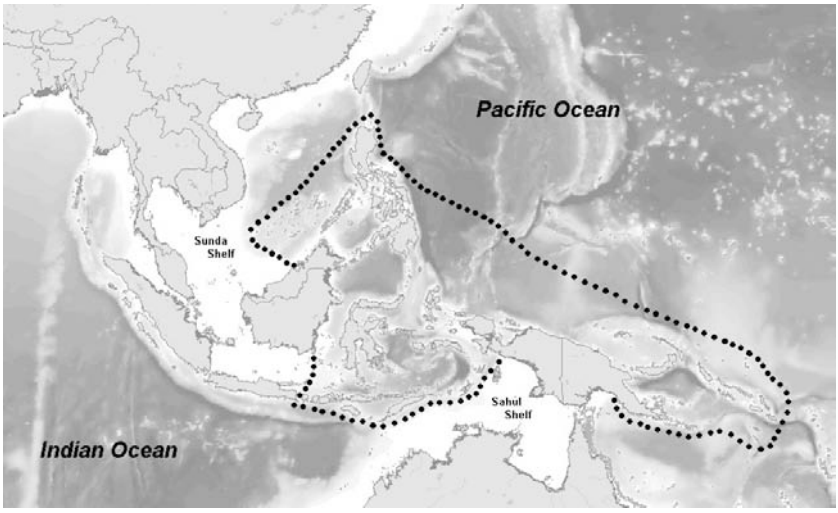

Fig. 3.1. The hypothetical centre of maximum coastal marine biodiversity in the Indo-West Pacific. The position and shape of the centre are based on bathymetrical topography excluding the major continental shelves. See text for explanation.

shallow sea bottom in the tropical coastal zone (Smith 1978; Burke et al. 2002). Coral reefs in the Indo-West Pacific constitute the richest shallow-water ecosystem of the world with many species of corals, sponges, molluscs, fishes, and other groups of animals (Spalding et al. 2001). More than mangrove woods and sea grass beds, coral reefs house many species of animals and plants that live together and depend on each other for survival. Therefore, coral reefs form the most important ecosystem in biodiversity studies, but they should not be considered the only important ecosystem since individuals of several species of animals start their lives in mangroves, live as juveniles in sea grass beds, and migrate to coral reefs as adults. Nevertheless, biodiversity is most obvious in coral reefs, and especially in the area with the highest concentration of marine species within the Indo-West Pacific, the eastern part of the Indo-Malayan region (Ekman 1953; Briggs 1974, 1995; Hoeksema 1992; Hoeksema and Putra 2002).

The topographic position of this centre of maximum marine diversity is not clearly defined (cf. Briggs 1995). Since the continental shelves of Australasia were dry during the last ice age, which lasted until about 15,000 years ago, marine life was only able to survive between the Sunda Shelf off Southeast Asia and the Sahul Shelf off New Guinea and Australia. This area, consisting of the Philippines, Eastern Indonesia, Malaysia, and Papua New Guinea, is probably

where the centre of maximum diversity is situated (fig. 3.1). A hypothetical explanation for this location is that coral reefs in the area remained present around deep sea basins and sea straits during the various sea level changes, while coral reefs on the major continental shelves developed only after the sea level rose again and not all species may have managed to settle here since the last ice age (Hoeksema and Putra 2002).

The Economic Value of Marine Biodiversity

The role of coral reefs in fisheries is one of the most obvious proofs of their economic importance in densely populated areas in Southeast Asia. Fishers catch food on the reefs in the coastal area where they live (Polunin 1983). Marine products, such as live fish (groupers and wrasses), dried sea cucumbers ('teripang'), and pearls (Erdmann and Pet-Soede 1996; Kelso 1996) are important as export commodities. Some marine plants and animals such as algae, sponges, sea squirts and soft corals produce substances that may have important industrial and pharmaceutical potential (Adey 1998; Colin 1998; Newman 1998; Adey et al. 2000). Other fishes, corals, shellfish, and turtles have value in the international aquarium and souvenir trade (Wells and Alcala 1987; Wood and Wells 1988; Wells and Wood 1989, 1991; Coffey 1991; Hingco and Rivera 1991; Best 1995; Pelicier 1998; Raymakers 1998, 2001; Walch 1998; Bruckner 2002). Marine tourism is another source of revenue to people in coastal areas (Wong 1991; Cochrane 1993; Hill 1998). Diving tourists are usually attracted by high numbers of fish, molluscs, crustaceans, and other colourful animals. Governments are well aware of coral reefs as tourist attractions.

Recently, researchers have started to analyse the economic value of coral reefs and other marine ecosystems in order to raise awareness of the monetary valuation of these species-rich ecosystems (Cesar 1996a, 1996b, 1998; Dixon 1998; Nunes 2001; Balmford et al. 2002; Burke et al. 2002).

Threats to Marine Biodiversity

It is ironic that the coral reefs of Southeast Asia, which are so rich in species, are also the most critically threatened (Hatcher et al. 1989;

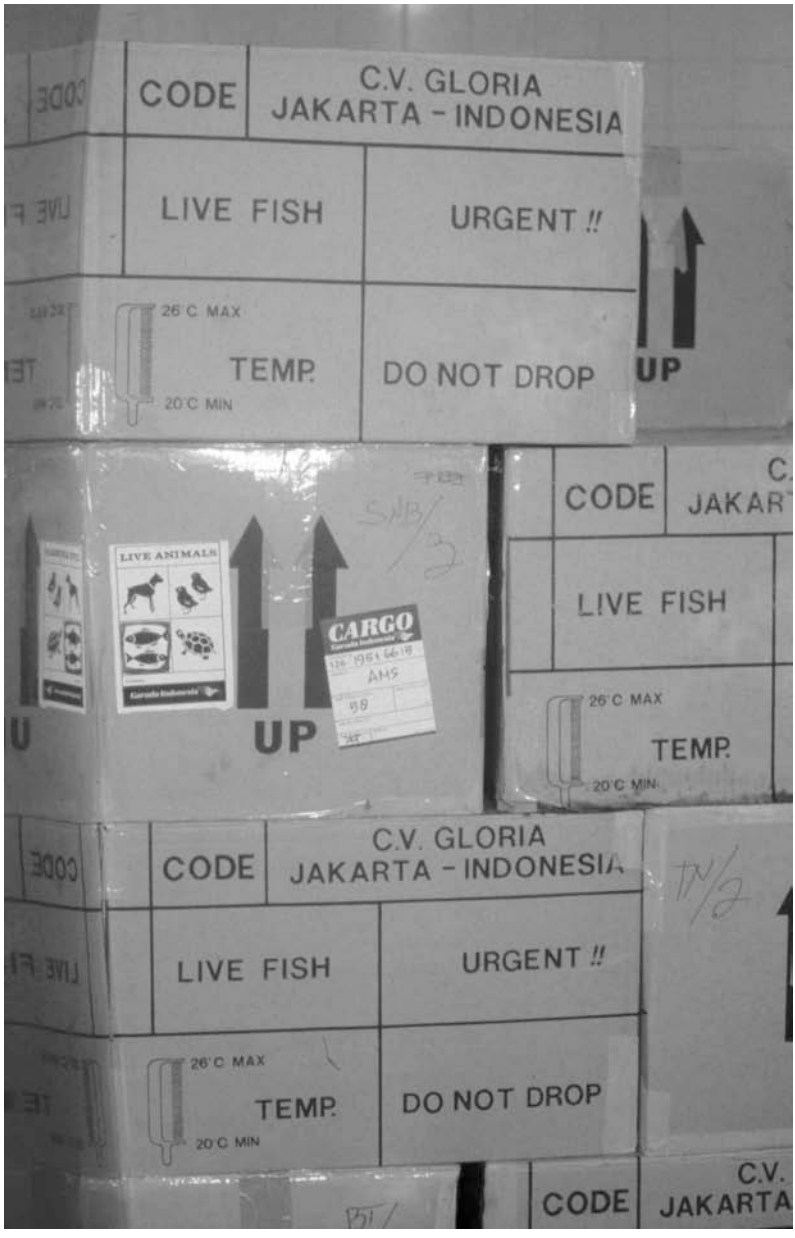

Fig. 3.2. Large shipments of live corals and reef fish are exported from Indonesia as air cargo for the aquarium industry.

Wilkinson 1992; Wells 1993; Hulm and Pernetta 1993; Wilkinson et al. 1994; Hoeksema 1997; Burke et al. 2002). Because of their biodiversity and productivity, these reefs are able to support the pres-

ence of large human populations, which, however, do not exploit them in a sustainable way (White 1987; Rice 1991; Bleakley and Mouldoon 1994; Wilkinson 1994; Wilkinson and Buddemeier 1994; White et al. 1994). Overfishing and destructive fishing practices are well-known examples (Alcala and Gomez 1987; Eldredge 1987; Gomez et al. 1987; Munro et al. 1987; Galvez and Sadorra 1988; Bohnsack 1994; Erdmann 1995; Johannes 1995; Newman 1998). Both species that are important for local consumption and species that are fished for export only are overexploited.

Trade and Protection of Tropical Marine Species

Species that are threatened with extinction are placed on lists, such as those of CITES or IUCN to improve public awareness and to regulate their international trade (Groombridge 1993; WCMC 1993; Armstrong and Crawford 1998; Bruckner 2002). The criteria for species' inclusion or exclusion are not always transparent since they may depend on political will and lobbying (Wells and Wood 1989; Hoeksema 1997). Export permits concerning threatened species can still be issued despite their inclusion in lists indicating their need for protection (Raymakers 1998, 2001; fig. 3.2). The regulation through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) helps to restrict trade in such species but does not strictly prohibit their international trade (Schouten 1992; WCMC 1993; Best 1995; Armstrong and Crawford 1998; Raymakers 1998, 2001; Green and Shirley 1999). Exploitation of tropical marine animals can be made more sustainable by conversion to the use of selective collecting methods regarding size and species, by development of less lethal means of collection and transportation, by temporary moratoriums in international trade, and by certification of traders (Yates and Carlson 1992; Pelicier 1998; Resor 1998). Some examples of overexploitation are treated here.

Teripang and Bêche-de-mer

Sea cucumbers (*Holothuria*) have been collected and processed into a dried food product for Asian and West Pacific markets since the 18th century (South Pacific Commission 1994). By fishermen they are generally known as 'teripang', 'tripang', 'trepang', 'gamat', 'gamah',

Fig. 3.3. Teripang sundrying in a village street on an island off Makassar, South Sulawesi, Indonesia.

or 'gamet'. In international trade, after processing by boiling, cleaning and drying, they are uniformly known as the commodity 'bêche-de-mer' (fig. 3.3). However, each particular species may have specific local and English names in addition to the Latin name used in the scientific literature (Koningsberger 1904; South Pacific Commission 1994; Kelso 1996; Massin 1999; James 2001).

At the start of the 20th century, the East Indies government became worried about possible over-exploitation. At that time this concern may not have been justified, since the fishers only collected sea cucumbers from shallow sea bottoms, leaving untouched those assumed to survive at greater depths (Koningsberger 1904). However, at the end of the 20th century (in particular since the late 1980s) fishermen started to use dive tanks with compressed air (SCUBA) and the cheaper 'hookah' equipment (fig. 3.4). This latter, which they operate from small boats, consists of an air compressor and a flexible hose with a diving regulator that delivers air to the fishermen who search the sea bottom (Erdmann 1995). This equipment allowed them to reach all depths at which sea cucumbers live, including depths below twenty metres where the largest individuals reside. Due to high market prices, many fishermen are tempted to remain underwater too deep and for too long and frequently they become victims of the diver's disease the 'bends'.

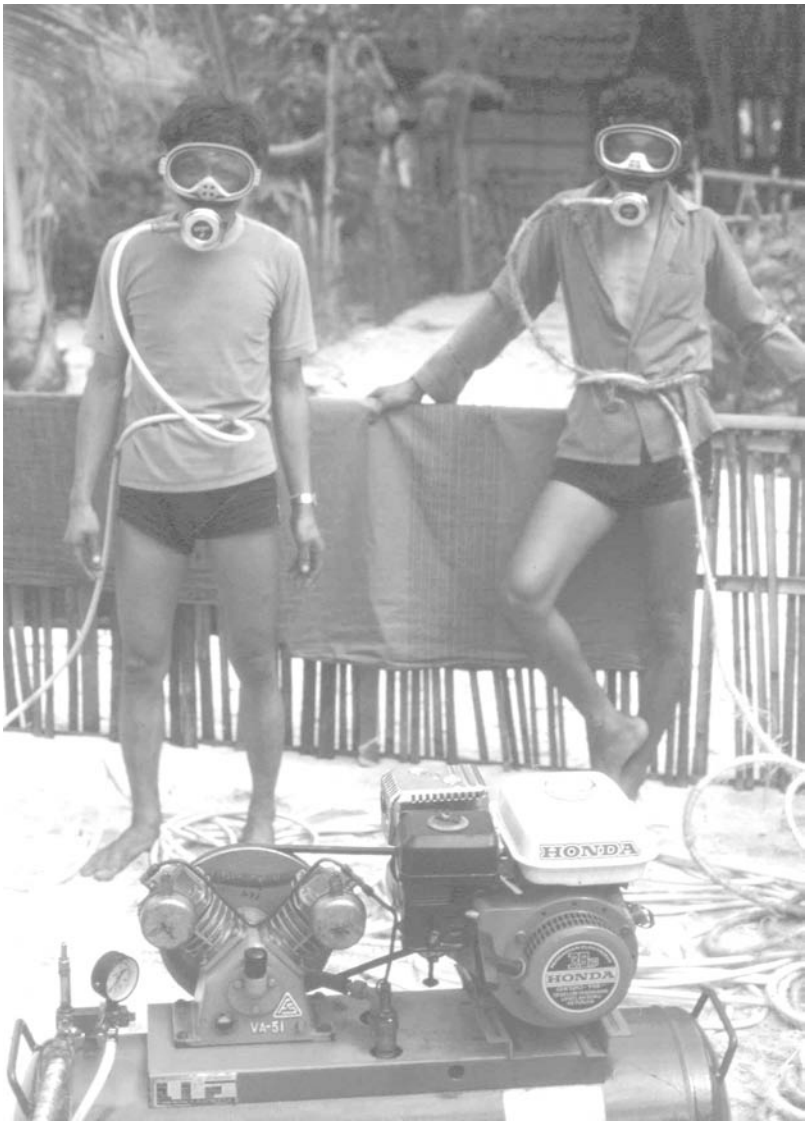

Fig. 3.4. Hookah equipment demonstrated by two Makassarese fishermen of South Sulawesi. The fishermen are connected by air hoses to the same air compressor.

Around the islands off Makassar, South Sulawesi, large sea cucumbers were commonly observed during reef surveys (1984-1986) on the sandy sea bottom underneath reef slopes deeper than twenty metres (Hoeksema, pers. obs.). Ten years later (1993-1998), after the introduction of the 'hookah' in this area, several species were absent, rare or only represented by a few small specimens. Most importantly,

the commercially important species have almost disappeared (Massin 1999). In contrast, in areas with very little fishing effort, such as Palau in the West Pacific, large sea cucumbers were still very common even in 2002 (Hoeksema, pers. obs.). Although not based on scientific study, this is a clear indication that overfishing of 'teripang' is a threat to some local varieties. Management controls that may have effect in some countries consist of export bans or quotas in trade and minimum size limits in fishing (Kelso 1996). There are no international agreements on trade in 'bêche-de-mer' and so far attempts to culture sea cucumbers appear not to have been successful.

Pearl Oysters and Giant Clams

Tropical oysters from the Indo-West Pacific, where most species in the world can be found, have long been famous for their valuable pearls, and therefore they have been collected from nature and also have been cultivated (Angell 1986; Gervis and Sims 1992; Shirai 1994). Much more is known about the cultivation of tropical oysters than about the ecology of natural populations (Gervis and Sims 1992; Shirai 1994). Hence, whether they have been historically overexploited is not so clear. Since this is likely the case, their increasing rarity has probably made it more economic to cultivate them than to catch them.

Giant clams form another group of species that are richest in the Indo-West Pacific. They have been collected for their meat by local fishers, for their shells as curio ornaments, and because of their popularity in the aquarium trade (Wells and Alcala 1987; Wells and Wood 1991; Knop 1996). Since the international trade of giant clams is restricted now by CITES regulations (WCMC 1993), this may have reduced shell collecting, but local fishermen still continue to collect the animals as a protein source. However, giant clams can also be cultivated in hatcheries and afterward released in the wild (Copland and Lucas 1988; Braley 1992; Knop 1996).

Corals

Stony corals and black corals have also become a commodity. Most species are known from Indonesia and the Philippines, which are

Fig. 3.5. Female workers at a coral farm near Cebu City (Philippines) are connecting coral fragments to tiles by using galvanised wire. Eventually the corals attach themselves to the tiles and can be used in aquariums. No complete corals are taken away from the reefs since not only the fragments but also the parent corals survive (Photograph Dr. Thomas Heeger, University of San Carlos, Cebu City).

also the major export markets. Dead corals are used as ornaments and jewels, whereas living corals are increasingly popular in the aquarium industry (fig. 3.2). Their trade is regulated through CITES (Raymakers 1998; Green and Shirley 1999). In practice, the export quotas in numbers of specimens for each species may be much higher than the official numbers of traded pieces, which indicates that the trade regulations have no directly visible effect (Green and Shirley 1999). Corals are also protected by laws that prohibit collection from marine parks (White 1988; Alcala 2001). To compensate for the loss in income by the catch restrictions, the fishermen need alternative ways to make a living. Therefore, there is an increasing effort to cultivate corals by asexual reproduction or, in other words, by growing coral fragments into larger colonies by fixing them to tiles or to concrete blocks (Heeger and Sotto 2000; fig. 3.5).

Trade in Live Reef Fish and Shark Fins

The youngest trade in reef animals from Southeast Asia is that of live groupers and wrasses (Johannes 1995; Erdmann and Pet-Soede 1996; Hughes et al. 2003). Southeast Asia has the most species of reef fish and also the largest potential of local fishermen who are recruited for catching the fish with the help of poison. It is obvious that this practice not only has a negative effect on the fish populations of several species but also on the reefs as a whole. Corals may be killed by the poison that is intended to stun the expensive fish and since poisoned fish may try to hide between coral branches, fishermen break away the corals that protect the targeted hiding fish (video movie by Rili Djohani, The Nature Conservancy, Indonesia). Sharks are another threatened group of fishes being overexploited. Whitetip, blacktip, and grey reef sharks are finned alive after which the fins are dried before they are sold (Erdmann 1995). Although Indonesia is known to have the richest shark fauna of the world and its exports of processed shark fins are increasing, the trade in shark products is not regulated by such agreements as CITES in order to prevent their overfishing (Raymakers 1998).

Other Common Anthropogenic Threats to Species-rich Ecosystems

There is a large variety in the other ways human intervention can harm species rich ecosystems in Southeast Asia. Anthropogenic threats are usually chronic and widespread, and may therefore have serious, long-lasting effects if not managed carefully. Some examples of these threats are the following:

- Sedimentation through human-induced land erosion, harbour dredging and metal mining (Salvat 1987; Chansang 1988; Brown et al. 1994; Hodgson 1994a, 1994b).
- Pollution in the form of household litter, sewage, eutrophication, pesticides and industrial waste on reefs near dense human populations (Willoughby 1986; Marszalek 1987; Brodie 1995).
- Destructive fishing methods, such as blast fishing (fig. 3.6), use of large 'muro-ami' nets attached to the reef, use of fish traps, and cyanide fishing, despite their prohibition in certain countries (Salm and Halim 1984; Aliño et al. 1985; Alcala and Gomez 1987; Eldredge 1987; Gomez et al. 1987; Munro et al. 1987; Randall

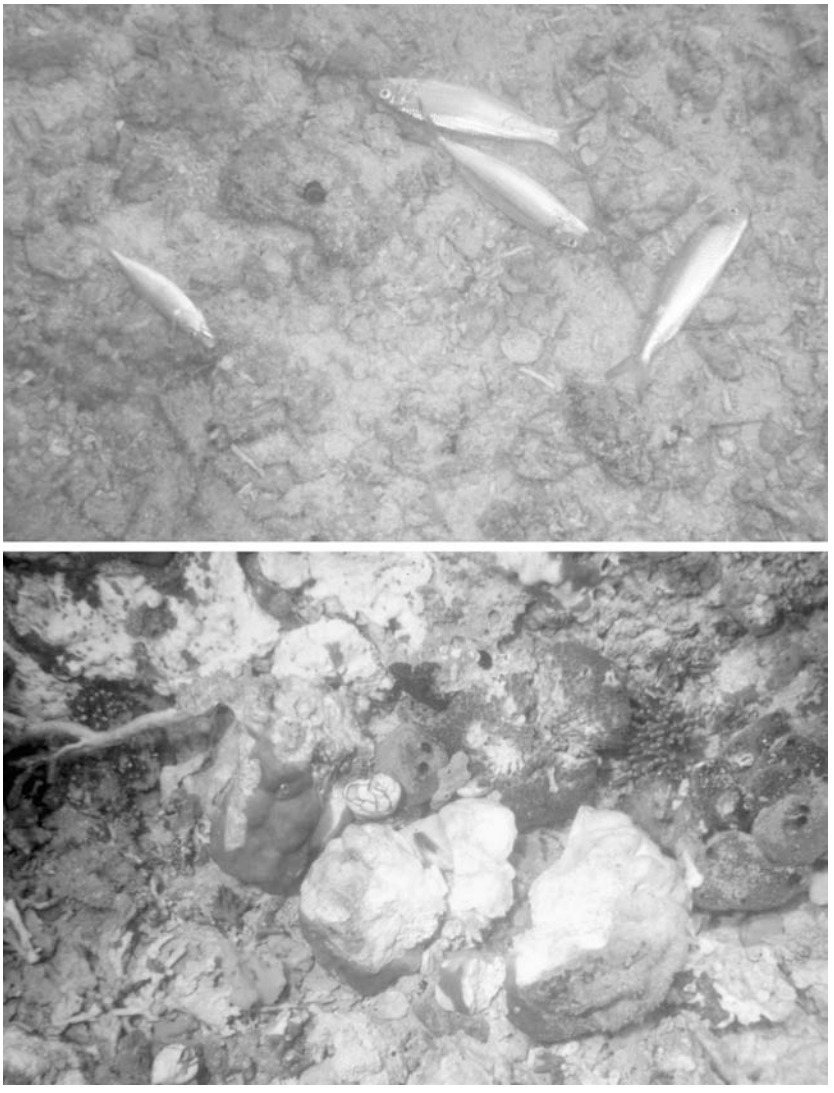

Fig. 3.6. The damaging effect of blast fishing on South Sulawesi. Stunned and dead fish can easily be collected from the shallow reef flats. In the process, large coral boulders break into fragments, die, and remain scattered over the reef. Recovery of the reef bottom will take much time since the loose fragments do not easily form a consolidated substratum.

1987; Galvez and Sadorra 1988; Galvez et al. 1989; Hingco and Rivera 1991; Manuputty and Soekarno 1994; Erdmann 1995; Johannes 1995; Erdmann and Pet-Soede 1996; McManus 1996;

Hatziolos et al. 1998). Overexploitation of reef fish may have an impact on the whole coral reef community (Bohnsack 1994).
– Coral fragmentation happens when people tread on reefs for food collecting or for taking corals as building material, or when recreational activities of tourists result in trampling, anchoring, and boat groundings (Tilmant 1987; White 1987a; Wong 1991; Auyong 1995; Burke et al. 2002).
– Construction activities and land reclamation may require coral reef area and coral boulders and sand for building material (Salvat 1987; White 1987a, 1987b; Hulm and Pernetta 1993). This has led, for example, to the disappearance of some coral reef islands off Jakarta (Ongkosongo and Sukarno 1986).

Widespread Damage to Species-rich Communities

Mass mortalities of corals due to large-scale elevated seawater temperatures events, such as the El Niño-Southern Oscillation (ENSO), are becoming increasingly frequent and severe (Glynn 1990). There are also other threats related to a global climate change that may have harmful effects on local coral-dominated communities. Changes in rainfall may affect the flux of nutrients and sediments on near-shore reefs. In some areas, a more frequent occurrence of severe storms can be expected (Buddemeier 1992; Wilkinson and Buddemeier 1994). It is not clear how these climatic changes have been induced and whether their progress can be prevented and reversed. Since the changes are quick and seem not to be precedented, human involvement is suspected. The worldwide degradation of coral reefs underlines the need for international action with regard to integrated coastal zone management (Grigg 1994; Adey et al. 2000; Hughes et al. 2003).

Integrated Coastal Management

In order to maintain the diversity of species-rich communities that are presently polluted or overexploited, and to guarantee them as sustainable marine resources, integrated coastal management plans have to be developed (Best et al. 1992; Munro and Munro 1994; Hotta and Dutton 1995; Alcala 2001). This can partly be done by establishing and protecting Marine Protected Areas (MPAs) and ma-

rine sanctuaries, as has been done for the Great Barrier Reef, for the Thousand Islands off Jakarta and for several island marine reserves in the Philippines (Robinson et al. 1981; Ongkosongo and Sukarno 1986; Kelleher and Kenchington 1991; Flores 1994).

MPAs consist of 'core' and 'buffer' areas, varying in intensity of protection and exploitation, in order to maintain critical ecological processes that are necessary to prevent the disappearance of species (White 1988; Foster and Lemay 1989; Agardy 1994, 1995; Kelleher 1994; Lassig and Woodley 1994). Furthermore, community involvement should be developed through education programmes and tools made for local villagers, tourists, and decision makers (White et al. 1994).

Public awareness can also be improved through recreation in parks, public aquaria, and museums (Hopper 1992; Kelly 1992; Neudecker 1992; Yates and Carlson 1992). Other management options may consist of installing mooring buoys to prevent damage by anchoring (Tilmant 1987). Transplantation of corals and other coelenterates may enhance the recovery of damaged reefs, and may also help to populate artificial substrata (Harriot and Fisk 1988; Yap et al. 1990; Newman and Chuan 1994; Clark and Edwards 1995).

It is clear that the Indo-West Pacific centre of marine coastal diversity is an area in which people depend heavily on living coastal resources. For both people and nature there is a need for proper management of these resources in the most sustainable way.

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Note

1. Department of Invertebrates, National Museum of Natural History – Naturalis, PO Box 9517, 2300 RA Leiden, The Netherlands. Hoeksema@naturalis.nnm.nl

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4

A Concerted Approach towards Managing Living Resources in a Marine Protected Area

Jean Worms, Mathieu Ducrocq, and Abdelkader Ould Mohamed Saleck[1]

Introduction

Managing a national park of international repute does not mean only preserving its landscape, fauna, and flora in as pristine a state as possible but also comprises the difficult task of reconciling this approach with sometimes very ancient uses of the land and resources. In the case of the *Parc national du Banc d'Arguin* in the West African state of Mauritania the permanent presence of populations within the limits of the park was ignored for many years until conflicts arose, forcing the park's authorities and their closest partners to rethink their management strategies.

The evolution of fishing practices of the Imraguen population offers a good example of such a conflict. Within the interval of a few years, internal and external pressures enticed Imraguen fishermen to shift from traditional fishing for yellow mullets to other species and to the use of more destructive gears, creating at the same time ecological and social problems. In this paper, we give first a quick overview of the geographical and historical contexts. We summarise the legal framework, the evolution of fishing practices as observed over the last two decades, and the many perverse consequences of these changes in fishing. We then describe how the park's authorities reacted, albeit belatedly, and explain the various steps taken to establish an open dialogue with the main stakeholders so that mutually beneficial solutions could be devised and agreed upon by all parties involved.

Historical Overview

The Banc d'Arguin National Park (PNBA) was established in 1976 by Presidential Decree, following active lobbying by international scientists to protect what had been identified as an exceptional wintering habitat for millions of palearctic migrating waders. Located north of Mauritania, between 19°21 and 20°50 N, the PNBA covers 12,000 km of desert, coastal and marine areas. It is the largest marine protected area of Africa.

Birds constitute only the most visible expression of the Banc d'Arguin's amazing biological diversity. From benthic organisms in the mud flats and seagrass areas through to shellfish, fish, marine mammals, and sea turtles, this area offers a cornucopia of marine life which has attracted all sorts of predators including humans.

The history of human presence in this now desolate area is very ancient. The coastline, as well as the interior, are littered with artefacts dating back mostly to the last great marine transgression of the Neolithic period (6,000 to 2,500 BP), a time when the climate was Sahelian (Vernet 1993). Among these remains, the presence of net sinkers made of clay, accumulations of *Anadara senilis*, and other shells and fish bones show an already very active exploitation of the sea's bounty. Some sites were obviously occupied for centuries (pers. obs.; R. Vernet, pers. comm.).

During the last two millenaries, climatic changes, including a sharp decrease in rainfall, have resulted in loss of plant coverage and desertification. The Imraguen[2], whose presence is documented since the early 15th century when the Portuguese first visited this part of West Africa (Valentim Fernandes, translated by Cenival and Monod 1938), established a long running tradition of seasonal fishing for yellow mullet (*Mugil cephalus*) which they processed as sun-dried '*tischtar*'[3] for consumption during the rest of the year when they returned to other activities like herding and extraction of salt in the eastern part of the area. The Imraguen were tributaries of local Moorish emirs for whom they worked in return for protection during the endless quarrels and wars which opposed the nomadic tribes of the region.

From the beginning of twentieth century, deep changes in social structures brought about by French colonisation, including buy-back of tributary rights and establishment of large European fishing companies like SIGP[4] (Picon 2002), induced a progressive settling of

Imraguen populations in coastal villages mostly established where the seasonal fishing camps used to be.

Legal Framework

After several decades of almost total isolation with little or no contact with the fast changing political, economic, and social realities of the country and no rules other than those formerly imposed by the Moors, the creation of the *Parc National du Banc d'Arguin* in 1976 introduced for the first time in this very remote area a set of modern regulations.

The creation decree n° 76-147/PR for the park does not pay much attention to the Imraguen and exclusively defines the park's mission as one of protecting the environment, as exemplified by its Article 2:

> The Parc National du Banc d'Arguin aims exclusively at the propagation, protection, conservation and management of the marine and terrestrial fauna and flora as well as at the protection of geological sites of a specific scientific and aesthetic value, in the interest of the general public and for their recreation.

Articles 3 and 4 proscribe a number of activities within the park's limits, including small-scale fishing. However, Article 5 waives these rules for park's authorities, research scientists, and resident populations, under certain conditions:

> ....articles 3 and 4 do not apply to:
> - Park authorities in charge of its management and surveillance and to those persons it contracts to make works deemed useful to management and conservation.
> - Research scientists having been granted a written authorisation from the Minister in charge of nature protection.
> - Local communities fishing for their subsistence with traditional means; any improvement to these traditional means has to be submitted to the park's authorities for approval.[6]
> - Local herders moving between pasture lands for cattle feeding.
> - The gathering of dead wood for their own needs by local communities.

In 1993, another decree reinforced this text and made an important addition by giving the park the additional mission to: *assist in the follow up and supervision of the socio-economic activities of communities residing within the park's limits in order to introduce those the concepts of conservation and development for sustainable use of resources*. For the first time, the Imraguen settled within the park's limits are considered as an important part of the ecosystem.

This statement is given even more strength by placing the PNBA under the direct authority of the Prime Minister's Office[7].

Promulgation of Law number 2000/024 relative to the PNBA on January 19, 2000 placed sustainable development at the forefront of PNBA's targets, and reinforced the pivotal role of the people living in the park area in reaching conservation objectives. In its article 2, this law states that the PNBA

> ...Is a protected area established on national territory with the following objectives:
> - Contributing to the sustainable development of the nation;
> - Supporting the harmonious development of the people living in the park area who exploit the park's natural resources;
> - Maintaining the integrity and productivity of the Banc d'Arguin's natural resources;
> - Protecting, preserving, and managing terrestrial, marine, and island ecosystems...

It also explicitly limits fishing activities by residents to those operated on foot from the shore or with sailboats called *lanches*,[8] in usage by the Imraguen since the early twentieth century.

Fishing Practises and their Evolution

Traditional fishing

In a country for centuries almost exclusively oriented towards the desert, the Imraguen are the only human group holding a strong although seasonal relationship with the sea. Although the Imraguen always maintained their centuries old link to the desert and to herding activities, they developed a distinctive culture centred on the cap-

ture and processing of a single group of fish species (mullets) using mainly one fishing technique (the shoulder net).

Several authors have described not only the way fishing was organised but also the many rules regulating the activity and structuring Imraguen society (for a literature review see Worms and Ould Eida 2002).

Aside from the spectacular but rather anecdotal aspects popularised by a number of documentaries including the collaboration of bottlenose dolphins in fishing (Pelletier 1976), the social nature of this fishing activity is very much noteworthy. Operated from the shore, the fishing technique is community-based, as individual fishermen have to pool their gears to encircle a school of fish. All groups of the community are involved: men for the fishing, women for the processing, older people for the mending of nets, and children for helping at various stages of these activities.

As fishing takes place only during the north-south migration of mullets along this coast from July to December, processing techniques were developed to ensure proper storage of product for several months after the fishing season. Sun dried flesh (*tischtar*); dried roe (*poutargue*); oil made from mullet heads and guts boiled in water (*dhîn*) are some of the most common forms of processed mullet, not only allowing steady supply of fish during the rest of the year when camps were moved toward the east but also bringing a precious supplement of vitamins and trace elements.

After centuries of geographic seclusion and social ostracism which had efficiently preserved a unique way of life, the rapid evolution of the Mauritanian political, economic, and social context in the last decades of the twentieth century forced the Imraguen to face a new reality.

Recent Evolution of Fishing Activities: the Ray and Shark Fishery

What went wrong

Fishing activities by resident populations remained relatively consistent with their long-standing traditions until the early 1980s when

several factors combined to prompt a rapid alteration of their way of life.

Until then essentially oriented toward subsistence fishing, Imraguen fishermen were lured into targeting new species by external operators with promises of higher and easier cash value for their product. In 1987, fishing for sharks and rays to supply the East Asian shark fin market started in the northern part of the park and quickly spread to all villages. Many species were targeted of which only the fins were cut away and collected by intermediaries placed in the various villages by outside traders.

Meanwhile, the success of mullet roe on the European market prompted the launching, in the early 1990s, of a semi-industrial purse seining mullet fishery south of the park, the uncontrolled activity of which rapidly drove down mullet stocks.

Growing scarcity of their traditional target species combined with increasing pressures from external operators to catch more selachids resulted in extremely unsettling consequences for the Imraguen and their environment (Ould, Bouceif and Worms 2000). Several of its most important effects are listed here:

- External demand shifted most of the fishing effort towards species whose very unusual reproductive strategy makes them extremely vulnerable. Even moderate fishing pressure has rapid negative effects on the yield of such species;
- Because of the need to buy new fishing gears, the level of indebtedness of Imraguen fishermen rose sharply, increasing their level of economic dependency on the same external operators who got them involved in this new activity;
- Imraguen fishermen became primary producers with little or no involvement in the processing and marketing circuits and hence they derived no benefit from value added to the product they fished;
- The gradual abandonment of traditional techniques and knowledge integral to Imraguen culture is part of the larger threat to their distinct way of life;
- Rays and sharks were neither processed nor consumed which had two immediate perverse effects: women were totally kept out of the newly established production circuit and subsistence consumption fell to almost nil resulting in a real problem with the family food ration.

It was clear that such a development path put in question the very foundations of the PNBA's policies as it had obvious negative impacts on the park's environment and its biological diversity as well as on the harmonious social and economic development of its people.

Another detrimental factor was illegal fishing by motorised canoes within the park's limits. The fast development of small-scale fisheries combined with the lack of a suitable legal framework and clear zoning enticed many fishermen, especially from Nouadhibou, into entering the park illegally to make a living.

Why it went wrong

Despite the existence of a protected area, placed under the authority of the highest level of the State and supported by several foreign partners, it appears clearly that things ran out of control. Several elements may partly explain this situation:

- When the park was established in the early 1970s, fishing was not an issue, the activity being almost exclusively traditional or operated as an industrial activity by foreign fleets holding licenses to fish in the Mauritanian Exclusive Economic Zone;
- The park was created first and foremost to protect a unique wintering area for palearctic migrating birds. Most of the attention was focused in this direction and protecting this pristine environment was the only target. The presence of people living in the park area was noticed but more for their folkloric character than as active players in the ecosystem;[9]
- The park as an institution lacked adequate resources to exert any control in the field and to apply the few existing park regulations;
- Traditional partners of the park, mainly FIBA[10] and the French Co-operation, a government agency forming part of the Ministry of Foreign Affairs neglected the rapid development of fishing activities inside and outside the park's limits because they focused most of their efforts on biodiversity conservation and birds. They overlooked the capacity of the Imraguen fishermen to adapt to new demands and use what they considered as ideal tools for sustainable development, like the sail *lanches*, in a non-sustainable manner. A small wooden sailboat generally conveys an image of environmentally friendly tool. However, targeting a very fragile group of species, the selachids, and introducing a set of new fishing gears (shark and ray nets) with significant bycatches of ma-

rine mammals and green turtles turn these traditionally innocuous fishing units into efficient and deadly tools.

