ACP-EU Fisheries Research Initiative

Proceedings of the INCO-DEV International Workshop on Information Systems for Policy and Technical Support in Fisheries and Aquaculture

Los Baños, Philippines, 5-7 June 2000

Edited by

Enrico Feoli
University of Trieste, Italy

and

Cornelia E. Nauen
Directorate General for Research, European Commission, Brussels, Belgium

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The ACP-EU Fisheries Research Reports are a series of publications that aim to share information about the development of the ACP-EU Fisheries Research Initiative and wider findings generated in order to maximise the impact of its activities. It includes proceedings of workshops and meetings, statements on policy and research activities under the Initiative. An increasing number of these, in fact, transcends the strict framework of ACP-EU bi-regional S&T cooperation, in line with the global nature of the issues at hand.

Abstract

The present report contains the proceedings of the INCO-DEV International Workshop on Information Systems for Policy and Technical Support in Fisheries and Aquaculture, convened in Los Baños, Philippines, 5-7 June 2000. It was convened to address issues associated with the difficult transition from abundance to scarcity in aquatic resources. Reliable information will spread the right perception of the productive capacity and result in more realistic assessment of decreasing benefits and rising costs. Conservation of aquatic biodiversity, ecosystem approaches to fisheries and aquaculture production and food quality and safety along the entire chain from production to the consumer are key concepts that will govern approaches to aquatic living resources in the future. International trade is a major driving force in bringing many of these problems to a head, while also offering opportunities for socio-economic development.

To this effect, scientists and other knowledgeable persons active in relation to these key aspects contribute a panorama of existing information resources, experience with their development, but also difficulties encountered. The papers point out avenues how global public goods necessary for the transition towards sustainability can be either created or more effectively shared. International cooperation based on mutual respect and interest, mobilising the best of science across continents to ensure trustworthy information and knowledge, is confirmed as a most useful approach to support societal demands for sustainable fisheries and aquaculture.

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Introduction[a]

by

Enrico Feoli[b] & Cornelia E. Nauen[c]

Background

These are the proceedings of an INCO -DEV International Workshop on Information Systems for Policy and Technical Support in Fisheries and Aquaculture, convened 5 -7 June 2000 in Los Baños, Philippines. The workshop focused on aquatic resources, which are globally in a state of crisis as reflected in estimates by the Food and Agriculture Organization of the UN that >75% of capture fisheries are overfished, fully exploited or in a state of recovery. Aquaculture production already supplies supposedly some 30% of fishery products for human consumption. More than 40% of all fishery and aquaculture production entered international trade in the 90s, contrary to other staple foods, namely rice and other ce reals. Furthermore, harmful algal blooms (HABS) with their significant human health risks and impact on fish kills, compounded by species invasions, e.g. as engendered by ballast water exchange and other sources of species introductions, have increased substantially in recent times.

This requires developing new strategies to adapt production and consumption patterns with a view to ensuring harmony with the environment in the face of globalisation. In the context of fisheries resources, this implies focus o n rehabilitation and facilitating progressive replacement of single stock-based, technocratic management approaches by ecosystem -based ones, which can also be sensitive to the economic, social and political dimensions of resources use. Reliable information on which to base policy and investment decisions is crucial to achieve societal agreement for such rehabilitation and deference of benefits.

Conventional approaches towards fisheries management have not reverted the general trend of ecosystem degradation and productivity loss and are ill equipped to address the new dimension of economic development epitomised by the above highlights. Introduction of ecosystem approaches to policy and management in the above comprehensive sense would be in line with the Ja karta Mandate under the Convention of Biological Diversity and similar demands endorsed in many international fora.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los B años, Philippines, 5-7 June 2000;

b) Department of Biology, University of Trieste, Via L. Giorgieri 10, 34127 Trieste, Italy. E -mail: feoli@univ.trieste.it

c) European Commission, Directorate General for Research, 8, Square de Meeûs, 1049 Brussels, Belgium. E-mail: cornelia.nauen@cec.eu.int

Industry, government and science have to cope with the transition from abundance to scarcity. In this context, the main forces working against sustainability are:
?? lack of information;
?? diminishing benefits and rising costs.
Transparence and quality checks could combat the lack of trust in the reliability of information, which currently jeopardises agreement on new management approaches. Reliable information will spread the right perception of the productive capacity and result in more realistic assessment of decreasing benefits and rising costs. This is essential to promote flexible policy response able to compensate for diminishing benefits in one sector through alternative sources of income.

The emergence of the knowledge soc iety supported by modern communication infrastructure, in particular the Internet, opens entirely new opportunities for structuring and sharing information and knowledge relevant to both policy and technical applications. The workshop was therefore intende d to contribute to enlarging the present and future collaboration between the scientists and decision - makers in Europe and in developing countries. Emphasizing the international role of Community research, it could dwell on INCO's major thrust of incorpora ting key principles of Agenda 21 adopted at the 1992 Rio Earth Summit into the research agenda. Developing trustworthy, science - based information tools can enable a large range of societal stakeholders to access and contribute to the knowledge required for the transition to sustainability.

FishBase, the electronic encyclopaedia on the biology and ecology of finfish, is an early example of international cooperation to construct a knowledge platform, which is by now encouraging increasing ramifications into analytical tools for a variety of applications. These include teaching and informing policy e.g. in relation to innovative concepts of fisheries and protected area management. The number of users, two years after the creation of the FishBase internet site, exceeds 100,000 per month (situation early 2001). Building on this successful experience, some 30 researchers and selected representatives of management/information support bodies and fishermen's organisations from Europe and developing countries were inv ited on the basis of complementary competencies and shared interests in information systems in relation to aquatic resources.

The workshop was thus relevant to all three levels of research promoted by the INCO -DEV Programme, namely (a) policy research on t he conditions for sustainable development, (b) systems research on natural capital, and (c) tools for sustainable development.

Workshop Objectives

Specifically the workshop aimed at

?? reviewing the state of the art of available information systems and acce ssible information resources about key areas and identifying the critical knowledge gaps for policy and environmentally friendly production and trade;

?? determining a strategy for information sharing and interaction between scientists and decision makers in key thematic areas related to aquatic resources and management of protected areas;

?? defining in a concerted way which information tools would be indispensable for policy formulation or technical improvements in the respective fields, including aquaculture, sanitary and phytosanitary standards, trade in fishery products.

Steering Committee

The scientific steering committee of the workshop was composed of the following members:

- Prof. Enrico Feoli, plant biodiversity, coastal management, decision support systems; Workshop Convenor, Italy.
- Dr. Rainer Froese, FishBase Teamleader, Co-host, Philippines;
- Dr. Carlos Antonio Lima dos Santos, sanitary and phytosanitary standards and related trade issues, Brazil;
- Dr. Philippe Cury, ecosystem modelling and coastal processes, South Africa;
- Dr. Ussif Rashid Sumaila, game theory and economic modelling, Norway.

Structure of the proceedings

The contributions to these proceedings are either full articles, extended summaries of the presentations given at the workshop or provided for it. Extended summaries provide at least some guidance to further reading or Internet resources for the interested reader. A small number of workshop contributions is only presented as a one-page abstract. All contributions have been up-dated up to the publication date of the proceedings. Thematically, the written contributions are structured under the following headings:

- *Rationale and wider context* with four contributions providing historical rationale and contextualisation for knowledge structuring, accumulation and sharing as well as an introduction to Internet structure and approaches to spatial information;
- *Species databases* with eight contributions covering fishes, cephalopods, molluscs, decapod crustaceans, seaweeds and genetic diversity;
- *Other information needs for sustainable development* with eight contributions covering a wide range of topics from economics, valuation and regulatory approaches to resources, through trade issues to seafood safety standards;
- *Developing country and user perspectives* with six contributions addressing selected experiences of DC institutions or socio-professional groups and user interfaces.

The report thus provides an overview of information resources on aquatic resources (objective 1) and substantive materials on identified needs, available analytical approaches and avenues to increase the number of areas which should be covered by public knowledge goods (objectives 2 and 3). While not very extensive, the last category gives a flavour of local or national information/knowledge needs and efforts to address these. Indirectly, this also provides indications on the significant potential for added value from more intense and well-structured cooperation between global and local initiatives based on mutual interest and respect.

Strategies for the public knowledge goods required for the transition towards sustainability

In terms of feasible strategies (objective 2), there was agreement that information systems of the FishBase type represented a good way of structuring and sharing currently scattered knowledge which has been gathered over long time periods and in many societies. Increasing efforts within the (species-based) FishBase system to support ecosystem approaches explicitly warranted attention and support. Such systems should be developed for other species groups and also for economic, sanitary and trade information.