The responsibility for the situation as it prevails now is obviously shared among all stakeholders. It is hard to determine whether the factor triggering State reaction was of a conservation nature, due to the identification of a threat to biological diversity, or of a social nature, due to the understanding that indeed populations were living there, exploiting renewable natural resources, and needing some guidance regarding the special status of the area.

It is evident that the two elements emerged pretty well at the same time and that both demanded a reconsideration of the way the park had been managed since its creation.

Management Solutions

The reaction of the park's management and its main foreign partners to a very worrying situation was slow, and it was not until the early 1990s that they began a process of reflection that generated the following objectives:

- **Drafting of a management plan**: this came to fruition in 1994 with the publication of *the Master Plan for the Banc d'Arguin National Park 1994 – 2003*;
- **Drafting of a scientific research plan**: the *Scientific Research Master Plan for the Banc d'Arguin National Park* was published in 1994;
- **Finalisation of a community development strategy in line with the constraints of a protected area**: work on this objective resulted in the drafting of a project entitled 'PNBA Development Project' which was funded by a loan from the International Fund for Agriculture Development (IFAD).

On the basis of this much needed exercise some basic principles were established among which were the need to acknowledge the presence of the Imraguen, to include them in the daily management of the park, and, above all, to involve them in the decision-making process as much as possible. It was then recognised that it was unrealistic to expect full participation of the Imraguen in conservation efforts without helping them to better their living conditions at all levels.

One of the most visible results of the PNBA Development Project was the creation of community-based co-operative structures in each of the park's villages. These structures were established only after a long period of sensitisation of the resident populations to the benefits of working together on some basic daily activities and after training in areas like bookkeeping and stock management was given to those in charge of managing the co-operatives.

Co-management was seen as the only viable solution to reach an acceptable compromise between conservation and community development. Until then, communication between the park's administration and resident populations was at best rudimentary. Initiation of the IFAD Project allowed the PNBA to start establishing a real dialogue with the local populations, paving the way for their active participation.

Although the potential conservation problem with sharks and rays was obvious, it was necessary to collect scientific data in order to document its magnitude and devise adequate solutions. The Ray and Shark Project, funded by the International Foundation for the Banc d'Arguin (FIBA), was initiated in the field in January 1998. Using the existing network of field technicians put in place in July 1997 in six of the villages to monitor catches (ACGEBA Project[11]), it put more emphasis on sharks and rays and included the reproductive biology of those species considered most at risk. The technicians were specifically trained to precisely identify the numerous species caught and to collect biological data.

The data collected during the first nine months of the project were pre-processed during the fall of 1998 and presented at a consultation workshop organised in Mamghar in October 1998 in order to voice the park's concerns regarding the future of the shark and ray fishery and that of fishing in general. It gathered under the same tent representatives from the various villages (local authorities, fishermen, and women), delegates from park management, and representatives of the park's most important national and international partners. A special effort was made to convey to fishermen's representatives complex notions such as the population dynamics of exploited marine stocks, secondary production, predation, and reproductive strategies. As selachids are ovoviviparous, in that females give birth to fully formed offspring, it was possible to draw on the still very vivid Imraguen's herder sensitivity which prohibits the killing of a female

camel, sheep, or goat which has never given birth or, worst of all, is pregnant.

Also, fishermen expressed their views and concerns that fishing yields had declined very significantly over the last several years since the start of the shark fishery. Through at times animated discussions, it was then possible to reach a consensus on necessary control measures in terms of seasons and the authorised lengths of nets operated by each sail *lanche*.[12]

This first encounter set the pace for a new climate of relationships based on open-mindedness and mutual confidence. The agreed upon measures were applied on a voluntary basis and an informal survey conducted by PNBA field personnel in 1999 showed that they were respected by the vast majority of the fishermen.

Based on the same principle, the second workshop held in October 1999 in Iwik confirmed the measures adopted in 1998 and made some slight adjustments to them. Most importantly, it provided an opportunity to discuss the actions required to offset the loss of income caused by the decrease of fishing effort on selachids. How to get better value for their product and how to target other less fragile, yet more valuable species were some of the many topics explored during this meeting.

In return for the commitments of the resident populations with regard to their fishing activities, the park's administration committed itself to formulating new development projects and finding necessary funding for them with its partners.[13]

It was made clear that, in terms of conservation, the final objective was to come to a total moratorium on selachid fishing while working together with the resident populations and funding partners to find new revenue generating activities with little or no impact on the environment.

To start implementing the PNBA commitments, the 'Project to Support the Redeployment of the Imraguen Fishery' (PARPI[14]) was implemented, the main objectives of which were:

1. To improve PNBA capacity to manage local fishing activities by strengthening PNBA human resources and maintaining a climate of open communication with the people living in the area;
2. To continue scientific monitoring of the fishery and the biological studies initiated in the frame of the ACGEBA Project and the Ray and Shark projects;

3. To formulate micro-projects on the basis of very concrete practical solutions which will help the Imraguen to progress towards an efficient, self-sustained, and profitable redeployment of their fishing activity.

Several activities were started in 2000 around the following objectives:

Objective 1. Local management capacity and capability:
- Recruitment and training of a local counterpart to the expatriate project leader;
- Compilation of a bibliography on methods used to manage and monitor small-scale fisheries and on the specific techniques used to manage fishery resources in marine protected areas;
- Organisation, in close collaboration with other PNBA departments, of regular information and consultation meetings with all participants in fishing including fishermen, women's groups, village co-operatives, fishmongers, and others;
- Organisation of the third fishery workshop with the same stakeholders;
- Drafting of a strategy document with regard to the fishery sector.

Objective 2. Scientific monitoring:
- Collection of fishing effort and catch composition data and production of pertinent reports;
- Inception of a quick assessment method for monitoring the biological cycles of the most important species targeted by the fishery;
- Collection of empirical knowledge concerning biological cycles, migration patterns, variation of abundance of fish species in time and space, et cetera;
- Formulation of methods and preparation of documents aimed at raising the awareness of local fishermen about responsible fishing and conservation.

Objective 3. Technical and infrastructure improvement:
- **Micro-project 1**: Provision of light equipment to at least two village co-operatives to keep frozen and fresh fish; Helping the co-operatives to elaborate fair commercial agreements with outside fish traders to develop marketing of fresh fish.

– **Micro-project 2**: Giving assistance to the village co-operatives to sell part of their production directly in the main markets of Nouakchott and Nouadhibou by contributing to the financing of 40 percent of a transport vehicle through credit at 0 percent interest rate conditional on the capacity of the co-operative to bring in matching funds corresponding to 60 percent of the cash value of the vehicle.
  Reimbursement of this credit is meant to feed a revolving fund directed towards financing new activities to be discussed and agreed upon by co-operative members, PARPI, and the PNBA Community Development Department.
– **Micro-project 3**: Support fish processing activities in the villages that foster an economic context favourable to women's activities. This will take the form of study tours in countries of the sub-region where such processing activities are well developed and include micro-credit to women's groups to buy fish from fishermen and small equipment from retailers.

Towards a More Sustainable Fishery within PNBA Limits

Based on the first results of the current PARPI project, a new 5-year plan has been started which tries to better integrate scientific, socio-economic, and institutional aspects. This is reflected in its three major objectives:

1. Providing tools for sustainable management of the PNBA's living marine resources;
2. Upgrading the quality of life of resident populations, socially, economically, and culturally through better control over all aspects of fishing and through a higher level of awareness of sustainability issues;
3. Helping put in place pertinent institutional mechanisms for the sustainable management of fishing activities in the park.

First evaluations were made during the third and fourth consultation workshops held in Tessot in January 2001 and in R'gueiba in December 2001. Although preliminary results are encouraging, it is too early to draw conclusions regarding the to the durability of the strategy adopted by the park's administration.

However, some important lessons have been learnt:

– *A protected area cannot be managed without the involvement of resident communities and, even less so, when it contravenes their basic interests*. It is clear from past experience that establishing and maintaining an open dialogue with the main stakeholders is essential for the park's administration. It is unrealistic to manage such a complex, multifaceted reality without the full support of the resident populations.

  Recognising the pivotal role of the people living in the park and starting to improve their capabilities and capacities have constituted a major step forward, although a lot remains to be done to bring them up to par with the requirements of a rapidly developing society. Only their full participation can turn the Imraguen into real partners of conservation efforts, and thus secure the future of the PNBA.

– *The Banc d'Arguin National Park cannot be managed as an entity isolated from its surroundings*. The PNBA is an integral part of the geographical, ecological, economic, and social fabric of Mauritania. Such influences that impinge upon the park have to be taken into account. This means that consultation with stakeholders has to go far beyond a process strictly internal to the park. Fishing, an activity shaped by many factors endogenous and exogenous to the park, provides an excellent example of this inescapable interdependency between what is going on inside and outside the park. Most of the problems identified over the past decade or so originate in part from having overlooked this fact.

  Establishing a constructive relationship with all stakeholders, including the Ministry for Fisheries and Maritime Affairs that is in charge of this vital sector of activity for the Mauritanian economy, professional fishermen associations, fish traders, and intermediaries is a challenge park authorities have to take up.

– *To establish a productive dialogue requires clearly identified, credible partners on both sides*. This emphasises the need for a stronger institution on the PNBA side and the strengthening of representative associations and groups among the resident population. The PNBA can and will only negotiate regulatory measures and assistance packages with duly commissioned bodies like village co-operatives or women's associations.

  The PNBA is engaged in an all-encompassing exercise of institutional structuring and strengthening. This will improve its

performance in helping local communities in the park get better organised.

– *It is essential to know well to manage well*. Targeted scientific research has a key role in acquiring knowledge of ecological and socio-economic factors, thus allowing the PNBA to develop more adequate management tools.

  On the basis of the *Scientific Research Master Plan* and under the guidance of its International Scientific Council, PNBA has formulated a multidisciplinary research programme aimed at elucidating the functioning of its complex ecosystems and the role played by its main users including people, fish, and birds. Several projects have already been drafted and partnerships established with national and international institutions to help achieve this very ambitious programme.

– *As is the case for all human groups, Imraguen attitudes are driven by their own self-interest*. Resident populations are ready to engage in any type of action as long as they see some concrete benefits not too far down the line. It is part of the park's leadership role to carefully balance between the constraints of conservation and its commitments regarding socio-economic development.

Communication is instrumental in the whole process of conservation and development. Effective communication is at the very basis of all attempts to establish constructive relationships, be it to inform, to explain, or to convince. In the area of communication, the PNBA has a rather poor record. In a developing country like Mauritania which relies heavily on its marine resources, it is essential to raise the awareness of politicians, economic operators, and the public at large on the benefits everybody can draw from sound management of a marine protected area.

A process to draft a communication and environmental education strategy has recently been initiated. The first step is to make an inventory of the different perceptions stakeholders have of the park. Then the various communication targets will be identified, important messages to convey will be drafted, and best communication channels and processes will be discussed.

The park's authorities know that it is paramount in the short term to convince policymakers of the economic potential of such a marine protected area in order to have them on their side. Environmental education is also seen as a very important issue but one that has to be viewed as a long-term endeavour which will require an in-depth

change of mentality of political and economic decisionmakers and the public at large.

The efforts of diversification should not focus solely on the fishery sector. PNBA has other economic assets which deserve higher valuation. The most evident of these is its potential for tourism. Conscious of this and pushed by an ever growing demand from national and international tour operators, park authorities have drafted a strategic document to guide the development of tourism within its borders.[15] The approach chosen is based on the principles of eco-tourism: tourism that is respectful of ecological and cultural values, and whose economic benefits go first and foremost to the resident populations.

Implementation of this strategy has already started on a small-scale basis and it is expected that tourism-related activities like catering, lodging, guiding, and handicrafts could constitute in the long term a significant source of income, especially for women's groups.

It is evident that all these efforts will be in vain without a strong investment into improving Imraguen livelihood conditions. Although significant progress has been made over the last decade, a lot remains to be done in areas such as health and hygiene, housing, education and adult literacy, and development of community-based cooperative structures. Because the PNBA cannot take the place of government bodies in charge of the various sectors concerned, stronger, more effective partnerships with the ministries in charge will have to be established and common actions taken. Better collaboration is also needed with regional authorities.

Combining conservation and socio-economic development is not an easy task. In such an endeavour, it is essential not to take radical stands and instead to look for the best compromise between two paths that are at times in conflict with each other.

To efficiently manage the park in all of its aspects, incumbent authorities have a much better set of tools than ever was available to them in the past: a strong legal framework, a strengthened although still insufficient work force, a clear choice for a co-management model, and a set of strategic documents dealing with the most important issues. The main challenge now is to pull together these elements and define a genuine governance approach.

The park is engaged in a medium-term reflection on governance, in collaboration with two other West African marine protected areas.[16] A project entitled 'Coherence of conservation and development

policies for Coastal and Marine Protected Areas in West Africa', funded by the European Union for three years, started in January 2002 with the help of several European institutes.[17] It aims at reviewing the present situation in each of the CMPAs, analysing the existing legal frameworks and public policies which regulate access to renewable natural resources in and around the protected areas, identifying gaps and failures, and proposing necessary changes in terms of governance.

Meanwhile, much effort has been put into the formulation and implementation of a proactive approach to managing the park's ecosystems based on the monitoring of a number of pertinent biophysical, socio-economic, and governance indicators. A test phase has started in early 2003 as part of an initiative aiming at bettering the preventive monitoring of marine protected areas and thus their overall governance. This programme is sponsored by National Oceanic and Atmospheric Administration (NOAA) and the World Wildlife Fund (WWF) and involves seventeen such areas around the world. Much is expected from this programme including identification and fine-tuning of better governance tools.

Notes

1. Scientific Advisor to the PNBA Director; Head *Projet d'appui à la diversification de la pêche Imraguen*, PNBA; Head, Department of Scientific Co-ordination, PNBA.
2. In Hassaniya, the local dialectal Arabic, *Imraguen*, plural of *Amrigue*, means 'the one who enters the sea with a net'.
3. *Tischtar* is traditionally sun-dried camel meat, a technique the Imraguen successfully adapted to fish meat.
4. SIGP stands for 'Société Industrielle de Grande Pêche', a French company which established an ambitious operation in Port Etienne (now Nouadhibou) in 1907 and created commercial links with the Imraguen in the late 1940s.
5. Translation by the authors.
6. Underlined in the official text.
7. The park is placed directly under the authority of the *Secrétariat Général du Gouvernement*. The only other national park in Mauritania (Diawling National Park) is placed under the authority of the Ministry for Rural Development and the Environment.
8. *Lanches* are 9 to 10 meter wooden sailboats of Canarian origin used as dinghies by larger fishing boats and left behind in the 1930s when Canarian fishermen stopped fishing the Banc d'Arguin.

9. The creation decree is clear in this regard, listing resident populations after the park's authorities and research scientists in its article 5 (see *Legal Framework* above).
10. International Foundation for the Banc d'Arguin.
11. This is the acronym for 'Appui à la Conservation, la Gestion et la valorisation de l'Ecosystème du Banc d'Arguin' a project funded by France and mainly aimed at describing the Imraguen fishery qualitatively and quantitatively.
12. See Appendix 1.
13. Appendix 2.
14. This is the acronym for 'Projet d'Appui à la Reconversion de la Pêche Imraguen'.
15. *Stratégie de développement du tourisme pour le Parc National du Banc d'Arguin*, June 1999.
16. The Saloum Biosphere Reserve in Senegal and the Bolama-Bijagós Archipelago Biosphere Reserve in Guinea Bissau.
17. Center for Marine Economics (CEMARE) of the University of Portsmouth (UK); Faculty of Law of the University of Perpignan (France); *Institut de Recherche pour le Développement* (IRD – France).

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APPENDIX 1 – Control measures adopted following the 1st Consultation Workshop held in Mamghar from October 3 to 5, 1998

1. Fishing for selachids (skates, guitarfish, and sharks) is authorised between February 1st and September 15. The season is subdivided as follows:
   - February 1 – March 15, use of both skate and shark nets is authorised
   - March 16 to April 15, only shark nets are authorised
   - April 16 to May 30, only skate nets are authorised
   - June 1st to July 15, use of both skate and shark nets is authorised
   - July 15 to September 15, only shark nets are authorised.
2. The following fishing gears, are authorised during the periods detailed above:
   - 10 skate nets per *lanche*, each 150 m long for a total length of 1,500 m maximum
   - 3 shark nets per *lanche*, each 150 m long for a total length of 450 m maximum
   - Fishermen commit themselves to throw back into the water all living hammer sharks less than 1 meter long.
3. Based on research projects conducted during the 1999 season, an assessment will be made of these measures and a new consultation meeting will be organised. Meanwhile, discussions will be held to identify activities able to provide alternative sources of revenue.

APPENDIX 2 – 2nd Consultation Workshop held in Iwik from October 21 to 23, 1999

Resolution adopted by representatives of resident populations

1. Concerning *selachid* fishing:
   - Throw back in the water all individuals of *Rynchobatos lübberti* without cutting their fins;
   - Abide by the closure between September 16 and January 31;
   - For the 2000 fishing season:
     - Use a maximum of 1,500 m of skate nets and abide by the specific closure between June 16 and September 15

- Use a maximum of 450 m of shark nets and abide by the specific closure between April 16 and June 15.

2. Concerning marine turtles:
   - Immediately stop targeted fishing;
   - Throw back to the water all living turtles accidentally caught;
   - For scientific purposes, give PNBA technicians access to all dead turtles accidentally caught.
3. Concerning *lanche* staff:
   - No more than 5 fishermen on a given *lanche*
   - The *lanche* captain has to be a park resident
   - No more than 2 non-residents can be part of the *lanche* staff.

Commitments made by the park's management board:

1. Contribute to solving the drinking water problem by starting operation of a tanker truck before the end of 1999.
2. Study the feasibility of a micro-financing project designed to fit the specific requirements of resident populations.
3. Protect the resident fishermen from a possible influx of outside, non-resident, fishermen.
4. Conceive and operate a project to support small-scale fishing in the park by:
   - Assisting the village co-operatives in terms of management, technical choices, financing, et cetera;
   - Supporting local fish processing;
   - Making available adequate facilities for the storage of fresh fish prior to marketing.

5

'Making Do': Integrating Ecological and Societal Considerations for Marine Conservation in a Situation of Indigenous Resource Tenure

Flip Van Helden[1]

Introduction

The establishment of protected areas is based on the notion that 'wild' nature needs to be kept separate from human society in order to preserve it and that it is the duty of the State and its agencies to restrict the use of ecosystems in need of protection (Peluso 1993; Colchester 1994). In this view, protected area establishment and management are largely 'technical' matters and the realm of natural scientists such as ecologists, biologists, and conservation managers. These scientists assess the ecological significance of potential protected areas on the basis of ecosystem characteristics, species composition, endemicity, levels of disturbance, and the like. Subsequently they design a protected area on the basis of considerations of size, shape, habitat variability, the requirements of specific species, and so on. Once these technical matters have been settled conservationists come to deal with the local people, often by excluding them from previously accessible resources in order to conserve nature in the area of their choice (Van Helden 2001a).

The debate over the position and involvement of local people within and around protected areas has mainly focused on land-based protected areas and national parks. Whereas in the 1980s tropical rainforests came to be seen as the symbol of biological diversity, in recent years there has been a shift towards the realisation that the oceans and their marine life are at least as diverse and vulnerable. Coral reefs are nowadays popularly referred to as the 'rainforests of the seas'. This realisation has led to a shift in attention from land-based interventions towards a variety of marine conservation and

coastal management programmes. Large private foundations and non-governmental organisations are now developing a variety of programmes aimed at establishing marine protected areas in a range of tropical countries. In doing so, these programmes are confronted with the fact that the livelihoods of coastal people are often dependent on the use of marine resources. Simply designing protected areas on the basis of ecological considerations often intensifies the tension between the economic needs of local communities and the conservation goals of these programmes.

In recent years, the traditional model of state-induced protected area establishment has been challenged for both moral and practical reasons. Morally, because it has often meant that the opportunity costs of conservation are imposed on poor people living inside and around protected areas. Practically, because there is ample evidence of the ways in which local people strike back at conservation interventions. These responses usually contravene the conservation objectives of the executing agency and in many cases break state law, as people continue to use protected resources (Colchester 1994; Brown and Wyckoff 1992; Wells and Brandon 1992; Pimbert and Pretty 1995; Peluso 1993). Resistance to protected area establishment is not an issue restricted to developing countries; western countries also are experiencing an intensifying level of conflict around their protected areas (see for example Stoll-Kleemann 2001 on the case of Germany).

Within the realm of marine conservation, the call for establishing marine protected areas has often been legitimised by the idea that marine resources are open-access resources and therefore subject to a 'tragedy of the commons' type of overexploitation by profit maximising individuals (Harding 1968). The only way to avoid the degradation of such systems is seen in a strong role for the State and its agencies in regulating access to marine protected areas, restricting the use of damaging technology, and enforcing the size and species of the catch through trade controls (Gordon 1954; Berkes 1985). It has been shown (Cordell 1989; Osseweijer 2001) that the assumptions underlying this policy of state-led regulation and control are often uncritically applied to the fishing practices of coastal people around the world.

Towards Participatory Conservation and Development

The struggle between conservation agencies and local people over the management, conservation, and use of natural resources has gradually forced conservation agencies to think about ways of integrating notions of human development with the conservation of nature. In recent years, the debate over how to link the interests of the global conservation constituency with those of the local population in areas of high biodiversity has led to a range of methods that are invariably labelled as 'integrated', 'community-based', 'joint', 'co-', or 'participatory' (Korten 1986; Pomeroy 1991, 1994). These approaches, collectively dubbed the 'new conservation' by Hulme and Murphree (1999), have in common that they entail:

– A transition from a top-down and expert-driven form of conservation towards more participatory and community-based forms of resource management;
– A shift from the use of coercive conservation methods to a combination of coercive and incentive measures aiming to develop integrated forms of area management.

With regard to marine conservation there is the additional realisation that coastal marine resources are often not of an open-access nature but characterised by elaborate customary resource management systems which regulate the harvesting of resources and which may provide a basis for localised conservation regimes. The additional fact that many state administrations simply lack the ability and the means to control the harvesting of marine resources has forced conservation agencies to look for locally specific, decentralised, and community-based forms of marine management.

The Changing Composition of Project Teams

This recent focus on indigenous forms of resource tenure and the question how to involve local people in marine conservation induces changes in the composition of the project teams designing such interventions. Where previously the process of establishing marine protected areas was dominated by natural scientists, the growing awareness of the importance of socio-economic and cultural aspects of conservation has led a range of social scientists such as anthropo-

logists, community development specialists, and economists to become involved in conservation interventions.

Co-operation between managerially oriented ecologists and social scientists is not always easy. Not only do both fields of study and practice consist of expert systems with their own rules of debate, concepts, language, training and culture, but they also have very different focuses. Where conservationists tend to concentrate on the needs of nature, social scientists often aim to represent the interests of local people, thus reproducing the conflict between conservationists and local people within the project teams responsible for the implementation of 'integrated' conservation policies (Van Helden 2001a).

Moreover, as social scientists are finding their way into conservation agencies, the number and variety of organisations involved in the field of conservation and development has dramatically increased. Where previously conservation was seen as the realm of a state department or executing agency, environmental interventions have now also become a topic of concern for a wide-range of actors including: local level governments; citizen-led pressure groups; non-governmental organisations focusing on indigenous peoples; human rights and rural development agencies; business proponents; and special interest groups such as farmers, fishermen, hunters, and tourists. McNeely and Guruswamy (cited in IUCN 1999: 9) note how these competing groups claim resources, power, and privileges through a political decision-making process in which biologists, local communities, the private sector, and conservationists have become inextricably embroiled.

The proliferation of interest groups dealing with issues of conservation is changing conservation practice from the traditional, rather technocratic, expert-driven top-down approach to a much more fuzzy, political process in which social and economic considerations gain in importance. This paper illustrates this change in managerial practice by looking at the case of a marine conservation programme in Papua New Guinea. The Milne Bay Community-based Coastal and Marine Conservation programme (CMCP) constitutes an interesting case study as it illustrates how, over the life of the project, the project team was forced to shift its focus from the biodiversity that they wanted to protect towards a systematic consideration of the perceptions and needs of local communities and the provincial government.

Resource Tenure and Conservation in Papua New Guinea

Papua New Guinea consists of the eastern half of the Pacific island of New Guinea, which is the world's largest tropical island. New Guinea is largely covered by rainforests and includes some 600 islands scattered within a vast sea area of more than 3 million square kilometres. Its marine resources include an estimated 40,000 square kilometres of coral reefs, which belong to the most biologically diverse and least degraded coral reef systems on earth.

The most critical feature of natural resource management in Papua New Guinea lies with the clan group ownership of land and resources. These tenure rights are recognised in the Constitution. More than 97 percent of the land is held under customary tenure arrangements, a mere three percent is state-owned. Customary tenure not only covers land and terrestrial flora and fauna, but also extends into freshwater and marine resources, covering beaches, reefs, and fishing grounds. Only rights to open seas, mineral resources, government land, and protected fauna are vested in the State. Although the *Land Act* formally allows for the alienation of land and resources, such alienation has rarely occurred due to its politically sensitive nature. In practice, the government of Papua New Guinea does not have the legal means to access, manage, conserve, or exploit natural resources without the consent, co-operation, and compensation of local resource owners.

Given that fish has always been a primary source of food, barter, and trade, local communities have always tried to exert control over their marine resources by delineating ownership and use rights over resources vis-à-vis other groups. The occurrence of management regimes appears to be partially a function of population densities. In Micronesia and Polynesia the variety of marine management systems has led Johannes (1978: 352) to conclude that almost every means of fisheries management currently practiced in western countries was already in use in the South Pacific centuries ago. In Papua New Guinea, where population densities have been relatively low, the need for detailed and closely guarded systems appears to have been less immediate, although, as indicated in the next paragraph, a variety of systems aimed at preventing overharvesting has been described.

Usually the clan group as a whole owns the marine resource stretching from the beach up to the outer reefs, in some cases also including outlying islands and reefs. By virtue of birth, adoption, or mi-

gration, individuals of the group are accorded use-rights within the community-held resource. Given that these resources are found within a specific geographical area reserved for the members of the group, the most important management arrangements consist of limited-entry systems, which regulate harvesting by outsiders. Other more internally-oriented arrangements, which may have had a positive impact on the availability of marine resources, are prohibitions on the use of certain technologies and restrictions on fishing during certain times of the year or in certain places following important events such as deaths or feasts (Johannes 1982; Nietschmann 1989; Carrier and Carrier 1989; Polunin 1984; Akimichi 1995).

Conservation in the Context of Community-owned Resources

The fact that local people own most natural resources implies that they, not the government, are the primary party when it comes to negotiations over the management and conservation of natural resources. This generates a power relationship in which local communities have much more influence relative to the State and its conservation agencies than found in most other countries. It also emphasises the need for an approach in which local peoples' views of nature, the use and management of natural resources, and the often strongly-felt need for socio-economic development are integrated into the design, planning, and implementation of conservation programmes.

The situation in Papua New Guinea is even more complicated since resource developers and conservationists are often in direct competition with each other over the hearts and minds of resource-owning communities. Thus the operators of pelagic fishing vessels enrol local communities in harvesting high-value marine resources, while conservationists try to convince the local people that the short-term exploitation of their resources will result in further impoverishment. A growing number of environmental groups have come to the view that 'raising awareness' is not good enough and that income-generating options have to be developed as part of conservation interventions.

The experience with integrated conservation and development projects in Africa offered the theoretical framework for this new approach (Wells and Brandon 1992; Hannah 1992). The difference is that where elsewhere such methods are used as a means to reduce the pressure on existing protected areas, in Papua New Guinea they

were proposed as a means to establish conservation areas. This view became very popular during the 1990s when integrated conservation and development approaches were regarded as a means to make conservation economically competitive with more destructive forms of resource use. As a result conservationists now find themselves in the business of putting together attractive packages of conservation-related benefits (Filer with Sekhran 1998; Van Helden 2001a).

Involving local resource owners in conservation programmes tends to generate a variety of different responses. Some communities tend to genuinely reflect on the issue of conservation, taking the opportunity offered by the project as a means to improve the management of their local resources. Others tend to see the rapid commercial exploitation of their resources as their only chance to attain a better and more modern life. The responses to conservation programmes tend to be similarly variable. Some local people see projects as a source of short-term rewards that need to be captured here and now, sometimes leading to aggressive and opportunistic behaviour (compare with McCallum and Sekhran 1997; Van Helden 2001b). Other groups may have an interest in establishing long-term relations with such project teams as a result of their experience with environmental degradation and social and economic change.

The case of Milne Bay in Papua New Guinea demonstrates how the growing importance of social and economic factors in the development of marine protected areas affects the process by which such areas come into being. Rather than being a largely expert-driven, state-sponsored sequence of steps undertaken to conserve a valuable marine ecosystem, conservation interventions such as the one in Milne Bay are increasingly turning into highly social and negotiated processes with largely unpredictable outcomes. In contrast to the initial intention of the ecologists involved, protected areas in Papua New Guinea turn out not to be established on the basis of ecological best practice but more on a fuzzy process of 'making do' with the available means under the existing social and economic circumstances.

The Case of Milne Bay

Milne Bay province comprises the far eastern end of the mainland of New Guinea and 10 large and some 150 small islands. The sea area of the province encompasses some 110,000 square kilometres of which

13,000 square kilometres include coral reefs (Frelink 1983). Milne Bay province has a population of about 200,000 of which 80 percent live on small islands or on the coastal mainland. Due to the small size of most islands, the rugged interior of the province, and the limited alternatives for economic activity, the people of Milne Bay are more dependent on marine resources than those of any other province in Papua New Guinea. The situation in which the needs of the coastal population and the availability of marine resources were more or less in balance has been rapidly changing as a result of 1) the growth of the coastal population, 2) the growing need for cash incomes and the rapid commercialisation of marine resources, and 3) the availability of modern technology. Where the state of marine resources is an issue of global concern triggering interventions such as the one described in this paper, to many people of Milne Bay the most pressing issues are the lack of sufficient water and food and the difficulty of earning a cash income (Kinch 2001).

Traditional strategies that in the past served to reduce the pressure on resources, such as migration to new territory, are now limited by the fact that all land in Papua New Guinea is already under tenure. Out-migration to the growing towns of Papua New Guinea is restrained by the current economic crisis. Not surprisingly, therefore, the food and income derived from the use of marine resources are a crucial part of local livelihood strategies. The most valuable marine resources are pelagic species such as tuna that are targeted by trawlers but are largely out of reach to local fishermen. Local livelihoods mainly depend on reef fish, turtles, and, increasingly, on the sale of sedentary species such as a variety of bêche-de-mer species, trochus, giant clam, green snail, and pearl shell. In 2000 the value of the bêche-de-mer in all of Papua New Guinea stood at some 5.2 million U.S. dollars of which 2.45 million came from Milne Bay waters (pers.comm. Jeff Kinch). The commercialisation of these marine products and the availability of modern technology have led to two different, but closely related sources of marine degradation. The first of these is intruding fishing vessels of especially Taiwanese origin, while the second arises from the changing livelihood strategies of a growing coastal population.

State Control, Foreign Intruders, and Local Livelihoods

The National Fisheries Authority aims to control pelagic fishing within Papua New Guinea's territorial waters by regulating and monitoring licensing, trading, reporting, transhipment, and export requirements. Due to the lack of enforcement capability, foreign fishing vessels commonly contravene Papua New Guinea fisheries laws. The most common violations consist of:

- *Fishing without permits:* In 2000 an aerial survey by the Australian Defence Force counted no less than 38 fishing vessels within the Milne Bay Archipelago of which at least half were suspected to be without license (pers.comm. Jeff Kinch);
- *Sharing permits and illegal transhipment:* Foreign fishing vessels leaving Papua New Guinea waters are known to pass their registration number and papers on to incoming vessels, allowing fishing companies to operate more than one vessel under a single vessel permit. Alternatively, vessels are known to tranship their illegal catches onto other vessels before offloading in Papua New Guinea harbours or before inspection;
- *Fishing in coastal waters:* long-lining permits to catch tuna are misused to fish for shark in shallow waters, while foreign and Papua New Guinea trawlers regularly fish for coastal resources. In doing so, vessels transgress the three-mile limit they are legally obliged to remain from land, while degrading reef systems, eliminating fish stocks available to local people, and affecting the livelihoods of local people. Vessels that accidentally run aground are systematically plundered in retaliation (Kinch 2001).

These breaches are a source of frustration to coastal communities and their leaders who see valuable resources taken away with little or no benefits to the State and local communities. However, the attitudes of local people towards these outside vessels are ambivalent. Villagers on outlying islands are often angered by illegal fishing by outsiders but cannot do anything to prevent these practices. Many of these same communities, however, also benefit from the foreign presence as these vessels are known to purchase bêche-de-mer, trochus, and clams from local villagers without checking the required licenses, thus allowing villagers to by-pass provincial, national, and international trade controls (Kinch 2001).

The pattern of events based on experiences from Asian countries suggests that local people play a major role in the depletion of coastal

marine resources. This pattern is one in which people initially focus on catching sedentary high-value resources in shallow waters (for example giant clam and trochus). The illegal use of explosives, poisons, surface lights, scuba, and hookah gear further intensifies the pressure on scarce high-value resources. The introduction of new technology also has the effect that boundaries are redrawn and new conflicts arise as fishing communities are now able to harvest previously inaccessible resources. Once resources have been fished out and become commercially extinct, people move down the 'value-chain' towards less valuable and more labour intensive species. The end-point of this process is the situation found in countries such as the Philippines and parts of Indonesia where large fleets of artisanal fishermen chase an ever-dwindling stock of smaller and smaller sized fish (Pomeroy 1991).

The Politics of Provincial Fisheries Management

Although the Papua New Guinea Fisheries Act focuses on regulating pelagic fishing, it also allows provinces to draw up management plans with regard to specific export species. These management plans are mainly developed for the regulation of sedentary resources such as bêche-de-mer and prawns, to ensure that harvesting is in line with the established maximum sustainable yield (MSY). Management measures generally consist of:

- *A licensed marketing arrangement:* Because the fishing activities themselves are hard to control, the province limits the number of legal buyers and exporters, thus monitoring and regulating the catch, processing, packaging, and marketing of the end product as a proxy for controlling the actual fishing activities;
- *Species restrictions and size limits:* The provincial government reserves the right to restrict the harvesting of species on an annual basis and establishes both a live and a dried minimum size limit on species eligible for capture;
- *Total allowable catch (TAC):* The plan establishes a TAC for each class of species to ensure that the MSY is not exceeded. Fishing is to cease when the TAC has been reached;
- *A closed season:* The plan also stipulates a compulsory closure of the fishing season, terminating all harvesting, selling, and storage.

In practice, the effect of these measures is limited. Notwithstanding their management plans, Western Province and Manus have seen their bêche-de-mer resource largely fished out and it appears that Milne Bay is embarking on a similar course. In Milne Bay province the TAC for bêche-de-mer has been exceeded time and again without leading to the closure of the fishing season as stipulated by the management plans (Kinch 2001). During the year 2000 politicians and traders alike put pressure on the National Fisheries Authority to approve a bêche-de-mer plan with a significantly shorter closed season and a higher quota than deemed wise by the authority. The original closed season from October to February corresponded to the bêche-de-mer spawning season, a period of considerable importance for the reproductive rate of the species.

This closed season however, conflicts with the cyclical need for income by many fishing communities. People need an income to celebrate Christmas, offset social obligations, and pay school fees in the beginning of January. The costs of schooling has increased significantly over the last few years, partly due to the application of the user-pay principle under World Bank reforms. Local politicians who felt the need to give their people a 'Christmas present' therefore called for an early start of the fishing season. To local bêche-de-mer traders there is an additional incentive to call for the early opening of the fishing season as they mainly serve the Chinese market. During Chinese New Year of January 2001, for example, the demand and prices for bêche-de-mer were higher than usual, providing a powerful incentive to shorten the closed season.

The National Fisheries Authority was not able to resist the resulting political pressure and agreed to open the fishing season in Milne Bay on the 15th of December 2000 instead of February 2001. In addition, it maintained the existing TAC on high valued bêche-de-mer species but added a second schedule of low value species. By doing so Milne Bay is following the course of the Philippines and Indonesia, and within Papua New Guinea of Manus and Western Province, where sedentary fishing resources of high value were the first to be fished out, followed by the depletion of lower value species. According to the Sedentary Fisheries Manager of the National Fisheries Authority it was up to the provinces themselves, in conformity with the principles of governmental decentralisation, to decide whether they preferred to limit the use their resources for the long-term benefit of their citizens or whether they wished to embark on a rapid but short-term intensification of resource extraction.

The Milne Bay Community-based Coastal and Marine Conservation Programme

From 1996 onwards the UNDP, which played a crucial role in the development of so-called integrated conservation and development interventions in Papua New Guinea (McCallum and Sekhran 1997; Filer with Sekhran 1998; Van Helden 2001a), became interested in developing a marine conservation project in the country. Milne Bay province soon became the focus of these efforts. In 1997 Conservation International, a large Washington-based conservation foundation became the executing partner, and in 1999 funding for further project development was secured from the PDF-B facility of Global Environment Fund (GEF). In 2002 after years of project development work the GEF Council approved a five-year U$ 7.1 million proposal to implement a so-called Community-based Coastal and Marine Conservation Program (CMCP).

The aim of the CMCP is to establish a number of community-managed conservation areas zoned for strict protection and sustainable use. Impetus for the programme came from research suggesting that marine protected areas reduce the pressure on stocks, thereby enhancing the spawning of stock biomass, and allowing for larval dispersal and the export of adults to adjacent non-protected areas (Alcala and Russ 1990; Roberts and Polunin 1991; Bohnsack 1993; Nowliss and Roberts 1998). Thus the establishment of marine protected areas is not only good from a biodiversity conservation point of view, but may also assist local communities to maintain the resource base on which they depend. In addition to the establishment of these marine protected areas, the programme aimed to improve the policy environment for marine conservation by strengthening the provincial and local-level governments, and by developing an environmental education programme that sought to impart conservation values and resource management skills to a variety of groups (Kinch 2003).

Collecting Data, Drawing Maps

Programme development in Milne Bay was initially guided by ecological considerations. In 1997 Conservation International conducted an intensive assessment of provincial marine biodiversity, which confirmed the high levels of biodiversity of the province and

legitimised further donor expenditure (Werner and Allen 1998). The threats identified by the programme related to over-fishing of pelagic and sedentary coastal species, the use of damaging technology such as dynamite and cyanide for the live fish trade and the impact of land-based activities such as sedimentation run-off due to logging and mineral exploration. A future conservation programme, however, would not be able to do much about the land-based activities affecting marine life. The resulting CMCP proposal did not intend to do anything about pelagic fishing and the intrusions of foreign fishing trawlers either. This was the responsibility of the National Fisheries Authority and fell outside the scope of the programme. The fact that this was also a highly political issue with several prominent members of national government involved in the pelagic fishing business may have played a role as well. This was hard to swallow for a number of commentators who continued to call for a ban on long-lining in Milne Bay waters even though such was clearly impossible both from a legal and a political perspective. As a result of these considerations, the eventual proposal came to focus on the management of local people's fishing practices by establishing a number of marine protected areas.

In 1999, an office was established at Alotau, Milne Bay, and a programme development team comprising several Papua New Guinean experts and two members from the Milne Bay provincial government staff was put together. This office worked under the aegis of the Papua New Guinea Country Office of Conservation International in Port Moresby. As part of the programme development process, technical support was provided by staff from Conservation International and a raft of external consultants, among whom was the author of this paper. During 2000 a number of Province Wide Assessment Patrols were held, while a second biodiversity appraisal was conducted (Allen 2000). This assessment had an unexpected side effect as the data actually gave the NFA an argument to raise the TAC on bêche-de-mer species in Milne Bay from 60 to 140 metric tonnes (pers.comm. Jeff Kinch).

The decision to restrict the programme to coastal marine resources and the findings of the two biodiversity surveys led to a site selection process culminating in a workshop in July 2000. During this workshop it was decided that three conservation zones would be selected. These zones jointly encompassed a vast sea area of some 46,800 square kilometres.

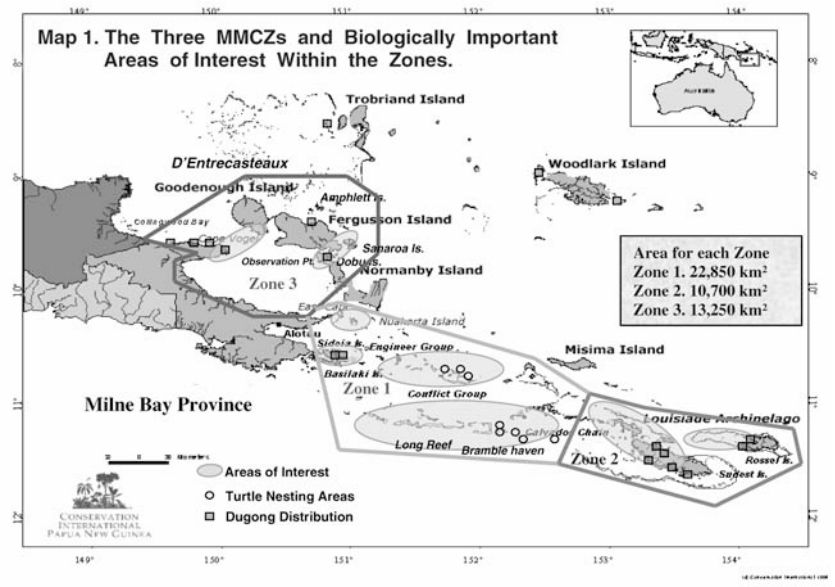

Fig. 5.1. The Conservation Zones of the CMCP.
Map reprinted by courtesy of Conservation International Papua New Guinea.

From Maps to People

During the site selection process, the project development team began to raise the question of local participation. The team realised that it needed to think carefully about how it could stimulate local communities to become involved. Under Papua New Guinea tenure arrangements, conservationists have no means to enforce or restrict resource-related behaviour and cannot stop communities from pursuing destructive forms of resource use. The conservation programme can only discuss the issue with local people and develop incentives in an attempt to steer interested communities towards conservation.

In other conservation projects in Papua New Guinea this realisation had led to the definition of three sets of overlapping conditions for protected area establishment. Only where one finds: 1) a biological resource worth conserving, 2) a community of resource owners who are both willing and able to partake in a conservation initiative, and 3) specific possibilities to develop conservation related income-generating activities, is there a chance for success (Van Helden 1998). The realisation that social and economic indicators are at least

as important for protected area design as biological indicators often triggers a debate between natural and social scientists about who takes the lead in establishing the protected area (Filer and Sekhran 1998; Van Helden 2001a).

In the case of the CMCP, the initial site selection process satisfied the ecologists who usually argue from a 'bigger is better' point of view and who saw the value of local marine biodiversity confirmed by their surveys. It also suggested to potential donors that a sizeable intervention worth funding was underway. Others, however, pointed to the impossibility of monitoring and protecting such a huge area, the lack of a legal framework to do so, and as the social and economic consequences of imposing a strict conservation regime on such a huge area. Some 80 percent of the provincial population depends on marine resources from the planned conservation zones for cash incomes and subsistence, and the banning of commercial exploitation of marine resources within those zones would entail a loss of livelihood opportunities to some 65,000 people. It was also highly unlikely that the provincial politicians, who regard the exploitation of marine resources as one of the few viable economic activities for a large part of the Milne Bay population, would agree to such drastic conservation measures.

In response to these comments and the perceived impossibility of developing a programme of this scale it was subsequently decided that the programme would initially focus on a number of smaller areas in Zone 1 during the first five years of implementation. Thus the spatial scope of the programme narrowed significantly. However, these areas were still very large, each comprising several thousand square kilometres and including numerous islands and communities. During the stages of programme formulation, tension developed between the ecological considerations underpinning the design of the CMCP, which emphasised the preferred outcome on the basis of ecological considerations, and the social and political realities of project development in Milne Bay.

Social Evaluation and Community Entry

In early 2000, Conservation International commissioned a so-called Social Evaluation Study (SES). Following the example of the Social Feasibility Study of the Bismarck-Ramu Integrated Conservation

and Development Project (Van Helden 1998), this study intended to determine the communities with which the programme could best co-operate, and where the establishment of marine protected areas within Milne Bay would be most feasible from a societal perspective. Important elements in such assessments usually are:

– The pressure on natural resources in various parts of the programme area;
– The mutual recognition of rights to resources and the clarity of boundaries between the involved clan groups;
– The cohesion of resource owning groups and the ability and willingness of their members to jointly undertake activities;
– The socio-economic expectations of people, and the available opportunities to link economic activities to conservation initiatives.

The SES carried out in Milne Bay collected a vast amount of information on the area, its history, the kind and scope of conflicts between the various clan groups, and their various resource-uses. Following the decision to focus on Conservation Zone 1, the SES gave an indication of three communities where the best opportunities for achieving marine conservation in that zone were to be found from a societal perspective (Kinch 2001).

The SES also recommended making use of the so-called Ward Development Committees (WDCs) to develop village-based marine conservation strategies and to conduct further socio-economic and biodiversity assessments. The WDCs consisting of six village members representing the ward in the local level government and determining the needs of the ward in terms of services, programmes, and infrastructure. The wards often reflect communities, or clan groups, thus making them more or less representative of community interests. This made the WDCs interesting vehicles for managing community interests in the field of resource management.

Following the SES the programme developed a Community Engagement Programme (CEP) largely based on the experiences of the Bismarck-Ramu Group (compare with Van Helden 2001a). This programme made use of so-called village trainers who were trained in a variety of awareness raising and Participatory Rural Appraisal techniques (Kinch 2003). During their patrols these village trainers undertook discussions with a variety of groups and their WDCs. The aim of these discussions was to explain the nature of the programme to the local people, and to (i) train local groups to serve as village-based awareness and local contacts; (ii) conduct in-depth biological

and social inventories that would help to assess the best place for action; (iii) mobilise communities to improve local management of marine resources by means of local capacity building; and (iv) create economic incentives for marine conservation and the sustainable use of marine resources. This last point became a major issue, as it happened to further restrict the scope of potential programme implementation.

The Economic Underpinnings of Conservation Initiatives

The question of why local people would refrain from resource use in the name of global conservation was an important one to the programme. One answer often heard is that in the longer run conservation is good for local people and that a carefully phrased communications programme may convince people to look after their marine resources. Kinch (2001) for example argues that due to the restricted resource base of many small islands, and the long history of commercial exploitation of some marine species, many people in Milne Bay have an understanding of vulnerability of marine resources to human use. A different argument is that people are locked in a downward spiral of degradation due to a lack of alternatives and that conservation can only be socially sustainable if it directly contributes to the well-being and the increase of livelihood opportunities of the owners of those marine protected areas. According to this argument it is necessary to integrate development activities into the management of a conservation area in order to guarantee the sustainability of the protected area.

The Milne Bay programme developed the innovative approach of forging a linkage with the local dive boat industry. Milne Bay is one of the world's most pristine diving sites and a number of dive boat operators visit outlying community-owned reefs with their guests. Developing a system of dive fees could create an economic incentive by which local people would become interested in maintaining their marine protected areas. This would give the diving industry a guaranteed access to unspoiled areas thus ensuring the sustainability of the industry, while it would provide local people with income from the marine protected areas. The programme management team would have to negotiate with the dive boat operators about the fees, and would also have to carefully plan how the earnings should be distributed among the resource owning groups and their members.

Unfortunately, the tourist industry in Papua New Guinea is very small and the diving industry in Milne Bay consists of only three independent diving boat operators who jointly serve about 1,000 visitors each year. The number of communities that can benefit from this form of income generation is limited to those who are within a reasonable sailing distance from the provincial capital Alotau, and those who own good quality reefs for diving. These reefs are not always the most valuable from an ecological point of view. Spreading the benefits too thinly among the resource owners would reduce the incentive to maintain the integrity of the marine protected areas supported in this manner. Finally, it turned out that the possible number of community-based marine protected areas that would provide sufficient economic benefit to the owners through the diving industry was very limited.

As a result, the programme management team engaged in a search for other economic alternatives. One option is the use of so-called 'conservation agreements'. Such agreements are essentially performance contracts whereby communities get paid to keep their resources intact. According to Ferraro and Kiss (2002) such direct payments can be more effective and efficient than the usual approach. Conservation International is presently testing such direct payment strategies in a variety of places, but it is still unclear whether they will also use such contracts in Milne Bay, or how issues of price setting, the distribution of benefits, and the resolution of conflicts that arise as a result of these payments between particular individuals and between and within particular groups would be solved. The Nature Conservancy, another American NGO working in Papua New Guinea has given up on developing this approach, while the experiences with conservation agreements at Lak in South New Ireland and elsewhere have led the Bismarck-Ramu Group to vehemently oppose the use of any economic incentive for conservation (Van Helden 2001a).

Conclusion and Discussion

The pattern that conservation interventions take is usually one of ecologists and conservation managers analysing local circumstances, listing threats in the form of population growth, local subsistence and cash earning practices, and industrial processes. Subsequently these experts turn to their maps to define the areas of high

biodiversity and draw the outlines of potential protected areas. Having defined both the problem and the solution, these interventions subsequently move on to 'dealing' with local communities. In the past this often meant that local people were excluded from previously accessible resources. Nowadays conservationists are in the business of designing integrated packages of development and conservation measures that rely on a combination of coercion and incentives. In the case of indigenous resource ownership such as found in Papua New Guinea, the use of this sequence of steps based on ecological and spatial criteria for protected area design can be questioned.

The CMCP, for example, initially planned to protect a vast sea area and coastline through the establishment of three large conservation zones in which the most serious threats to local biodiversity were to be dealt with. Thus overfishing was to be avoided through a strengthening of provincial control systems, local communities were to be involved in managing these protected areas, and economic incentives were to be derived from the diving industry and other sources. During the design phase of the programme however, the management team was continuously confronted with the social and economic realities at play in Milne Bay and Papua New Guinea. In its attempts to deal with these realities, it was forced to step-by-step reduce its vision of establishing a sizeable marine park in Milne Bay.

First of all the project team realised that it could do very little to control the long-lining industry and foreign intrusions. Decisions concerning this matter fell outside the competency of the Milne Bay Provincial Government and outside the scope of the programme. The programme therefore restricted itself to the conservation of coastal marine resources and the strengthening of provincial controls on sedentary fishing, even if this was highly political. Following the designation of the three conservation zones in July 2000 it soon became obvious that controlling such a large area was impracticable. The fact that the provincial government and project team did not have any legal means to control resource use in that area meant that intensive discussion with local communities and an assessment of the social feasibility of setting up community-based marine protected areas in Zone 1 had to take place. The Social Evaluation Study that resulted, recommended three communities for further work. Later, the need to create economic incentives for community-based marine protected area establishment, and the limited ability of the local diving industry to provide a meaningful linkage between conservation and development further reduced the options available.

Rather than aiming for the initially planned large and continuous conservation zone the project vision gradually evolved into developing a *network* of much smaller community-based refuges (Kinch 2003).

These changes led to discussion within CI. In the second half of 2002, even after the GEF Council had approved the CMCP proposal, a senior official of CI visited Milne Bay to see how the programme was coming along. Following his visit, CI developed an action plan for Milne Bay called 'Doing Conservation Over and Above the GEF Grant for Milne Bay'. The action plan was clearly written from the perspective that the Milne Bay programme was doing too little too slowly and emphasised the need for immediate action and a more proactive and aggressive approach to conservation. After reiterating the importance of existing activities under the GEF project the action plan made several suggestions including 1) a ban on long-lining in Milne Bay waters, 2) a ban on all commercial harvesting in conservation zones 1, 2, and 3 with a total sea area of 46,800 kilometres, 3) a 'massive reduction' of the fishing industry in Milne Bay, and 4) a 'massive expansion' of tourism. In doing so, the discussion about what form of conservation was feasible in the context of Milne Bay came full circle and the ground staff went through another round of explanations as to what they were doing and why, emphasising the societal limitations under which its conservation interventions were taking place.

Towards 'Data-less' and 'Map-less' Conservation Intervention

This account of how in the context of indigenous resource tenure the ecological considerations for conservation become subsidiary to the societal context not only illustrates the difficulties that conservation organisations have in coming to grips with the practical consequences of 'people-oriented' approaches to conservation, but also points to the limited use of detailed data collection and spatial planning. Johannes (1998), for example, calls for a 'data-less' approach to marine resource management in the Pacific. Data-less management is not based on the conventional approach of intensive data gathering and analysis, but it is not information free either. The term refers to the use of local knowledge and self-reinforcing feedback systems at the local level, where communities assess the status of their resources and take conservation measures in the form of gear restric-

tions, size limitations, and the spatial and temporal closure of certain resources. It reflects the need for local communities to share in the view that their resources are at risk and the need for support to be given for the implementation of the conservation measures that they themselves, as owners of the resource, consider necessary. Thus it is not the expert assessment of the situation, but the local perception of what needs to be done that counts.

In a similar vein, the tenure system in Papua New Guinea calls for 'map-less' conservation interventions. The drawing of charts that outline the views of the conservation agency and its experts may help to define a general working area, but has very limited practical value.

What was missing in the initial zoning maps of the CMCP was the realisation that the livelihood options pursued by local people are highly variable and that the responses to its conservation intervention may differ from community to community. While the project team wanted to include people in its operations as much as possible, it did not realise that doing so meant that outlining conservation zones had little practical use in terms of further programme development. To group disparate communities together in a series of conservation zones, ignores the social and cultural reality of community-based conservation. The management team cannot possibly predict the outcomes of its programme, as these are not so much the result of its own spatial planning process, but more the result of the day-to-day interactions between the programme and local resource-owners.

Experiences from mainland Papua New Guinea point in a similar direction: The Bismarck-Ramu programme in the highlands, for example, started with defining a very wide 'area of interest' of some 325,000 hectares and conducted a single biodiversity survey. It did not go into any further mapping activities within that area, but instead concentrated on building up relations with local communities and assessing which communities it could best work with. After three years of extensive interactions with local communities two so-called community-based Wildlife Management Areas were established. Both of these however, happened to fall well outside the initially targeted area that had been surveyed by biologists (Van Helden 2001a).

These experiences thus point to the limited use of detailed ecological data collection and planning exercises in the context of indigenous resource tenure systems. The actual conservation activities as they develop tend not to be based on ecological best practice and de-

tailed spatial planning, but are a product of societal considerations and the responses of local communities to the conservation intervention. In the context of conservation in Papua New Guinea it may make more sense to talk to people than to survey biodiversity or draw maps.

Note

1. Flip van Helden is senior policy advisor at the Nature Department of the Ministry of Agriculture, Nature and Food Quality in The Netherlands. E-mail : Vanhelden-Stocking@hetnet.nl. The author is grateful to Gaikovina Kula, Country Director of Conservation International in Papua New Guinea, for his permission to use the project map of Milne Bay Province. This paper is based on a Ph.D. thesis on Integrated Conservation and Development Projects in Papua New Guinea (Van Helden 2001a) written at Wageningen University, the Netherlands, and on consultancy work conducted for Conservation International, the UNDP, and the GEF in Milne Bay Province in 2000/2001 (Van Helden 2001c). The views expressed do not reflect the position of these organisations but are the responsibility of the author.

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6

Basic Principles Underlying Research Projects on the Links between the Ecology and the Uses of Coral Reef Fishes in the Pacific

Michel Kulbicki[1], *Pierre Labrosse*[2], *and Joceline Ferraris*[1]

Introduction

Pacific island countries cover a very wide geographical area, spanning more than 10,000 kilometres from west to east. This region is the most diverse in the world for shallow water marine life, a characteristic due in large part to the presence of its extensive coral reefs. There are well over five thousand fish species known to date in this area, of which several hundred have not yet been described. This diversity is reflected in the number of coastal organisms of human interest in this area, as well as by the variety of the uses of lagoon and reef fishes or invertebrates (Dalzell et al. 1996). In most Pacific island countries, the catch coming from coastal resources is used mainly for subsistence. This contrasts with offshore fisheries, in particular those for tuna, which are essentially market driven (Gillett and Lightfoot 2001). Because of the low monetary exchange that these coastal resources generate, little attention has so far been given to their management.

Most Pacific island states are facing dramatic increases in their populations. This is resulting in many anthropogenic effects on coastal ecosystems and deep modifications of the socio-economic conditions of human populations, such as a crowding of the metropolitan islands, a decrease in the population of the islands most distant from the major cities, and profound changes in social structure. At the same time, the influence of the market economy is increasing, due in particular to demand for fish products from urban areas and the export of fisheries products to the Asian market or to emerging markets (Dalzell et al. 1996; Sadovy and Vincent 2002). The impact

of the market economy is also felt by the introduction and use of increasingly efficient, and at times destructive, gears (Dalzell et al. 1996) and by the decrease in some places of subsistence fishing. On the other hand, subsistence fishing, as previously mentioned, remains a major source of food for large groups within these populations (Gillett and Lightfoot 2001). Subsistence uses are usually in conflict with monetary uses of coastal resources. As coastal resources are a major source of protein for Pacific island populations, these new monetary uses of resources not only result in increased ecological stress, but threaten food security and change feeding habits. In the coming years, drastic changes in resource levels and their uses are probable and in great part dependent on the population level. Figure 6.1 shows the type of variations one may expect.

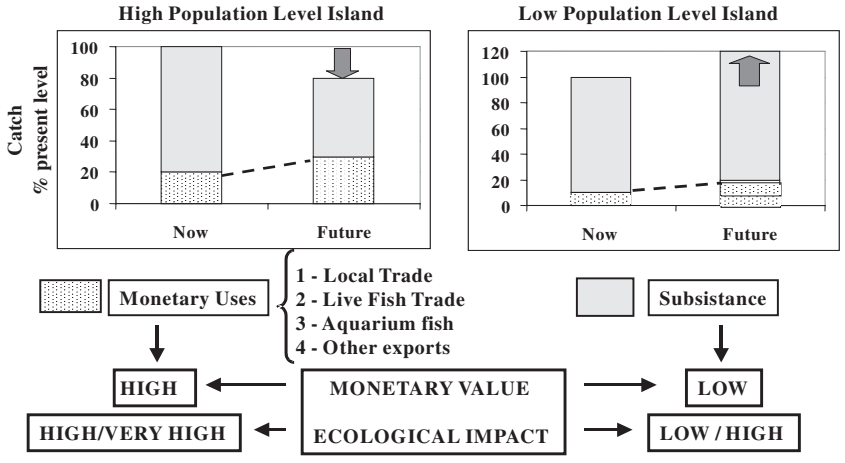


Fig. 6.1. Example of expected evolution of the uses of coastal marine resources in Pacific island countries in the near future.

In this scenario, monetary use of coastal resources would increase most in the populated islands where comparatively larger perturbations of the environment are expected. This could bring lower fish yields in weight even though the monetary value might increase substantially. The decrease in subsistence uses could happen in tandem with changes linked to resource availability, time spent on fishing, new consumption habits, and the availability of non-traditional marine products, like canned and frozen fish. On islands with low popu-

lations or on islands far from the metropolitan areas, it is likely that total catch will increase as a result of an increase in labour and better fishing gear, but the total financial income will remain the same or increase only slightly because of their low connection to the market economy. An increase in catch would only be possible if the resources were not initially exploited at their maximum level. The ability of island populations to sell resources for money will vary widely, depending on factors such as accessibility of the resource, distance to markets, and the availability of local infrastructure such as airports, ports, roads, and storage facilities. The present scenario is of course not unique, but it reflects some of the issues Pacific island states are facing.

This situation necessitates more and better management of coastal ecosystems and their uses (Maragos and Crosby 1996; Crosby et al. 2002). However, Pacific island countries do not usually have the means to conduct sophisticated surveys of their resources and of their uses or to follow intricate management schemes. Even when they do, it is of paramount importance to have solutions which are accepted by local populations (Crosby et al. 2002). Solutions have to be understandable at all levels and easily applicable. Therefore, in order to manage coastal resources, it is necessary to identify solutions that will produce efficient, yet simple, management tools. As the ecosystems supporting these coastal resources are extremely complex and their uses multiple (Dalzell et al. 1996) there is an antagonism between, on the one hand, finding ways to simplify data collection and interpretation and, on the other hand, taking into account the complexity of this environment. The present article investigates the theoretical background underlying potential applications of several current research projects dealing with these coastal resources and their uses. In particular, we will attempt to bridge information coming from ecology with social and economic studies of fisheries. In other words, this is an endeavour to use information on the composition and functioning of whole assemblages with information on the catch (species, level, sizes). It is very important to note that the present article is mainly hypothetical, most of the ideas presented being currently tested by several research programmes but not yet fully assessed.

General Conceptualisation of an Ecological Approach to Pacific Island Fisheries

Pacific countries are archipelagos with a limited number or no large (more than 2,000 km^2) islands. From an ecological point of view, these systems are subject to limited outside influences. These include, for instance, the fact that many species have exchanges with nearby islands only through larval colonisation, this phenomenon being itself irregular through time (Doherty 1991). Similarly, most of these islands are isolated socially and economically, as exchanges with other islands are few and often lopsided, with the capital island generally acting as a magnet for people and resources. It is therefore possible to consider, as a first assumption, that these islands are isolated systems from both an ecological and a socio-economic point of view (fig. 6.2). This does not mean that these systems have no exchanges with the outside world, but that these exchanges are limited and in most part measurable with a reasonable accuracy and a limited effort.

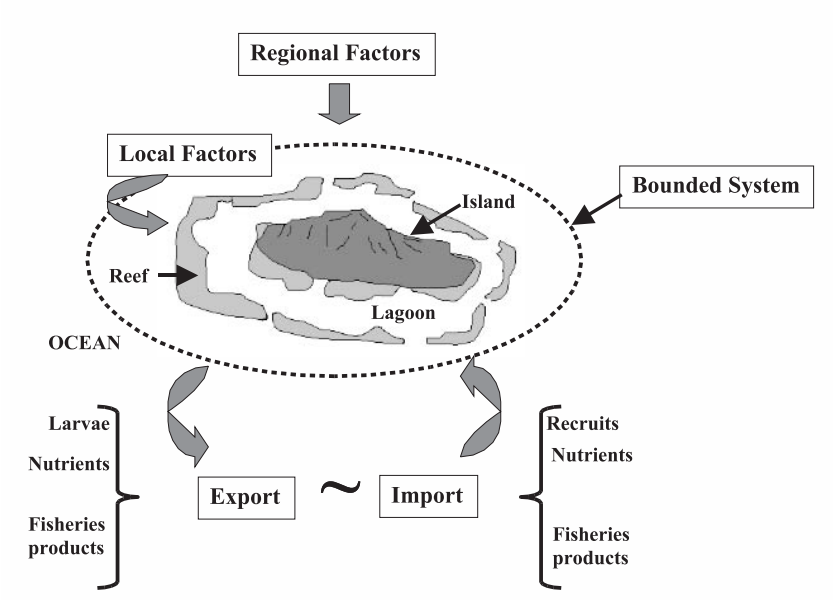


Fig. 6.2. Islands as semi-closed systems from an ecological and socio-economic standpoint.

These basic features make Pacific islands ideal field laboratories to test a number of hypotheses linking resources levels with the ecology of the resources and the uses to which they are put. Indeed, the very large number of islands (thousands, amongst which several hundred are inhabited) makes it possible to look at a range of islands according to criteria such as island size, island type, population level, and distance to the capital island. This potential for an experimental approach based on an analytical design of both ecological and human factors is quite unique in the maritime world.

The status of the resources on a given island is influenced by two major types of factors: regional and local. Regional factors give a general setting to the resources. For instance bio-geographical region, island size, island type, and distance to the nearest island may be considered as regional factors. Local factors will modify, sometimes considerably, the action of the regional ones. One may cite biotope, depth, pollution, fishing level, and climatic events as such local factors. The combination of these local and regional factors determines the nature and the abundance of resources. In order to follow an analytical design, each of the factors one wishes to study will need to have several classes or levels. For instance, island size could be differentiated into small, medium, and large. The number of possible combinations will depend on the number of factors and the number of levels within a factor. In turn, the models subsequently built from this analytical approach will be limited in their precision and predictability level by the number of factors and levels considered as well as by the number of observations per factor and level. In this type of approach there is therefore necessarily a trade-off between the level of precision required from the models and the quantity of fieldwork it is possible to accomplish.

This modelling, or *ecosystem approach*, has several objectives:

a. To evaluate what can be attributed to uncontrollable *versus* controllable factors in the observed structure of reef fish communities. In particular, to evaluate the impact of fishing on the structure and functioning of reef fish communities;
b. To give an indication, based on a minimum of easily available information, of the resource potential of a given island or area;
c. To indicate, within the above resource potential, if one or more group(s) of species is, or are, at risk or, on the contrary, can be further exploited;

d. To identify habitats or biotopes which may play a particular role in the functioning of these communities.

This approach intends to take into account simultaneously the fish communities, their environment, and the use to which they are put. For the determination of use we will be more interested in exploitation levels and consumption rather than more traditional catch and effort data, as the latter are extremely difficult to assess in artisanal fisheries.

The following overview of our current knowledge of the ecology and fishery of coral reef resources suggests that this ecosystem approach may meet a number of the expected management objectives of Pacific island countries.

Material and Methods

As social and economic studies of fisheries and ecology tend to attribute different meanings to the same word, we wish to give the following definitions for the present article:

Regional diversity: number of fish taxa occurring in a given region;

Regional or Island species pool: list of all the species occurring in a given region or island;

Local Diversity: number on fish taxa on an island, usually restricted to a given biotope (e.g. reefs) and to a particular sampling method (in our case underwater visual censuses – UVC – unless otherwise stated);

Species Density: number of species per unit of observation. All species densities will be expressed in terms of the number of fish species per 50 m transect;

Fish Density: number of fish per unit of area. Here densities will be expressed as fish /m^2;

Fish Biomass: weight of fish per unit of area. Here biomasses will be expressed as grams of fish /m^2;

Fish stock: cumulated weight of fish over an area. Here stocks will be expressed in tonnes;

Fish meta-community: community represented by all fish species existing in a large area (region, island, or part of an island) encompassing several habitats. Meta-communities will usually be defined for a given biotope as, for example, reef fish meta-community.

Reef fish live in clear and warm waters. Most of the species exploited for subsistence fishing live in relatively shallow waters. These characteristics allow for the survey of these fish communities by underwater visual censuses (UVC). This method has many advantages. In particular, it is non-destructive, which allows for unbiased time replication; it records a large number of species in a limited amount of time; it records habitat characteristics simultaneously (particularly coral and algae cover); and it records size and behaviour easily. UVC sampling allows for the estimation of species density, fish density, and fish biomass as well as the size distribution of the most abundant species. These estimates, combined with information on the diet, size, range, and behaviour of fish species enable us to study the structure of reef fish communities and their variations with a number of factors. In this presentation we will use results from transects that we conducted in several island-states of the Pacific, along with results from transect work found in the literature (Appendix 6.I, Table 6.1).

Ecological Framework

This ecological framework is built on the existence of relationships between parameters of fish communities such as species density, density or biomass at different spatial scales (see Peterson et al. 1998 for the importance of scale). These relationships are then considered with respect to the properties of fish communities such as stability, resistance, and resilience, which are of particular interest for their management.

Relationship between Regional and Local Diversity

Our first hypothesis is that local diversity strongly depends on the number of species found in the region (Hillebrand and Blenckner 2002). The link between regional and local diversity being influenced in particular by factors such as island size, distance between islands, and distance to the centre of biodiversity (Bellwood and Hughes 2001).

The coastal fish fauna found in the Pacific islands has several important characteristics. First it is the most diverse fish fauna in the marine world with more than 5,700 taxa known to date in the 0-100

m depth range. Among these taxa, more than 3,000 are associated with reefs. As a comparative example, the most diverse fish fauna in the Atlantic, the fish fauna of Caribbean reefs, totals less than 500 species. The second characteristic of this fish fauna is the important gradient in regional diversity as one goes from the biodiversity centre of this fauna, located in the Philippines-South China Sea-Indonesia triangle, eastward towards Polynesia (fig. 6.3).

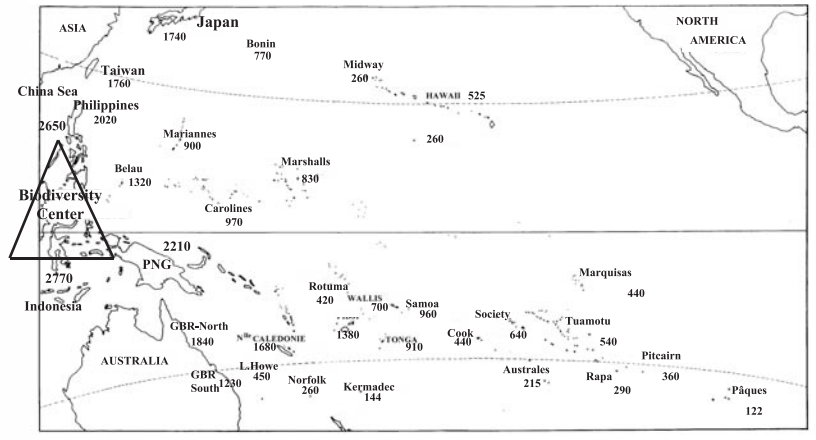


Fig. 6.3. Distribution of coastal species (0-100 m) in the tropical Pacific. References and data available from the first author on request.

This decrease is greatly linked to the increasing distance between islands as one goes eastwards, as well as to the size of the islands which are smaller and smaller on average on this west-east gradient (Kulbicki and Rivaton 1997; Bellwood and Hughes 2001). If both distance and island size are combined it is possible to estimate the potential number of species of an archipelago from these two factors with a reasonable accuracy:

> Number of Species = 336 – 0.026 D + 99.9 T with r =0.84 (N=54 and p<0.00001)
> D: Distance to Biodiversity Center in km
> T: Island Size on log scale

It is often interesting to classify fish species according to criteria such as their family, genus, size, or trophic status. Grouping by fam-

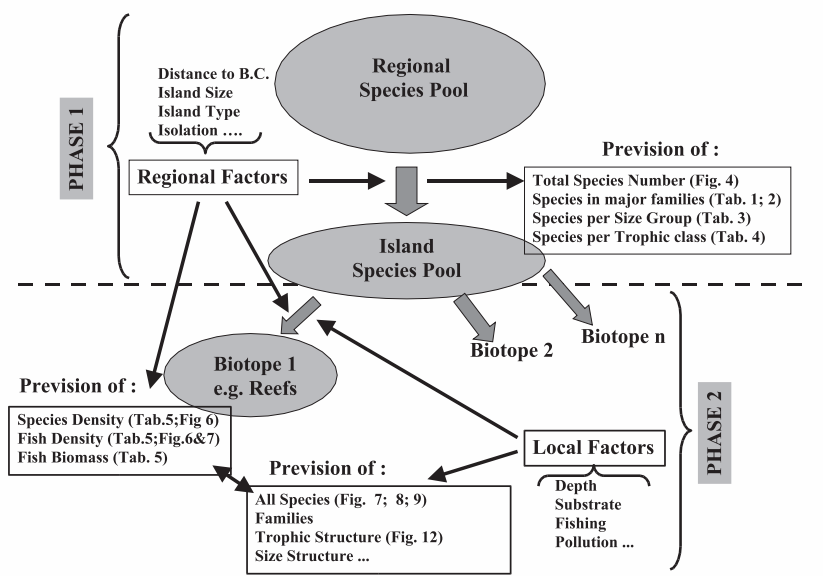


Fig. 6.4. Ecological framework proposed for the analysis of reef fish communities of tropical Pacific islands and the development of management tools.

ily or genus is usually done because within a family, and more so within a genus, species usually share many biological and ecological characteristics, such as size, behaviour, diet, and reproductive strategies. Classifying fish by size may be interesting from an economic point of view as usually the largest species are those which are the first targeted by fishermen and they are often also the most vulnerable. There is also usually a strong relationship between size and abundance, the smallest species being the most abundant. To classify species according to their diet may give important insights into the functioning of fish communities. An analysis of the relationship between regional and local diversity for these various classes shows that for the family level (Appendix 6.II, Table 6.2), the genus level (Appendix 6.II, Table 6.3), the size distribution (Appendix 6.II, Table 6.4), or the trophic structure (Appendix 6.II, Table 6.5) one finds significant correlations with distance to the biodiversity centre and to island size.

In other words, from our current knowledge of the distribution of fish species across the Pacific, from only two regional factors it is possible to make a first evaluation of the characteristics of the species one should find on a given island (fig. 6.4). Of course such a result can be greatly improved by adding to the model other regional factors

such as distance between the islands, the island type, and the reef to land ratio. This modelling corresponds to *phase 1* in our ecological framework (fig. 6.4).

Relationship between Diversity and Other Parameters of the Fish Communities

Once we have established the relationship between the species pool of an island and some regional factors, one may consider the *second phase* of our approach (fig. 6.4). This phase aims at relating the *combined* effects of these regional factors with local factors on specific fish communities. Specific fish communities in this case are defined as belonging to a given biotope within an island. One notices that a restricted number of factors may explain a very high proportion of the variation. This is common to other ecological models (Côté and Reynolds 2002), the usefulness of which depends on how easily the necessary information may be gathered.

A specific fish community may be characterised by a number of parameters, the most frequently used being its species density (species/sampling unit), density (fish/m^2) and biomass (g/m). There are clear relationships between the species pool of an island and these parameters as illustrated for species density (fig. 6.5a) and density (fig. 6.5b).

This means that it is possible to relate these parameters of fish communities directly to a number of regional factors. We are developing a statistical model relating species density, density, or biomass of given types of reef fish communities (barrier reefs in our case) to regional factors. The modelling is in its initial phase as it includes only 4 factors: island size, the distance to the bio-geographical centre, length of the coastline, and island type (Appendix 6.II, Table 6.6). This preliminary model indicates that the species density and density or biomass found on barrier reefs on an island are linked to the general characteristics of this island. Despite the fact that this model yields highly significant results, it still leaves a very high margin of error. The major reason for this is that local factors are not included.