It was expected and hoped that coordination and cooperation would be strengthened between the science efforts under the Global Biodiversity Information Facility (GBIF) supported by the OECD, Species 2000 and North American 'Interagency Taxonomic Information System' (ITIS) with the facilitation of the Global Taxonomy Initiative (GTI) under the Convention on Biological Diversity (CBD). Convergence of efforts towards a Global Catalogue of Life as also supported by the European Environment Agency (EEA) was on the agenda, towards which aquatic resource knowledge bases could make significant contributions. Biodiversity work is an area, where much pioneering work has been done and workable concepts do either exist or can be developed reasonably easily by capitalising on past efforts. There is realistic hope to start reversing the trend of knowledge loss due to retirement of experienced taxonomists without replacement. Modern information technology and open access have a confirmed capacity to turn the potential e.g. of museums, collections and much of the basic taxonomic work into active knowledge at the service of all societal stakeholders.

Some workshop participants followed up through the creation of consortia submitting research proposals to the 2000 INCO-DEV call. Two proposals were evaluated as excellent and funded, in particular the expansion of the seaweed datasystem for Africa and analysis and documentation of the Eurasian freshwater fish fauna, which would feed, among others, into FishBase.

Developing electronic information systems in other thematic areas, particularly economics, trade and food safety remains a major challenge, which will need priority attention in the near future. Key concepts were discussed at the workshop, which should form the basis of workable approaches to address these areas in a systematic way. Given the number of information sources with a limited geographical focus or narrow objective that could be brought together in suitable ways, the conceptual progress could rather quickly lead to a useful level of content accumulation for wider sharing. It could thus emulate within a shorter time span the success of FishBase. It could be expected that the virtuous circle of knowledge accumulation, broading partnerships, encouragement of new types of analysis and opening new options for pathways towards sustainability would be extended to these fields.

It is equally clear that efforts will have to be diversified and bridges built between different societal actors and knowledge systems. The contribution on common names shows one demand-driven direction in which scientific and 'local' knowledge can be made to meet. Reaching across linguistic diversity is another important avenue that is expected to be helped by technological progress in machine translation, but could be supported in different ways by policies encouraging multi-linguistic education.

The workshop and these proceedings open a few doors, but cannot pursue in depth the opportunities lurking behind them. The editors and the scientific steering committee hope that the information and leads provided are useful. It would be gratifying to see further follow-up resulting in additional activities along the lines discussed at the workshop and put forward in these proceedings.

Rationale and wider context

Importance of the historical dimension in policy and management of natural resource systems[a]

by

Daniel Pauly[b]

Abstract

Scientific knowledge – however defined – does grow cumulatively when not impaired by external crises, in contrast to fashionable beliefs of about 'paradigm shifts' that fail to account for the increasing empirical contents of new, over old, paradigms.

On the other hand, crises of science generated externally e.g. by drastic funding cuts, or the loss of the institutional basis of entire disciplines by wars (civil or not) do lead, at least locally, to loss of knowledge, especially in disciplines (such as taxonomy) which rely on archived specimens, and on explicit transfer of arcane skills from one generation of specialists to the other.

Various disciplines, such as e.g. physical oceanography, have data recovery programmes dedicated explicitly to recovering the earlier data sets that, because of such crises, failed to become incorporated into their mainstream.

Taxonomy and the biological disciplines depending on proper identification of numerous specimens, did not until recently have any vehicles for such explicit recovery programmes. Relational databases, such as e.g. FishBase for fishes, can be used as hubs for data recovery programmes in both developed and developing countries.

Such programmes are important because the concept of 'sustainability', is meaningless unless it implies reliance on accurate estimates of initial baselines or reference points. Without reference points, biodiversity will suffer from the "shifting baseline syndrome".

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000;

b) Science Advisor, FishBase Project, and Professor, Fisheries Centre, 2204 Main Mall, University of British Columbia, Vancouver, B.C., Canada, V6T 1Z4. E-mail: d.pauly@fisheries.ubc.ca

Introduction

Science proceeds by accumulation of knowledge. This truism brings to mind a smooth process, the naïve view represented in Fig.1A. Different shapes for the curves result from whether knowledge is thought to be reflected by the amount of 'data', or the number of new publications, both usually exponential (a), or whether knowledge growth is defined by increase of well corroborated integrative concepts and theories, which may imply a gradual slowing down (b). In either case, an increase of knowledge occurs. This contrasts with what may be called the 'Standard Social Science Model', where, based on crudest reading of Kuhn (1960), the process of natural sciences science is viewed as dominated by sequences of 'paradigm shifts', or by different 'discourses', each reflecting mainly the vested interests of a currently elite group (Gross & Levitt, 1994). 1B gives a schematic representation of this view.

Yet, in the natural sciences, we do know *more* about the Earth since Plate Tectonics replaced earlier, static representations of global geological processes, and we know *more* about biology since Darwin's selectionist paradigm replaced its creationist predecessor. In both examples, the new paradigm not only explained more than did its predecessors, but spawned new opportunities and methods of investigations.

Thus, a key criterion for a true advance is that the new model or explanation should explain more than its predecessor(s), i.e., provide a context for incorporating into a coherent body of knowledge more of the empirical evidence established by previous generations of researchers. Thus, even when acknowledging that paradigm shifts do occur, an overall increase of knowledge occurs as well. Thus, the naïve view of science operating in cumulative fashion is vindicated, though perhaps in form of a slightly more complex representation (Fig. 1C).

What is required for the cumulative process of science to break down are crises external to science itself (Fig. 1D).

Crises and challenges

Crises capable of interrupting scientific growth are, for example, those caused by unstable research support, in both developed and developing countries.

In developed countries, examples of such crises were induced, starting in the early 1970s, by failing support for institutions devoted to taxonomy (mainly museums), once a vibrant area of biological research. As a result, a large fraction of the knowledge held by the last working generation of taxonomists is not being passed to successors.

In many developing countries, the same period has seen, in relative terms, even sharper declines in support, often reducing research institutions to shadows of their former selves – even when acute conflicts such as civil war did not lead to scientists having to flee their jobs, and valuable archives and specimens being burnt or looted.

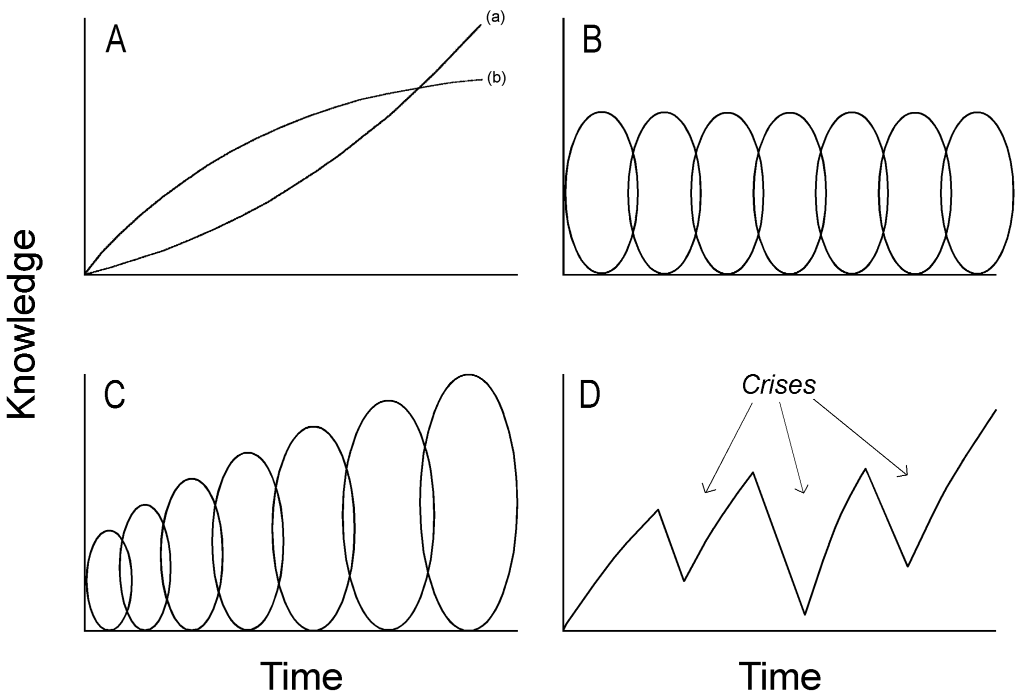

Fig. 1. Aspects of the growth of scientific knowledge. A: Naïve models, assuming that growth does occur. Different view may exist as to whether this growth acc elerates (a) or not (b), depending on how 'scientific knowledge' is defined. B: The Standard Social Science Model, wherein paradigms (the ovals in the graphs) are successively replaced, without net increase of knowledge. Note that this model may well apply to literature, in that early work by say Aeschylus or Homer's was not subsequently 'improved'. C: While paradigms, in the natural science, do replace their predecessors, they will do this only if they can accommodate an increased empirical content, i.e., explain more 'facts', and lead to more knowledge. Hence the naïve view in A is largely validated. D: Crises (slashed funding, or failures in knowledge transmission from one generation of scientists to the next) can, however, impair the growth of scientific knowledge, and hence the need for data recovery programs and databases dedicated to overcoming the effects of such crises.

In some disciplines, notably oceanography and meteorology, vast programmes of data recovery have been initiated, often triggered b y the need for the proper baselines required by global climate models. Here, the cumulative process is restored *post hoc*, to bridge the gaps caused by institutional crises. For example, programmes presently exist to recover oceanographic and weather data pertaining to areas held by the Axis powers during the Second World War (the ultimate institutional crisis), and previously available in global databases.

Similar efforts are exceedingly rare in the biological sciences. Many colleagues believe that this is due to the complex nature of biological data, compared to the straightforward formats required for oceanographic (mainly salinity, temperature) or meteorological information (mainly wind direction and strength, and air pressure).

However, one could argue if there is a will, there will be a way. One way, for example, is to define a minimum format for *the* key biological information and then do an all out effort to get that information, because although it may be difficult to access, it *is* there. Here, I think of the example provided by the Species 2000 Initiative, which aims to gather, in a single database, the valid scientific name of all the organisms described since the 10th, 1758 Edition of Linnaeus' *Systema Naturae*, and the references which document these names. Another example is provided by occurrence records, called 'bioquad' because they contain the four items (species name, source, date and locality) required for biodiversity studies (see contributions in Pullin *et al*., 1999). About 10 million bioquads exist in the various museums of the world for fishes alone, and their recovery and analysis should represent a challenge similar to those taken up by oceanographers and meteorologists.

Where some information beyond the original description is available on each species, another way to deal with the challenge of recovering the past is to provide a structure for more detailed information to be captured and standardised, tailored to the features of the type of field survey (Pauly, 1996) or of the taxon for which information is to be recovered. A taxon-specific, but global approach was taken for FishBase (Froese & Pauly, 2000), and we hope that specialists for other groups will follow this example, now shown to work *in practice*.

Approaches also exist for recovering complex ecological information, notably on the structure of the food webs largely defining aquatic ecosystems. Thus, the present state of a given ecosystem (biomass of its various functional groups, fluxes of matter between producers and first-order consumers, predatory fluxes from the latter to higher-order consumers, etc.) can be represented in standardised fashion using Ecopath models (see software and documentation on www.ecopath.org). Then, the data recovered from the past can be used to modify the contemporary model such that it will tend to represent an earlier state of the ecosystem, e.g. before the biomass of major resource species was reduced by industrial fishing. Numerous application cases documenting the practicality of this approach also exist (see www.ecopath.org).

This establishes that approaches are available for digitizing, documenting and analysing, on a global basis, the aquatic species that have so far been identified, the occurrence records that document their distributions in space and time, and their interactions with other species. Moreover, approaches similar to the Ecopath software can be easily conceived which would allow the validity of this statement to be extended to terrestrial ecosystems as well.

Using recovered knowledge to prevent baseline shifts

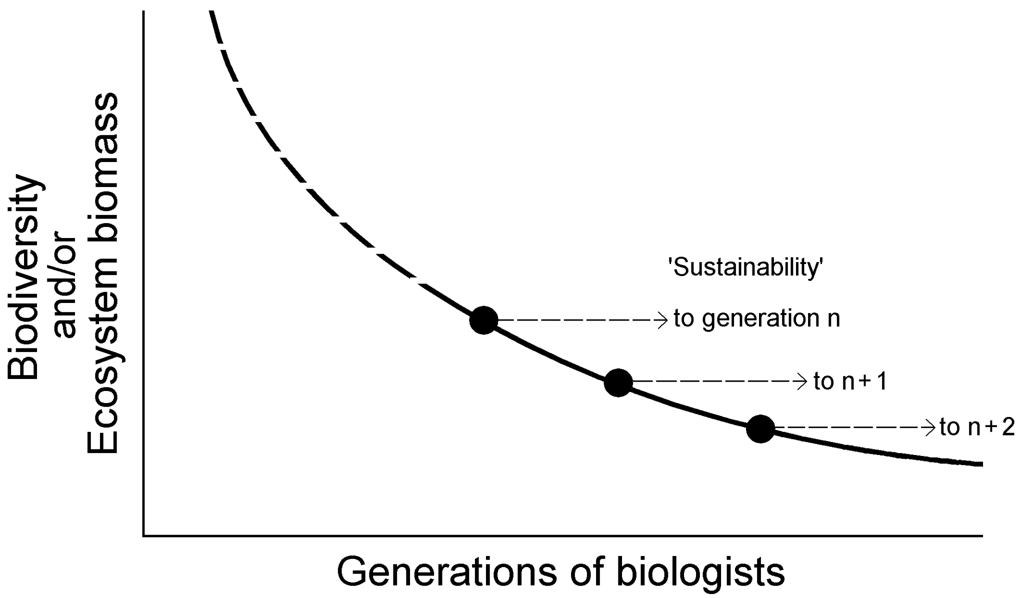

Fig. 2. Human exploitation of newly accessed ecosystem typically implies that the animals that are largest and most valuable (in the nutritive or commercial senses) are taken and depleted first, often with simple methodologies. Smaller, less valuable animals are then the next to be taken, with improved technologies. Early serial depletions of this sort (thick dotted line) are not documented in the literature with the standards now prevailing, and thus often dismissed. Moreover, successive generations of biologists will tend to use the ecosystem state at the start of their career as baseline for what biodiversity and abundances 'ought to be'. This leads to shifting baselines, with each generation aware of less that ought to be sustained. This undermines the concept of sustainability, which becomes generation-specific. Countering this 'shifting baseline syndrome' (Pauly, 1995) requires recovering and synthesizing historic information, i.e., data on earlier ecosystem states, as can be achieved by the tools also useful to address the crises in Fig. 1D.

The question, which now emerges is why we would want to do this? After all, this work covers much of the agenda proposed for the U.S. based *Census of Marine Life*, an initiative initially costed at 10 billions US \$ (10^{10} \$), a rather large sum. However, we may wish to compare this with the sum spent annually by governments to subsidise already overcapitalised fisheries: 50-70 billions \$ *per year*. As every fishery economist will confirm, subsidies encourage overfishing and resource depletion. Thus, all of a sudden, the *Census of Marine Life* does not look so expensive any more, at least compared with the support to forces that are presently contributing to reducing biodiversity, and of which fisheries are but a small part (Pullin *et al.*, 1999).

However, the real reason why we would want to get proper baselines of the marine life we have now, or once had, is because it is only when it is based on well established baselines that the concept of sustainability, otherwise nothing but a feelgood concept can be made to mean anything.

Indeed, without firmly rooting in scientific, quantified knowledge of what we no w have, or had, we will experience what I called the "shifting baseline syndrome" (Pauly, 1995). Herein, successive generations of naturalist, ecologists, or even nature lovers use the state of the environment at the beginning of their conscious interactions with it at 'the' reference point, which then shifts as successive generations degrade that same environment (the story of the frog kept in water that is heated very slowly comes here to mind, and if we are not careful, we are going to get boiled as does the frog: a runaway greenhouse effect would do the job nicely).

Acknowledgments

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The European Research Area's contribution to international S&T cooperation for sustainable development with particular emphasis on aquatic resources[a]

by

Cornelia E. Nauen[b]

Abstract

Europe has played a pioneering role in scientific and technological cooperation with developing countries ever since the 1979 UN Conference on Science and Technology for Development. The attempt at creating a European Research Area (ERA) with a strong international dimension can draw on this experience both for its internal integration and for necessary partnerships with developing and industrialised countries. Reliable information, open to scrutiny and shared widely, will be increasingly critical for natural resources management in the face of scarcity and increasing costs. Developments in information technology offer increased opportunities for joint research activities between European and DC teams sharing their results to enhance contribution to a sustainable development path. This will create a new research infrastructure requiring more long-term support and cooperation in order to yield the full benefits from the combination of scientific partnership and information systems accessible via the Internet. The realisation of this potential requires at least a two-pronged approach: moves towards socially-aware high quality research for sustainable development and an enabling policy environment, in which research capacity in strengthened and harnessed for sustainability goals.

a) Adapted from a presentation at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) European Commission, Directorate General for Research, 8 Square de Meeûs, B-1049 Brussels, Belgium. E-mail: cornelia.nauen@cec.eu.int

Introduction

Europe's long traditions of scientific endeavour coupled with great cultural diversity is recognised as an essential foundation of its relative socio-economic wellbeing. Science and technology are already at the origin of between 25 to 50% of economic growth and expected to determine to a large extent the region's competitiveness and ability to tackle the major environmental and socio-economic problems in the new century.

Research plays a central role in the definition and implementation of public policies and influences strongly major political decision making processes. Research is carried out in a continuum of public, associative and private establishments, universities and research centres. Collaborations and consortia are on the increase to better mobilise limited resources and capacities in originally fragmented national contexts. Private sources account for more than 50% of research funding and about 2/3 of research activities, with upward trend.