The number of combinations of the various levels of regional and local factors is nearly infinite. Therefore, it is necessary to find which factors are the most important both on a regional and local basis. One way to explore how these factors affect fish communities is to keep constant as many factors as possible and have only one factor

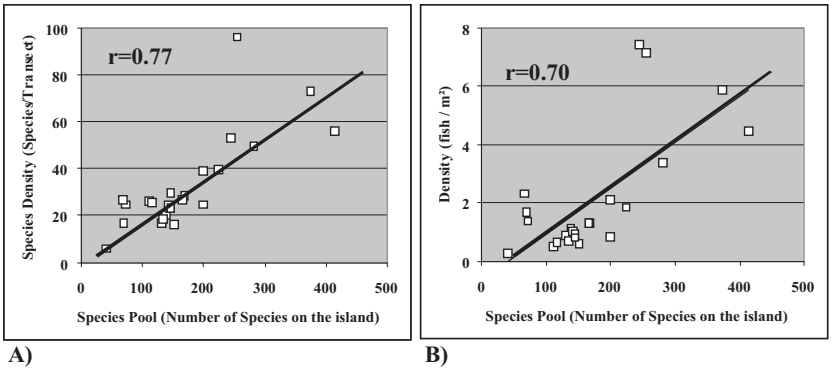


Fig. 6.5. Relationship between local diversity (number of fish species detectable by UVC) and species density (3A) (average number of species per transect) or density (3B) (average fish/m^2). Each point represents the average of at least 20 transects on an island. N = 24 islands (references of data Table 1). Results are similar (r=0.768) for biomass (g/m^2).

fluctuate. This is unfortunately very difficult to achieve, as the number of factors is very high. For instance, fishing pressure is among the most important local factors (Jennings and Kaiser 1998). In order to test its action one would need to compare fish communities from a given reef type on islands from different regions but of similar size, and type. Fortunately the problem is partly reduced by focusing on relationships linking regional and local diversity to species density; and on relationships between species density and other fish community parameters, in particular density and biomass.

Species extinction or extirpation (local extinction) is rather exceptional for coral reef fish (Jennings and Kaiser 1998; Hawkins et al. 2000), affecting only rare species, and it is unlikely that local factors will induce much change in the species pool. In contrast, fishing pressure is well known to decrease local species density (Jennings and Kaiser 1998). As can be observed in figure 6.5a, the local species pool will greatly determine the species density for a given reef type. Such a result is generally acknowledged in ecology (Hillebrand and Blenckner 2002). For a given set of local factors, species density will in turn determine in great part density (fig. 6.6a) and biomass (fig. 6.6b).

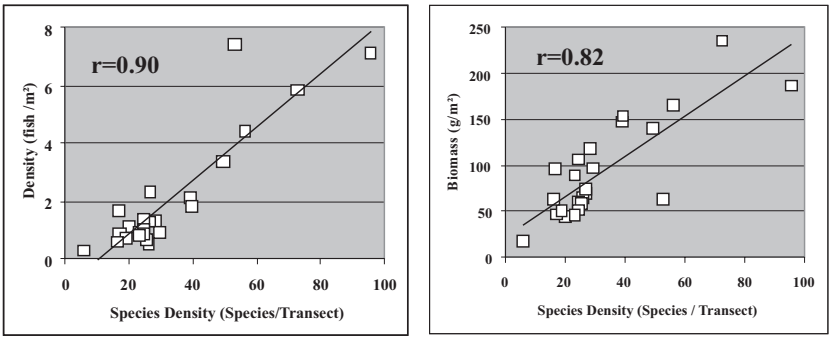
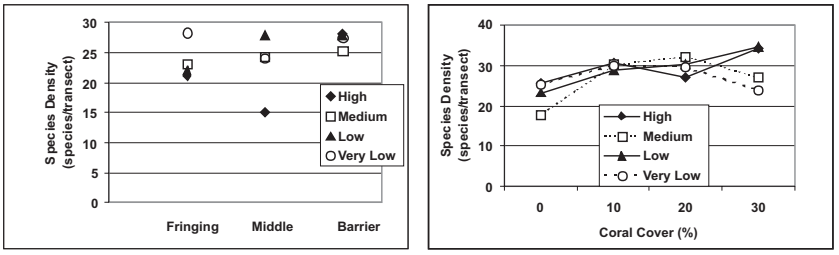


Fig. 6.6. Relationship between species density (average number of species per transect) and observed density (A) (fish/m^2 on transects) or observed biomass (g/m^2)(B). Each point represents the average of at least 20 transects on an island. N = 24 islands (references of data Table 6.1)

The relationships between species density and density or biomass are expected to be influenced by local factors, of which biotope, fishing pressure, and depth are particularly important. We developed the hypotheses that for a given set of regional factors:

1. Species density will vary little with fishing pressure for a given set of local factors.
2. The relationship between species density and density, or biomass, will depend on fishing pressure (Jennings et al. 1998), when all other local factors are set.

To test the first hypothesis we need to find how species density will vary according to local factors, once regional factors are set. The literature and our own data show that species density will vary with local factors such as coral cover (Bell and Galzin 1984; Roberts and Ormond 1987), algae cover (Rossier and Kulbicki 2000), depth (Luckurst and Luckurst 1978; Friedlander and Parrish 1998), oceanic influence (Grimaud and Kulbicki 1998), type of reef (Williams 1991; Kulbicki 1997) and combinations of these factors (Friedlander and Parrish 1998). However, little is known on how fishing pressure may intervene in these relationships. Fishing pressure is likely to influence local factors such as coral cover or algae cover and therefore indirectly affect species density. Available data from New Caledonia (fig. 6.7) suggest that fishing pressure, within the range available in

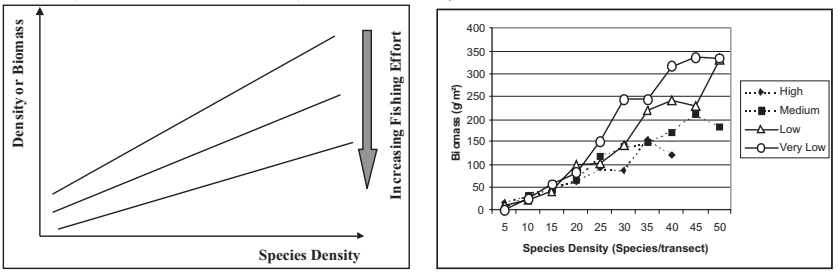


A) B)

Fig. 6.7. Variations of species density with reef type (A) or coral cover (B) according to four levels of fishing pressure (Very Low to High). Data are for commercial reef species in the Northern Province of New Caledonia (Labrosse et al. 1999).

that data set, has little influence on the relationships of species density with other local factors such as reef type or coral cover.

While relationships resulting from the second hypothesis may in general look like figure 6.8, opposite trends can also be expected. In particular, increasing fishing pressure on piscivores may favour higher densities of prey species (even though this is seldom observed – Cury et al. 2002; Pauly et al. 2002).



A) B)

Fig. 6.8. A) Expected relationship between density or biomass with species density for increasing levels of fishing effort; B) observed relationship between biomass and species density of commercial reef fishes for increasing fishing levels (from Very Low to High) based on data from New Caledonia (Labrosse et al. 1999).

Structure of Fish Communities

The last step in this ecological approach to local fish communities is to look at their structure. Amongst the many traits structuring a community, three are particularly important in regard to the functioning

of the community: diet (Pauly et al. 2002), size (Peterson et al. 1998) and home range (Peterson et al. 1998; Jennings and Kaiser 1998). This type of information is available at a crude level for most species known from Pacific island reefs and lagoons and can thus be included in statistical models, which estimate species diversity according to regional factors (see Appendix 6.II, Tables 6.4, 6.5). One may therefore probably estimate with a reasonable precision the trophic, size, or behavioural structure of a reef fish community from a limited number of regional and local factors. The latter do indeed also play an important role in determining the type of species which will constitute a given community. Consequently, it should be therefore theoretically possible to build a statistical model that shows the structure of a fish community at the species level for a given reef of a given island.

The next question is whether this structure can be linked at the species level to the structure in terms of density, biomass, or even production[3] (at present our lack of information on the biology of reef fishes prevents any good estimate of production). This is likely to be a very difficult task since species density is not the only factor driving density, biomass, or production of a fish community. We are presently thinking of testing whether the relationships between species density, density, and biomass, within a given set of regional factors, can be estimated from a limited number of local factors for at least some particular groups, for instance herbivores, large species, or sedentary species. Preliminary results lead us to think that such relationships can be established at least in some cases. We will illustrate this with an example from French Polynesia (fig. 6.9). The reef fish communities from the lagoons of ten atolls were surveyed. The atolls had been chosen according to two gradients: size and degree of opening to the ocean. A statistical model based on General Linear Model (GLM) allowed for the estimation of values of species density (noted as *species* in fig. 6.9), density, and biomass for several trophic categories. This model yielded results for three classes of atoll size (a regional factor) and three levels of hard bottom (a local factor). The figure indicates that there are important trends in the trophic categories according to these two factors. It is not so much the specific results shown in figure 6.9 which are of interest here, but the fact that this type of modelling could be developed for a number of situations. One of the goals of our programmes is to model the trophic structure of fish communities according to the region, the island size, the island type (as regional factors), and according to biotope and fishing level

(as local factors). Graphical representations like figure 6.9 would be generated by this modelling and could assist our understanding of the functioning of these fish communities and how they may be managed.

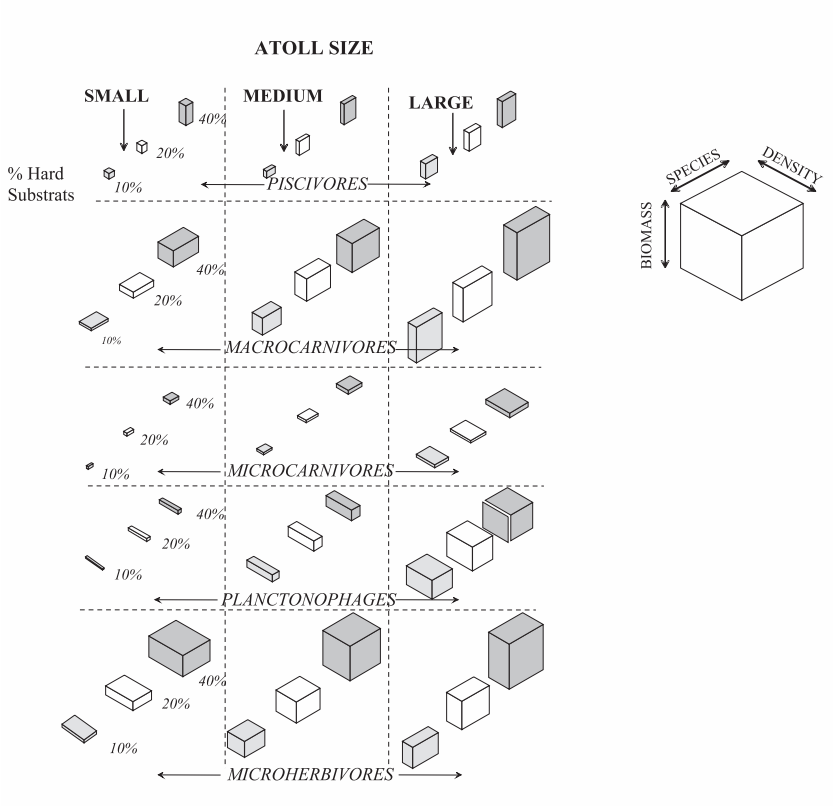


Fig 6.9. Example of a statistical modelling of the trophic structure of reef fish communities. For each 'cube' the vertical dimension represents the biomass (g/m^2), the horizontal dimensions giving the species density (species/transect) and the density ($fish/m^2$) as indicated on the separate diagram. The dimensions of the 'cubes' are proportional to the highest value estimated for all situations. Two factors are tested: atoll size (small, medium, and large) and hard substrate cover (10, 20, and 40 percent). Based on data from 10 atolls of the Tuamotu archipelago (French Polynesia) (Kulbicki et al. 2000). Note the importance of herbivores in all cases, the increase of plankton feeders and macrocarnivores with atoll size, and the general increase of species density, density and biomass with hard substrate level.

Models might yield estimations for species density, density, biomass, or even production, of whole fish communities or for some particular groups within these communities. As demonstrated further, these data can be used in a pragmatic way with a limited theoretical background. However, they could be used even more effectively if they were placed within a framework explaining the possible role of these various parameters in the functioning of the fish community.

At the moment the theoretical background linking these parameters to the functioning of a community is rather tenuous. Most theories are based on diversity and more recently on abundance (Rice 2000; Hubbell 2001; Cury et al. 2002), but very little deals with biomass or production even if these parameters are at times implicit.

From a management point of view, one aim is to harvest as much of a resource as possible without jeopardising it. In such instances it becomes important to consider three parameters of fish communities, stability, resistance, and resilience (see Peterson et al. 1998 for a general review and McClanahan and Polunin 2002 for a review specific to coral reefs). Current theory suggests that these parameters are greatly linked to diversity as indicated hereafter (McCann 2000). Fish communities may be thought of as entities with their own functioning dependent on the properties of each species belonging to this community. However, each species does not have the same importance in the functioning of the community (Cury et al. 2002), some species being more important than others because of specific behavioural, biological, or ecological traits, or because of their density, biomass, or productivity. Species may be gathered into functional groups, a group being defined as all the species having similar biological, behavioural, and ecological traits within a community. For instance in a coral reef fish community one could consider the functional group of small, territorial, and sedentary coral feeders. The diversity of a functional group will change with a number of factors that are not only regional but also local. Another important point is that most functional groups will have a dominant species, often called *driver* species. These driver species will change from place to place and through time within a given place. In other words, the function will be maintained but the rank of the species within a functional group may change with a number of factors (Peterson et al. 1998). A given species will often participate in several functional

groups as it grows. For instance, very small parrotfishes tend to eat small benthic organisms, but as they grow they will switch to herbivory. Therefore they belong first to the category of the small, mobile, schooling microcarnivores, then switch to the category of mobile, schooling herbivores. Some communities are also characterised by *keystone* species or functional groups (Cury et al. 2002). These keystone species or groups may have a tremendous impact on the parameters or the structure of the fish community. For instance, urchin predators can be a keystone group in some tropical fish communities (McClanahan and Shafir 1990). These fish will control the urchin densities which otherwise tend to proliferate and eat most of the algae. In turn the algae level will control the herbivorous fish level which themselves are preys of the piscivores. However, it is important to notice that the role of drivers and keystone species is likely to decrease with the diversity of a community (Peterson et al. 1998).

There are several definitions of stability for a community (McCann 2000). One of them is to consider that a stable community is one for which the densities do not change much over time. Theoretically, stability will increase with diversity (fig. 6.10).

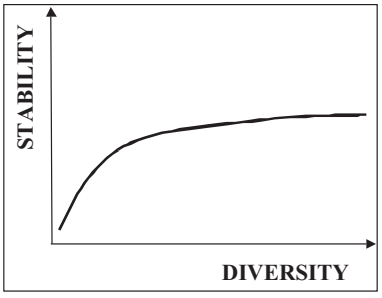


Fig. 6.10. Theoretical relationship between species diversity (e.g. species /transect) and fish community stability (inverse of the variability over time of density or biomass) (Peterson et al. 1998).

This can be illustrated by an example for several lagoon fish communities from New Caledonia (fig. 6.11) for which short-term stability (less than 3-year periods) increases along with diversity (measured by species density). Therefore, factors promoting diversity should also promote stability (see Peterson et al. 1998 for a review on the stability-diversity debate). Stability is an important parameter of fish communities as it plays a major role in the response of these communi-

ties to disturbances. For instance, in a stable system, fishing will usually need to be at a higher level than in an unstable system in order to induce irreversible changes in the fish communities of these systems.

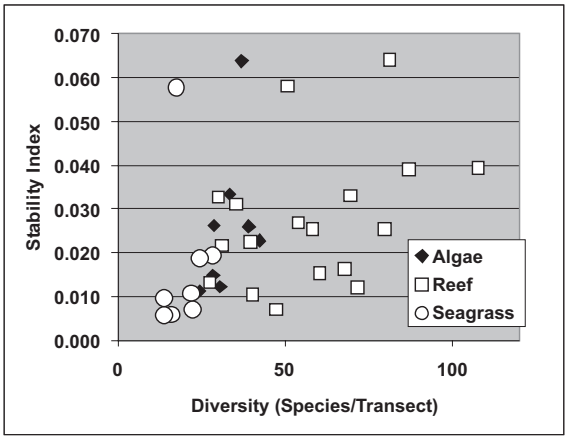


Fig. 6.11. Relationship between fish species diversity and a stability index (inverse of the coefficient of variation of the density over time) for three fish communities of New Caledonia (Labrosse et al. 1999).

Resistance and resilience depend very much on the biological and ecological characteristics of the species involved. Typically, species with short life cycles, high mortality rates and high reproductive efforts are more resilient and less resistant than species with long life cycles, low mortality rates, and late reproductive effort. Therefore, the relative proportion of these species within a community will determine in part the resiliency and resistance of a community to perturbation. In general (Hillebrand and Blenckner 2002), the ratio of long-living (large) species is thought to increase with the number of species (see fig. 6.12). Therefore, one would expect that fish communities with higher species diversity should tend to be more resistant to perturbation, but less resilient. In other words, if for instance a species rich community is submitted to high fishing pressure, it is likely to resist longer than a community with less species, but once this species rich community starts to be affected by fishing it will need a longer time to recover. However, we need to test if this relationship between species diversity and resistant-resilience can be estimated from a limited number of regional and local factors.

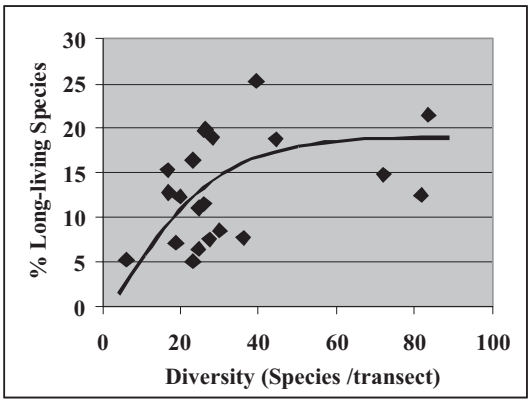
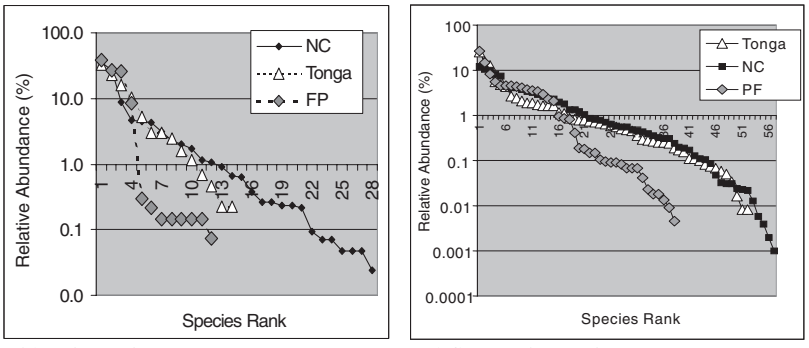


Fig. 6.12. Relationship between diversity and relative importance of long-living species. Each point is the average for an island. N = 20 (references of data Table 6.1)

It is possible to outline the dominance of driver species by using rank-abundance plots (Hubbell 2001). Functional groups with driving species will have steep curves (fig. 6.13a,b), whereas functional groups without such driving species will tend to have flatter curves. This has implications for both the management of these groups and their uses. Groups with steep slopes in their rank-abundance relationships will probably be more resilient and less resistant to exploitation than groups with weak slopes (given that their life-history strategies are similar). On the other hand, from a fisherman's point of view, it could be more interesting to have a steep slope as the number of species entering the catch is limited and consequently easier to target and market.



A) Epinephelinae B) Commercial Herbivores

Fig. 6.13. Relationship between relative abundance (percentages on a log scale) and species ranking in abundance (references of data Table 6.1). NC: New Caledonia ; FP: French Polynesia.

One of the main links between density and biomass in theoretical work is the analysis of size-abundance curves (fig. 6.14) (Dickie et al. 1987; Sprules and Stockwell 1995; Rice 2000). The slope of these curves can be compared to some theoretical fit based on the trophic relationship dominating the community. For instance, communities driven by high primary production inputs should have steep initial slopes. A departure from such predicted features can then be interpreted according to local factors (e.g. fishing effort). Recent developments (Raffaelli 2002; Neutel et al. 2002) indicate that the patterns of the food webs and the trophic structure expressed as biomasses can also be good indicators of the stability of communities.

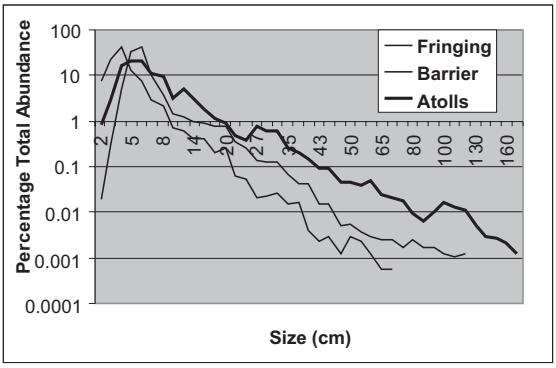


Fig. 6.14. Relationship between relative abundance (percentages on a log scale) and size. Data from New Caledonia (Labrosse et al. 1999).

Fisheries Framework

Reef fisheries in Pacific island countries play a major role in food security and in meeting the need for increased income. In addition to the high species diversity and the wide variety of exploitation types, one of the main characteristics of these fisheries is also represented by the high percentage of subsistence fishing compared to commercial fishing. This situation tends to change slowly as it is linked to the transition from a subsistence economy towards an exchange economy. Thus, Dalzell et al. (1996), considering all Pacific island states together, estimated that around 80 percent of the total catch is represented by subsistence fishing. Subsistence fishing and reef fishing pressure are most often linked to population growth (Russ et al. 1989; Jennings and Kaiser 1998). In recent years, this pressure has

tended to increase in conjunction with the introduction of boats, more efficient fishing gears, and the emergence of new markets. This increase of fishing pressure is often accompanied by a degradation of marine habitat and can lead to overfishing. These disturbances affect both resource characteristics and their users (Johannes 1975; Roberts 1995; Birkeland 1997; Jennings and Kaiser 1998). On a long-term basis, they can threaten the food security of island communities and also affect their sources of income, at the risk of increasing their economic dependence (Anonymous 2000).

Subsistence fishing is at best difficult and most often almost impossible to assess directly, i.e. through monitoring fishing effort and landing surveys. This leads to a general lack of reliable statistics and the impact of this activity is poorly known (Mac Manus 1996). This also makes it difficult to implement relevant reef fisheries management plans (Munro and Fakahau 1993). Despite some attempts (Gillett and Lightfoot 2001), it is also difficult to give a value to subsistence fishing. Indeed, its value lies more in the importance it has for the Pacific islanders themselves, including a cultural value rather than a monetary value. For all of these reasons, obtaining new data on subsistence fishing remains a major concern for managers and decision makers (Adams 1996; Dalzell et al. 1996). Under certain conditions, surveying fish consumption can assist in making indirect estimates of catches due to subsistence fishing (Loubens 1975; Coblenz 1997; Paddon 1997; Labrosse et al. 2000). This can also be used to better understand what the structuring factors of this activity are and then to build indicators of fishing production.

The need for information to better manage reef fisheries is diversely expressed by managers and decision makers. They often still ask for stock estimates and derived parameters, including maximum sustainable yields (MSY). However, these estimates may not be an accurate representation of the real potential, especially in the case of multi-species fisheries (Larkin 1977). MSY values should not be used so much as absolute representations of potential yields but rather as a means to compare areas and then discuss what can be done in terms of management actions and policies. The accuracy of total stock estimates is linked to the accuracy of biotope surface estimates, the latter being often of very heterogeneous quality. MSY estimates are linked to the availability of biological information, but unfortunately current biological knowledge is poor for most reef species and often not easy to access. Therefore, it is difficult to make reliable esti-

mates of MSY and more widely to apply the population dynamics models that are frequently used for mono-specific fisheries. For these reasons, one may wish to favour the use of parameters independent from capture assessments. For instance, species richness, densities, and mainly biomasses estimated from underwater visual censuses can be used for comparisons between different biotopes or locations. These parameters may also be used in conjunction with catches from experimental fishing which are more rigorous and accurate than catch estimates from surveys (Letourneur et al. 2000). Such catch independent parameters may yield useful indications about the status of the resource in regard to fishing activities.

The lack of information for reef fisheries management purposes forces us to look for more global or ecosystemic approaches in order to assess reef fisheries. These combine both socio-economic and resource aspects, including the status of the habitat, and lead to the development of tools, such as indicators, for more ecologically based management of reef fisheries. This should allow us to respond directly to the urgently expressed need of the managers and decision makers of management and monitoring tools as soon as possible. This should be a basis for collection of biological, ecological, and socio-economic information.

Interaction between the Ecological and Fisheries Frameworks

The ecological and fisheries frameworks need now to be related in order to generate information which can be of direct use to management. To illustrate this we will examine two possible scenarios based on data currently under study. The first scenario is based on the first phase of the ecological framework and the second on the second phase of this framework (see fig. 6.4), each scenario uses ecological and fishery data.

Information at the regional level may be difficult to collect, but it can be very powerful when it comes to making management decisions. In our example (fig. 6.15) we wish to show that depending on where one is in the Pacific, decisions taken regarding the use of resources should be different because fishing potential is different. We know from figure 6.4 and Tables 6.2-6.5 that the number of species available in Polynesia is much lower than in Melanesia. Therefore, if one compares an island of similar characteristics (size, type, popula-

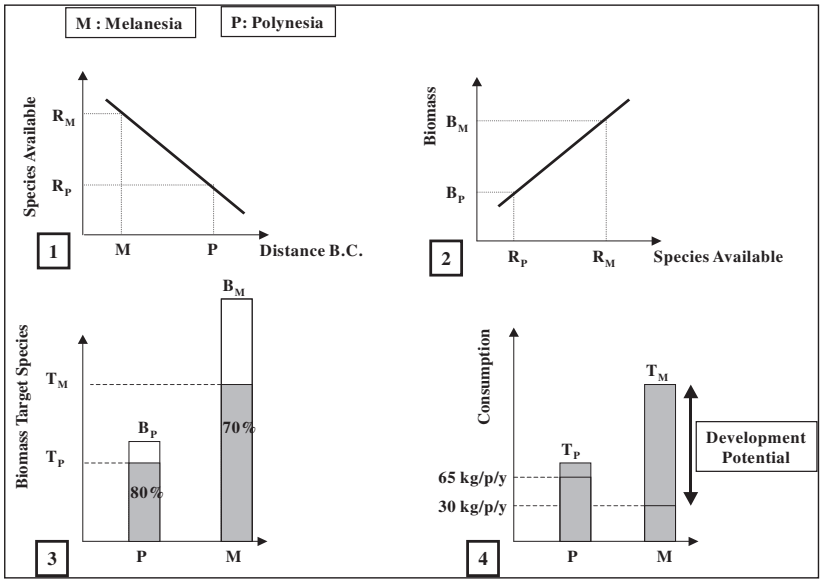


Fig. 6.15. Scenario of comparison between two similar islands from Melanesia and Polynesia.

Rm: number of species on the Melanesian island; Rp: same for the Polynesian island.

Bm: biomass of these species on the Melasian island; Bp: same for the Polynesian island.

Tm: biomass of target species on the Melanesian island; Tp: same for the Polynesian island.

tion level) from Polynesia and Melanesia, the number of species should be much higher in Melanesia (fig. 6.15-1).

Given the relationship between total biomass and species diversity (see fig. 6.6b), one will therefore expect lower biomasses on the Polynesian island (fig. 6.15-2). As fish composition (Randall 1985; Rivaton et al. 1989) and people's feeding habits (Leopold 2000; Poignonec 2002; Yonger 2002) are different in Polynesia and Melanesia, the proportion of the biomass which can be extracted will differ between the two islands (fig. 6.15-3). The fisheries framework indicates that one may consider these islands as more or less isolated systems and that fish consumption is usually a very good indicator of fishing effort. These assessments will indicate the amount of fish consumed in relation to the fish which is available (fig. 6.15-4) and therefore give a good indication of the potential for new develop-

ment. This approach could be very important when considering the potential for the expansion of the live reef-fish trade (Kiribati, Fiji, Tonga), the necessity of increasing lagoon fisheries (Wallis), or the need for coastal resource preservation (Niue).

The second example (fig. 6.16) shows how ecological and fisheries information can be combined to yield useful information for management.

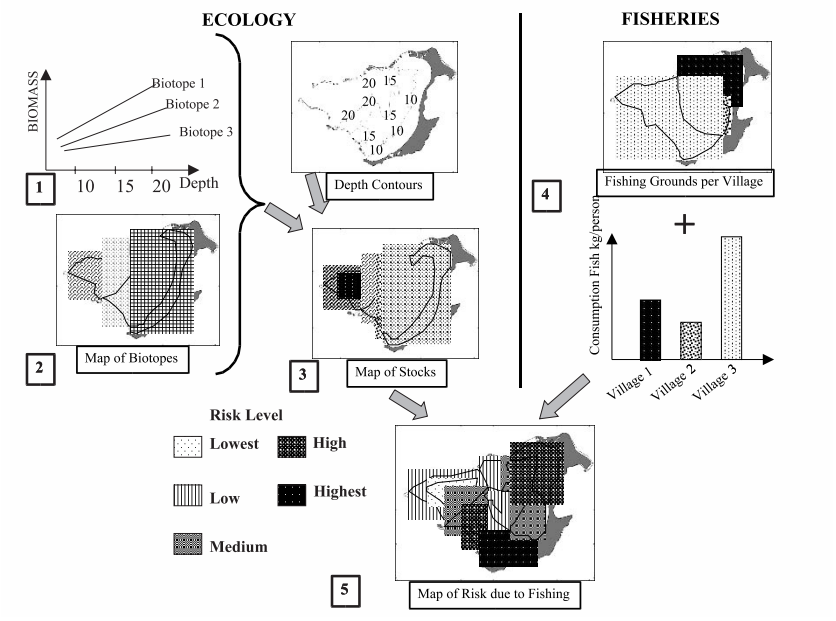


Fig. 6.16. Example of a scenario for the possible interaction between ecology and fishery frameworks to obtain useful information for management purposes.

The atoll of Uvea (New Caledonia) is used here to support the demonstration. On this island (fig. 6.16-1) there is an increase of the biomass with depth (Kulbicki 1995), although this is usually not the case in most atolls. From the analysis of satellite images, aerial pictures and *in situ* verifications (Kulbicki et al. 1993), it is possible to map the major biotopes (fig. 6.16-2). By combining the distribution of biomass with depth with the map of the depth contours it is possible to build a map of the stocks within this lagoon (fig. 6.16-3). Fisheries and fish consumption surveys (Leopold 2000) with the local people may yield crude information on the fishing grounds and the level of

fish consumption (fig. 6.16-4). Combined with the map of the biomasses, this allows the drawing of a map that indicates the level of risk for the resource (fig. 6.16-5). Such maps are not very precise, but they may assist considerably in local management.

These two examples are intended to show that ecological information can be very useful even at a low level of analysis, especially when combined with fisheries information. In order to optimise these ecological and fisheries interactions we need to have solid theoretical foundations (Cury and Cayré 2001; Cury et al. 2002). However, at the moment this is lacking, especially because we know very little about the normal evolution of complex communities exposed to perturbations (Jackson et al. 2001). This lack of theoretical background is expressed by Cury et al. (2002): 'no general theory can be ascribed to the functioning of marine ecosystems, except in the light of the evolutionary theory, which results in poor predictive power for fisheries management'.

Discussion

In the past most fisheries were managed on the basis of single species dynamics or at best on the dynamics of a restricted number of species. Such an approach has proven to be inappropriate in most cases and new approaches are needed (Cury and Cayré 2001). As stated by Pauly et al. (2002), management will 'move towards ecosystem-based management. What this will consist of is not clearly established'. In tropical areas like the Pacific islands the number of exploited species is very important, often more than a hundred in a single fishery, and the variety of the gears used is also high, which requires new strategies to manage fisheries (Crosby et al. 2002). The ecosystems in which these resources evolve are very complex, with in particular a very high spatial heterogeneity. Therefore an innovative approach is needed. This paper indicates two useful directions to pursue by taking into account simultaneously regional and local scales, and the need to further develop pluri-disciplinarity (Bowen 1997; Botsford et al. 1997).

The applications of the frameworks proposed in this paper are mainly designed for closed systems such as islands or lakes. In a continuous system, such as a continental coastline, it is likely that the ecological and fishery situations are far more complex. For instance, consumption is no longer a good indicator of fishing effort, except

maybe in very isolated areas. Similarly, the fish communities are no longer independent from one another.

But even for the type of fisheries where this approach may apply, one may question the feasibility of such an approach. In the ecological framework one may have to consider the regional and the local analytical phases separately. The regional phase supposes the gathering of checklists from as many areas as possible. This is a time-consuming task and requires specialists, in particular taxonomists. At the moment, in the Pacific there are approximately fifty large islands for which such lists exist. The major problems are for the smallest archipelagos in the centre of the Pacific: Gilbert, Phoenix, Line Islands, Tokelau, Tuvalu and also two archipelagos of large islands: Solomon and Vanuatu. Such species lists are not readily available for these areas, even if 'FISHBASE',[4] an international database created by ICLARM, has lists of species for most countries. In addition, in places like the Pacific, many species are still unknown. These undescribed or unknown species are usually of little economic importance, but in an ecological approach their contribution needs to be evaluated. Nevertheless, the information currently available at the regional level is already sufficient to estimate a number of features of meta-communities. Therefore, for many regions of the Pacific, this regional phase can be considered as already accessible. The connection between the regional and local phases is perhaps where data are the most wanted. There have been numerous surveys of reef fishes across the Pacific in the last thirty years. Unfortunately, much of the initial data has been lost or is very difficult to access. In addition, most surveys have been undertaken using widely varying methods and it is not always possible to compare results between surveys and to use data from different surveys in the same analytical context. This points to the great need for standardised methods. There have been numerous attempts in the past to do so (English et al. 1997; Cappo and Brown 1996), but with little success on a regional basis, mainly because there was no global scheme to use as a frame for these methods. With these problems in mind, SPC (an international organisation working for the development of Pacific island Sates) is currently trying to standardise such methods in South Pacific countries (Labrosse et al. 2001). In order to connect the regional and the local scales we also need more information on the geography of the islands. Basic information such as island size, population density, and area covered by reefs and lagoons is not readily available and often contains many errors. Satellite images may in part answer these

requirements, but they are not a panacea. They are in fact rather poor tools for marine mapping beyond depths of ten metres, at least with the type of images available at the moment.

Despite this situation there are already a number of island-states for which it is possible to make this regional to local connection. These include in particular New Caledonia, Fiji, some areas of French Polynesia, and, soon, Tonga. The research phase at the local level requires recent data which is hard to obtain in most places for two reasons. Firstly there is usually no plan to gather the proper information and, secondly, the staff and finances required are not always available. In this regard, SPC is currently implementing a work plan in collaboration with the fisheries and/or environment departments of most Pacific island states. For the local level one needs data on the biotopes and on the distribution of the species. Together with this field information, ecological and biological data are also needed, but the models which are currently being developed by SPC only require a broad classification of species. One may be interested for instance to know if a species is carnivorous, has a slow or fast growth rate, or forms schools. More detailed information is at this stage not necessary (e.g. seasonal growth variations, changes of diet with biotope). The proposed framework is in some sense the opposite of classical population dynamics because detailed information on the biology and ecology is not the key issue. The important point is to relate the information from various levels from the regional down to the local (Peterson et al. 1998; Langton and Auster 1999) and to stratify the factors that influence the abundance and quality of the resources. The approach we are promoting matches some of the criteria defined by Murawski (2000) in predicting overfishing. In particular, evaluation of biomass and diversity at different levels of organisation and the evaluation of spatial variability are part of our framework. We know that in such a complex environment it is not possible to properly assess the absolute abundance of even a single species. Instead, a comparison of the relative abundance of a species or group of species with what could be expected from the analysis of the regional and local factors is feasible. This level of information is probably sufficient for present management purposes in many islands of the Pacific. However, this does not imply that basic research on the biology and ecology of fish species should not be given priority. For instance, at the moment we do not have the proper data on mortality, growth, and reproduction needed to evaluate production or productivity of

fish communities, but in the distant future this could be the most pertinent parameter required to evaluate the status of fisheries and other human uses of marine resources. Of course any relationship between production and diversity would greatly ease predictive studies since diversity is far easier to measure than production.

Conclusion

As any initial framework, the approach proposed in this paper will need to be refined. Yet, to our knowledge this is the first attempt to connect ecology, fisheries sciences, and economics in order to provide scientific input for the management of insular fisheries. Quite possibly the barrier to management represented by the complexity of coral reef environments can be overcome by this approach. Meanwhile we need to be careful not to re-introduce this complexity by using intricate models, but neither should we oversimplify these ecosystems. There is a particular need in this type of approach to develop tools which can be used by managers in conditions where there is a minimum of appropriate data. The approach should also be based on concepts that local people can understand. Of special interest in areas like the Pacific is the potential to apply such a framework for local community management.