The recent Commission Communication 'Towards a European Research Area' takes stock of the achievements but also of the weaknesses of European research. It proposes the creation of an integrated European research area to better mobilise the human, institutional and financial resources required across the region for the improved scientific excellence and relevance to meet societal aspirations. Indeed, it underscores the role of the European Research Area for regional integration and growing cohesion within Europe and for the promotion of shared social and ethical values concerning research and technology (European Commission, 2000a).

In the face of global trends in relation to demography, movements of people and products, trade, information technology and automation, international scientific research for the generation and sharing of knowledge will play an important role in Europe's approach to ERA. ERA itself will have to strengthen its international dimension as Europe seeks to define its future role in a globalising world. Indeed, the great interdependence of countries and regions on each other when it comes to

?? the environment (e.g. Kyoto Protocol of the UN Convention on Climate Change adopted in December 1997 – http://www.unfccc.de/resource/docs/convkp/kpeng.html);

?? biodiversity (Convention on Biological Diversity adopted at the Rio Earth Summit in July 1992 – http://www.biodiv.org/);

?? biosafety (e.g. Cartagena Protocol on Biosafety adopted in Montreal in February 2000 – http://www.biodiv.org/biosafe/Protocol/Index.html);

?? health (e.g. The World Health Report 2000 – http://www.who.int/whr/2000/en/report.html); and

?? food security (e.g. the Rome Declaration on World Food Security and the World Food Summit Plan of Action adopted in November 1996 – http://www.fao.org/spfs/);

to name but a few, makes scientific and technological cooperation the obvious choice of how to develop and strengthen peaceful international relations and strive towards greater sustainability of the Life Support System Earth.

It therefore comes hardly as a surprise that Europe dwells on its pioneering role in S&T cooperation with developing countries to address key issues of sustainable development. The underlying partnership approach was set up as a direct result of the 1979 UN Conference on Science and Technology for Development, where developing countries objected to simple technology transfer.

Furthermore, European decision makers at the time recognised that specific research efforts had to be directed to address the conditions in tropical and sub-tropical countries to meet their development aspirations (European Commission, 1998). This now almost two-decade-old experience (currently called INCO-DEV – international S&T cooperation with developing countries - and its predecessors SDT and INCO-DC) has during its lifetime mobilised more than 7,000 successful research teams from developing countries and Europe in joint research activities and many more in getting together in the attempt to obtain funding. Its quality is ensured by its non-governmental nature of voluntary cooperation between research teams and strict external review examining proposals on a competitive basis.

International political dialogue on S&T cooperation

Over the years, the deliverables and future potential, but also the limitations of this essentially project-based approach have become apparent. Up-take of scientific knowledge for sustainable development hinges on the continued strengthening of research institutions in developing countries and constant adjustment of priorities to the changing conditions of developing and emerging economies (Bell, this vol.). Equally important is an enabling policy environment for such research and its pro-active use in the pursuit of societal goals.

This was one of the driving forces behind a Resolution on Fisheries Cooperation adopted in October 1993 by the ACP-EU Joint Assembly, a parliamentary body composed of representatives of African, Caribbean and Pacific countries and the European Parliament. As a result of this resolution, the Commission set up a task force between directorates-general for research and development, which produced, in consultation with EU Member States senior fisheries cooperation advisers, a background paper on an ACP-EU Fisheries Research Initiative. Through 1995 and 1996, this discussion paper served as a basis for three regional dialogue meetings between ACP and EU senior scientists and development advisers. This first round of dialogue meetings was concluded in 1997 with recommendations to the Joint Assembly and the EC for continued dialogue, capacity building in ACP countries and joint research on the jointly determined priority subjects (Anon 1995, 1996, 1997). They were subsequently followed up through a number of development projects (e.g. Vakily *et al.*, 1997; Vakily, 1998; Bâ, 1999) and through the transcription of priorities into the annual calls for joint research proposals under INCO with a number of resulting joint research projects (Nauen, 1997).

It is also with this understanding that many other opportunities for high-level political dialogue between Europe and other regions of developing and emerging economies have been multiplied over the last years and used to discuss S&T cooperation in all other thematic areas of special relevance for sustainable development.

Recent occasions were seized through the Euro-Mediterranean partnership and the largely informal ASEM process (Asia-Europe Meetings offering a dialogue and cooperation platform for 10 Asian and 15 EU countries and the European Commission). An ASEM ministerial meeting on S&T cooperation in October 1999 recognised the need to intensify various planned and on-going collaborations with emphasis on cross-cutting issues that cannot be tackled by individual countries or institutions. The meeting put sustainable use of natural resources and biodiversity conservation high on the agenda and the chairman's statement also singled out joint research on aquaculture and water resources.

Following the signing of a science cooperation agreement between Brazil and the EU end 1999, steps have been taken to set up a similar framework to the ASEM S&T cooperation with Latin

America and the Wider Caribbean. The REALC (Reuniones Europa -América Latina y Caribe) process is putting particular emphasis on scientific and technological cooperation. During 2001, a series of workshops on priority themes is intended to feed initial orientations for priority S&T cooperation into a succession of senior representative meetings from both regions leading up to ministerial and heads of state and government in 2002.

Furthermore, the Heads of State and Government at their EU -Africa Cairo Summit in April 2000 incorporated increased science and technology cooperation in their Declaration and Plan of Action, thus setting the stage for potentially far-reaching action against the marginalisation of the African societies. Given the state of overall economic development on the continent, it may be assumed that more emphasis may be required on broad -based capacity building throughout the educational system to enable the range and depth of S&T cooperation already possible with other parts of the world. However, the existing collaborations represent good foundations for stepped up future cooperation.

Opportunities for S&T cooperation

It is thus apparent that the roots of the international dimension of the European Research Area date back many years, and that the succession of INCO -programmes has offered a valuable learning context at the small scale. Interdisciplinarity has been introduced in the invitations for submissions in the early 90s and policy research on the conditions of sustainable development was specifically and systematically invited since the second half of the 90s. As it stands now, the full suite of types of research are covered ranging from (a) policy research, through (b) systems research to (c) research on technological solutions in relation to sustainable production of goods and services in developing countries. Cross-cutting concerns such as environment conservation, gender and equity permeate all annual calls for proposals.

INCO-DEV calls throughout the 5th Framework Programme for Research, Technology and Demonstration (FP5 – 1998-2002) invite proposals through the entire spectrum. Policy research focuses on

(i) research and technology development in the global knowledge society with emphasis on "*efficient and cost-effective RTD policies in DCs*" and "*policies for the use of innovative information technologies in teaching and learning processes, including lifelong learning, and distance learning in specific context of developing countries*"; and

(ii) "*natural resource use and economic production: adaptation to globalisation and ensuring harmony with the environment*" with particular emphasis on policy design (e.g. European Commission, 2000b).

In 2000, the system research bracket invited, among others, joint research on a series of topics of particular concern to aquatic resources, such as the study of how to obtain from natural ecosystems products and services in sustainable ways or how to restore lost productivity, the analysis of socio - economic factors governing the use of 'natural' and managed ecosystems, their limits and options for enhancing outputs and the establishment and validation of criteria and indicators of sustainability and rehabilitation as well as related information systems in support of ecosystem management.

The technology segment of the 2000 call most relevant to this workshop focused finally on the "*Identification of suitable source populations with profitable traits, integration of associated analytical tools and populations to selective breeding programmes*".

The 2001 call for proposals will shift attention away from 'rural systems' and rather focus on the rapid urbanisation processes in developing countries leading to profound changes in their societies' perceptions, value systems, and use of natural and human resources. The associated development of urban-rural interfaces should also receive attention, including use of and effects on natural resources.

Generation of information and sharing of knowledge as essential ingredients for sustainable development

"*As industry, government and science struggle with the transition from abundance to scarcity, the main forces working against sustainability are:*

?? *lack of information;*
?? *declining benefits and rising costs.*

These factors lead inevitably to a breakdown in voluntary compliance. Agreement on conservation and management is unlikely in the absence of quality information. Lack of trust in the source of the information sabotages any chance of broadly based agreement. No agreement will hold when benefits decline and costs rise." (Haggan, 1998). While initially framed in the context of the changing structures of fisheries management, Haggan's basic observation can safely be extended to many other areas and even serve as a leitmotiv to the present workshop. One needs to elaborate though on the simple statement of 'lack of information' in that it means reliable information open to scrutiny and accessible to all stakeholders. Such information may arise from various sources, e.g. scientific and indigenous, but it is important that it be shared in democratic ways rather than be the monopoly of specialists or special interest groups. Information turned into understanding and knowledge is one of the key driving forces for sustainable social and economic development in general and in relation to aquatic resources in particular (Nauen, 2000).