Notes

1. IRD- B.P. A5 – 98848 Noumea – NEW CALEDONIA e-mail: kulbicki@noumea.ird.nc ; ferraris@noumea.ird.nc.
2. SPC – B.P. D5 – 98848 Nouméa – NEW CALEDONIA e-mail: PierreL @spc.int.
3. Production: amount of matter (e.g. fish) produced over a time period, expressed for instance as g/m /year.
4. The FISHBASE data base is available at: www.fishbase.com.

Appendix 6.I

Table 6.1. References to the data sources of transect work used

Countries	*Method*	*Number of islands*	*Reference*
New Caledonia			
Main Island	UVC – rot.	1	Labrosse et al. 1998
Uvea Atoll	UVC	1	
Chesterfields	UVC – rot.	1	
French Polynesia			
Moorea	UVC	1	Galzin 1985
Tuamotu	UVC	10	Kulbicki et al. 2000
Society Is.	UVC	4	Galzin et al. 1994
Tonga			
Tongatapu	UVC	1	Unpublished:
Hapai	UVC	2	SPC- Noumea
Vavau	UVC	2	New-Caledonia
Fiji	UVC	6	Jennings and Polunin 1996
Samoa	UVC	6	Green 1996
Hawaii			
Midway	UVC	1	Schroeder, 1989
Hawaii	UVC	1	Hayes et al. 1982; Brock et al. 1979; Walsh 1983; Wass 1967; Friedlander 1996
Marianas	UVC	4	Molina, 1982; Dobbelaer 2001
Flores	UVC	1	Kulbicki 1997
GBR	Explosives	1	Williams and Hatcher 1983
Wallis and Futuna	UVC	2	Wantiez 2000

UVC: underwater visual census (transect) rot.: rotenone poisoning

Appendix 6.II

Table 6.2. Multiple regression of species diversity versus distance to the biodiversity centre (km) and island size (log scale) (N=50)

	r	*Intercept*	*D*	*IS*
Acanthuridae	0.83***	16.77	-0.000539	3.38
Apogonidae	0.87***	19.15	-0.002529	9.87
Balistidae	0.91***	14.26	-0.001120	4.03
Blenniidae	0.83***	11.97	-0.001288	7.67
Carangidae	0.84***	11.09	-0.001080	5.29
Chaetodontidae	0.90***	24.10	-0.001311	3.46
Gobiidae	0.83***	21.07	-0.004598	23.33
Labridae	0.91***	39.48	-0.002862	12.82
Lethrinidae	0.88***	9.36	-0.000913	2.33
Pomacentridae	0.91***	31.90	-0.003167	11.83
Scaridae	0.85***	13.30	-0.000829	2.92
Serranidae	0.89***	26.23	-0.002545	8.41
Siganidae	0.90***	6.82	-0.000754	1.25
Tetraodontidae	0.84***	7.21	-0.000667	2.68

*** $p < 0.001$. For each family there is:
Number Species = Intercept + Distance (in km) x D + Island Size (log 10 scale) x IS

Table 6.3. Correlation between the relative importance of genera (within the families Labridae, Pomacentridae and Serranidae) and total diversity; multiple regression of the relative importance of genera with distance to the biodiversity centre and land mass. The data are from 18 regions in the Pacific

		Diversity	*Distance*	*Land mass*
Labridae		-0.33		
	Anampses	-.056*	0.58*	-0.59*
	Bodianus	-0.20	0.33	0.001
	Cheilinus	-0.49*	0.09	0.26
	Choerodon	0.83***	-0.56*	0.76***
	Cirrilabrus	0.77***	-0.38	0.67**
	Coris	-0.54*	0.55*	-0.41
	Halichoeres	0.81***	-0.72**	0.65**
	Thalassoma	-0.92***	0.66**	-0.82***
Pomacentridae		0.64**		
r	*Abudefduf*	-0.62**	0.25	-0.75***
	Amblyglyphido-don	0.60*	-0.66**	0.48
	Amphiprion	0.55*	-0.74***	0.34
	Chromis	-0.32	0.53*	-0.24
	Chrysiptera	0.66**	-0.45	0.50*
	Neopomacentrus	0.90***	-0.61*	0.82***
	Pomacentrus	0.85***	-0.60*	0.66**
	Stegastes	-0.41	0.57*	-0.39
Serranidae		0.53*		
	Cephalopholis	0.18	-0.24	-0.11
	Epinephelus	0.19	-0.39	-0.15
	Plectropomus	0.61*	-0.51*	0.47
	Pseudanthias	0.58*	-0.54*	0.49*

Diversity: Pearson correlation between relative genus importance and total diversity
Distance: Partial Pearson correlation between relative genus importance and distance to the China Sea
Land mass: Partial Pearson correlation between relative genus importance and land mass on a log10 scale
r significant at: * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Table 6.4. Multiple regression of species diversity (grouped by size classes) versus distance to the biodiversity centre (km) and island size (log scale)

	r^2	*Intercept*	*Distance (D)*	*Island Size (IS)*
>10 cm	0.50;***	27.7;***	–0.000032;*	1.17;***
10-20 cm	0.65;***	31.7;***	0.00036;***	–0.77;***
20-50 cm	0.03;NS	28.7;***	–0.00012;NS	–0.031;NS
>50 cm	0.31;***	11.9;***	0.000090;NS	–0.38;**

For each size class there is:
Number Species = Intercept + Distance (in km) x D + Island Size (log 10 scale) x IS
* p<0.05; ** p<0.01; *** p <0.001

Table 6.5. Multiple regression of species diversity (grouped by diet category) versus distance to the biodiversity centre (km) and island size (log scale).

	r^2	*Intercept*	*Distance (D)*	*Island Size (IS)*
Carnivores				
Piscivores	0.36;***	9.76;***	0.00024;**	-0.18;NS
Macrocarnivores	0.21;**	17.1;***	0.00020;*	-0.22;NS
Microcarnivores	0.16;*	22.8;***	-0.00027;**	-0.21;NS
Herbivores				
Macro-herbivores	0.10;NS	2.95;***	$-7.3\ 10^{-6}$;NS	-0.11;*
Micro-herbivores	0.33;***	13.1;***	0.00014;NS	-0.55;**
Plankton Feeders				
Plankton only	0.31;***	11.4;***	-6.8 10-5;NS	0.46;***
Plankton + invertebrates	0.66;***	7.00;***	-0.00036;***	0.49;***
Plankton + algae	0.54;***	2.73;***	-0.00011;**	0.21;***

For each trophic group there is:
Number Species = Intercept + Distance (in km) x D + Island Size (log 10 scale) x IS
* p<0.05; ** p<0.01; *** p <0.001

Table 6.6. Factors significant in linking diversity, density or biomass of reef fishes to diversity of the species pool in a multilinear regression model

	Diversity	*Density*	*Biomass*
Intercept	65.8; <10-6	4.49; 0.0025	105;0.039
Island Size	NS	NS	NS
Island Size (log)	NS	NS	10.4;0.0078
Coast length	0.11; 0.00014	0.013; 0.0012	NS
Island type	NS	NS	NS
Distance to Biodiversity Centre	–0.0044; 0.0015	–0.00037; 0.0031	-0.0063;NS
Total r^2	0.80***	0.74***	0.52***

Island size is expressed either in km^2, log (km^2) or coast length (km), the model keeping the best out of these three expressions. Island type is a qualitative factor (atoll or high island).
Number of Islands: 25. All data for barrier reefs
The first number indicates the coefficient in the regression, the second the p level
NS: not significant; *** p <0.0001

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7

The Marine Implementation of the EC Birds and Habitats Directives: the Cases of Shipping and Oil Exploration Compared

Daniel Owen[1]

Introduction

This paper focuses on two European Community instruments, the Birds Directive[2] and the Habitats Directive,[3] that, *inter alia*, provide for the establishment and management of protected areas, including marine protected areas. The paper uses the examples of shipping and oil exploration to illustrate how the international law of the sea does not permit a coastal state to restrict all human activities to the same degree and by the same route. This paper is a follow-up to a previous paper by the author which addressed more generally the source of European Community Member States' powers under international law to implement the Birds Directive in the marine environment.[4]

Some abbreviations have been adopted in this paper. The European Community is referred to as the 'EC'. Member States of the European Community are referred to as 'Member States'. The European Community courts, i.e. the European Court of Justice and the Court of First Instance, are referred to collectively as 'the Court'. Specific articles of the Birds Directive and the Habitats Directive are referred to as, say, 'Art 4(4) BD' or 'Art 6(3) HD' respectively. The 1982 United Nations Convention on the Law of the Sea is referred to as 'the LOSC', and specific articles of the treaty are referred to as, say, 'Art 211 LOSC'.

Within the footnotes in this paper, the acronyms 'OJ', 'CMLR', and 'ECR' refer to the following publications respectively: the 'Official Journal of the European Communities', the 'Common Market Law

Reports', and the 'European Court Reports'. Other abbreviations are explained in the course of the paper.

Within the EC, there are currently fifteen Member States[5], of which only two have no coastline.[6] Put briefly, the Birds and Habitats Directives place duties on Member States to establish protected sites, both on land and at sea, and to manage human activities in order to meet the sites' nature conservation objectives. The overall network of sites established under both directives is referred to as 'Natura 2000'.[7] The directives constitute important legal tools for the protection of marine sites in Member States' waters.

Geographical Scope of the Directives

Before explaining the precise nature of the duties on Member States in respect of site protection, it may be helpful to have in mind the sea areas to which the Birds and Habitats Directives apply.

A state's 'internal waters' are those waters on the landward side of the baseline from which the breadth of the territorial sea is measured.[8] A state's 'territorial sea' is a belt of sea extending up to twelve nautical miles from the baseline.[9] In both its internal waters and its territorial sea, the coastal state has sovereignty.[10] There appears to be little doubt that the directives apply to each Member State's internal waters and territorial sea, in that both directives refer to the purpose of achieving nature conservation 'in the European territory of the Member States to which the Treaty [establishing the European Community] applies'.[11] All littoral Member States, with one exception, have established territorial seas out to twelve nautical miles from the baseline.[12] This in itself creates an extensive sea area to which the directives must be applied, though that area is nonetheless considerably smaller than the corresponding land area.

Every Member State with an Atlantic, Baltic, or North Sea coastline also has a zone of jurisdiction that extends beyond the seaward limit of its territorial sea. This may take the form of, *inter alia*, an exclusive economic zone (EEZ), an exclusive fishing zone (EFZ), and/or a legal continental shelf. An EEZ or EFZ may potentially extend from the seaward limit of the territorial sea out to 200 nautical miles from the territorial sea baseline;[13] the legal continental shelf may in some circumstances extend even further offshore.[14] Under the international law of the sea, these zones convey certain rights on the Member

State. The question is whether the coastal Member States are under a duty to use such rights in order to implement the Birds Directive and Habitats Directive in these zones.

The European Commission takes the view that '[a]s far as Member States have competence, it [i.e. the Habitats Directive] applies to the exclusive economic zone'.[15] Logically, the same conclusion should be reached for the legal continental shelf; and what is said for the Habitats Directive should also be said for the Birds Directive. A legal continental shelf need not be declared by a coastal Member State; under the LOSC, '[t]he rights of the coastal State over the continental shelf do not depend on occupation, effective or notional, or on any express proclamation'.[16] In contrast, an EEZ, or elements of an EEZ, must be declared by the Member State. Not all Member States have declared the same EEZ powers. Thus some have declared an EEZ, while others have so far chosen to exercise only some of the EEZ rights and jurisdiction available under the LOSC (e.g. sovereign rights over fisheries resources, in an EFZ).

Therefore, even if the European Commission is correct in its assertion, there are two possible interpretations of its statement. One is that a coastal Member State is only bound to implement the Birds and Habitats Directives to the limits of the powers it has so far claimed, or otherwise possesses, under international law. For example, let us suppose that a coastal Member State has not yet declared sovereign rights with regard to production of wind energy out to 200 nautical miles and that, as a result, a company unrelated to that State chooses to use the zone for that purpose. Under the interpretation in question, the coastal Member State would not be bound to manage the wind energy activities in respect of any Natura 2000 site in its 200 nautical mile zone, since it had not claimed the power to do so.

The other interpretation of the European Commission's statement is that a coastal Member State is required to claim those powers available to it under international law to the extent that such powers are necessary to implement the directives. Thus, using the above example, the Member State could not get away with arguing that it had not claimed sovereign rights with regard to production of wind energy and hence could not regulate the company concerned. Instead, the Member State would be required under the directives to claim the relevant sovereign rights. Of the two possible interpretations, this one is more consistent with the objectives of the Birds and Habitats Directives.

However, the Commission's view of the geographical scope of the directives is not determinative. Ultimately, the power to interpret law rests with the Court, which has not yet ruled on this issue. The matter has, however, been raised in a court in the United Kingdom. Thus in the case of *The Queen v The Secretary of State for Trade and Industry, ex parte Greenpeace Ltd* in the English High Court, the judge held that 'the Habitats Directive applies to the UKCS [United Kingdom continental shelf] and to the superjacent waters up to a limit of 200 nautical miles from the baseline from which the territorial sea is measured'.[17] As a judgment of a national court, rather than of the Court, this decision is not binding on the other Member States. However, for the purposes of this paper, it will be assumed that the Birds and Habitats Directives do indeed apply out to the limits of coastal state jurisdiction in respect of the EEZ and the legal continental shelf.

Member State Duties under the Birds Directive

Under the Birds Directive, Member States have a duty to classify 'in particular the most suitable territories in number and size' as 'special protection areas' (SPAs).[18] This duty applies to those bird species listed in Annex I of the directive and also to 'regularly occurring migratory species' not listed in Annex I.[19] Annex I does include some marine bird species; many other marine bird species are covered by the directive by virtue of being 'regularly occurring migratory species'. Member States also have a duty to manage the SPAs. However, as explained below, the nature of the management duty differs according to whether the site is (a) a classified SPA or (b) a site which has not been classified but which should have been so classified.

With regard to the latter category, in the *Basses Corbières* case[20] the Court held that '[i]t is clear ... that areas which have not been classified as SPAs but should have been so classified continue to fall under the regime governed by the first sentence of Article 4(4) of the birds directive'.[21] The first sentence of Art 4(4) BD states that:

In respect of the protection areas referred to in paragraphs 1 and 2 above [i.e. SPAs], Member States shall take appropriate steps to avoid pollution or deterioration of habitats or any disturbances affecting the birds, in so far as these would be significant having regard to the objectives of this Article.

With regard to sites that have been classified as SPAs, Art 7 HD states that '[o]bligations arising under Article 6(2), (3) and (4) of this

Directive shall replace any obligations arising under the first sentence of Article 4(4) of Directive 79/409/EEC in respect of areas classified pursuant to Article 4(1) or similarly recognised under Article 4(2) thereof'. Thus if a site is a classified SPA, the management duties are those in Arts 6(2)-(4) HD, and not those in the first sentence of Art 4(4) BD. Arts 6(2)-(3) HD state that:

> 2. Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive.
>
> 3. Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

Art 6(4) HD allows a damaging plan or project to go ahead 'for imperative reasons of overriding public interest, including those of a social or economic nature', albeit only on the condition that 'the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected'. Art 4(4) BD contains no equivalent to Art 6(4) HD; however, in the *Leybucht Dykes* case[22] the Court held, in respect of Art 4(4) BD:

> 21. [...] the power of the Member State to reduce the extent of a special protection area can be justified only on exceptional grounds.
>
> 22. Those grounds must correspond to a general interest which is superior to the general interest represented by the ecological objective of the directive. In that context the interests referred to in Article 2 of the [Birds] directive, namely economic and recreational requirements, do not enter into consideration. [...]

It is arguable that the principle established in paragraph 22 of the *Leybucht Dykes* judgment should apply not only to activities causing a reduction in geographical extent of a SPA, but also to any other activity caught by the first sentence of Art 4(4) BD. If so, it is in turn arguable that the management regime under Art 4(4) BD is stricter than that under Arts 6(2)-(4) HD. This is because the former, despite not requiring appropriate assessments, provides no exception for plans or projects justified solely by reasons of an economic nature.

Member State Duties under the Habitats Directive

Under the Habitats Directive, Member States have a duty to designate 'special areas of conservation' (SACs).[23] This duty applies to sites hosting the natural habitat types listed in Annex I of the directive and habitats of the species listed in Annex II of the directive.[24] Annex I includes some marine habitat types and Annex II includes some marine species. The procedure leading up to designation is laid down in the directive, and involves the European Commission.[25] In contrast to SPAs, there is one unified management regime for SACs, i.e. the management duties laid down in Art 6(1)-(4) HD. The duties in Art 6(2)-(4) have already been described in section 3 above. Art 6(1) HD additionally requires that:

> For special areas of conservation, Member States shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites.

Of note, the European Commission, in *Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC* (2000), has interpreted the duties in Arts 6(1)-(4) HD. I shall not duplicate that interpretation here, except to add that it represents only the view of the Commission (albeit, in some cases, a view taken in light of the case law of the Court). Ultimately, the power to make binding interpretations of EC legislation rests only with the Court.

Applying the Directives to Human Activities in the Marine Environment

A wide range of human activities takes place in the marine environment. Examples include aggregate extraction, bio-prospecting, dumping, fishing, fish farming, laying of submarine cables and pipelines, marine scientific research, oil and gas exploration and production, energy generation (e.g. from waves, currents and winds), shipping, and waste disposal. However, as noted in section 1 above, this paper will focus on just two human activities, shipping and oil exploration. In each case, the focus will be on regulation of the activity beyond the Member State's territorial sea.

Shipping

Regarding shipping, let us assume (a) that a Member State has declared an EEZ providing all the rights and jurisdiction mentioned in the LOSC, (b) that the Member State has classified a SPA within this EEZ (e.g. in the vicinity of a front between two water masses, important for feeding marine birds), and (c) that movements through and adjacent to the SPA by foreign-flagged vessels present a significant risk of both accidental and deliberate oil pollution to the SPA. On the basis of the assumption made in section 2 above regarding the geographical scope of the Birds and Habitats Directives, the management duties in Art 6(2)-(4) HD apply to the coastal Member State in respect of the SPA.

Art 6(3) HD requires the use of appropriate assessment for plans or projects 'likely to have a significant effect' on the SPA. However, it is questionable whether ongoing vessel traffic through or adjacent to the SPA would constitute a 'plan or project'. For the purposes of this paper, it will be assumed that the duty in Art 6(3) HD does not apply to the scenario in question.

Art 6(2) HD requires Member States to take appropriate steps to, *inter alia*, avoid deterioration of the habitat of the bird species for which the SPA has been classified. In a SPA in the EEZ, the water column itself may be regarded as part of the habitat. Deterioration of such habitat could occur through, say, oil pollution from shipping. The Member State may therefore wish to take steps to reduce the risk

of oil pollution from shipping passing through or adjacent to the SPA.

Within the EEZ, the coastal state has, *inter alia*, 'jurisdiction as provided for in the relevant provisions of this Convention [i.e. the LOSC] with regard to ... the protection and preservation of the marine environment'.[26] Provisions on the legislative and enforcement jurisdiction of the coastal state with regard to pollution from shipping are found in Part XII of the LOSC, entitled 'Protection and Preservation of the Marine Environment', and notably within Arts 211 & 220 LOSC.

However, it is important to note that foreign-flagged vessels enjoy the freedom of navigation through the EEZ of a coastal state.[27] The discretion of the coastal Member State to regulate traffic by foreign-flagged vessels in relation to the SPA in its EEZ is therefore limited. Under Art 211(5) LOSC, a coastal state may adopt laws and regulations for the prevention, reduction, and control of marine pollution from foreign vessels in its EEZ. However, such laws and regulations must conform to and give effect to 'generally accepted international rules and standards established through the competent international organization or general diplomatic conference'. It is generally acknowledged that the 'competent international organization' referred to in Art 211(5) LOSC is the International Maritime Organization (IMO). Various IMO treaties addressing oil pollution from vessels already exist.

Of these, MARPOL[28] is the most relevant as a standard-setting treaty intended to reduce the risk of oil pollution. MARPOL establishes, *inter alia*, standards for vessel design and limits for deliberate discharges of oily waste from vessels. However, these standards and limits are applicable globally; in principle, they therefore apply irrespective of the presence or absence of protected areas. MARPOL does offer the possibility of establishing 'special areas', in which the limits for deliberate discharges of oil or oily mixture from vessels are tightened.[29] Such special areas may only be established with the approval of the IMO.[30]

However, the current special areas in respect of oil or oily mixture are very large in geographical extent;[31] they include, *inter alia*, 'the Mediterranean Sea area', 'the Baltic Sea area', and 'the North-West European waters', which already cover much of the Member States' waters. For those parts of Member States' waters not covered by

these special areas, it is questionable whether the relevant coastal Member State would be willing to seek support within IMO for a special area under MARPOL to assist in the protection of an individual SPA in its waters.

Art 211(5) LOSC is supplemented by Art 211(6) LOSC under which the coastal state may, in certain circumstances, take 'mandatory measures' in 'special areas' within its EEZ. Certain conditions must be met for a LOSC special area to be established, and such establishment anyway requires the approval of the IMO. The conditions are that (a) the international rules and standards to prevent, reduce, and control pollution from vessels 'are inadequate to meet special circumstances', and (b) 'coastal States have reasonable grounds for believing that a particular, clearly defined area of their respective exclusive economic zones is an area where the adoption of special mandatory measures for the prevention of pollution from vessels is required for recognised technical reasons in relation to its oceanographical and ecological conditions, as well as its utilization or the protection of its resources and the particular character of its traffic'.

The 'special areas' referred to in Art 211(6) LOSC are different in terms of their legal basis to the 'special areas' provided for under MARPOL. No special areas in the former category are yet in existence, and because of this there is no precedent in terms of geographical scope. However, Art 211(6) LOSC implies that such a special area should be 'a particular, clearly defined area of their [i.e. coastal States'] respective exclusive economic zones'. This in turn implies that LOSC special areas are intended to be relatively discrete in geographical extent. As such, it is arguable that a LOSC special area would be more suitable than a MARPOL special area as a means of protecting an individual SPA.

However, even if a LOSC special area were to be established, the question is whether a coastal state would subsequently be able to adopt measures in that area that helped to protect the SPA in question. Art 211(6) LOSC provides that IMO approval is required for proposed measures for foreign vessels additional to those implementing any international rules and standards or navigational practices for special areas. It also states clearly that such additional measures 'may relate to discharges or navigational practices but shall not require foreign vessels to observe design, construction, manning or equipment

standards other than generally accepted international rules and standards'. Thus there is scope for tightening discharge limits and perhaps prohibiting certain vessel movements, but no scope for imposing design or construction standards beyond 'generally accepted international rules and standards'.

Looking beyond special areas established under MARPOL or the LOSC, there are at least two tools developed by the IMO that may be of assistance. The first is routeing systems. In the IMO's *General Provisions on Ships' Routeing* ('the General Provisions'),[32] the term 'routeing system' is defined as '[a]ny system of one or more routes or routeing measures aimed at reducing the risk of *casualties* ...' (emphasis added).[33] This implies that the General Provisions cannot be invoked to adopt routeing systems for the purpose of reducing the risk of deliberate discharges of oily waste from vessels. However, in practice, invocation of the General Provisions in order to reduce the risk of casualties is likely to have the secondary effect of reducing the risk of deliberate discharges.

The term 'routeing system' is stated in the General Provisions to include 'traffic separation schemes', 'two-way routes', 'recommended tracks', 'areas to be avoided', 'inshore traffic zones', 'roundabouts', 'precautionary areas', and 'deep-water routes'.[34] All of these terms, and other traffic-related terms, are in turn defined in the General Provisions.[35] The responsibility for adoption of routeing systems for international use in the EEZ falls to the IMO.[36] However, the General Provisions state that:[37]

> In deciding whether or not to adopt or amend a routeing system which is intended to protect the marine environment, IMO will consider whether ... given the overall size of the area to be protected, or the aggregate number of environmentally sensitive areas established or identified in the geographical region concerned, the use of routeing systems – particularly areas to be avoided – could have the effect of unreasonably limiting the sea area available for navigation.

Thus a coastal Member State could propose a SPA in its EEZ as, say, an 'area to be avoided'. However, this would require IMO approval, and the IMO might be reluctant to give such approval if, despite the small size of the area under immediate consideration, it considered that an anticipated proliferation of offshore SPAs in the waters of Member States was in turn likely to lead to a proliferation of propos-

als for 'areas to be avoided'. To the author's knowledge, no Member State has yet proposed an offshore SPA as an 'area to be avoided' (or indeed as a site for any other type of route or routeing measure).

A second tool developed by the IMO that may be of assistance is that of 'particularly sensitive sea areas' ('PSSAs'). By Resolution A.927 (22), the IMO Assembly in 2001 adopted *Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas* ('the PSSA Guidelines').[38] The PSSA Guidelines define a PSSA as:[39]

> an area that needs special protection through action by IMO because of its significance for recognised ecological, socio-economic, or scientific reasons and because it may be vulnerable to damage by international shipping activities.

PSSAs may only be designated by the IMO,[40] and there are currently only two PSSAs in existence.[41] The criteria for the identification of a PSSA are laid down in the PSSA Guidelines.[42] In order to be identified as a PSSA, the area in question should meet at least one of the listed criteria and should additionally 'be at risk from international shipping activities'.[43] The listed ecological criteria are 'uniqueness or rarity', 'critical habitat', 'dependency', 'representativeness', 'diversity', 'productivity', 'spawning or breeding grounds', 'naturalness', 'integrity', 'vulnerability', and 'bio-geographic importance'.[44] In principle, using at least one of these criteria, coupled with demonstrating a risk from international shipping activities, there is no reason why a coastal Member State should not submit a proposal for a PSSA in view of concerns about oil pollution risk to a SPA in its EEZ.

Even if a PSSA were to be established, the question arises as to what could in turn be done to manage oil pollution risk within that PSSA. On that point, the PSSA Guidelines take two approaches. Initially, they state that 'associated protective measures for PSSAs are limited to actions within the purview of IMO' including (a) designation of MARPOL special areas,[45] (b) 'application of special discharge restrictions to vessels',[46] (c) 'adoption of ships' routeing and reporting systems near or in the area',[47] and (d) 'development and adoption of other measures ... such as compulsory pilotage schemes or vessel traffic management systems'.[48]

A little later, the PSSA Guidelines specify that the applicant State should identify the proposed associated protective measures, includ-

ing (a) 'any measure that is already available in an existing instrument', or (b) 'any measure that does not yet exist but that should be available as a generally applicable measure and that falls within the competence of IMO', or (c) 'any measure proposed for adoption in the territorial sea or pursuant to Article 211(6) of the United Nations Convention on the Law of the Sea'.[49] The PSSA Guidelines confirm that such measures 'may include ships' routeing measures; discharge restrictions; operational criteria; and prohibited activities, and should be specifically tailored to meet the need of the area at risk'.[50]

Taking these provisions together, it is helpful to consider what a PSSA may add in terms of measures to those available through the other mechanisms already mentioned above. MARPOL special areas, special discharge restrictions, routeing systems, and measures adopted pursuant to Art 211(6) LOSC have all been mentioned above. The adoption of reporting systems, compulsory pilotage schemes, and vessel traffic management systems are other options raised by the PSSA Guidelines. All may potentially serve to reduce the risk of oil pollution in a SPA located in the EEZ. Furthermore, novel measures may potentially be available within the category 'any measure that does not yet exist but that should be available as a generally applicable measure and that falls within the competence of IMO'.[51]

In conclusion, it should be recalled that foreign-flagged vessels enjoy the freedom of navigation through the EEZ of a coastal state, and that the discretion of a coastal Member State to regulate traffic by foreign-flagged vessels in relation to a SPA in its EEZ is therefore limited. In practice, the IMO and the LOSC together provide various mechanisms with the potential to protect a SPA in an EEZ. These include, *inter alia*, MARPOL special areas, LOSC special areas, routeing systems, and PSSAs. Three MARPOL special areas for oil and oily mixture already cover much of the Member States' waters. Based on the precedent set by the large size of existing special areas, the prospects for using additional MARPOL special areas to protect individual SPAs in the remaining waters are perhaps slim.

Instead, LOSC special areas may provide a solution for such sites. The text of Art 211(6) LOSC suggests that LOSC special areas are intended for smaller sea areas. Within a LOSC special area, there is scope for measures relating to vessel discharges or navigation practices. However, no such areas yet exist. Routeing systems, such as 'areas to be avoided', present another possible solution. However, the

IMO is likely to guard against a proliferation of, say, 'areas to be avoided' if this could have the effect of unreasonably limiting the sea area available for navigation across Member States' waters. PSSAs provide another solution. These potentially encompass several of the mechanisms already mentioned. Yet they also allow for other measures that may assist in reducing the risk of oil pollution within a SPA located in an EEZ.

The need for IMO approval is a feature of all of the shipping management measures described above. This need for recourse to the IMO is illustrated by Annex V of the 1992 OSPAR Convention.[52] The OSPAR Convention provides for the protection of the northeast Atlantic, and establishes an inter-governmental commission, the 'OSPAR Commission', for this purpose. Annex V in turn provides for measures to protect marine species and habitats in the northeast Atlantic. However, Art 4(2) of Annex V states that '[w]here the [OSPAR] Commission considers that action under this Annex is desirable in relation to a question concerning maritime transport, it shall draw that question to the attention of the International Maritime Organisation'. Thus the OSPAR Commission may identify an environmental risk arising from shipping, but it may not actually adopt the appropriate shipping management measure itself.

However, the need for IMO approval of the various shipping management measures in the EEZ potentially presents a problem to a coastal Member State. Member States are bound to implement their duties under the Birds and Habitats Directives, and potentially face censure by the Court for failure to do so. In the *Marais Poitevin* case,[53] the French government sought to explain the deterioration of the SPA in question by arguing that 'Community aid measures for agriculture [under the common agricultural policy] are disadvantageous to agriculture compatible with the conservation requirements laid down by the Birds Directive'.[54] In response, the Court held that 'even assuming that this were the case ... this still could not authorise a Member State to avoid its obligations under that directive ...'.[55]

In the case of a SPA in the EEZ, a Member State could attempt in good faith to persuade the IMO of the need for shipping management measures to regulate the risk of oil pollution in the SPA. Yet the Member State might still be unsuccessful. As such, would the Court find the Member State in breach of Art 6(2) HD? As noted in section 2 above, the European Commission takes the view that '[a]s

far as Member States have competence, it [i.e. the Habitats Directive] applies to the exclusive economic zone'. The implication is that beyond the point at which the Member State has competence, the Habitats Directive does not apply to the EEZ. One point at which the Member State ceases to have competence is the point at which it submits its proposal for a shipping management measure to the IMO for approval. At that point, the competence for approval and adoption of the measure passes to the IMO. Thus it is strongly arguable that a Member State should not be held in breach of Art 6(2) HD where the absence of a shipping management measure derives not from the Member State's failure to propose such a measure but from the IMO's failure to approve and adopt the measure.

Oil Exploration

Regarding oil exploration, let us assume (a) that a Member State has a legal continental shelf ('shelf') extending beyond the 200 nautical mile limit, (b) that a SAC has been designated for the purpose of protecting reefs of the deep-water coral *Lophelia pertusa* on that part of the shelf occurring beyond the 200 nautical mile limit,[56] and (c) that a company applies to the government of the Member State for permission to undertake oil exploration over a portion of the Member State's shelf, including inside the SAC. On the basis of the assumption made in section 2 above regarding the geographical scope of the Birds and Habitats Directives, the management duties in Art 6(1)-(4) HD apply to the Member State.

Beyond the 200 nautical mile limit, there is no overlap between the EEZ regime and the shelf regime as far as the seabed and its subsoil are concerned. Thus the above scenario is concerned exclusively with the regime for the shelf. With regard to its shelf, Art 77(1) LOSC provides that the coastal state has 'sovereign rights for the purpose of exploring it and exploiting its natural resources'. Even if the term 'natural resources' could be interpreted to include *Lophelia* reefs,[57] it is notable that Art 77(1) LOSC makes no express reference to sovereign rights for the purpose of 'conserving' such resources. However, with regard to seabed activities subject to its jurisdiction, the coastal state has a duty to 'adopt laws and regulations to prevent, reduce and control pollution of the marine environment arising from or in connection with' such activities (Art 208(1) LOSC).[58] The LOSC defines

the term 'pollution of the marine environment' broadly, to include pollution of 'marine life'.[59]

It is reasonable to suppose that living *Lophelia* reefs, and species inhabiting such reefs, are part of 'marine life'. Implicit in the duty in Art 208(1) LOSC is the existence of the powers necessary to implement the duty. Therefore, even if the coastal state does not, under Art 77(1) LOSC, expressly have a sovereign right to conserve *Lophelia* reefs occurring on its shelf, it does have the power, under Art 208(1) LOSC, to adopt laws to reduce pollution of the marine environment, including pollution of *Lophelia* reefs, from seabed activities occurring on its shelf.

However, Art 208(1) LOSC relates solely to pollution; it does not relate to disturbance, and yet oil exploration may pose, *inter alia*, a disturbance threat to *Lophelia* reefs. The question is whether the LOSC provides the Member State with a power to regulate the disturbance risk from oil exploration activities in respect of *Lophelia* reefs in a SAC on its shelf beyond the 200 nautical mile limit. It is arguable that the answer is 'yes', on the basis that Art 194(5) LOSC states that:

> The measures taken in accordance with this Part shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life.

Art 194(5) LOSC refers to '[t]he measures taken in accordance with this Part'; the term 'this Part' refers to Part XII of the LOSC, entitled 'Protection and Preservation of the Marine Environment'. Art 208(1) LOSC, mentioned above, is one of the provisions in Part XII. Therefore, one possibility is that Art 194(5) LOSC was introduced to provide a focus for the various anti-pollution measures referred to in Part XII, including the laws and regulations referred in Art 208(1) LOSC. However, the word 'measures' in Art 194(5) LOSC is not qualified by any reference to pollution. It is therefore possible that Art 194(5) LOSC creates a stand-alone duty to protect and preserve the specified ecosystems and habitats, and that this duty exists irrespective of the nature of the threat caused by human activities. In other words, assuming that *Lophelia* reefs are 'rare or fragile ecosystems', or 'the habitat of … forms of marine life', it is arguable that Art 194(5) LOSC establishes a duty (and hence a power) on coastal states to pro-

tect and preserve such reefs from disturbance from those seabed activities subject to their jurisdiction.

In the discussion on shipping in section 5.1 above, it was observed that the discretion of coastal states to regulate shipping activities in the EEZ is limited by the need for the laws and regulations to conform to and give effect to 'generally accepted international rules and standards established through the competent international organization or general diplomatic conference'.[60] However, such a limitation does not arise in respect of regulation of seabed activities. Instead, there is merely a requirement that the coastal state's laws and regulations 'shall be *no less effective* than international rules, standards and recommended practices and procedures' (emphasis added).[61] The point is therefore that the LOSC imposes no maximum standard beyond which the coastal state may not go in terms of regulation.

However, the coastal state must ensure that its efforts to regulate oil exploration do not 'infringe or result in any unjustifiable interference with navigation and other rights and freedoms of other States as provided for in this Convention [i.e. the LOSC]'.[62] Furthermore, the coastal state must respect constraints imposed upon it by international human rights law and, if relevant, the need to avoid conflict with duties imposed by any treaties other than the LOSC. Nonetheless, compared to regulation of shipping in the EEZ, it is clear that the coastal state is in a relatively unfettered position when it comes to implementing the management duties under Art 6(1)-(4) HD in respect of oil exploration in and adjacent to the SAC within its legal continental shelf.

In addition to the LOSC and the Birds and Habitats Directives, various regional treaties also provide for measures to regulate oil exploration. Those applicable to the waters of Member States are the 1992 OSPAR Convention, the 1992 Helsinki Convention,[63] and the 1976 Mediterranean Convention.[64] However, in the Baltic and Mediterranean, no Member State has a legal continental shelf extending beyond the 200 nautical mile limit. Therefore, the only instrument that is relevant to the scenario in question is the OSPAR Convention. Under this instrument, regulation of oil exploration is provided for by Art 5 and Annexes III and V, as well as by decisions and recommendations adopted by the OSPAR Commission.

However, the obligations that arise under the OSPAR Convention in respect of oil exploration are distinct from those arising under the

Birds and Habitats Directives. SPAs and SACs arise under the directives, rather than under the OSPAR Convention, and a Member State cannot simply rely on its membership of the OSPAR Commission as a means of implementing the management duties applicable to such sites. The legal framework provided by the OSPAR Convention may assist, but it is not a substitute for the implementation of the Birds and Habitats Directives. In this respect, it is relevant to note that Art 2(5) of the OSPAR Convention states that '[n]o provision of the [OSPAR] Convention shall be interpreted as preventing the Contracting Parties from taking, individually or jointly, more stringent measures with respect to the prevention and elimination of pollution of the maritime area or with respect to the protection of the maritime area against the adverse effects of human activities'.

It should also be noted that the EC has adopted legislation that relates expressly to offshore oil and gas activities, in the form of the Hydrocarbon Licensing Directive[65] and the EIA Directive.[66] The former instrument has as its main justification the reinforcement of the internal market. However, Art 6(2) confirms that 'Member States may, *to the extent justified by* ... protection of the environment, [and] protection of biological resources ... impose conditions and requirements on the exercise of the activities set out in Article 2(1) [i.e. prospecting, exploring for and producing hydrocarbons]' (emphasis added). The EIA Directive requires the use of environmental impact assessment ('EIA') for certain oil and gas projects. The use of EIA is a procedural tool. Thus the only impact of these two instruments on Member States' ability to adopt environmental protection measures in respect of oil exploration is the requirement in the Hydrocarbons Licensing Directive that Member States' environmental protection measures must be 'justified'.