Pauly (this vol.) adds the important dimension of historical accumulation of information and derived knowledge and points to the challenge of making past information available in structured ways such that today's knowledge integrates earlier understanding and builds on it. The systematic development of the historical dimension of natural resources, their ecosystem and human interaction with them is bound to change our perception of present systems and options available in profound ways (e.g. Jackson *et al*., 2001).

Given the global scale of the environmental and biodiversity challenge, such knowledge accumulation and classification efforts must take place at a commensurate scale in time and space. This challenge exists at several interdependent and not always clearly separated levels:

(i) first, perhaps at the level of identification of organisms, illustrated by the Species 2000 Initiative (see http://www.sp2000.org/), the more limited European Register of Marine Species (http://erms.biol.soton.ac.uk/) and many other complementary undertakings;

(ii) second, in terms of compiling, structuring and sharing of a great range of information on the building blocks of ecosystems, best exemplified through the thorough work on all fishes in the world with FishBase (Froese & Pauly, 2000; www.fishbase.org/; see also Froese, this vol.);

(iii) third, the ecosystem context of the organisms needs to be classified and analysed in time and space. In the terrestrial context, this has been done e.g. by Grigg (1980) in his global classification of agriculture systems, and is forthcoming for large marine ecosystems through a combination of Longhurst's classification and Sherman's LME concept (Pauly *et al*., 2000). Promising analytical possibilities at this and smaller scales are offered by the Ecopath family of modelling tools (Walters *et al*., 1997; Pauly *et al*., 1998; Pauly *et al*., 2000a). For several years already, the Intergovernmental Panel on Climate Change (IPCC) produces a range of global and regional analyses on the drivers, impacts of climate change (e.g. Watson *et al*., 1997) and mitigation options;

(iv) fourth, socio-economic and economic information is being compiled and made available in database formats, often with associated mapping and analysis possibilities; a case in point is the World Data Center for Human Interactions in the Environment (e.g. http://www.ciesin.org/ datasets/gpw/globaldem.doc) as part of the World Data Center System of more than 40 institutions designated by the International Council of Scientific Unions (ICSU) in Paris.

Technological developments with information technology are continuing at such speed that the opportunities for integration of the various levels can only grow in the future. Thus, new users and new user-interfaces for education, scientific, managerial and recreational purposes are to be expected.

This also means accessing many of the more conventional data and information resources, such as the data material compiled by the UN system etc., in novel ways. Thanks to the Internet and its rapid penetration also of developing regions of the world, we are witnessing the beginnings of a real chance of much wider participation of and interaction between scientists, public and private organisations and civil society at large. The scale of new opportunities through the innovative combination of accumulated knowledge and new research warrants a longer -term approach than conventionally provided with project funding. Early discussions about the articulation of the ERA already point in this direction and recognise the need for long-term institutional support for the research infrastructure, increasingly constituted by global databases and information systems (European Commission, 2000c). ERA is intended to create the enabling policy environment in which joint research within Europe and between Europe and its partners abroad can provide essential stimulus for equitable societal progress and a global sustainable development path. It must be continuously developed to accommodate the evolving relations between public and private sectors and civil society, between industrialised and developing economies, between conventional national and international and new global institutions emerging as a result of globalisation processes and recognition of global interdependencies.

While information, not even reliable and scientifically vetted information, alone will automatically lead to a sustainable development path, it is an indispensable condition for more informed choices at individual, corporate and societal levels.

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Using the Internet to access and deliver information worldwide[a]

by

Jacqueline M. McGlade[b]

Abstract

The Internet has completely changed the way people work and communicate. The paper describes how this loose organisation of computer networks functions and what types of of information are now available via the Internet.

As with any technology there are pros and cons as to the exact applicatio n that best suits a particular task; the Internet, with its ability to provide users with access to multimedia and communications can sometimes overwhelm a rather simple exercise in information gathering. Portals, which are designed to provide signposting to related Web sites and meta -databases of information stored at those sites, will therefore become increasingly important.

a) Prepared for the INCO -DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquacul ture, Los Baños, Philippines, 5-7 June 2000;

b) University College London, Department of Mathematics and Complex Systems, Gower Street, London Wc1E 6BT, UK. E -mail: jacquie.mcglade@ucl.ac.uk

Introduction

The Internet has completely changed the way people work and communicate. Worldwide, millions of people log onto the cyberspace network, that crosses political, racial, ethnic and religious boundaries, to conduct research, send email, do business and exchange ideas. To understand how this is possible, and the types of information that are now available via the Internet, we first need to look at the elements of which it is made.

The Internet is a loose organisation of computer networks. A wide variety of private organisations, universities and government agencies pay for and run parts of it, all working together in a democratic, loosely organized alliance. The Internet's growth is guided by a number of groups, who establish standards and educate people as to the proper use of the system. The Internet Activities Board handles much of the "behind-the-scenes" development and architectural issues, such as the protocols for data exchange and transmission. The World Wide Web Consortium (W3C) develops standards for the evolution of the fastest growing part of the Internet, the World Wide Web: it is an industry consortium run by the Laboratory for Computer Science at the Massachusetts Institute for Technology.

Private companies, or registrars, oversee the registration of Internet domains. These companies must all co-operate with a quasi-private company called the InterNIC, which maintains the central database of all domains registered. Registrars are overseen by a board made up of people from business, government and individual Internet users. The Domain Name System includes such extensions as: *bus (business)*, *com* (commercial), *edu* (education), *gov* (government), *info* (information), *mil* (military), *net* (ISPs and networks), *org* (organisation). Examples include:

http://www.ecopath.org; http://www.nationalgeographic.com; http://www.dost.gov.ph/.

Although all these kinds of organisations are important to glue the Internet together, at its heart, the Internet is a system of individual networks. These can be found in private companies, universities, government agencies and online Internet Service Providers (ISPs). Although fees are paid in many different ways, at root everyone who uses the Internet helps to pay for it. The networks are connected in a variety of ways; local networks often join consortia of regional networks: a range of leased lines connect regional and local networks, including single telephone lines and fibre-optic cable with microwave links and satellite transmissions. Large private companies and government agencies provide very high-speed backbones, which carry Internet traffic across the world. The National Science Foundation (USA) and the Office of Science and Technology (UK) are also developing GRID computing, which will enable the research community to link a wide range of small computers to super-computers and communicate at speeds of up to 2.4 gigabits per second, compared to the 56 kilobits per second obtained via a dedicated telephone line.

There are many different ways to connect to the Internet: (a) Serial Line Internet Protocol (SLIP); (b) Point-to-Point Protocol (PPP); (c) via an Integrated Services Digital Network (ISDN) line; (d) an Asymmetric Digital Subscriber Line, (ADSL), a newer technology which sends and receives data at different speeds and allows for very high-speed connections over the existing copper phone lines; (e) via Network Computer; (f) cable modem (e.g. coaxial television cable); (g) palmtop (personal digital assistants) and (h) satellite connections.

Sending Information across the Internet

The process of sending and receiving information is remarkably complex. First, the Transmission Control Protocol (TCP), breaks the information up into packets, which are then sent to a local network, ISP or online service. From there, the packets travel through many levels of networks, computers and communication lines until they reach the final destination. The hardware involved in this transfer includes *hubs* (which link computers to one another and let then communicate), *bridges* (which link local area networks (LANs) and allow data destined for another LAN to be sent while keeping local data inside its own network), *gateways* (similar to bridges, but also translate data from one kind to another), *repeaters* (which amplify the data at intervals so that the signal does not weaken) and *routers* (which play a key role in managing Internet traffic; they examine packets to determine their destination, take account of the volume of traffic and send the packets to another router closer to the packet's final destination).

Midlevel or regional networks hook LANs together using high-speed telephone lines, Ethernet and microwave links; a wide area network (WAN) is an example, and consists of an organisation with many networked sites together. If the destination of a packet lies outside a midlevel network, it is sent to a Network Access Point. There, packets are sent on the high-speed backbones. Once the packets have arrived at the destination they are reassembled by the TCP. Ensuring that the packets are sent to the right destination is the responsibility of the Internet Protocol (IP). TCP/IP is used on the Internet because it is a packet-switched network; i.e. there is no single, unbroken connection between sender and receiver. By contrast, the telephone system is a circuit-switched network, i.e. the network is dedicated only to that single connection once it is made.

To enable IP to work effectively, it uses Internet address information; this is a series of four numbers separated by dots, e.g. 163.52.177.78. As these numbers are difficult to remember, a Domain Name System (DNS) of textual addresses has been developed, which are more recognisable. An Internet address is made up of two major parts, separated by an @. The first part - to the left of the @ sign - is the user name; the second part, to the right, is the hostname or domain name of the specific computer where the user has an Internet account. Host computers differ from desktop computers in that they can handle multiple telecommunications at one time. They also have gigabytes of hard-disk storage, considerable random access memory (RAM) and a high-speed processor. The DNS system keeps track of changes in numeric addresses, so that the Internet address can stay the same for user's convenience. Computers called name servers are responsible for keeping track of these and ensuring that when a Web Uniform Resource Locator (URL) is typed in, the mail is delivered to the right person.

Internet File Types

There are millions of files on the Internet that let you see pictures, hear music and sounds, watch videos, read articles and run software. In general there are two types: ASCII (American Standard Code for Information Interchange) files and binary files. ASCII files are often referred to as plain text files, text files or ASCII text files; they lack sophisticated formatting commands so they appear as plain text. Binary files, by contrast, contain special coded data and can only be run or read by specific computers and software. Hypertext Text Mark-up Language (html) pages make up the World Wide Web. They are plain ASCII text files that contain coding information telling the browser how to display a Web page.

In contrast to ASCII files, there are files that contain sophisticated formatting and graphical information, for example, PostScript and Acrobat PDF formatted files. Often you will need special software readers and printers to access these. Similarly, video, sound, visual image and animation files, which are all binary files, need specialised software and sometimes hardware. However, some of these files, such as streaming audio and video files can be viewed while online.

Internet Client/Server Architecture

The Internet model is based on a client computer that connects to a server (known as the *host*) computer on which information resides: the client depends on the server to deliver information. The client requests the services of the larger computer: these services may involve searching for information and sending it back to the client, such as when a database on the Web is queried. Other examples are delivering Web pages, handling incoming and outgoing email.

The connection between client and server is maintained only during the actual exchange of information. So after a Web page is transferred from the host computer, the Hypertext Transfer Protocol (http) used by the Web is broken, although the TCP/IP connection to the Internet can be maintained by the ISP. The client/server model enables the desktop PC to run the browser software to search the Web, and access host servers around the Internet to execute search and retrieval functions. The architecture enables the Web to be thought of as a limitless file storage medium and database, distributed among thousands of host computers, all accessible by any individual PC.

Communicating on the Internet

There are many ways in which users can use the Internet to communicate directly with particular groups of people and obtain information relating to specialist interests. The most common method is via email, which remains one of the most popular and most powerful uses of the Internet. Millions of people now have email addresses, and it is possible to find someone, even if you only know their name, by using a Lightweight Directory Access Protocol. Other modes of communication include Internet Relay Chat, Instant Messaging, IP Telephony and Usenet.

Usenet, the world's largest electronic discussion forum, provides a way for messages to be sent among computers across the entire Internet. People from all over the world participate in discussions on thousands of topics in specific areas called *newsgroups*. There are at least 20 different major newsgroups, each with categories and sub-categories. Examples of science based newsgroups are *sci.bio*, *sci.chem* and *sci.astro.hubble*. Users participate by reading the messages and responding to them. A good newsgroup reader lets the user view the ongoing discussion as *threads*. These are ongoing conversations that are grouped by topic. Some sites archive old discussions. In moderated newsgroups, each message goes to a human moderator to ensure that they are appropriate for the group before they are posted.

Web sites & databases

The World Wide Web is the fastest growing part of the Internet. The Web contains many things, but what makes it so fascinating are the Web "pages" that incorporate text, graphics, sound, animation and other elements relating to multimedia. Pages are connected to one another by hypertext; they are built using a markup language called html (Hypertext Mark-up Language), which tells the browser how to display the information and how to link the pages to other Internet resources. The "home page" often has a road map or set of connections that tell the user how and where to find other related pieces of information. The collection of pages connected to the home page make up the Web site.

In general, Web sites use three kinds of organisational structure: a *tree* (a pyramid format that allows users to navigate through the site to find what they want), *linear* (one page leads to the next) and *random* (pages are connected to one another at random). When pages have been designed they are posted to the Web server using File Transfer Protocol (FTP) software. Each web site has a unique identifier called a URL (uniform resource locator). A typical URL looks like this:

http://www.fishbase.org/forum/.

The first part specifies the type of transfer protocol used to retrieve any documents on the site, i.e. http. The second portion specifies the host computer or domain name. Any further listing refer to files in directories and sub-directories on the hard disk that houses that Web site.

One of the most useful applications of the Web is its ability to link a web site with a database so that users can search for information. In essence the web site becomes a front end for database applications, enabling you to select search criteria and execute complex searches of a database on the host computer. The Web page and the database are linked by a bridge called the Common Gateway Interface (CGI). On the client side of the database, the user sees a welcome web page that includes a form in which search terms can be entered. By executing the search, a CGI script is launched that sends a search command to the Web server in the form of a link to the CGI bin on the server. For example, a search on the Yahoo! Site for marine surveying firms would look like:

http://search.yahoo.com/bin/search?p=marine+surveying.

When the Web server receives this URL, it identifies the URL as a trigger for a CGI script and passes it along with a programme. The CGI script then send the search to the database, receives the results of the query along with the HTML page created by the database to contain the result and passes it on to the Web server to be sent back to the client. As the handling of all these tasks occurs simultaneously, it does not generally take very long.

Once a file or dataset has been located, it will need to be downloaded; because some files are so large it can take a tremendous amount of time, especially if the connection is via a modem. As a way to speed up file transfer and save space on the FTP server, files are usually compressed using a variety of algorithms. A header can also be added which contains information about the file, such as its name, size and compression method used. This information is used to reconstruct the file when it is uncompressed. File extensions indicate which compression method has been applied; examples include: *file.zip; file.arj; file.pak; file.tif; file.bin; file.gz*).

Networks & portals

Databases are created using a variety of software packages and maintained in a variety of forms. Users who wish to draw together data from a number of sources can use the Internet, first to locate sites and then arrange to download particular sets of information. To enable users to do this more efficiently, portals have begun to appear. These are openings into a network of Web sites that offer access to data. Some portals also provide a meta-database, which informs the user which data are held where and how information can be extracted to create one seamless file. An example of a meta-database site is www.noaa.gov, the web site for the National Oceanographic and Atmospheric Administration in the USA. Users can download a wide variety of free digital products from a number of different parts of NOAA, as well as graphics, images, animations, videos and information about environmental events worldwide. The site is funded by the Department of Commerce. The products are freely available.

An example of a portal is www.oceannet.org: this site links together web sites and products from the key organisations in the UK that are involved in the collection and archiving of marine environmental data. The network partners include private organisations, non-governmental bodies, government agencies and industry associations. The core activities of the network are to develop, maintain and make available inventories of data, to improve data exchange mechanisms and raise awareness of the marine environment. In contrast to the NOAA site, the portal does not provide direct or free access to data, but rather provides inventories to data held by the partners. This reflects a key difference in the policy and attitudes to data in North America and Europe. Simply because a portal allows the user to see what information exists, it does not necessarily enable the user to gain access to it.

Security & Privacy

By its very nature, the Internet is vulnerable to attack. Those who provide access to information via a Web site need to ensure that they have security systems to prevent attacks from viruses, smurfs and other devices that hackers use to cripple Internet and networked systems. Security systems, including firewalls, encryption and digital certificates have been developed for organisations that handle sensitive information, and these are now widely available to anyone wishing to protect information on a computer system connected to the Internet. However, security systems are only as good as the people who use them and the physical protection provided for the computers themselves.

Two controversial technologies - cookies and Web tracking - have also raised concerns about invasion of privacy. Cookies are bits of data put on a hard disk when a user visits certain Web sites. The data can be used for many purposes; one common one is to make it easier for people to use Web sites that require a username and password by storing the information and then automatically sending the information whenever it is required. Cookies and Web tracking can also help customise the Web to user's interests. One technology that has emerged in response to users concerns is a passport, which enables people to decide what kind of information may be tracked by Web sites.

Conclusion

The Internet has enabled millions of people around the world to gain ready access to information that they would otherwise find difficult or time-consuming to locate. As with any technology there are pros and cons as to the exact application that best suits a particular task; the Internet, with its ability to provide users with access to multimedia and communications can sometimes overwhelm a rather simple exercise in information gathering. Portals, which are designed to provide signposting to related Web sites and meta-databases of information stored at those sites, will therefore become important.

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Advances in spatial data storage, retrieval and analysis with emphasis to developing countries needs for management fisheries and aquaculture [a]

by

Massimo Dragan[b], Enrico Feoli[b] and Michele Fernetti[b]

Abstract

The integration of databases, remote sensing, geographic information systems (GIS) and telecommunication is necessary to develop spatial decision support systems (SDSS) for the sustainable use of natural biological resources. Sustainability implies that the use and conservation of biodiversity should not be two conflicting activities but complementary objectives to be at the heart of management practice.