As noted in sections 3 and 4 above, Art 6(3) HD requires the use of appropriate assessments for plans or projects 'likely to have a significant effect' on the site in question, in this case a SAC. It is strongly arguable that the proposed oil exploration activities, in contrast to shipping activities, should be regarded as a 'plan or project'. If the activities were in turn deemed to be 'likely to have a significant effect' on the SAC, an appropriate assessment would need to be carried out. In turn, under Art 6(3) HD, the oil exploration activities could only go ahead if it had been ascertained that they 'will not adversely affect the integrity of the site concerned' (unless the exception under Art 6(4) HD is successfully invoked).

It is clear that if even a part of the project in question were deemed to not adversely affect site integrity (e.g. exploration relatively far from the SAC), and so be allowed to go ahead, the Member State would still be bound by its duty in Art 6(2) HD to take appropriate steps to avoid deterioration and disturbance by such exploration. In regulating the exploration to avoid deterioration and disturbance, and indeed to avoid adverse effects on site integrity, the Member State would have at its disposal the relatively unfettered regulatory powers described above. However, it is acknowledged that the existence of such powers is clearer in respect of pollution than in respect of disturbance.

Conclusion

When managing marine protected areas, coastal States are bound by applicable constraints imposed by the international law of the sea. Such constraints may be felt more in respect of some activities than others. Thus the regulation of foreign-flagged vessels in the EEZ by the coastal state is subject to more constraints than the regulation of oil exploration by the coastal state in relation to its legal continental shelf. In practice, the need for approval of certain shipping management measures by the IMO may hamper the efforts of a Member State in respect of protecting a particular marine SPA or SAC.

The reality is that where a SPA or SAC is subject to risks of environmental damage arising from both foreign-flagged shipping and oil exploration, it is the oil exploration that may end up being more readily controlled than the shipping. Any such difference arises not necessarily because oil exploration presents a greater risk of environmental damage, but because the route to the control of foreign-flagged vessels involves a process whereby other member states of the IMO, whose interests may stand to be affected by the measure, have the potential to influence the outcome.

The use of IMO-approved measures for the control of shipping in relation to SPAs and SACs has not yet been tested. MARPOL special areas, on the basis of the size of existing examples, may be too large to assist on a site-specific basis. LOSC special areas may be more appropriate in terms of size, but none has yet been established. PSSAs may likewise be appropriate but only two have so far been established. Routeing systems, and notably areas to be avoided, are an obvious choice; however the IMO is likely to guard against a prolifera-

tion of such areas. In contrast, a wide range of measures is available to the coastal state, acting unilaterally, to control oil exploration activities.

Notes

1. Barrister. Fenners Chambers, 3 Madingley Road, Cambridge, CB3 0EE, England, UK (e-mail: daniel.owen@fennerschambers.co.uk). The text for this chapter was submitted in December 2002.
2. Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (OJ L 103, 25.04.1979, pp 1-18), as amended.
3. Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.07.1992, pp 7-50), as amended.
4. D. Owen, *The Application of the Wild Birds Directive Beyond the Territorial Sea of European Community Member States*, Journal of Environmental Law, Vol.13, No.1, Oxford University Press, 2001.
5. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.
6. Austria and Luxembourg.
7. Art 3(1) HD.
8. Art 8(1) LOSC.
9. Art 3 LOSC.
10. Art 2(1) LOSC.
11. Art 1(1) BD and Art 2(1) HD.
12. The one exception is Greece, which has a territorial sea of 6 nautical miles (though a 10-mile limit applies for the purpose of regulating civil aviation). Note also that the territorial sea of Finland is at some points less than 12 nautical miles. Source: Law of the Sea Bulletin No.45 (2001) United Nations (Office of Legal Affairs, Division for Ocean Affairs and the Law of the Sea).
13. Regarding the EEZ, see Art 57 LOSC.
14. Art 76 LOSC.
15. Answer dated 17.01.97 by the European Commission to Written Question E-3529/96.
16. Art 77(3) LOSC.
17. [2000] 2 CMLR 94, at para [79].
18. Art 4(1) BD.
19. Art 4(2) BD.
20. Case C-374/98 *Commission v France* [2000] ECR I-10799.
21. Para 47 of Judgment.
22. Case C-57/89 *Commission v Germany* [1991] ECR I-883.
23. Art 3(2) HD.
24. Art 3(1) HD. The directive does not apply to birds, in view of their separate coverage under the Birds Directive.
25. Art 4 HD.
26. Art 56(1)(b)(iii) LOSC.
27. Art 58(1) LOSC.

28. International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto.
29. Regulation 10 of Annex I of MARPOL.
30. Paras 3.1 & 3.4 of Annex I of IMO Resolution A.927(22). The resolution was adopted on 29 November 2001; Annex I is entitled *Guidelines for the Designation of Special Areas under MARPOL 73/78*.
31. Regulation 10(1) of Annex I of MARPOL identifies the special areas as being: 'the Mediterranean Sea area, the Baltic Sea area, the Black Sea area, the Red Sea area, the "Gulfs area", the Gulf of Aden area, the Antarctic area and the North-West European waters'.
32. 7th edition, 1999. Based on Resolution A.572(14) (as amended), and 'established pursuant to regulation V/8 of the SOLAS Convention' (i.e. the 1974 International Convention for the Safety of Life at Sea, as amended).
33. Para 2.1.1; see also para 1.1.
34. Para 2.1.1.
35. Paras 2.1.2 – 2.1.15.
36. Paras 3.1 and 3.11 of the General Provisions.
37. Para 3.6.2.
38. Annex 2 of IMO Resolution A.927(22). The resolution was adopted on 29 November 2001. The PSSA Guidelines are stated to 'supersede chapter 3 of the Annex to resolutions A.720(17) and A.885(21)'. The annex to Resolution A.720(17) contains *Guidelines for the Designation of Special Areas and the Identification of Particularly Sensitive Sea Areas*, of which chapter 3 addresses PSSAs. Annex I to Resolution A.885(21) contains *Procedures for the Identification of Particularly Sensitive Sea Areas and the Adoption of Associated Protective Measures*, of which chapter 3 addresses *Application by a Proposing Member Government for Identification of a PSSA and the Adoption of Associated Protective Measures*.
39. Para 1.2.
40. Para 3.1 of the PSSA Guidelines.
41. Great Barrier Reef (Australia) and Archipelago of Sabana-Camaguey (Cuba). For further details of these sites see Appendix to Annex 2 of IMO Resolution A.927(22).
42. Section 4.
43. Para 4.4 of the PSSA Guidelines. Factors to be taken into consideration in deciding whether the area is 'at risk from international shipping activities' are listed in section 5.
44. Para 4.4 of the PSSA Guidelines. Each of these terms is elaborated on in the PSSA Guidelines.
45. The PSSA Guidelines actually refer to 'designation of an area as a Special Area under Annexes I, II or V, or a SOx emission control area under Annex VI of MARPOL 73/78' (para 6.1.1).
46. Para 6.1.1.
47. Para 6.1.2.
48. Para 6.1.3.
49. Para 7.4.2.1.
50. Para 7.4.2.1(b).
51. Para 7.4.2.1(a)(ii). However, it is unclear who has the task of judging whether a measure 'should be available', and what criteria are to be used in reaching this judgment. Also, the meaning of the term 'generally applicable' is unclear. The term is not used in the LOSC; in contrast, the terms 'applicable'

and 'generally accepted' are used in Part XII of the LOSC (notably in Art 211 and in Arts 213, 214, 216-220 & 222), and much has been written on their meaning.

52. 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic.
53. Case C-96/98 [1999] ECR I-8531.
54. Para 40 of Judgment.
55. Para 40 of Judgment.
56. The UK has expressed its intent to work towards designation of a site on its legal continental shelf as a SAC for reefs of *Lophelia pertusa* (see News Release 185/01 issued by UK Department for Environment, Food and Rural Affairs, 23 October 2001).
57. The term 'natural resources', for the purpose of the continental shelf regime, is defined in Art 77(4) LOSC as follows: 'The natural resources referred to in this Part [i.e. Part VI of the LOSC] consist of the mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil'.
58. The same duty also arises in respect of pollution from 'artificial islands, installations and structures under their jurisdiction, pursuant to articles 60 and 80' (Art 208(1) LOSC).
59. Art 1(1)(4) LOSC.
60. Art 211(5) LOSC.
61. Art 208(3) LOSC.
62. Art 78(2) LOSC.
63. 1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area. Regarding oil exploration, see Art 12 and Annex VI.
64. 1976 Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (revised in 1995, though the revised version is not yet in force). Regarding oil exploration, see (a) Art 7 of the 1976 Convention, (b) Art 7 of the 1995 revised version, and (c) 1994 Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil (not yet in force).
65. Directive 94/22/EC of the European Parliament and of the Council of 30 May 1994 on the conditions for granting and using authorizations for the prospection, exploration and production of hydrocarbons (OJ L 164, 30.06.1994, pp 3-8).
66. Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (OJ L 175, 05.07.1985, pp 40-48), as amended by Council Directive 97/11/EC.

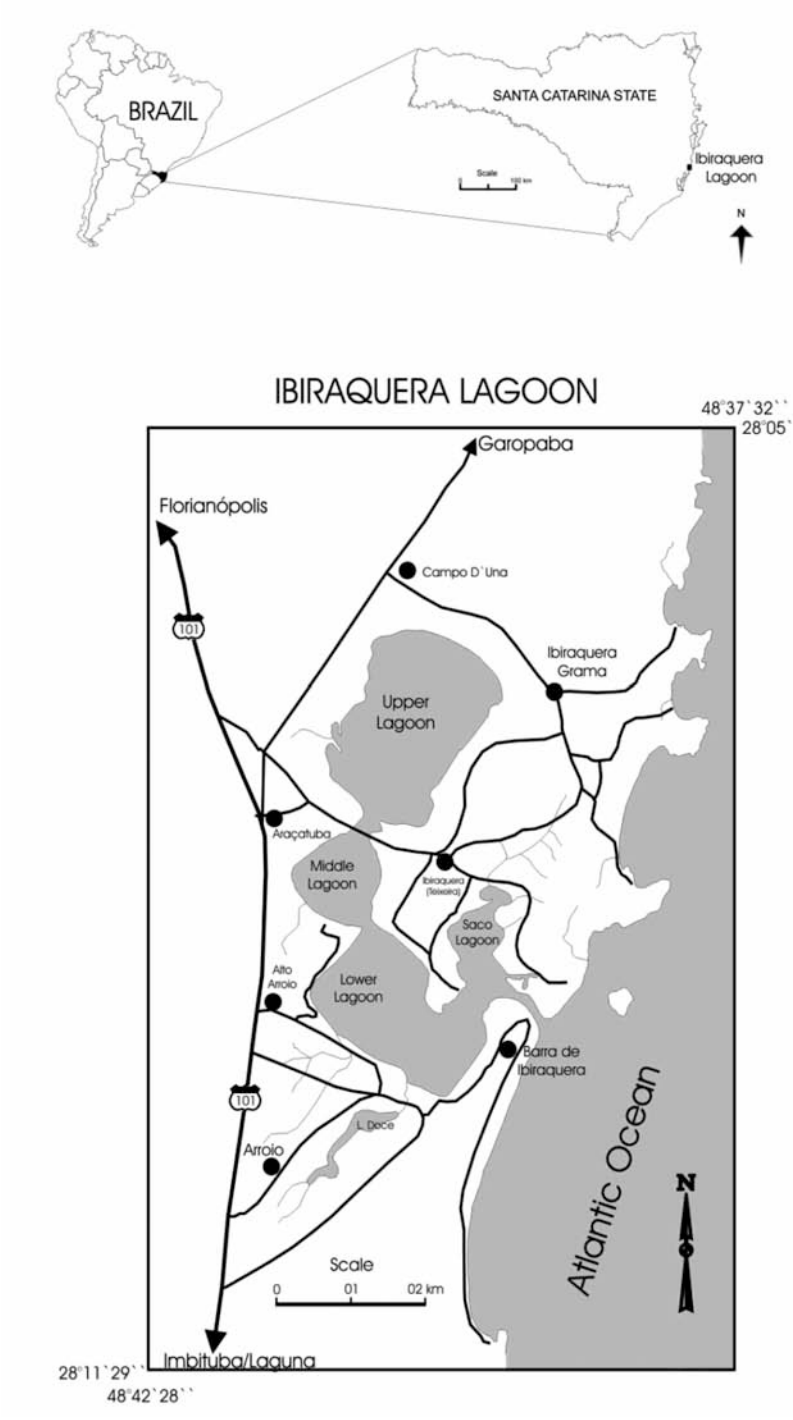

Fig. 8.1. Map of the Ibiraquera Lagoon, Santa Catarina State, Brazil.

8

Stakeholder Conflicts and Solutions across Political Scales: The Ibiraquera Lagoon, Brazil

Cristiana S. Seixas and Fikret Berkes[1]

Introduction

Coastal resources are often managed by more than one agency (e.g. different branches of the government, private, and community organisations) at different political scales (local, municipal, state, national, and international) and in distinct sectors of an economy (e.g. fisheries, tourism, urban development, maritime transportation, and oil drilling). For instance, fisheries departments at any governmental level usually deal with regulations concerning only access to, and use of, fish stocks. Little attention is given to the fact that fishing areas and fishers' livelihoods are affected by other economic activities taking place at the same time and in the same locality. This lack of co-ordination in managing coastal areas usually results in conflict among usergroups, environmental degradation, and resource overexploitation. Such situations call for an improvement in both cross-scale and cross-sector efforts to develop integrated coastal management.

Efforts towards integrated coastal management may occur at different scales from the local to the national. An example of the national and state level effort is the Train-Sea-Coast Programme[2] in Brazil which included representatives of several national and state governmental and non-governmental organisations, environmental institutions, universities, and financing agencies associated with coastal and ocean development (Reis et al. 1999). What is often missing in these nation-wide efforts, however, is input from resource users and other stakeholders.[3] According to the Lisbon Principles[4] (Costanza et al. 1998, 1999), full stakeholder participation in formulating and implementing decisions about environmental resources is one of the key principles for promoting sustainable governance of the oceans

and coastal areas (Table 8.1). This is particularly true in the case of multifaceted conflicts about resource use, which require a participatory resolution process (Hanna and Smith 1993). User-participation in decision-making helps to increase the transparency and legitimacy of the process and, ultimately, compliance (McCay and Jentoft 1996).

Table 8.1. The Lisbon principles – key principles to promote sustainable governance of the oceans and coastal areas

Lisbon principles	
Responsibility principle	the responsibility of individuals or corporations to use environmental resources in an ecologically sustainable, economically efficient, and socially just manner
Scale-matching principle	the importance of assigning decision-making to the scale of governance which has the most relevant ecological information, which considers ownership and actors, and which internalises costs and benefits
Precautionary principle	the need to take uncertainty about potentially irreversible environment impacts into account
Adaptive management principle	the requirement to continuously monitor social, economic, and ecological systems because they are dynamic and have some level of uncertainty
Full cost allocation principle	the need to identify and allocate all internal and external costs and benefits (social and ecological) of alternative uses of environment resources
Participation principle	the importance of full stakeholder participation in the formulation and implementation of decisions about environmental resources

Source: Costanza et al. 1998, 1999

Although nation-wide efforts towards integrated coastal management are important, solutions to specific problems should be tackled at the scale that matches the problem to be solved (Folke et al. 1997). Thus, efforts focusing on a particular locality using participatory approaches are likely to solve local management problems more effectively than regional or national approaches. Identifying stakeholder conflicts and their origins, together with stakeholder concerns, may be a first step towards an integrated coastal management. Conflicts and concerns usually point out the weakness of the current manage-

ment arrangements, the main organisations involved as well as their capacities and vulnerabilities, and the major issues that have to be addressed.

Berkes (2002) identified some promising institutional forms to establish cross-scale participatory management processes (Table 8.2). There is not one general model that can be universally applied. The most appropriate approach or combination of approaches for each case will depend on the political and cultural history of the area as well as on its geographical and ecological aspects.

Table 8.2. Promising institutional forms for cross-scale linkages in natural resource management (based on Berkes 2002)

Institutional forms	*Institutional Attributes*
Co-management linking communities and government	combine the strengths of government-level and local-level resource management and mitigate the weaknesses of each
Multi-stakeholder bodies	link multiple user-groups and interests (local and regional) with the government, and provide a forum for conflict resolution and negotiation among users
Development, empowerment, and co-management arrangements	emphasise development and empowerment (co-management is a result), the involvement of NGOs or other capacity-building bodies, and the presence of lateral as well as cross-scale linkages
Institutions for linking local users with regional agencies	bring local issues to the regional and international arena. Examples include epistemic communities (groups of scientists, government experts, and NGO representatives), and funding agencies
Research and management approaches to enable cross-scale linkages	may impact local and higher-level institutions. Examples include adaptive management, ecosystem-based management, participatory rural appraisal (PRA), and participatory action research (PAR)
'Citizen science' or 'people's science movements'	combine local knowledge and inputs from university scientists into alternative resource and environmental assessments

User participation in management is also a way of broadening the knowledge base on which management decisions rest, thus improving management (McCay and Jentoft 1996). Therefore, an impor-

tant task in integrated and participatory coastal management is to build a common knowledge base upon which management decisions can be made. Such a knowledge base may include scientific knowledge, resource managers' and resource users' practical knowledge, and socio-economic and ecological data at local, municipal, state, and national levels. Such a database may serve at least three purposes: 1) it provides a large set of information for decision-makers; 2) it minimises differences in stakeholder understandings of problems, and 3) it provides an input to management co-ordination at a larger scale. We expand on each of these purposes in the following.

First, user knowledge may supplement scientific data, especially in areas where scientific knowledge is scarce, as in most developing countries (Berkes et al. 2001). Resource users have ecological knowledge about species and ecosystem processes (Seixas and Berkes 2003a; Calheiros et al. 2000; Olsson and Folke 2001). Moreover, using fishers' knowledge and scientific knowledge together has improved management systems in several localities (Seixas and Berkes 2003a; Johannes 1998; Neis et al. 1999).

Second, conflicts within and between user-groups and other stakeholders, including government agencies, are often a result of their very different management goals that may reflect different worldviews (Hanna and Smith 1993; Brown and Rosendo 2000). Building a common and reliable knowledge base may help reshape, to some extent, stakeholder views of management problems and their management goals. When reliable information is made available to all stakeholder groups, they might get a different understanding of causes and effects of the management problems, and perhaps they might rethink their goals.

Third, sharing a locally developed knowledge base across political scales and localities (geographical scales) may lead to better co-ordination and outcomes from integrated coastal management at regional, state, and national levels. Fisheries measures, which are usually based on scientific research conducted in relatively small areas, are more often than not implemented in large regions without regard to varied socio-economic and local ecosystem characteristics.

The aim of this paper is to investigate stakeholder conflicts in a coastal area in order to develop a participatory resource management approach that takes into account stakeholder concerns, user knowledge[5], and government institutional frameworks. Our focus case is

the small-scale coastal fishery in the Ibiraquera Lagoon, Santa Catarina State, in southern Brazil. In that setting, we investigate stakeholder conflicts and interactions among management institutions across political scales, administrative sectors, and organisational spectra.[6] We trace how these institutions help to minimise or exacerbate conflict and propose some mechanisms to integrate different types of knowledge through an adaptive co-management forum as a way to help resolve conflicts.

Site Profile

The Ibiraquera Lagoon is located in the municipality of Imbituba (pop. 33,000 in 1991) in Santa Catarina State, along the southern part of the Brazilian coast (fig. 8.1). This is a brackish water lagoon, intermittently connected to the Atlantic Ocean by a channel, which is opened by human actions and closed by natural processes. The lagoon has four basins and an area of approximately 900 hectares. Pink shrimp (*Farfantepenaeus paulensis* and *F. brasiliensis*) and mullet (*Mugil platanus, Mugil* spp.) are the main fishing resources and fishing is usually a male activity. There are no effective legal access restrictions to the lagoon. As of 2000, there were about 350 licensed fishers and many other unlicensed ones living in seven communities around the Ibiraquera Lagoon: Ibiraquera (also known as Teixeira), Barra da Ibiraquera, Arroio, Alto Arroio, Araçatuba, Campo D'Una, and Grama (or Ibiraquera de Garopaba). Many of the fishers were descendants of immigrants from the Azores Islands, who arrived in this part of Brazil about 200 to 250 years ago. Fishers from other communities and municipalities also frequently fished in this lagoon.

The large majority of local fishers have a living standard well above the poverty line. They own houses, have access to electricity and running water, and own appliances. Many have bicycles but very few own cars. Few fishers depend exclusively on fishing for their livelihood; most complement their income working in tourism-related activities such as construction and housesitting in the off-season. Some local fishers are small-scale farmers. Fishers who come from other places are often retired from the public or private sectors, and seem to have a higher standard of life than the locals. Many outsiders, for example, drive their own car to the lagoon. Most of these outsiders fish for recreation.

Local Economy

In the study region as a whole, tourism-related activities seemed to be the main source of income for most people. Small-scale fishing and small-scale agriculture were the major sources of income during the 1970s, but they became less important to the local economy by the late 1990s. Fishing evolved from a subsistence-level activity in the 1950s to a market-oriented activity in the 1970s. By the 1990s, it was a commercial activity and had also become a sport activity. Agricultural production changed from a market-oriented activity in the 1960s to a subsistence one in the 1990s.

The Ibiraquera region is a popular summer spot for tourists due to its scenery, the lagoon's warm and safe waters, and four beautiful ocean beaches. Most tourists come from Porto Alegre, which is the largest city to the southwest. Although tourism had started to develop in Ibiraquera by the late 1970s, tourism boomed in the region during the 1990s. For instance, in the Barra da Ibiraquera house numbers increased about tenfold between 1990 and 2000 due to the construction of summer cottages and guesthouses. In the Ibiraquera community, the percentage of summer cottages grew from 8 percent of the houses in the community in 1979 to 45 percent in 1993 (Avellar 1993). In 2000, according to data obtained from the local electricity distributor, this figure had jumped to 81 percent.

Lagoon Fisheries Management

In the early 1960s, the Ibiraquera Lagoon fishery was managed communally. Management practices were flexible and resilient[7], based on local ecological knowledge, and enforced by social rules. (Seixas and Berkes 2003a,b) During the 1970s, the lagoon became open-access due to several changes in local socio-economic conditions, including the development of external markets for shrimp (Seixas and Berkes 2003b, Seixas and Troutt 2003). The system regained its resilience during the 1980s and early 1990s. We identified a number of key factors that have helped build resilience in the lagoon and some that have weakened it (Seixas and Berkes 2003b), as summarised in Table 8.3.

Table 8.3. Key factors affecting social-ecological resilience of the Ibiraquera Lagoon management (after Seixas and Berkes 2003b)

Factors building social-ecological resilience
Strong institutions (leadership and rule enforcement)
Good cross-scale communication (co-management of scientific and local knowledge)
Political space for experimentation
Equity in resource access
Use of (local people's) memory and knowledge as sources of innovation and novelty
Factors weakening social-ecological resilience
Breakdown of locally-devised institutions and authority system
Rapid technological changes leading to more efficient resource exploitation
Rapid changes in the local socio-economic system
Institutional instability at higher political levels negatively affecting local management

Co-management arrangements triggered by local fisher action (Seixas and Berkes 2003b), notably good cross-scale communication and political space for experimentation, allowed for the incorporation of local knowledge and fisher concerns into federal government regulations. These new regulations served to optimise catch size while maintaining the stock for the future and minimizing conflict among user-groups by promoting equity in resource access (Seixas and Berkes 2003b). During this period, through an agreement between the federal and state governments, two local fishery inspectors were hired for rule enforcement in the region.

However, in 1994, the inspector positions were discontinued, probably due to budget constraints, and enforcement became sporadic. The lack of personnel and equipment supplied by the Brazilian Agency for the Environment (IBAMA[8]) and the State Environmental Police in this new enforcement arrangement resulted in an unstable management situation during the second half of the 1990s when rule breaking became common. The history of Ibiraquera Lagoon fisheries management demonstrates that institutional instability at higher political levels negatively affects local management (Table 8.3). Institutional instabilities appeared to be the result of frequent changes in government management agencies in the last four decades of the 20th century (Table 8.4). For instance, government agencies responsible for fisheries enforcement in the Ibiraquera Lagoon changed six times during this period.

Table 8.4. Government agencies responsible for Ibiraquera Lagoon fisheries management during the past four decades

GOVERNMENT AGENCIES	*Political level*	*Period*
Fisheries regulations		
Decision-makers		
– Service for Fishing and Hunting [a] (SCP)	Federal	1960 – 1967
– Federal Fishery Agency [b] (SUDEPE)	Federal	1967 – 1989
– Brazilian Agency for the Environment [c] (IBAMA)	Federal	1989 – 2000
Information providers		
– Fishery Research Institute [d] (IPEP)	State	1980s
– State Association for Fishery Credit and Assistance [e] (ACARPESC)	State	1980s
– Federal University of Santa Catarina [f] (UFSC)	Federal/State	1992-1998
– Santa Catarina State Research Agency [g] (EPAGRI)	State	1992-1998
Enforcers		
– State Department of Fishing and Hunting [h] (DECP)	State	1960 – mid-1970s
– Navy District Office [i]	Federal	1960s
– SUDEPE	Federal	1967 – 1989
– IPEP	State	1982 – 1984
– ACARPESC	State	1984 – 1989
– State Environmental Foundation [j] (FATMA)	State	1991 – 1994
– State Environmental Police [k]	State	1994 – 2000
Channel openings		
Decision makers and enforcers		
– Navy District Office	Federal	1960s – 1988
– Municipal Government	Municipal	1988 – 2000

Agencies:
[a] Serviço de Caça e Pesca do Minitério da Agricultura;
[b] Superintendência do Desenvolvimento da Pesca do Ministério da Agricultura;
[c] Instituto Brasileiro do Meio Ambiente e Recursos Renovaveis;
[d] Instituto de Pesquisa e Extensão da Pesca;
[e] Associação de Crédito e Assistência Pesqueira de Santa Catarina;
[f] Universidade Federal de Santa Catarina;
[g] Empresa de Pesquisa e Difisão Tecnológica do Estado de Santa Catarina;
[h] Departamento Estadual de Caça e Pesca;
[i] Capitania dos Portos;
[j] Fundação do Meio Ambiente do Estado de Santa Catarina;
[k] Companhia de Policia de Proteção Ambiental.
Observation: In fact, during the 1960s, regulations decision making, information provision, and enforcement were all performed by the local communities. Similarly, channel opening decision making and opening action were performed by local fishers and/or their fishers' organisation, Colônia, from the 1960s until 1988; and from 1993 to 2000 (Seixas and Berkes 2003b).

Lagoon Fisher Groups and Stakeholder Conflicts

Lagoon fishers can be grouped according to 1) whether they are locals or outsiders; 2) their status as full-time or part-time commercial fishers, sport fishers, or subsistence fishers[9]; 3) their legal status: professional fishers, sport fishers, or unlicensed fishers; and 4) by gear group: cast-netters or gill-netters. These categories may overlap, as, for example, one person could be at once a local, full-time, professional cast-netter. Indeed, local fishers included all full-timers, most part-timers, and a few subsistence fishers, while outside fishers included most sport fishers. The large majority of fishers were cast-netters.

Major conflicts concerning lagoon fishery management involved: a) fishers and tourists for the use of the lagoon area; b) gill-netters and cast-netters; and c) local fishers and those who come from outside the lagoon area to fish. In addition, there was some disagreement between local fishers and government managers concerning some fishing regulations and locally-devised management techniques (Seixas and Berkes 2003a). These disagreements were largely the result of different understandings of lagoon ecosystem dynamics (Seixas and Berkes 2003b).

Fishers vs. Tourists

The conflict between fishers and tourists has emerged during the last 25 years as a result of major tourism development in the communities around the lagoon, with consequences for the lagoon fisheries (see below). Fishers', tourists', and tourism entrepreneurs' understanding of how the lagoon and its surroundings should be managed differ vastly because of their different goals. For example, fishers want to improve fishery production, tourists look for entertainment, and tourism entrepreneurs want to increase their profits.

The conflict is frequently expressed in the form of complaints by local fishers to authorities and to researchers. The biggest problem is that local fishers feel powerless against tourists who usually have a higher degree of education, socio-economic status, and arguing skills. For example, when fishers and a local community council complained to government agents and the tourism industry about construction irregularities, the government ignored them and the industry threatened them.

Overall, this situation results from conflicting goals and a different degree of dependence on resources. Ultimately, it expresses a lack of empowerment of fishers and local community councils; a lack of government personnel and equipment to enforce regulations; and a mismatch in scale of lagoon management to accommodate local problems through the regulatory and enforcement agencies at municipal, state, or federal levels (Folke et al. 1997; Brown and Rosendo 2000; Kalikoski et al. 2002). Table 8.5 provides an overview of the lagoon management problems and the regulatory and enforcement agencies at different political levels responsible for managing them.

Cast-netters vs. Gill-netters

The conflict between gill-netters and cast-netters has existed at least since the 1940s. The conflict is about resource allocation since gill-netters, who are only a few in number, capture much more resources with less human effort than the large majority of fishers who use cast nets. Moreover, the intensive use of gill nets attached together and used as beach seines along the shore of the lagoon produced the collapse of the fishery system at the end of the 1970s.[10] In 1981, government regulations banned gill net use in the lagoon, as a result of cast-netters' requests. Consequently, the conflict between the two groups temporarily disappeared until 1994 due to strong regulation enforcement provided by state and federal agencies. But the conflict flared up again due to lack of enforcement after 1994.[11]

Over the past five decades, most conflicts appeared in the form of arguments, with a few episodes of physical confrontation and shotgun threats. Indeed, to avoid verbal or physical confrontations, gill-netters often run away when they are approached by cast-netters. In 2000, gill-netters included both local and outside fishers. According to some fishers, however, they were mainly locals spread across all of the lagoon communities. Interestingly enough, local cast-netters can name local gill-netters[12] although gill net fishing is an illegal activity.

No movement towards the legalisation of gill net fishery has been observed, although a few individuals have suggested it. This probably happened because even former gill-netters admitted that the unrestricted use of gill nets was the major cause of the fishery collapse. In addition, previous research showed that the small depth of the lagoon does not sustain a gill net fishery, particularly in face of an increased number of fishers. Hence, this conflict essentially results

from the lack of strong regulation enforcement and penalties for gill net cheaters.

Until 1998, penalties consisted basically of the impounding of illegal gear and sometimes the imposition of a small fine, and were ineffective in discouraging fishers from taking risks. Since then, according to the Nature Law (Law 9605/98), fines have been increased and jail terms added. The problem is that many fishers are still taking risks in the face of weak enforcement in the lagoon. Although penalties are heavy, the transgressors are not being caught.

Local Fishers vs. Outside Fishers

Outside fishers started to come to the lagoon about two or three decades ago when access to its shore became available due to road construction. Conflicts only started to build up when the sport-fisher populations (mainly outsiders) increased, especially during the 1990s. The conflict between locals and outsiders, however, is often low-key as all local fishers acknowledge the outsiders' rights to fish at the lagoon. Physical confrontations rarely occur. From the point of view of most outsiders interviewed, there seemed to be no conflict between them and local fishers. Nevertheless, many locals have complaints about outsiders. First, some locals argue that outsiders are the ones who usually introduce more efficient but destructive gears into the lagoon, which are later used by both some locals and some outsiders. Second, some locals say that it is mostly outsiders who use banned gears such as gas lamps, small-mesh cast nets, and shrimp small-trawls. Third, local fishers respect each other's fishing activities more than outsiders, especially concerning fishing spots and first-comers' rights. Finally, because most outsiders are retired from other professions and only fish for sport and private consumption, some full-time local fishers argue that these outsiders should give them priority in accessing a fishing spot.

Therefore, the conflict in this case is about fishing rights, livelihood dependency on fishing, and access to resources. Again, the weak enforcement of regulations contributes to the conflict because it allows for the use of banned gears.

Resource users are quite aware of the major environmental and management problems affecting their livelihoods. According to some Ibiraquera fishers and local residents, intensification of tourism and lack of enforcement of environmental regulation resulted in several problems during the late 1990s, as presented in Table 8.5.

As Table 8.5 demonstrates, there are several agencies from different political scales and sectors in charge of responding to the environmental and management problems that affect the Ibiraquera Lagoon and its surrounding area. However, it was not our intention to map the entire institutional framework affecting resource management in that region. The purpose here was to record some institutions and organisations related to the lagoon environmental and management problems that were pointed out by fishers. Problems mostly resulted from a lack of co-ordination among these many management agencies and their ineffective management capabilities. For instance, the Santa Catarina State Environmental Foundation (FATMA) office in Tubarão – whose jurisdiction encompasses Imbituba – had, in April 2000, only seven personnel and one vehicle to monitor eighteen municipalities concerning deforestation and water quality, among other issues. Another example is the State Environmental Police in Maciambu – a jurisdiction that encompasses Imbituba – who had, in early 2000, only one group of four policemen to monitor fisheries issues in thirteen municipalities.

Proposing an Alternative Management Structure for the Lagoon

So far we have discussed the need for institutional stability at higher political levels, problems caused by the diversity and ineffectiveness of management agencies, and the need for co-ordination among government agencies from different levels and sectors. The current management conditions have resulted in stakeholder conflicts, environmental degradation, and resource overexploitation at the Ibiraquera Lagoon and the surrounding area. We have also observed that stakeholder conflicts reflect a number of systemic problems including a divergence in management goals; disagreements about fishing rights and resource allocation; a lack of resources to enforce regulations; a mismatch in the scale of problems and those of man-

agement agencies; disempowerment of fishers and local councils; and different understandings of lagoon ecosystem dynamics. We now turn to the question of what can be done to overcome such problems and develop an integrated and participatory management plan.

Any promising solutions to these problems depend upon the willingness of governments at various political scales to deal with these issues. It may require governments to modify their current structures in order to: a) coordinate actions at different levels to minimise discrepancies in management goals and policies; b) allow stakeholder concerns to be addressed; and c) incorporate user knowledge into management. The first task may be initiated by efforts such as the Train-Sea-Coast Programme in Brazil, which helps to build the capability of coastal managers at different scales. Tasks b) and c) may be accomplished by facilitating a participatory management process for the Ibiraquera Lagoon.

The establishment of an Ibiraquera Lagoon management Forum may help address stakeholder concerns and conflicts and build a knowledge base upon which management decisions can be made through an adaptive co-management process (Folke et al. 2002). Such a process can combine the elements of co-management (a sharing of responsibility among governments, non-government organisations, and resource users) and an *adaptive management* approach premised on the idea of learning by doing and building on experience in an iterative way (Holling 1978; Walters 1986).

Such a forum can benefit from extensive experience in various parts of the world with co-management and participatory management in fisheries (Jentoft 1989; Pinkerton 1989; Hanna 1996; McCay and Jentoft 1996; Sen and Nielsen 1996; Pomeroy and Berkes 1997; Singleton 1998). Many case studies from different world regions have reported on lessons with fisheries co-management, and the major issues that need to be addressed (Appendix A). The Forum can also benefit from the experience in Brazil with the concept of *extractive reserves* (Cunha 2002; CNPT-IBAMA 2002) some of which are found in the coastal zone.

The adaptive co-management Forum could be established through a joint effort of all of the federal, state, and municipal government agencies holding responsibility for lagoon management (e.g. IBAMA, Environmental Police, FATMA, EPAGRI, City Hall, and DPU – Table 8.5) and other lagoon stakeholder-groups (local fishers,

Table 8.5. Major environment and management problems affecting the Ibiraquera Lagoon fisheries during the late 1990s

Problems	*Regulatory and/or enforcement agencies*	*Government level*	*Stakeholders responsible for them*	*Most affected stakeholders*
Illegal fishing gears and methods affecting resource stocks and triggering fisher conflicts	Brazilian Agency for the Environment (IBAMA)[a] Environmental police [b]	Federal State	Local fishers Outside fishers	Full-time and part-time, local fishers
Motor vessels and windsurf boards in the lagoon	City Hall	Municipal	Tourists	Fishers
Garbage dumping at the lagoon margins	City Hall	Municipal	Tourists Fishers	Fishers Local residents Tourists
Sewage drainage into the lagoon and poorly constructed septic tank contaminating the water table	State Environmental Foundation (FATMA)[c] City Hall	State Municipal	Tourism industry	All fishers Local residents Tourists
Management of lagoon channel openings	City Hall Fishers organisation [d]	Municipal	Tourism industry Tourists	Fishers
Illegal construction inside and around the lagoon (*areas de Marinha*)	Department of State Properties (DPU)[e] City Hall	Federal Municipal	Tourism industry Tourists	Fishers Local residents
Deforestation of lagoon margins, along springs, and on hills; and consequent landslides	IBAMA FATMA Environmental Police	Federal State State	Tourism industry	Local residents Fishers
Siltation of shrimp/fish migratory channels due to deforestation and poorly-planned construction around the lagoon	IBAMA DPU FATMA Environmental Police City Hall	Federal Federal State State Municipal	Tourism industry	Fishers
Closure of lagoon access trails by tourist landowners	(regulatory gap)	—	Tourists Outsiders	Fishers Local residents

Agencies: [a] *Instituto Brasileiro do Meio Ambiente e Recursos Renovaveis;* [b] *Companhia de Policia de Proteção Ambiental;* [c] *Fundação do Meio Ambiente do Estado de Santa Catarina;* [d] *Colônia de Pescadores Z13 – Imbituba;* [e] *Delegacia do Patrimônio da União.*

outside fishers, fisher organisation, local residents, tourists, and the tourism industry).[13] Scientists and natural resource managers could also be part of the Forum to provide information, methods and tools to be used in each of the co-management phases: planning, implementation, monitoring, evaluation, and adaptation.