Spatial applications in fisheries and aquaculture are not yet widespread. Some concepts and models of data, information and knowledge integration are discussed as the basis of new technologies that could become more widely used in the sector. They are getting within the reach with what can be implemented also in Developing Countries. They offer opportunities to support conservation and the transition to sustainability but also represent dangers of unilaterally serve short-term cost-efficiency leading to further resource destruction. Developing countries could benefit from scientific and other cooperation with Europe for capacity building and management for sustainability.

a) Extended version of introductory remarks presented by the second author at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000;

b) Department of Biology, University of Trieste, Via L. Giorgieri, 10, 34127 Trieste, Italy. E-mail: dragan@univ.trieste.it; feoli@univ.trieste.it; fernetti@univ.trieste.it

Introduction

The topic of this meeting "Information Systems for Policy and Technical Support in Fisheries and Aquaculture" belongs to the broad "chapter" of our scientific life that is dedicated to Biodiversity. Why? Simply because both fisheries and aquaculture are utilising species of natural and/or artificial ecosystems. In this paper, we refer to the definition of biological diversity used by the Convention on Biological Diversity (CBD):

"*'Biological diversity' means the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems*."

The CBD entered into force on 29 December 1993 after having been initiated at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. The CBD has the merit to have promoted a co -ordination and an integration among many scientific initiatives and programmes that were already dealing with many aspects of Biodiversity, including its economic value (Pearce & Moran, 1994). In particular, a great interest by the scientific world was given to creating many Biodiversity Data Bas es (BDBs) useful to improve the "Global Biodiversity Assessment" (Heywood & Watson, 1995) and to offer tools for the sustainable use of Biodiversity. It is this second aspect that the CBD is promoting and that is the focus of this workshop. In fact, the broad scope of CBD is illustrated in its Article 1, Objectives, which states:

"*The objectives of this Convention, to be pursued in accordance with its relevant provisions, are the conservation of biodiversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources…* "

The "use of the components of biodiversity" is a modern ex pression to define the exploitation of living organisms as sources of food, beverages, chemicals, medicine, fuel, wood, fodder, fibres, soil protection, arts, tourism, etc. The use of living organisms and the actions for their conservation (conservation of biodiversity) are strictly related to human cultures (Gomez Pompa & Jimenez - Osornio, 1989). In one perspective, agriculture, animal breeding, forestry and aquaculture might be considered as concrete actions to reduce the risk of loosing biological resourc es, and therefore to preserve biodiversity. However, in fact, human population growth had the effect of reducing and fragmenting the natural ecosystems and this, with pollution, led to evident ecosystem degradation and loss of the biodiversity from local t o global scale. Concerning fisheries Pauly *et al*. (1998, 2000a, 2000b) have shown that industrial fishing over the past half -century has noticeably depleted the topmost links in aquatic food webs. Thus today, not only are some ecosystem functionalities being lost, but entire aquatic species are threatened, even many of the cultured species in rural and coastal areas of developed and developing countries. The question arises: "How can we integrate conservation and development programmes?" Since biodiversity is a property of ecosystems (which are functional and spatial entities), it is obvious that biodiversity management is also a spatial problem. As such, the scientific community and decision makers need proper methodology and technology capable to deal with spatial data. In particular, the development of fisheries and aquaculture and the protection of the aquatic organisms concerned by these activities constitute a spatial problem of the coastal areas.

This paper presents a brief review of applications of me thods for establishing a computer based spatial decision support systems (SDSS) for managing biodiversity resources with relatively low costs. We want to stress that hardware and software have now come within reach also of

Developing Countries. Creating a network of expertise assisting the new players in the "decision making world" appears as a particularly cost-effective and functional approach to bridging existing gaps. It should be clear that the ultimate objective of a SDSS in biodiversity management is to improve planning and decision making processes by providing useful and scientifically sound information to the actors involved (scientists, public officials, planners, investors and the general public).

From Decision Support Systems to Spatial Decision Support Systems

According to Fedra and Feoli (1998) decision support is a very broad concept, and involves both rather descriptive information systems as well as more formal, normative, optimisation approaches. Any decision problem can be understood as revolving around a choice between alternatives.

Definitions of decision support systems (DSS) are many, they range from: "interactive computer based systems that decision makers utilise to solve unstructured problems" (Gorry & Morton, 1971) to "any system that makes some contribution to decision making" (Sprague & Watson, 1986). However, our approach is most influenced by the definition of Malczewski (1999) as "an interactive, computer-based system designed to support users in achieving a higher effectiveness of decision making while solving a semi-structured decision problem". The concept of semi-structured problem fits very well with the problem of conservation of biodiversity and sustainable use of its components, where an interaction between decision makers, scientists, users, etc. and the computer-based system is required. The interaction is necessary because the decisions cannot be completely structured for programming and automatic solving by the computer. A step-by-step-approach by successive approximations is necessary. Continuous validation and sensitivity analysis have to be activated among the actors and can be achieved by mathematical and logical methods.

A decision support system is a Spatial Decision Support System when the spatial data are essential in the problem solving. Both fisheries and aquaculture occupy space e.g. in coastal areas and are conflicting with other activities or even between each other.

Biodiversity management requires the integration of often very large volumes of disparate information from numerous sources. The coupling of large masses of information with efficient tools for assessment and evaluation requires broad interactive participation in the planning, assessment, and decision making process, and effective methods of communicating results and findings to a broad audience, which can be helped by a good user interface.

The components of SDSS

A Spatial Decision Support System (SDSS) typically includes the following components: databases, GIS, data analysis and image processing, modelling and expert systems and user interfaces. They are discussed mainly following Fedra and Feoli (1998).

- *Databases*

When a SDSS is constructed the accessibility to the data, information and knowledge concerning taxonomy, biology, ecology, bio-geography and genetics of the interested living organisms is essential. In this context, the FAO initiative Aquatic Animal Diversity Information and Communication System (AADIS) in response to the global need for improving availability of information on the diversity of aquatic animals, especially at the genetic level (Pullin, this vol.), is an important information source towards the development of Spatial Decision Support Systems. Olivieri *et al*. (1995) offered a global review of the most important Biological Databases (BDBs) and associated projects by stressing also the importance to integrate the databases with information systems (including GIS) and communication technologies. In this workshop, specific species-based databases of aquatic organisms are presented and/or proposed. The Internet offers opportunities to connect previously separate species information sources (e.g. www.fishbase.org, Froese & Pauly 2000), bibliographic data bases (e.g. SILVERPLATTER), or databases of biological collections (Berendsohn *et al*., 1999). Meta-databases (Busby, 2001; WCMC, 1998) are increasingly important as roadmaps to find the necessary information (McGlade, this vol.).

- *Geographic Information Systems (GIS)*

a) A definition of GIS

We define GIS according to Chrisman (1996) as "*the organized activity by which people:*

- *measure aspects of geographic phenomena and processes;*
- *represent these measurements, usually in the form of a computer data base, to emphasize spatial themes, entities, and relationships;*
- *operate upon these representations to produce more measurements and to discover new relationships by integrating disparate sources; and*
- *transform these representations to conform to other frameworks of entities and relationships*."

b) The object oriented approach

Following the trend of software architecture, mostly driven by the advent of the Internet, GIS technology has also gone through a restructuring phase moving towards an object oriented approach. Access to distributed databases through the network is a typical example in this respect.

GIS applications are no longer an out-of-the-box package customisable with a proprietary language. The design and implementation take place in a programming environment such as Visual Basic, Delphi, C++, PowerBuilder, etc. We therefore deal with programmable GIS components that show properties and methods and are triggered by events. This scenario allows addressing more complex spatial questions especially when (static) geographic data layers are combined with dynamic and remotely sensed information. GIS experts today will no longer customise a fully featured GIS application, but assemble those software components that are needed to accomplish the selected list of spatial tasks inferred from the list of the final user's requirements.

The map-object oriented approach (Malczewski, 1999) can be considered as an alternative or an extension of the layered data base approach common in most of the GIS software available today. Higher efficiency, cost-effectiveness, speed and reliability can be achieved by creating applications from scratch featuring only the needed GIS functionality.

Serving the user perspective, self-explanatory user interfaces can be designed and implemented, while from the developer perspective GIS objects can be easily integrated with other local or distributed objects expanding the capabilities of the SDSS system.

Object oriented applications address the need for dynamic data management and can facilitate some functions that are required in fishery management such as ship and fish stock positioning, real time mapping and mobile GIS solutions. For doing this, the map-object oriented GIS must be able to interact with telecommunications services. The map-object oriented GIS can:

- link-up with a variety of local or distributed objects enabling spatial applications;

- integrate the appropriate level of GIS capabilities focusing on the required services;
- provide the necessary level of customisation for non-specialist users ensuring user-friendliness;
- speed up the development and the deployment phases and improve application performance, focusing mainly on large and detailed data sets.

Adequate infrastructure and advanced telematic services are the framework in which such approaches maximise their impact.

c) Applying object oriented GIS to fishery

Industrial Fisheries or even small-scale fisheries in industrialised countries are typically supported by such technologies as sonar, radar, Global Positioning Systems (GPS), radio and satellite telecommunications, to mention the most relevant. Commonly, the integration of the information provided by these technologies is based on the human experience, hence most of the decisions are taken upon subjective reasoning and personal knowledge.