Because fisheries management in Brazil is very centralised and its top-down management culture will not change overnight, the Forum would need to be a federal government initiative initially to legitimate participatory management. Moreover, various government agencies would need to play a major role in capacity-building to support the activities of the Forum, as NGO expertise in fisheries management that could assume this role does not exist in this part of Brazil.

The Forum may search for promising conflict resolution measures across different political scales. It may work to empower community councils and other local organisations by promoting, for instance, a diversity of courses on such topics as adult education, financial management, environmental legislation, and co-operatives. It may also work to set up agreements between groups of stakeholders by, for example, zoning different uses such as recreation and commercial fishing. The Forum may promote co-management between local resource users and government agencies. For instance, the decision on the channel opening date (which depends on precipitation, water level, water pollution, and ocean conditions) should be made *every season* in a common agreement between users and government. The Forum may also serve to mediate discussions about resource use among local users and community councils, and the municipal government may legitimise agreements reached in such discussions (i.e., it may turn an informal agreement into a municipal by-law). In another instance, the Forum may push the federal government to promote decentralisation of the enforcement function from federal and state governments to the municipal government, or even to community councils, or the Forum itself. This could result in a more effective, and possibly less expensive, enforcement regime, as local inspectors are more familiar with local conditions than are outsiders.

Co-managing Knowledge for Conflict Resolution and Resource Management

In this paper, we concentrate on one aspect of adaptive co-management, that of building a knowledge base to bridge user concerns and knowledge with manager concerns and knowledge. The major point here is that conflict resolution may be based on a common understanding of environmental and management problems. As Hanna and Smith (1993: 66) point out, 'a discussion of the various perceptions of the problem [is needed] to arrive at a consensus of the true nature of the problem and on a common principle that will structure the [co-management] process. The consensus includes recognition by each group that the other group's objectives are viable and thus supportable.'

To create an Ibiraquera Lagoon Forum and an integrated knowledge base, we propose a governance model (fig. 8.2) based on the Brazilian fisheries management structure in 2000. The central office of the Brazilian Agency for the Environment (IBAMA) in Brasília – the national capital – was responsible for approving all changes in fisheries regulation, while IBAMA's offices at the state level were in charge of presenting proposals of new regulations but did not have any power in decision-making.

In this model, we argue that government authority and responsibility should be transferred from the IBAMA central office to its state-level offices through administrative de-concentration (Pomeroy and Berkes 1997). Managers working at the state-level office need to have the necessary skills to enter into a co-management process. Capacity-building is needed for managers to: a) understand the important contribution stakeholders may have in management design, implementation, monitoring, evaluation, and adaptation; and b) learn tools and techniques to conduct workshops, to research stakeholder concerns and user knowledge, and to manage conflicts among user-groups (or even between themselves and users).

Combining science, managers' knowledge, and users' knowledge helps in the recognition that each knowledge system is valuable in providing different kinds of knowledge and different perspectives. Making resource users confident of their knowledge can increase user participation in decision-making and in providing local solutions for management problems. Solutions to problems, based on local knowledge, are more likely to be accepted by local communities (Antweiler 1998). In addition, increasing resource users' confidence

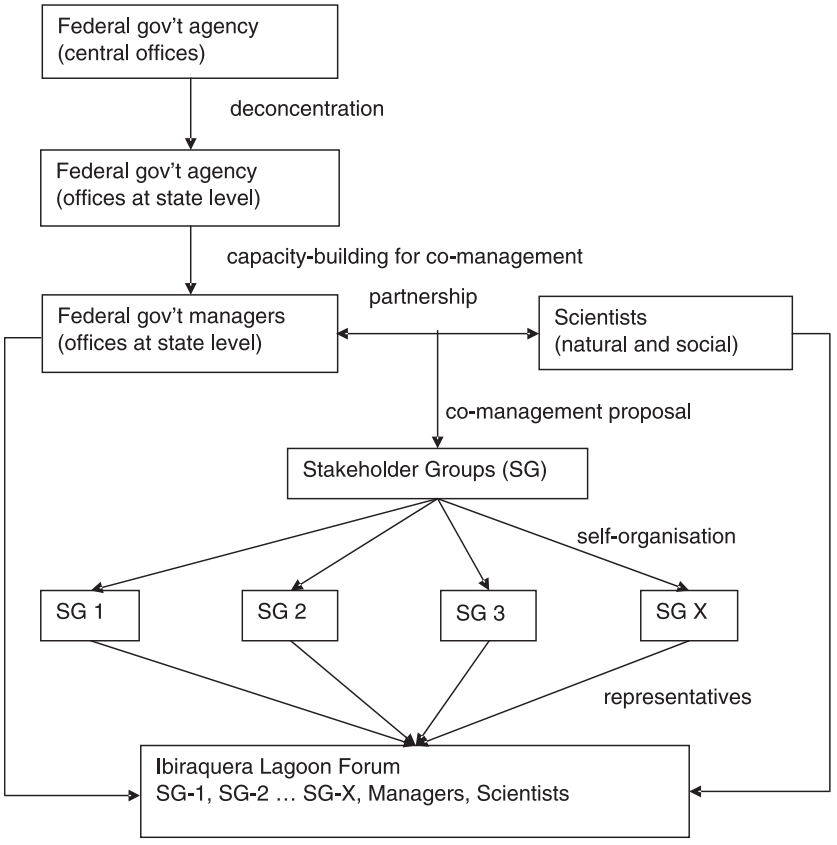

Fig. 8.2. Establishing the Ibiraquera Lagoon Co-management Forum. Stakeholders may include: different fisher-groups, community councils, and other local non-governmental organisations (e.g. representing tourists, small farmers, guesthouses and restaurants, constructors, nautical sports, etc.), as well as municipal government and any other state or federal government agency holding any responsibility for the lagoon management.

in their knowledge may even strengthen their ability to 'co-operate with external institutions on an equal basis' (Antweiler 1998: 490).

Specialists or scientists working with local knowledge and social organisations in coastal systems may provide capacity building. An ex-

ample is the programme in which researchers from the Unit of Environment and Development (NMD) of the Federal University of Santa Catarina (UFSC) has promoted a course for capacity building on *Education for ecodevelopment* for schoolteachers in the lagoon area. Scientists may also play a role in providing scientific data to complement user and manager practical knowledge. Hence, government fisheries managers may invite both natural and social scientists from nearby universities (such as UFSC, UDESC[14], UNIVALI[15], and UNISUL[16]) or research institutes (such as EPAGRI[17]) to be a part of the co-management process.

Once stakeholders have been identified (Berkes et al. 2001), Forum participants can discuss and negotiate steps of the co-management process and the actors to be involved in it. For instance, a board of representatives should be created for decision-making. Such board for the Forum may include one or two representatives from each community council, from each government agency and from each local NGO, who share a stake in the management of the lagoon. Efforts should be made to bring together an equal number of representatives from government agencies and from other stakeholder groups in the board in order to really share the decision-making power.

Forum participants can jointly discover the benefits, costs, and risks of such a process for each stakeholder group and for society in general. Self-organisation of the stakeholders is one of the key requirements for the success of co-management (Berkes et al. 2001). Hence, the first step in promoting co-management is to build capacity for self-organisation of stakeholder groups. Capacity building could be done through courses offered by government agencies and universities (cited above) working in the area. Effective participatory management requires decision-making processes that are legitimate, accountable, and inclusive, and that take into account multiple stakeholders and interests (Agrawal and Gibson 1999). In particular, legitimate representation is an issue; stakeholder misrepresentation may create a bias in the decision-making process (Jentoft et al. 2001) and a consequent lack of compliance, as in the case of the Forum of Patos Lagoon in southern Brazil (see Box 1).

Box 1 Participatory management: The Forum of Patos Lagoon, Brazil

An attempt to develop a participatory, cross-scale and cross-sector management effort in southern Brazil was the establishment of the Forum of Patos Lagoon in 1996. The Forum is a multi-partner entity encompassing 21 organisations from distinct political, economic and legal sectors, which involved civil society to evaluate fisheries management and enforcement in order to propose new regulations and management alternatives (Reis and D'Incao 2000). Although this Forum represents a very important step towards participatory and integrated management, Reis and D'Incao (2000, p.589-591) reported several issues that throw into question the fishers' real participation in the process and the decision-making process itself:

> *Fishermen representatives are restricted to coordinators of fishermen organisations and fishermen unions who are not necessarily active fishermen. Therefore, decisions within the Forum may be taken apart from daily reality. It is also difficult to expect that only one person ... may represent equally well five or more communities [or different fisher-groups] ... [As a consequence,] despite the regulation was discussed for more than 3 years, there are fishermen that misunderstand it or that think it is somehow harmful to their activity. [Moreover,] fishermen are not used to considering themselves responsible for regulations. So, an intense programme to make fishermen conscious of the important role that is expected from them has to be developed by [the Forum].*

If an Ibiraquera Lagoon Forum can be created, there will be a need for a 'working team' to build a knowledge base upon which decisions can be made. Some researchers, local residents, and managers, for example, could be part of the working team. Priority should be given to collecting information on the major environmental problems affecting the lagoon area, such as the use of illegal fishing gears, sewage drainage into the lagoon and contamination of the watertable, garbage dumping, deforestation, and irregular construction around the lagoon area.

Initially, the team can define research tools, techniques, and samples to search and compile information about the lagoon management system, including stakeholder concerns and user knowledge. In traditional/local knowledge research, in general, information-gathering techniques and sampling strategies may vary according to the local socio-political context and the diversity of resource uses. In fisheries, for example, 'the complex range of factors that probably influences fishers' [knowledge] means that reliance on a small sample could result in limited and perhaps biased data' (Neis et al. 1999: 222). The literature about traditional/local ecological knowledge, in general, and fishers' knowledge, in particular, provides several techniques such as semi-structured interviews, focus groups, ethnomapping, participant observation, and sampling methods[18] which

may be used individually or complementarily to collect user local knowledge (cf. Neis et al. 1999; Usher 2000; Berkes et al. 2001).

The team would need to be involved in data collection, organisation and communication, as well as in the discussion of such data with the public. The knowledge base would incorporate three main sources of information: 1) resource users, who would provide practical local knowledge; 2) managers, who would provide practical knowledge at local and/or regional scales, and scientific knowledge; and 3) scientists, who would provide scientific knowledge (fig. 8.3).

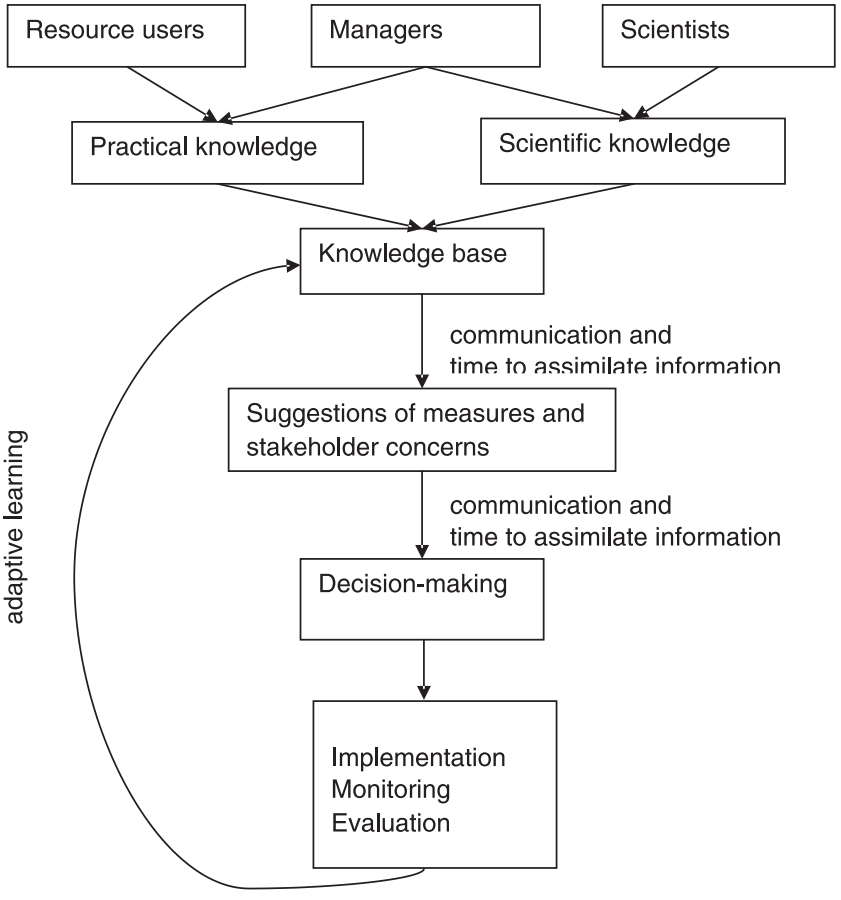

Fig. 8.3. Building a knowledge base for co-management (partly based on Mackinson 2000).

To integrate user and manager practical knowledge with scientific knowledge, management-relevant information must be collected, organised, and communicated effectively. For example, user and manager practical knowledge can be organised in a systematic way and distinctions made between observation and inference (Usher 2000). Moreover, the process of collecting and organizing practical information (as opposed to scientific data) must also include techniques of validation (e.g. data triangulation). Particular attention may be given to practical information directly relevant to conflicts among user-groups, since user statements may be 'politicised' (Neis et al. 1999). Both practical information provided by users and managers and scientific data must be considered during decision-making.

Both practical and scientific knowledge need to be made available to all actors in the co-management process in a way that makes it accessible to them. For instance, because many users are illiterate, figures, photos, videos, and radios, among other instruments, may be used to communicate information. Sufficient time should be provided for the groups to digest or check such information. Resource users need time to assimilate external knowledge by testing it in their everyday practices. As Antweiler (1998: 489) pointed out, 'Communities must have the opportunity in terms of time and social institutions to discuss the given information and integrate it into their system. They need to gain their own experiences with the application of external knowledge along the lines of their socialisation practices.'

Giving time to resource users, managers and scientists to assimilate information about an entire fishery system (including socio-economic and ecological information at the local and regional scale) may also encourage the search for more creative and viable management strategies and solutions to problems. This may reduce the time stakeholders spend arguing with one another about their own, often limited, views of the system.

Information gathering may take place during several phases of the co-management process, including: a) the definition of management goals; b) the building of an initial knowledge base concerning the economic, social, and ecological aspects of the system; c) the compilation of suggestions for, and decisions on, management and conflict resolution measures while considering their costs, benefits, and risks; d) the compilation of suggestions for, and decisions on, ways of implementing and enforcing such measures; e) the compilation of new data (through monitoring) to evaluate the implemented measures; f) and the formulation of new suggestions about how to

improve the implemented measures. The use of adaptive management means that new information would be continually incorporated into the knowledge base (learning-by-doing) to assist with the search for more appropriate management measures iteratively through feedback.

The continuous process of planning, implementation, monitoring, and evaluation is necessary because resource systems are 'non-linear in nature, cross-scale in time and in space, and have an evolutionary character' (Holling et al. 1998). Moreover, resource systems are complex in behaviour, non-linear, and unpredictable (Wilson et al. 1994). Therefore, management measures have to be adjusted in order to adapt to changes in the resource system. As well, measures also have to adapt to changes in the socio-economic system, especially when stakeholder conflicts arise.

Conclusions

The adaptive co-management Forum that we are proposing may be a feasible way to improve conflict resolution and resource management in the Ibiraquera Lagoon area, taking into account fisheries management policy in Brazil and the local social-political context. We are not advocating that this model be implemented universally, nor are we suggesting that this is the only way to solve stakeholder conflicts. The establishment of this Forum and the creation of a common knowledge base may just be a first step towards conflict management.

In many cases, such a forum will only provide a knowledge base and suggestions of promising solutions to government agencies at higher political levels, which in turn will make decisions that take into account other areas and groups of people. The central idea of this governance model is that stakeholder participation in management decision-making increases stakeholder compliance; decisions may be supported and subsequently formalised by the government. Such an approach does not provide a blueprint for solutions, but an action platform for 'adaptive management processes and flexible, multi-level governance that can learn, generate knowledge and cope with change' (Folke et al. 2002: 10).

The key idea of an adaptive co-management forum is to present and discuss knowledge and the values and concerns of users, other

stakeholders, managers, and scientists. As argued by Folke et al. (2002), the objective is to create a diversity of management options in the search for viable socio-economic and ecological solutions for existing management problems, in this case the Ibiraquera Lagoon. Such a process of cross-scale interaction (Berkes 2002) and multi-level governance can provide information for decision-making that may result in learning and knowledge adaptation for users, other stakeholders, managers, and scientists.

What are the possibilities of establishing a co-management forum in the Ibiraquera Lagoon or elsewhere? It is possible that stakeholder interactions may never emerge out of interest-based politics, and it is also possible that the various levels of government may not be willing to share power. The interactions among government agencies and the various actors may result in a different kind of multi-stakeholder body with a different mandate or structure. Indeed, co-management is an interactive process that may arise from negotiation, joint problem-solving, and mutual learning (e.g. Kendrick 2000; Blann et al. 2002).

Co-management requires 'two to tango' (Pomeroy and Berkes 1997). While the government may have to initiate the process in our case, the effectiveness of grassroots participation is what ultimately determines success or failure. The relevant principle, sometimes called the subsidiarity principle, may be phrased thus: as much local solution as possible, and only so much government regulation as necessary. An adaptive co-management structure cannot be imposed from the top down. It will depend on the ability of fishers and other stakeholders to organise themselves, and the willingness of the government to facilitate it.

Notes

1. Natural Resources Institute, University of Manitoba, Winnipeg, Canada. E-mails: Seixas (csseixas@hotmail.com) and Berkes (berkes@cc.umanitoba.ca).
2. This programme was established in 1993 by the United Nations Division for Ocean Affairs and the Law of the Sea (DOALOS/UN). In Brazil it has been supported since 1995 by the federal government through the Interministerial Commission for the Resources of the Seas (CIRM) (Reis et al. 1999).
3. There may be stakeholders such as businesspeople who are not resource users. Government agencies are also considered stakeholders.

4. The Lisbon principles – a set of guidelines on how ecological economics may help in reaching the goal of sustainable governance of the oceans – was proposed during a workshop held in Lisbon, Portugal, in 1997, and sponsored by the Independent World Commission on the Oceans (IWCO) and the Luso-American Development Foundation (Costanza et al. 1999).
5. We focus on user knowledge instead of stakeholder knowledge because those who depend on a resource for their livelihood are the ones who are most likely to have the best understanding of the ecosystem that supports them (Berkes and Folke 1998).
6. Fieldwork was carried out between June 1999 and May 2000. Research methods included structured and semi-structured interviews with key informants and small groups, archival research, and participant observation. Interviews elucidated fisher knowledge, stakeholder conflicts, stakeholder concerns, major management problems, actors and organisations responsible for and affected by such problems, and the main changes in the local socio-economic and ecological system in the last four decades. Archival research traced changes in fisheries legislation, government organisation, and the local socio-economic system. Participant observation was carried out to monitor fishing activities and understand the role of different actors in the management of the lagoon. Data analysis was based on triangulation of data from field notes, transcribed interviews, and from external sources including documents and literature. The main findings were verified with key people, including fishers, local residents, local schoolteachers, and the fisher organisation's president.
7. Resilience is defined here as the capacity of a social-ecological system to buffer disturbance, to self-organise, and to learn and adapt (Resilience Alliance 2001).
8. Instituto Brasileiro do Meio Ambiente e Recursos Renováveis.
9. Both full-time and part-time commercial fishers can sell their catches legally, while sport- and subsistence-fishers cannot. Full-time fishers are defined as those obtaining over 70 percent of their total income from fishing. Sport-fishers are mainly outsiders who fish for fun and do not depend on fishing for their living. Sport fishers come especially from neighbouring communities and municipalities, but also include some tourists from further afield. Subsistence fishers are individuals who do not sell their catches but fish to supplement their diets.
10. The Ibiraquera Lagoon is seasonally connected to the Atlantic Ocean two to three times per year through a channel. Almost all fishing resources in the Lagoon come from the ocean when the channel is open. Fish and shrimp grow in the lagoon habitat, and return to the ocean as pre-adults and adults in the next channel opening period. At the end of the 1970s, the lagoon fishery system collapsed due to over-harvesting. However, when measures were taken to reduce over-harvesting during the 1980s, the system rapidly recovered because new resources were seasonally entering the lagoon.
11. Since 1994, cast-netters have called IBAMA and the Environmental Police on several occasions to denounce fishing rule infractions. Government officers have very seldom come into the lagoon to enforce rules because of their lack of personnel and equipment. For instance, in 1999 IBAMA had only one inspector working with two helpers and the Environmental Police had four officers to monitor all natural resources (including fisheries) in a large area that encompassed several municipalities. In the face of ineffective rule

enforcement by government agencies, some cast-netters organised themselves in 1998 to patrol the Upper basin. Nonetheless, they did not receive legal support to enforce fishing regulations. Moreover, monitoring groups were threatened a few times with shotguns by gill-netters.

12. For instance, people could name ten gill-netters fishing in the upper basin (see Fig. 1), eight of whom had major sources of income other than fishing.
13. During fieldwork there were no NGOs actively working with environmental issues in the lagoon area, excepting the Ibiraquera community council. But if some NGO were to appear on the scene, it would be a welcome addition to the Forum.
14. State University of Santa Catarina.
15. University of the Itajaí Valley.
16. University of Southern Santa Catarina.
17. Santa Catarina State Research Agency.
18. For example, surveys of the most knowledgeable users, users from different user-groups, gender-based surveys, etc.

Appendix A. Important issues that may be addressed in establishing co-management regimes.[a]

Issues of concern	
participation (user-groups and other stakeholders)	– depend on the history of participation, structure and process of participation, resource conditions, and characteristics of the programme (Hanna 1996) – representation; degree of involvement (community support); scale and scope of users participation – organisation of user-groups (core groups) and other stakeholders
representation	– cohesiveness and differences inside a community (differences within user-groups/ difference among user-groups) – heterogeneity of users (socio-economic, gender, race, religion, literacy level, etc)
participants' motivation and commitment	– social and economic incentives to cooperate – compensations to change the status-quo – early actions increase motivation
building relationships	– trust, respect, open communication (dialogue), bridging historical gaps, continual process of confidence building – negotiation posture: flexibility, patience on the part of all stakeholders
decision-making power	– decision-making level; structure of decision-making; decision rules and distribution of authority – uneven power; power sharing; power transfer
process legitimacy	– accountability; credibility; responsibility – transparency of management decisions
local socio-political and cultural context	– social norms; political culture; cultural difference and misunderstanding; political and economic inequality – authority system, stewardship; leadership – rights (e.g. traditional rights) and property
stakeholder values, interests, and conflicts	– public interest; private interest; common interest; heterogeneous interest – perceptions, preferences and behaviours of user-groups
management boundaries	– physical (ecological), social, technical, economic, political criteria
resource condition	– scarcity, abundance
goals	– clearly defined goals
costs, funding and budget allocation	– shared cost of development projects – private and social costs may diverge; search costs (cause and scope of problems), bargain costs, monitoring and enforcement costs; transaction costs

time frame	– slow enough for the full consideration of co-management issues
capacity-building	– at government level: training facilitators – at local level: environmental awareness training
institution-building	– nested institutions
information gathering	– technical information – local knowledge ('time and place' information)
monitoring, enforcement and compliance	– monitoring indicators – self-imposed regulation; voluntary compliance
evaluation measures (criteria)	– sustainability: institutional, economical and ecological – sustainability: stewardship, resilience, efficiency, equity (Hanna 1996) – stewardship (time horizon, monitoring of behaviour, enforcement) – resilience (rule flexibility, structural adaptation, adaptation to markets) – efficiency (cost-effectiveness: information costs, coordination costs, enforcement costs) – equity (representation, process clarity, compatible expectation, distribute effects) – productivity
learning	– adaptive learning, social learning, mutual learning: learning-by-doing

[a] Also known as: collaborative management, participatory management, joint management, and joint stewardship.

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9

'The Rich Eat Fish and the Poor Eat Pork': The Decline of the Livelihoods of Handpickers of Aquatic Organisms in North Vietnam

Arie Pieter Van Duijn[1]

Introduction

Before any fishing gear was invented, men, women, and children used their hands and feet to capture fish and other aquatic organisms along the shores of rivers and seas. Over the years they developed artisanal fishing techniques to adapt to local conditions, the desired species, and the size targeted. The term 'fishing' does not exclusively refer to the catching of fish, instead it touches on the capture of all aquatic organisms (Brandt 1972:2). On Cat Hai Island in North Vietnam I found that people use, a variety of techniques to catch fish and other aquatic organisms (Van Duijn 2002). The focus of this paper is on the livelihoods and techniques of fishers who gather aquatic organisms with either their bare hands or by using simple gear (see fig. 9.1). The latter I consider to be tools that can be carried and operated by an individual alone. On Cat Hai Island this method for gathering molluscs (bivalves and gastropods), brachiopods, sipunculids, and crabs constitutes an important activity for the poorest local people in particular. As this manner of fishing invariably encompasses the use of one's hands to pick up the organisms, in this paper the terms handpicking, collecting, and gathering are used interchangeably to refer to this activity.

On Cat Hai Island the occupation of marine resource exploitation using active and passive gear has been declining in employment as well as production since at least as far back as 1990.[2] In the case of most species that are or were handpicked, the inhabitants of Cat Hai Island easily gathered aquatic organisms prior to 1990. For instance

Fig. 9.1. Collection of molluscs on the tidal flats of Cat Hai Island.

interviewees reported being fed up with eating mud crab (*Scilla serrata)*, which is currently the most valuable local crab species. Collected crabs were put into ceramic baskets and the fishers were not concerned about how many escaped. More recently, window shells (*Placuna placenta*) were gathered in such quantities that people put them in ponds near their houses so that they could gradually eat them.

Throughout the years aquatic organisms were collected mainly for consumption purposes and sometimes as an additional source of income from sale at a local market, but never as a main source of income. Local people handpicked aquatic organisms whenever they had an appetite for them or when food was scarce. The latter usually occurred when, as a result of climatic circumstances, it was difficult to go out to sea to catch fish and crustaceans. Especially in the summer when the currents are strong, fishermen were prevented from taking their small non-motorised bamboo vessels out to sea. Between 1985 and 1989 this situation gradually changed because fishermen started to equip their bamboo boats with engines.

Nowadays in the waters near Cat Hai Island, the catch per unit effort of almost every species of aquatic organisms is rapidly declining (ibid.). While handpickers gather those molluscs and crabs that are in low demand for consumption, an increasing number of species is

collected predominantly for commercial purposes. This is the result of growing demand from domestic as well as international markets coupled with increasing prices. Interviewees report that demand for high value species like Chinese dosinia (*Cyclina sinensis)* and rough periwinkle (*Babylonia areolata)* is so high that they can no longer afford to keep them for consumption. As a consequence of declining catches, local people are shifting or trying to shift to alternative activities which provide higher or more stable incomes. However, these alternative livelihood opportunities are not readily available or accessible. As a result, the problems most frequently mentioned by inhabitants of Cat Hai Island are an overall catch decline and widespread unemployment (ibid.).

Until recently, the views of local people were missing in prevailing views of conservation and development and local people's perspectives were not taken into account in policy design. This paper provides insight into the nature of the collection of aquatic organisms by those local people who depend on it and who consider it to be their 'activity of last resort'. It provides a deeper understanding of the social and ecological factors that influence this activity and the environmental, social, and political developments that have led to a declining catch. It provides a deeper understanding of the changing role of this activity in sustaining the livelihoods of artisanal fishermen in a relatively isolated setting where alternative opportunities are lacking.

Data Collection

In my field research during 2000 and 2001, I used rapid rural appraisal (RRA) and participatory rural appraisal (PRA) as the main tools for the collection of primary data. There is extensive documentation available on these tools and how to use them (Chambers 2002; Cornish 1999; International Institute of Rural Reconstruction 1998; Pido et al. 1996; Townsley 1996; Walters et al. 1998). Semi-structured interviews[3] (SSIs) and focused group discussions (FGDs) constituted the backbone of this investigation. This technique is flexible since new lines of questioning or inquiry can be opened at any time during the actual interview. The SSI proved to be ideal for discussing topics or issues, building up case studies, and collecting historical information. Group discussions are a variant of SSI. They are used in both field data gathering and community validation. As stated by

Pido et al. (1996), during fieldwork FGDs are effective in identifying social norms and accepted views, pinpointing special interest groups, and knowing collective views and feelings. Besides, they allow for the continuous validation of what is said. When their emotions carry participants away, other people frequently correct them and put things back into perspective. In most instances FGDs are preferable to SSIs. Especially when interviews are long, it appears that people in mixed as well as single gender groups enjoy the company of their peers and encourage each other in sharing experiences.

Vietnam

Vietnam is rich in coastal and marine resources, which include fish, molluscs, shrimp, mangroves, petroleum, and mineral resources (Asian Development Bank 1999). It is internationally regarded as a biodiversity hotspot and within its boundaries approximately 10 percent of the total number of species in the world can be found (Hoang Van Thang et al. 1998:ii). Like other Southeast Asian nations, Vietnam faces a number of resource and environmental issues within its coastal and marine zones, including urban and industrial pollution, loss of biodiversity, over-fishing, and destruction of wetlands (Asian Development Bank 1999).

The coastal zone of Vietnam is important to the country socio-economically. Firstly, fish is an important component of the Vietnamese diet as, in 1997, approximately 40 percent of the animal protein intake came from fish and fish products (World Resources Institute 2000:264). In the same year the consumption of fish per capita was estimated at 17.4 kilograms per year (ibid.:264). Secondly, fisheries play an important role in supporting the country's economy. The value of exports of fish and fishery products (including molluscs and crustaceans) rose from US$ 20 million in 1981 to US$ 252 million in 1991 (Menasveta 1997:140) and an average of US$ 587 million per year in the period from 1996-98 (World Resources Institute 2000: 264). In the period from 1996-1998 molluscs and crustaceans contributed to 84 percent of total exports of fish and fishery products (ibid.:264).

In Vietnam most marine and coastal resources are *de jure* State property, but *de facto* there is an open access regime, which allows any number of people to go anywhere to exploit living aquatic re-

sources. Fishery policies and plans in Vietnam focus largely on increased exploitation of coastal and marine resources through raising aquaculture production, increasing the efficiency of fish collection in coastal areas, increasing fisheries exploitation in offshore areas, and through the preservation of fish stocks for reproduction (Asian Development Bank 2000). The Ministry of Fisheries (MoF) regards coastal and marine aquaculture as a way of increasing fishery production and therefore foreign exchange earnings. Between 1993 and 1998, total coastal and marine aquaculture production increased by 37 percent, while the area utilised for aquaculture increased by 38 percent (ibid.:33). Rather than achieving this production increase through intensification, the comparable growth in area devoted to aquaculture indicates it has been accomplished through expansion. Aquaculture development has occurred at the expense of coastal ecosystems like mangroves and coastal wetlands. It has been estimated that the cumulative effects of human activities have reduced mangroves from some 400,000 ha in 1943 to approximately 150,000 ha at the present (ibid.). The loss and degradation of mangrove forest has led to a reduction of the nurturing and coastal protection functions and biodiversity provided by these forests.

Increasing international demand for marine aquatic products and the rapid development and urbanisation of coastal areas have created serious threats to the coastal environment and marine resources (Menasveta 1997:140). The estimates of the total biomass for the marine waters of Vietnam range from 3-3.5 million tonnes and the potential yield from 1.1-1.3 million tonnes. (Asian Development Bank 1999:10; Menasveta 1997:141). When comparing this figure with the total marine catch of 1998, which was estimated at around 1.13 million tonnes, the present level of harvest of inshore and coastal fishery resources may be close to or even above the long-term sustainable yield (Asian Development Bank 1999; Menasveta 1997).

Cat Hai Island

Cat Hai Island is a small and relatively isolated island located in the Red River Estuary (see fig. 9.2). Its total area is 2,556 hectares, of which around 1,965 hectares are covered in aquaculture ponds (District Statistical Office 2001). This leaves relatively little room for its 14,099 inhabitants and the average population density amounts to

2,386 people per km^2 (ibid.). From an administrative point of view, Cat Hai Island belongs to Cat Hai District, which consists of hundreds of islands and is a part of Hai Phong Province. In a spatial as well as an economic sense, the district is dominated by Cat Hai Island and neighbouring Cat Ba Island to the east. The latter is a well-known tourist destination in North Vietnam.

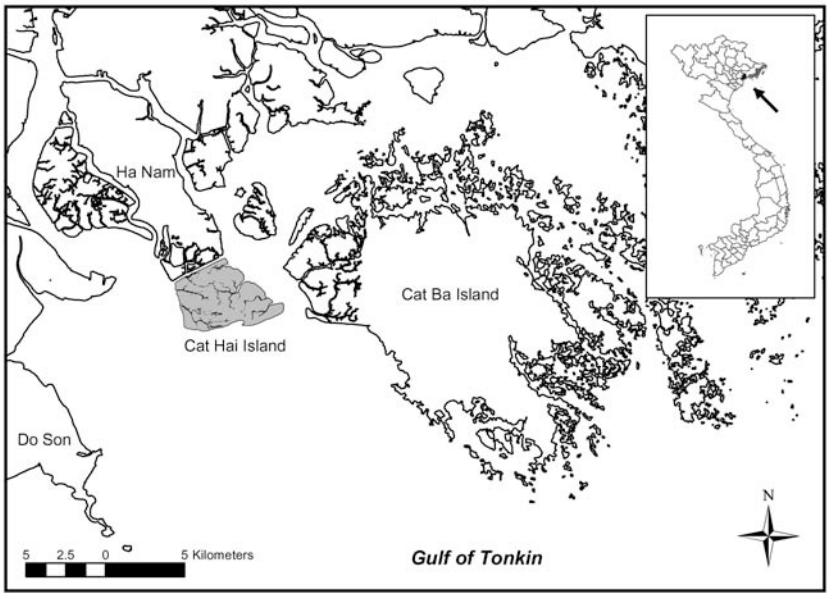

Fig. 9.2. Cat Hai Island in its regional context.

In Lach Huyen Straight, which separates Cat Hai Island from Cat Ba Island, environmental conditions are strongly influenced by the upper Gulf of Tonkin that borders the south of the island. Cat Hai Island is bordered to the west by the Nam Trieu Estuary, which is part of the Red River Delta. As a result, environmental conditions on this side of the island are dominated by an influx of fresh water. This exerts an influence on the presence or absence of particular species of aquatic organisms, most notably fish, shrimp, and molluscs (Van Duijn 2002). To the north, Cat Hai Island is separated from another island by a canal that was enlarged from a mangrove stream in 1987. This canal provides cargo ships, including coal ships coming from mines in Quang Ninh Province, with improved access to Hai Phong port.

From an employment perspective, Cat Hai Island is dominated, in order of importance, by the industry and handicraft sector, the salt farming sector, and the governmental sector (see Table 9.1). The industry and handicraft sector employs about a third of all people who are officially registered as having a job. This is mainly due to the presence of two large and a number of smaller fish sauce factories. In the north of Vietnam, Cat Hai Island traditionally has a name for high quality fish sauce. According to local fish sauce producers, at this moment the industry is not performing well. Difficulties originate from, among other things, poor governance, inability to ensure stable quality, a lack of business relations causing poor market access, strong competition from the south of Vietnam, and limited access to credit (ibid.). Around a fourth of all people with jobs operate their own salt farms. Salt farming is a small scale activity carried out on the scarce dry areas that have not been taken up by either urban development or road construction. As there is hardly any suitable land left, the number of salt farmers has not increased since 1995 (District Statistical Office 2001).

Table 9.1. Number of people employed[4] on Cat Hai Island per sector (2000)

Sector	*Number of people*	*Percentage of people*	*Index (1990 = 100)*
Aquaculture	301	5.0 %	327.2
Fisheries	354	5.9 %	62.1
Government	1,200	20.0 %	369.2
Industry and handicraft	1,995	33.3 %	123.9
Livestock	130	2.2 %	141.3
Salt farming	1,546	25.8 %	112.6
Trading and selling	250	4.2 %	227.3
Transportation	224	3.7 %	162.3
Total	4,005	100 %	139.2

Source: District Statistical Office 2001

From an employment perspective, the government sector is the third most important sector and, as can be seen in Table 9.1, it is also the sector that has undergone the most rapid increase in employment. The size of this sector is closely related to an increased military and security presence, as this area is near Hai Phong port, which is relatively close to the Chinese border. Other reasons for the rapid increase in government employment remain unclear. Besides the gov-

ernmental sector, an increase is evident in all sectors except the fishery sector. The second most rapid increase is visible in the aquaculture sector. This sector has expanded into virtually every available area behind the large sea dikes that protect the island. Most of these areas were previously covered by mangroves. The only opportunities for further expansion are in areas outside the sea dikes that are still covered by mangroves. As cutting mangroves is officially prohibited and mangrove soils are generally not suitable for aquaculture development, this is not a viable option. In any case, shrimp farmers report that further intensification is prevented by limited access to sufficient credit. A third conspicuous increase is that of employment in the trading and selling sector. This increase is influenced by families that previously depended entirely on the exploitation of marine resources and now try to sell a limited number of inexpensive consumer goods from their houses in order to compensate for declining catches.

The decline of the fishery sector is a direct result of the poor prospects of the fishing profession. The older generation is gradually retiring, while the younger generation is reluctant to go to sea. In the words of a local woman: 'the young people no longer want to stay here. They no longer want to become fishermen. Now they are always looking for a good chance to study, work, or get married in Hai Phong, Quang Ninh, or Hanoi. It is a good opportunity for them to leave.' Besides leaving Cat Hai District many young people, as well as families, migrate within the district to try and profit from the growing tourist industry on Cat Ba Island. As a consequence, during the last decade the population of Cat Hai Island has grown by only 8 percent, compared to a provincial figure of 13 percent.

Although local people confirm a statistical decline in the number of people working in the fishery sector, the official data only reflect jobs labelled as main occupations. Collection of aquatic organisms is hardly ever a main occupation and therefore people who practise it are not classified as fishermen, as they are not incorporated in annual district fishery reports. This data should thus be treated with caution, as people who handpick aquatic organisms remain statistically 'invisible'. The same is true for other part-time fishermen using active and passive gear. Even though all people that were interviewed agree that the sector as a whole is in decline and that ever fewer people fish as their main activity, the importance of fishing activities for the inhabitants of Cat Hai Island is underestimated.

Importance of collection

The handpicking of aquatic organisms is an important activity for the poorest in particular and indeed an 'activity of last resort' rather than an 'occupation of last resort'. Households that are excluded from other economic opportunities need to supplement their meagre income with the handpicking of aquatic organisms and are suffering from a declining catch. The degree of dependence on the collection of aquatic organisms varies between and within the five communes on Cat Hai Island. These discrepancies are at least partly conditional upon the availability of alternative job opportunities. In turn the availability of alternatives depends on the main economic activities in the commune, as well as the location of that commune in terms of relative isolation vis-à-vis other communes, transportation infrastructure, and collection areas. Throughout history, dwelling in the proximity of particular natural resources like fishing grounds, mangroves, and collection areas has influenced the activities traditionally carried out by local people. These activities are not easily altered as long as there is no subsistence crisis. Even when such a crisis occurs, it is hard to find new opportunities on a small and relatively isolated island where land is scarce.

Socio-economic inequity within communes results from socio-economic differences between individual households. In my research I assessed the relative socio-economic status of two villages through a PRA technique known as socio-economic ranking. This tool requires a stack of cards on which have been written the names of all households in the village. Subsequently in separate sessions a number of key informants are asked to group these cards on the basis of perceived socio-economic status. This technique was adapted from Gregory (1999), who applied it in Bangladesh. From these exercises emerged a general trend. On the one hand, stable households with a good standard of living mostly consist of men and women who work either for the government or in the service sector, or households in which the members carry out multiple occupations or which have overseas members who send remittances back home. On the other hand, people whose livelihoods are marginal are either unemployed or do not have a stable job, as in the case of households dependent on the exploitation of marine resources and salt farms. Among these categories, households that have older or handicapped members or a large number of children are particularly vulnerable. On the basis of a village survey, carried out in 2001, the leaders of two

villages that are a part of Cat Hai town concluded that the socio-economic circumstances of the poor had deteriorated not only compared to other livelihoods but also in an absolute sense. Furthermore my own interviews show that it is very difficult to get out of this downward spiral. Acquiring a government job, for instance, which is guaranteed to improve someone's relative socio-economic status, is virtually impossible if one does not have relatives already working for the government.

Compared to the other four communes on Cat Hai Island the inhabitants of Dong Bai commune appear to be most dependent for their subsistence on the collection of aquatic organisms. Here, the availability of alternative livelihood opportunities is limited, as approximately 95 percent of the inhabitants operate small salt farms as their main economic occupation. On average this provides them with 40-80 percent of their subsistence income. Around 70-80 percent of the inhabitants of Dong Bai have supplementary incomes from practising extensive aquaculture, distilling wine, keeping animals, or transporting salt as labourers. However, 20-30 percent of the families in Dong Bai do not have such alternative opportunities and it is this group of people that is most dependent on the collection of aquatic organisms as a supplementary source of income. When these people are unable to collect aquatic organisms during the times when they are inhibited from operating their salt farms (i.e. when the sun is not shining) this category of people experiences food shortage. For them life becomes increasingly difficult when the area accessible for collection declines and their catch per unit effort decreases. This is especially true since the main season for the production of salt, which lasts from the fourth lunar month until somewhere between the eighth and tenth lunar month (i.e. the dry season), is actually not the most suitable season. How lunar dates correspond with solar dates can be seen in Table 9.2. This period, when salinity is comparatively high, coincides with the winter when temperatures are lowest. During this time salt farming is less viable than during the hot rainy season when salinity is relatively low. Moreover, compared to other parts of the district, salinity is permanently lower around Cat Hai Island due to river runoff from the mainland (World Wildlife Fund 1993).

Table 9.2. Example of how lunar dates correspond with solar dates in the year 2003

1st day of lunar month	*Corresponding solar date in 2003*
Thang 1	February 1st
Thang 2	March 3rd
Thang 3	April 2nd
Thang 4	May 1st
Thang 5	May 31st
Thang 6	June 30th
Thang 7	July 29th
Thang 8	August 28th
Thang 9	September 26th
Thang 10	October 25th
Thang 11	November 24th
Thang 12	December 23rd

In Van Phong commune and Cat Hai town, a declining collection area and catch per unit effort is less of a problem. Inhabitants of Van Phong, along the major transportation axis of the island, have other supplementary jobs and the production of salt farms is higher compared to Dong Bai (Van Duijn 2002). Therefore most inhabitants of Van Phong only collect marine resources in order to acquire income beyond what they consider to be sufficient to live. The inhabitants of Cat Hai town, the governmental, trade, and service centre of the island, also appear to have more opportunities to find supplementary income from jobs like motorcycle taxi driver or brickmaker. However, for the poor fishers/collectors of Cat Hai Island alternatives providing a stable life are socially and economically inaccessible while even unstable alternatives are hard to find.

Collection of Aquatic Organisms on Cat Hai Island

On Cat Hai Island, people from a large number of families are at some time during the year involved in the collection of aquatic organisms. Various techniques are used for the collection of molluscs (bivalves and gastropods), brachiopods, sipunculids, and crabs. In general it is possible to differentiate between handpicking, fishing with the feet, and fishing by utilising simple tools like a knife, a long metal

pin, a shovel or spade, a hoe, or a scratcher. The use of a scratcher I discuss in more detail in the section on gender and age. These techniques are carried out especially along the shore, on emerging sandbars and mudflats or in shallow water (see fig. 9.3).

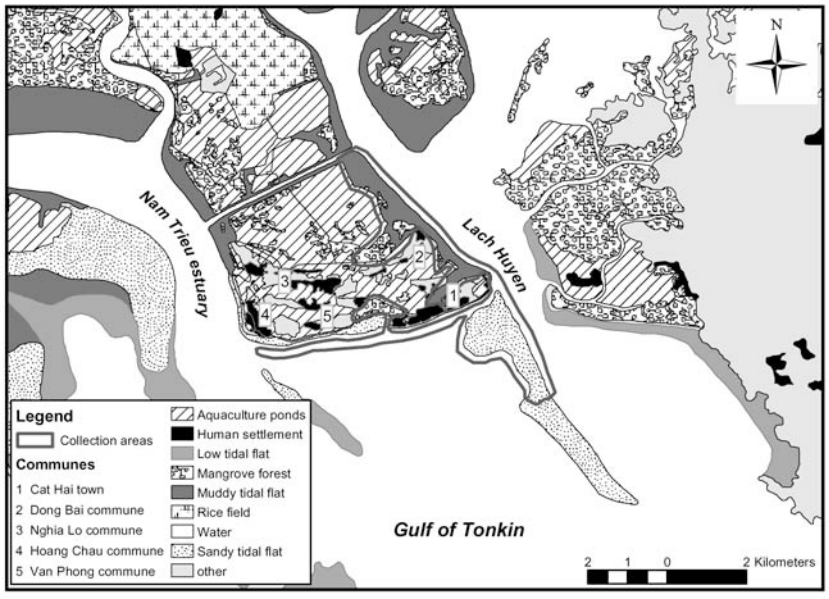

Fig. 9.3. Communes and collection areas of Cat Hai Island.

People travel on foot when gathering aquatic organisms in collection areas near their home, while they travel by bicycle to more distant areas. When areas are not accessible by land, like the offshore sandbanks and mudflats across Lach Huyen, people make use of small motorised bamboo boats. Those local people who do not own a boat pay a relatively small fee to accompany boat owners during periods when they hear collection is good in these areas.

The collected aquatic organisms are sold on a local market or to middlemen who visit or live on Cat Hai Island. These aquatic organisms are then consumed locally or taken to Cat Ba Island, where they find their way to the kitchens of many hotels and restaurants, to Hai Phong, and Quang Ninh Province, or all the way to China, depending on the market demand for the species (see Table 9.3). A few collectors report that when high value species are collected in small quantities they may choose to eat them rather than sell them. The decision to do so depends to a high degree on the level of dependence of

a particular household on this activity and I found that most collectors trade anything they can sell. An illustrative example is that of poor fishermen using trammel nets who sold three white prawns (*Penaeus merguiensis*) in an attempt to cover their operational costs. The trend that is revealed by the previous example is clearly encapsulated by a frequently mentioned local phrase: 'the rich eat fish and the poor eat pork.' Fishers (including collectors) cannot afford to eat aquatic organisms for which there exists (international) market demand. Therefore people sell their catch and eat comparatively cheap pork instead.

Table 9.3. Final destination of aquatic organisms as reported by interviewees in 2001

Common name	*Scientific name*	*Local name*	*Final destination*
Chinese dosinia	*Cyclina sinensis*	Ngó	China
Cockle spat		Sò Trung Quốc	China (after culture period)
Mud crab	*Scilla serrata*	Cua	China
Rough periwinkle	*Babylonia areolata*	ốc Hương	China
	Sanguinolaria diphos or Gari elongata	Tham Tham	China
Venus clams	*Meretrix meretrix*	Ngao	Hai Phong, Quang Ninh, China
Peanut worm	*Sipuculus nudus*	Sâu đất	Hai Phong, China
Half-crenate ark	*Arca 'anadara' subcrenata*	Sò lông	local market, Hai Phong, Quang Ninh
Lamp shell	*Lingula unguis*	Trá or Giá	local market, Hai Phong, Quang Ninh
Lantern clam	*Laternula truncata*	Phụt nước	consumption, local market
Window shell	*Placuna placenta*	Điệp	consumption, local market
	Glaucomya sp.	Don	consumption, local market
	Ostrea spp.	Hà	consumption, local market
	Lucina philippinarum	Ngán	no longer available locally
Fiddler crab	*Uca spp.*	Cáy	not investigated

How people gather different species depends on a range of factors including: seasonality and other determinants of resource availability; livelihood diversification; access to markets and market price; place of origin and specialisation; and gender and age of the collector. Depending on the mix of these factors, families and individuals specialise in the collection of one or more species of aquatic organisms. When people specialise in multiple species these are usually aquatic organisms that are collected during a single fishing trip or species that are collected in different seasons.

Seasonality

Seasonality can be divided into four distinct but closely related variations. First, seasonality refers to a part of the year when it is economically remunerative to collect an organism. This particular period is usually a consecutive number of weeks or months. For instance, filter-feeding lamp shells (*Lingula unguis*) are present throughout the year. However, they are preferably collected just after the rainy season when they are fat due to an increased flow of deposit-carrying water from the river.

Second, seasonality refers to a specific stage in the life cycle of an aquatic organism. For example cockle spat, locally known as 'sò trung quốc' (roughly translated as the cockle that is exported to China), are collected only when they are living in the muddy tidal flats along Lach Huyen Straight. According to handpickers, collection of this species starts during the fifth month of the Vietnamese lunar calendar. For two months collection is optimal, but after this period production gradually declines. During the beginning of the season the individual organisms are still too small to count and they are sold by 100 gram weights. Later in the season, collectors count them before sale.

Third, seasonality refers to a subsequent number of days or hours during which people are physically able to collect a distinct organism. This depends on the water level around Cat Hai Island where waters are subjected to a diurnal tidal regime, with a maximum amplitude of 4.3 m (World Wildlife Fund 1993). Both minimum low tide and maximum high tide vary in height in a regular manner throughout a period of approximately 28 days. Since, compared to the solar calendar, the Vietnamese lunar calendar is a better indicator of tidal cycles and seasons, fishers, aquaculturists, and collectors

plan their activities according to the latter. Local fishermen's practices are based on a combination of local knowledge and the lunar calendar (see Table 9.4). Each month consists of 30 days rather than the lunar calendar's 29 or 30. Handpickers start counting on day five of the first lunar month. From this day onward they add 14 days for each tidal cycle. Every half year an anomaly can be recognised, namely during the second and eighth lunar month. At these two moments collectors make a correction and add 12 days instead of the usual 14.

Table 9.4. Local fishing calendar

Thang	*Starting days of two-week tidal cycles*		
1	5	19	
2	3	17	29
3	13	27	
4	11	25	
5	9	23	
6	7	21	
7	5	19	
8	3	17	29
9	13	27	
10	11	25	
11	9	23	
12	7	21	

At the beginning and end of a tidal cycle (days 1 and 14) the tidal amplitude is at its maximum since the high tide is at its maximum while the low tide is at its minimum. From day 1 to day 7, both the maximum high tide and the minimum low tide decrease. The tidal amplitude is at its minimum on day 7. From day 7 to day 14, the amplitude increases and the cycle starts once again after day 14. As a consequence of the cyclical movements of the tides, there are times when handpickers are unable to collect the particular species they target. For most collectors an obvious impediment is a submerged collection area. A low tide during times when the tidal amplitude is relatively small is a less evident obstacle. During this period fishermen theoretically have the entire day to carry out their activity on the uncovered collection areas. While this is beneficial for the collection of

some species like *Glaucomya spp*. since it enables people to collect it all day, it also entails an important disadvantage. As a consequence of prolonged exposure, the sea substrate becomes well drained and compact. This makes it difficult for people to dig. For the successful collection of Chinese dosinia it is a necessity that the water be retreating during the time of collection. This reveals the hiding place of the creature as well as facilitates its manual collection as the substrate is easier to penetrate. These two species are most easily collected when the tide is high in the morning and low in the afternoon. In most cases darkness is an obstacle for collection of aquatic organisms. For instance in the past, lamp shells were never collected at night, but rather during 5-7 days of a tidal cycle when the tide is low during the day. Even though there is no obvious reason to collect them at night, this is no longer exceptional as handpickers enter into an agreement with middlemen who demand a stable supply of lamp shells in return for advance payments. In order to meet their commitments, collectors are often forced to collect at night. Conversely, in the case of rough periwinkle there does exist an obvious reason. I found that handpickers find darkness to be indispensable for successful collection since rough periwinkles come to the surface when the tide is low during the night.

Finally, seasonality refers to local people's ability to conserve the catch of a particular species. Some species can be collected and are edible only during periods when they are not easily preserved. This is a problem experienced by collectors of rough periwinkle and *Glaucomya spp* for example. People who collect *Glaucomya spp*. face this problem throughout the year while people who gather rough periwinkle only experience this problem during summer.

Livelihood Diversification

Relatively simple gathering techniques make it difficult for most people to gather enough aquatic organisms to sustain their livelihood on the basis of market sale. As a result, for all but a few collectors, the gathering of aquatic organisms is a supplementary occupation and source of income. Collection takes place, therefore, when people are not engaged in alternative livelihood activities. A clear example is that of Dong Bai commune of north-eastern Cat Hai Island, where approximately 95 percent of the residents work as salt farmers. Since a salt farm provides them with on average 40-80 percent of

their subsistence needs, these people must carry out supplementary activities. Around 20-30 percent of all households in Dong Bai collect aquatic organisms because of a lack of other options. In Dong Bai the most popularly gathered aquatic organism is lamp shell and collection is mainly carried out in rainy weather when people are prevented from working on their salt farms.

Access to Markets and Market Price

People decide to shift from one activity to another when carrying out their initial activity incurs an opportunity cost.[5] Interviewees state that when a species which they are familiar with is in season, they will start gathering it as soon as they hear that its price is good. The gathering of half-crenate ark (*Arca 'anadara' subcrenata)* along the south of Cat Hai Island is a good example, since respondents report that the total number of handpickers reaches an estimated maximum of 500 men, women, and children when collection is optimal. Collectors traditionally walk in the water and use their feet and toes to detect and grab the molluscs. As soon as their daily income from collection falls below the income from their primary activity they will shift back. It is normal for collectors to switch from one species to another when this is rewarded with a higher return. This switching between species is subject, however, to a variety of restrictions. Restrictions that relate to location, custom, gender, and age I discuss in the next two sections. In the remainder of this section, I discuss market-based restrictions.

Even when a particular species can be collected in sufficient quantities, access to a market is not a given. First, some species like *Glaucomya spp*. and rough periwinkle are difficult to preserve which inhibits transportation to any but local consumers. As a result, during the summer their market value is low. Rough periwinkle, for instance, can only be stored for a longer period of time during winter. As a result, its market value is comparatively low throughout the rest of the year. Second, people from other districts and provinces come to Cat Hai Island to collect particular species of aquatic organisms while the inhabitants of the island do not target these species as a result of technical and social factors that block their market access. For instance, women from Ha Nam (Quang Yen District, Quang Ninh Province), which is a predominantly agricultural commune north of Cat Hai Island, row their small bamboo boats to different parts of

Hai Phong and Quang Ninh Province to collect various species of bivalve molluscs. In 1997 these women began to collect a particular kind of cockle spat, locally known as sò trung quốc, on the muddy tidal flats east of Cat Hai Island. These spat are sold directly to shellfish farms in Ha Nam as shellfish farms requiring this particular species of cockle were not present on Cat Hai Island in 2001 and there are currently no markets or middlemen where local people can sell this kind of spat on or near the island. The inhabitants of Cat Hai Island lack the necessary connections to sell this spat. Local people are similarly disadvantaged when they try to access other higher order markets so as to receive a better price for products they are currently selling to middlemen or at local markets.

Place of Origin and Specialisation

Collectors can be found in all five communes on Cat Hai Island. Nevertheless the number of inhabitants within each commune that handpick aquatic organisms depends to a large extent on the adjacency of that particular commune to important collection areas. Generally a greater number of handpickers can be found in Dong Bai commune, Cat Hai town, and Van Phong commune, which both border one or more collection areas (see fig. 9.2). In spite of the fact that economic incentives may in many cases overrule physical distance, it appeared that specialisation is also a barrier.

Compared to other communes, those that are situated close to an important collection area for a specific species are more likely to have developed a specialisation in gathering it. For example, the half-crenate ark (*Arca 'anadara' subcrenata*) can be found predominantly along the south-eastern side of Cat Hai Island. Thus it is collected mainly by people from Cat Hai town. A similar kind of 'commune specialisation' occurs with respect to Venus clams near Cat Hai town and lamp shells near Dong Bai commune. The high value species like peanut worms and *Glaucomya spp*. that occur in mangrove areas bordering Dong Bai and Van Phong are collected mainly by people from these two communes. I found that this state of affairs corresponds with the situation that exists at the lower level of the village. Furthermore, within each village individual families often specialise in the collection of one or a few different species.

When the specialisation of a particular family did not originate on Cat Hai Island, it could often be traced back to women originating from Quan Yen District (Quang Ninh Province) who married local men. This is related to the techniques that are used and the experience that is required. For example on Cat Hai Island there are few people who are knowledgeable and hence capable of successfully collecting Chinese dosinia. Only local women who came from Quang Yen District appear to collect Chinese dosinia well. When the tide starts to move out and the muddy substrate is relatively soft and easy to penetrate they are skilful in recognising Chinese dosinia's 8-shaped hole and subsequently collecting it using their bare hands. Other collectors wait until the tide moves out before painstakingly turning over large areas using a hoe.

In other cases the species that is targeted is related to local customs of outsiders. For example, for over thirty years people from An Lu commune (Thuy Nguyen District), have been visiting Cat Hai Island to collect fiddler crabs (*Uca spp*.) that live between mangrove trees. People from An Lu use fiddler crabs to prepare crab sauce. People on Cat Hai Island are not used to carrying out this activity. In spite of the fact that they are technically able to collect this species, they have no direct use for fiddler crabs and subsequently do not target them.

When a market is available and techniques and experience are not a limiting factor, local people may change their behaviour. For instance, over twelve years ago people easily collected Venus clams (*Meretrix meretrix)* with a diameter of around 8x10 cm. However around seven years ago large numbers of people from Thai Binh Province started to visit Cat Hai Island to collect clams of all sizes for their shellfish farms. When the availability of large clams declined local people started to collect smaller clams. Nowadays large clams have virtually disappeared and only local people from Cat Hai town still collect a declining catch of small clams with a diameter of often less than 0.8x1 cm. The clams are sold to middlemen who come to the collection area or to their homes to collect the catch. The middlemen sell the clams directly to shellfish farms culturing the species. The example of Venus clams does not provide evidence of local people's ability to successfully access new markets as local people were not the initiators but were offered a new market by middlemen.

Gender and Age

Often collectors are people who, at the time when they are actually collecting, do not have any other obligations. The comparatively old are most likely to fall in this category and, when not in school, the comparatively young are a good second. Compared to other people who, due to their age, are a part of the working population, people from this category are more likely to not have any other obligations. As a result, engaging in collection is least likely to incur an opportunity cost for this group. Furthermore, in the past women stayed at home to take care of the children, do the housekeeping, repair fishing gear, and sell the catch while their husbands went out to sea. Nowadays, even though women are increasingly incorporated into the work force, they are still more likely to stay around the house. As a result, in general women find it comparatively easier to manage their time in order to collect aquatic organisms and thus are more likely to belong to this category than men. Consequently, in communes where alternative livelihood opportunities are relatively available, a comparatively larger percentage of collectors consists of (old) women and children rather than men (Van Duijn 2002). However, in Dong Bai commune where during rainy days people cannot operate their salt farms and have relatively few alternative livelihood alternatives, men also engage in this activity.

Furthermore, when a specific technique for collection of a particular species is physically straining in the sense that it requires physical strength, a comparatively larger proportion of collectors consists of men (ibid.). For instance the collection of Venus clam spat, for which a scratcher is used, depends to a high degree on physical fitness and is thus carried out by a mix of men and women. A scratcher is a bamboo or wooden stick of around 1.5-1.8 m in length. An approximately 60 cm wide flat metal bar is fixed to the end by means of an equally wide piece of wood. As can be seen in figure 9.4, the flat metal bar is used to scratch the bottom. Men use the scratcher while women follow them to visually identify and collect the spat.

Finally, it is important to keep in mind that, as mentioned in the earlier section on access to markets and market price, in situations when alternative livelihood opportunities are available but their actual implementation would be economically less rational, both men and women will change their main activity in order to try to maximise the benefits from collection.

Fig. 9.4. Collection of Venus clams on the offshore sandbar south of Cat Hai town.

Causes of the Eroded Status of Coastal Resources

Without exception, local people recount that over ten years ago all kinds of aquatic organisms were abundant. Whether particular species were collected or ignored depended on a person's taste for specific species and the availability of other food sources. As is evident from Table 9.5, local people's observations show that the catch per unit effort of virtually all species of aquatic organisms that are collected has declined dramatically. Respondents report that this declining catch per unit effort is the result of a number of social, economical, and political developments. These developments have reduced the size of the area available for collection, led to the over-harvesting of aquatic organisms, and resulted in declining environmental conditions in collection areas.

Table 9.5. Indexed productivity decline per unit effort of different aquatic organisms outside ponds in 2001[6]

Common name	*20 years ago*	*10 years ago*	*5 years ago*	*4 years ago*	*3 years ago*	*2001*
Chinese dosinia		100	50			20
Cockle spat					100	33
Half-crenate ark		100	100			100
Lamp shell		100	73			45
Lantern clam			100			55
Peanut worm		100	54			29
Rough periwinkle					100	30
Venus clams*		100	30			12.5
Window shell				100		0
Don		100				17
Ngán	100		25		5	0
Hà		100	50			25
Tham Tham		100				24
Fiddler crab		100				42
Mud crab		100				0

* This number does not reflect the changing composition of the catch from adult to juvenile and the subsequent decline of the latter

The Reduced Size of the Area Available for Collection

According to interviewees, the reduced size of the area available for collection is the main cause of the catch decline. This decreased area is a result especially of the construction of shrimp ponds. More recent development of bivalve molluscs bottom culture is contributing to the reduction of areas available for collection.

Around 45 years ago large sea dikes were constructed around Cat Hai Island to provide the inhabitants with protection from annually reoccurring storms. These dikes were constructed in such a way as to not hamper the tidal flow in order to facilitate a continuous supply of salt water for the benefit of salt farms. As these sea dikes did not prevent water circulation, they are reported not to have had a significant impact on the availability of aquatic organisms in the area behind the dikes. The construction of shrimp ponds that started in about 1996

changed this situation. In the previous year China had halted the import of seaweed from Vietnam and farmers consequently got stuck with their produce, which they were only able to sell at approximately 40 percent of the initial market value. This low price encouraged local people to convert their pens to ponds. They cut mangroves and built small dikes. The latter inhibit tidal movement and thus create obstacles for collection. As a result of the construction of ponds local people are no longer able to handpick aquatic organisms in areas that were previously under an open access regime.

Presently ponds occupy approximately 1,965 ha or 75 percent of the total area of Cat Hai Island (District Statistical Office 2001). In these ponds local aquaculturists raise various species of shrimp or seaweed, or an ever changing mix of shrimp, seaweed and fish (Van Duijn 2002). Aquaculturists and government officials report that on Cat Hai Island an estimated 20 percent of the shrimp farmers are making a profit, while around 30 percent break even, and approximately 50 percent actually loose money (Van Duijn 2002). The situation has been worsening recently since the People's Committees of both Dong Bai commune and Cat Hai town have started to rent out parts of sandbanks and mudflats that were previously accessible for the collection of aquatic organisms. These muddy tidal flats and sandbanks are rented to a small number of predominantly outsiders for the purpose of practising the bottom culture of bivalve mollusc. National government policy contributes to this trend by encouraging the development of aquaculture through the following: investment in water resource infrastructure; policies that increase the utilization of land and water areas for cultivating marine products; favourable though insufficient credit for poor farmers and fishermen; and preferential conditions for remote areas (Asian Development Bank 2000:17). At the same time the local government, which has the authority to withhold and revoke required permits, allows this development to continue rather than responding to the protests of the marginalised poor. Local people have submitted petitions to request the government to stop further development, especially on the muddy tidal flats and sandbanks, which are nowadays the only areas still under an open access regime. But their voices are not heard, and these areas are now private property. As a result local handpickers, who have no alternative livelihood opportunities, are left with nothing but a shrinking collection area.

The Over-harvesting of Aquatic Organisms

Since 1991, a rising, mainly Chinese, market demand for most species of aquatic organisms has caused the market value of these aquatic organisms to increase. For local people many species including shellfish, shrimp, and fish have become too valuable to keep for consumption. For that reason, local people have started to sell an increasing proportion of their catch on the market relative to that which they consume. Rising market prices, in combination with an overall fishery decline, have encouraged local people to increasingly target shellfish species that are still relatively abundant as a supplementary source of food and income. Accordingly, local people have had to develop a taste for species that were previously ignored because they were considered to be unsavory. However, nowadays even these species are collected at a level of exploitation that appears to be unsustainable.

The depletion of stocks of aquatic organisms that are collected using artisanal techniques around Cat Hai Island seems to be the result of three interrelated socio-economic, political, and environmental conditions. Due to an increasing market value, a declining stock will remain economically interesting to the point that collectors are no longer able to collect sufficient quantities for sale, or until the resource is completely exhausted. As a result, there is little chance for the stock of a commercially valuable species to recover, since as soon as the word spreads that numbers are again increasing it will immediately become subjected to exploitation. All the more so, because species that are no longer a major target continue to be collected as by-catch.

Besides the inhabitants of Cat Hai Island, outsiders from other districts and provinces in Northern Vietnam are increasingly targeting aquatic organisms within the boundaries of the different communes of Cat Hai Island. These are mainly people from nearby An Hai commune, Do Son District, and adjacent provinces like Thai Binh and Quang Ninh. Some of these people have only recently started to fish within this area while others have been fishing in the area for generations. Outsiders target aquatic organisms that are ignored by local people as well as aquatic organisms that are also collected by local people. In some instances the outsiders who were using mainly artisanal techniques have already departed, as yields are no longer sufficient. In other instances, as in case of the gathering of half-crenate ark (*Arca 'anadara' subcrenata*) during its most optimal

period, respondents from Cat Hai town refer to mainland Thai Binh Province and Do Son District rather than to other communes on Cat Hai Island as the origins of the people collecting it. Local people recognise that outsiders fishing within their area using comparatively modern techniques like dredges, (electrical) push nets, and (electric) trawlers contribute towards catch decline. Nevertheless, they complain about this less than might be expected, as they are historically accustomed to an open-access regime.

The Declining Environmental Conditions in Collection Areas

Apart from the reduced size of collection areas and over-harvesting of aquatic organisms, declining environmental conditions in collection areas negatively influence the ability of the coastal environment to sustain aquatic organisms targeted by handpickers.

According to local collectors the removal of mangroves and the construction of small dikes that inhibit the free circulation of water caused the environmental conditions in both the ponds and the surrounding coastal environment to deteriorate. However despite the fact that collectors were denied access to ponds during most of the year, initially handpickers were still able to collect in supply-canals and even in shrimp ponds. However this could only be done once a year during an approximately 20-day period around the Vietnamese New Year. This is the only period during the year when salt farmers are not operating their salt farms. As a consequence, this period is used to drain the water from the supply canals and ponds behind the sea dikes in order to clean and dry the ponds. During this time some handpickers entered into mutually beneficial agreements with pond owners to collect aquatic organisms in their recently drained ponds. Nowadays, this custom is in decline, as local collectors report that pond operators add to the environmental decline by using a particular chemical to kill fish living in their ponds. This chemical is also thought to kill shellfish living in the ponds and supply canals.

In Hoang Chau commune, officials and fishermen report increased sedimentation in Nam Trieu Estuary as a result of increased soil erosion from upland areas and the obstruction of a number of rivers due to the construction of dams. The latter has caused increasing sediment deposition in the Nam Trieu Estuary. According to the people I interviewed, the amount of rainfall increased in 2001. This further

increased the discharge of muddy freshwater from the river that coats collection areas and, according to respondents, causes shellfish to die. As a result of these environmental changes, upstream or on-site, some species cannot be collected anymore. For example, local people report that an increasing amount of mud is covering the sandy areas where Venus clams live. As a result of the effect of these environmental changes people from Hoang Chau commune no longer collect Venus clams while people who collect them on the east side of Cat Hai Island report a decline. In addition to these geophysical changes, local people are critical of the destructive effects of some the comparatively new techniques like dredges, (electrical) push nets and (electric) trawlers, predominantly by outsiders. These techniques are reported to cause damage by disturbing the mud, which subsequently settles on the areas where Venus clams live.

Conclusion

On Cat Hai Island a number of social, economic, and political developments have led to a sharply reduced catch of aquatic organisms. This declining catch is a consequence of a decrease in the size of the area available for collection, declining environmental conditions, and over-harvesting. Households that need to supplement their meagre incomes through the collection of aquatic resources suffer the most from the catch decline since alternative economic opportunities are socially and economically inaccessible. Governmental policies aggravate their situation by allowing local collectors to be increasingly excluded from the aquatic resources they depend upon, thus endangering their social-economically already weak position. This results in increased hardship. Without proper governance, the poverty and deprivation of the coastal poor will only increase.

Notes

1. E-mail address: ap_vanduijn@yahoo.com
2. The Cat Hai District Statistical office started collecting fishery data in 1990.
3. The semi-structured interview is a field technique where the informant is guided by the researcher during the interview by means of a predetermined set of open-ended questions.
4. This refers to the number of people that are officially registered as having a job and the sector they are officially registered as working in.

5. An opportunity cost is the difference between the actually achieved return and the maximum which could be achieved (Lloyd & Dicken 1983).
6. As reported by interviewees and measured either from the last available year or the first time a decline was detected.

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List of Contributors

Fikret Berkes is Professor of Natural Resources at the University of Manitoba, Winnipeg, Canada, where he occupies the Canada Research Chair. He completed his Ph.D. degree in Marine Sciences at McGill University, Montreal, in 1973. His main areas of interest are common property resources and community-based resource management. His e-mail address is: berkes@cc.umanitoba.ca.

Mathieu Ducrocq is an agricultural economist by profession. He is presently on contract to the Fondation International du Banc d'Arguin (FIBA) in Mauritania.

Joceline Ferraris specialises in bio-statistics and is currently employed by the Institut de Recherche Développement (IRD), in Noumea, New Caledonia. Her field of interest is artisanal fisheries. Joceline used to work on the coastal fisheries of Western Africa, but her focus has now shifted to South Pacific fisheries. Her e-mail address is: ferraris@noumea.ird.nc.

Bert W. Hoeksema is a marine biologist specialising in the taxonomy and ecology of reef corals, with a Ph.D. from Leiden University (1990). He has spent many years in Indonesia, working in the field of reef ecology and coastal zone management. Since 1998, Bert has been based at the National Museum of Natural History – Naturalis – in Leiden, as Head of the Department of Invertebrates and Coordinator of the museum's marine research programme. His e-mail address is: hoeksema@naturalis.nnm.nl.

Michel Kulbicki is a marine biologist with a Ph.D. from Oregon State University (1979). He currently works for Institut de Recherche Développement (IRD), in Noumea, New Caledonia. His main interests are reef fish ecology and the biogeography of the reef fish in the Indo-Pacific. His e-mail address is: kulbicki@noumea.ird.nc.

Pierre Labrosse used to be head of the coral reef branch at the Secretariat of the Pacific Community. Before that, he worked on aquaculture and on the assessment of reef fish resources in New Caledonia. He is currently writing his Ph.D. thesis. His e-mail address is: PierreL@spc.int

Abdelkhader Ould Mohamed Saleck is a pedologist specialising in wetland studies. He is currently Head of the Department of Scientific Co-ordination of the Parc National du Banc d'Arguin, Mauritania. In this capacity, he has contributed actively to the park's approach to managing its living resources.

Daniel Owen is a barrister at Fenners Chambers, Cambridge, England. He specialises in marine environmental law and marine fisheries law. Daniel's first degree is in zoology, and prior to training as a barrister he worked for the International Tanker Owners Pollution Federation (ITOPF) as a technical adviser and then for the Royal Society for the Protection of Birds (RSPB) as a marine policy officer. His e-mail address is: daniel.owen@fennerschambers.co.uk.

Cristiana Simão Seixas obtained a Ph.D. degree in Natural Resources and Environmental Management from the University of Manitoba, Winnipeg, Canada in 2002. Her research interests include common property resources, community-based management, co-management, social-ecological resilience, and traditional ecological knowledge. Cristiana has studied small-scale fisheries in the Amazon and along the Atlantic coast of Brazil. Her e-mail address is: csseixas@hotmail.com.

Arie Pieter van Duijn completed his Master of Arts degree in Economic Geography at Utrecht University, and his Master of Science in Integrated Tropical Coastal Zone Management at the Asian Institute of Technology (AIT), Bangkok, Thailand. Arie is currently working as a geo-information advisor for Nexpri, an independent research and consultancy agency in the Netherlands. His e-mail address is: A.vanDuijn@nexpri.nl.

Flip Van Helden is a rural sociologist and development economist by training. He obtained his Ph.D. from Wageningen University in 1998. At present, he is a senior policy advisor with the Department for Nature Management of the Ministry of Agriculture, Nature and

Food Quality in the Netherlands, where he deals with international forestry and biodiversity issues. His e-mail address is: vanheldenstocking@hetnet.nl.

Leontine Visser is Professor of Rural Development Sociology at Wageningen University, the Netherlands. She specialises in the use of and access to natural resources, particularly with regard to Southeast Asia. Leontine is a member of the executive committee of the Centre for Maritime Research (MARE). Her e-mail address is: leontine.visser@wur.nl.

Jean Worms is a marine and coastal ecologist, who from 1998 to 2003 was scientific advisor to the director of the Parc National du Banc d'Arguin, Mauritania. In this capacity he has co-ordinated a number of scientific field studies of biological, economic and sociological aspects of the park's management. His e-mail address is: jeanworms@wanadoo.fr.