GIS applications in fisheries are in their very early days. The technology is primarily motivated by cost-saving and efficiency concerns, particularly, when boat-owners are not also skippers. They might, however, also enable more ecologically sustainable strategies, if suitable valuation techniques were integrated.

A more integrated technology scenario based on object components may act in the future as an interface between the different hardware components. Gathering and processing data and GIS objects play key roles in this framework addressing spatial operations. The human-machine interaction is made through the user interface that not only displays data but allows the user to query the system and retrieve the required information.

The interface must take into account that also a skipper with low computer-skills should be able to take computer-assisted decisions in support of his daily activities and choices. Different scenarios can be portrayed where the integration of this technology can be clearly helpful.

Let us assume a skipper has identified an area of abundance for a certain species and quality of fish and receives information regarding demand at fish markets in different ports. The integrated system can combine the vessel position and the fishing route in relation to port locations, considering also other weighing factors like fish demand and quotations, thus supporting the skipper's choice of the most convenient market. Conversely, if he is informed that the spotted flock is in poor demand, he may chose moving to an area of a variety in higher demand.

In case of entire fleets using such approaches, the potential economic and environmental benefits of a sort of "fishing on demand" approach could be large, because they

- reduce fuel consumption;
- avoid economic waste;
- differentiate fish capture according to the season and population dynamics of the target species improving sustainability, if ecological concerns are reconciled with the time scales of economic imperatives (cash flow and longer-term considerations).

Such a scenario needs different tools and layers of information for its development:

- accurate flock positioning systems;
- constantly updated geographical information databases;
- predictive models of seasonal population dynamics capable of producing potential distribution maps for different species;

- relational databases to store environmental data (physical and chemical parameters, meteorological data, biodiversity maps, etc.) and socio -economical data (seasonal fish request fluctuations, e-commerce services, etc.);
- data retrieval and processing tools to produce up -to-date isopleths maps (water temperature, salinity, winds, streams, concentration of nutrients, plankton, pollutants, etc.) according to a monitoring network of mobile and fixed measurement instruments;
- decision-support-based tools to assist the different users.

The services offered by the information system could be made available ultimately through the Internet based on self-explanatory and easy-to-use interfaces and up-to-date information on cut down software installation. These would require minimal hardware and make use of the state -of-the-art client-server architectures for distributed solutions.

d) GIS approaches: what is available on the market?

As regards object oriented GIS approaches, it must be noted that any software component is based on a Component Model. The two dominant models are CORBA (Common Object Request Broker Architecture) and Microsoft's OLE/COM (Object Linking and Embedding/Component Object Model). CORBA model is suitable for cross -platform distributed applications and is widespread in UNIX environments. OLE/COM applications are restricted to the MS Windows environment but this component model is nevertheless beco ming the *de facto* standard.

Multiple GIS software component products are already available on Microsoft's OLE/COM component model, namely:
- MapObjects by ESRI;
- GeoView by BlueMarble Geographics;
- ArcObjects by ESRI;
- GeoMedia by Intergraph;
- MapX by Mapinfo.

Every automation object, through its properties and methods, provides the means for displaying and analysing the geographic information in an application. An application can be developed in a wide range of programming environments nowadays supporting the O LE/COM model. Public domain software is also available on Internet e.g. GRASS (U.S. Army Corps of Engineers, 1993), which uses the UNIX or LINUX systems. In this case the development of the SDSS requires very high level of computer programming.

- *Data analysis and image processing*

GIS will produce maps. Most important is the possibility to obtain data from the maps and remote sensing images in order to study spatial relationships between different features and variables. This allows applying specialised pac kages for data analysis (sampling, descriptive statistics, multivariate analysis, time series analysis, spatial pattern analysis, etc.) in integrated way with GIS software (eg. Feoli, 1995). Examples of early applications of multivariate data analysis to s earch for species clusters was developed in Mediterranean Sea by Bussani et al. (1979) and Brusle et al. (1979). Recent examples of multivariate data analysis of relationships between fish species and habitats and interspecific trophic relationships can be found in Giovanardi (2000), West and Walford (2000) and Faria and Almada (2001). Today, the application of multivariate data analysis is used for new cartographic representations by GIS (e.g. Feoli & Zuccarello, 1996; Kitsiou & Karydis, 2000). Remote sensing images can be processed by many data analysis packages (image processing) to get classification of landscapes and spatial distribution of dynamic features of the sea in terms of temperature, chlorophyll, surface slicks and suspended sediments. Results may be integrated in the GIS (e.g. Chauvaud *et al*., 1998; Phinn *et al*., 2000; Johannessen *et al*. 2000; Durand *et al*., 2000). Remote Sensing can be also used for mapping important physical structures in coastal waters (e.g. Carillo *et al*., 2001) and in studying relationships between physical parameters and fish recruitment (e.g. Demarcq & Faure, 2000). Properties of landscape of coastal areas potentially useful to plan fisheries and aquaculture may be obtained by spatial pattern analysis through the many different indices of landscape structure, such as autocorrelation, similarity, distance, shape, fragmentation, fractal, diversity, etc. (Klopatek & Gardner, 1999; Farina, 2000).

- Modelling, optimisation and expert systems

According to Malczewski (1999), there are two main thrusts in mathematical modelling within GIS environments: optimisation and simulation.

Optimisation is defined as a normative approach to identify the best solution for a given decision problem. The solutions require to minimise or maximise one or more quantities. Malczewski (1999) indicates many software tools that are used in GIS for optimisation problems. Janssen (1992) and Munda (1995) provide a comprehensive review of multi-criteria decision support for environmental management. In biodiversity management, to meet a specific objective such as identifying suitable areas for aquaculture, a suitable area for a port or conservation areas (parks, reserves, etc.), usually several criteria will need to be evaluated and pondered against each other. Making decisions about the allocation of land or sea areas is one of the most fundamental activities of resource development (FAO, 1976). Such procedures are called Multi-Criteria Evaluations (MCE) (Eastman *et al*., 1995, Malczewski 1999). Decisions about the allocation of land (for aquaculture, harbours, etc.) typically involve the evaluation of multiple criteria according to several, often conflicting, objectives. Although a variety of techniques exist for weighing, one of the most promising would appear to be that of PAIRWISE comparisons developed by Saaty (1977, 1999) in the context of a decision making process known as the Analytical Hierarchy Process (AHP).

In case of *complementary objectives*, multi-objective decisions can often be solved through a hierarchical extension of the multi-criteria evaluation process. For example, we might assign a weight to each of the objectives and use these along with the suitability maps developed for each to combine them into a single suitability map indicating the degree to which areas meet all of the objectives considered.

However, with *conflicting objectives* commonly encountered when we are dealing with exploitation of natural resources and their conservation – e.g. conservation of mangrove forests or their conversion into shrimp ponds - the procedure is more complicated. It is then necessary to rank the objectives and reach a prioritised solution (Rosenthal, 1985). In these cases, the needs of higher ranked objectives are satisfied before those of lower ranked objectives are dealt with. However, this is often not possible, and the most common solution to conflicting objectives is the development of a compromise solution. The most commonly employed techniques for solving conflicting objectives are those involving optimisation of a choice function such as mathematical programming (Fiering, 1986) or goal programming (Ignizio, 1985).

There are many applications of modelling in fisheries management that can help in decision making and managing the natural resources. An example of traditional modelling is offered by Munyandorero (2001) who introduces in the fish stock predictions the influence of the spawning stock biomass. A more articulated and structured model that can be included in SDSS for fisheries management are Ecopath with Ecosim (EwE) and Ecospace (Pauly *et al*., 2000a). They are offering a set of tools for evaluating ecosystem impact of fisheries based on modelling the mass balance fluxes in aquatic food-webs both in homogeneous and heterogeneous space conditions. Ecospace represents the spatial component necessary for SDSS in fisheries and is expected to be promising for simulating conservation alternatives.

Steyaert and Goodchild (1994) offer an overview of examples and methods of integrating GIS and simulation modelling. Berry *et al*. (1996) show how to link dynamic, stochastic simulation with the software of public domain GRASS.

While simulation is a powerful tool of analysis and forecasting, expert systems are often used to help configure models (implementing an experienced modeller's know-how to support the less experienced user) and estimate parameters in logical terms. Numerical models can be integrated into the inference chain of an expert system (Fedra 1994a, 1994b). According to Fedra and Feoli (1998) "*the flexibility to use, alternatively or conjunctively, both symbolic and numerical methods in one and the same application, allows the system to be responsive to the information at hand, and the user's requirements and constraints. This combination and possible substitution of methods of analysis, and the integration of data bases, geographical information systems, and hypertext, allows to efficiently exploit whatever information, data and expertise is available in a given problem situation*".

- *The user interface*

An efficient user interface is an essential characteristic of all SDSS. We are conscious that decision makers have no time to wait for results that require interpretation and lengthy presentations. Maps showing the different scenarios should therefore be easily available. An example of a suitable interface for SDSS that could be adapted to industrial fisheries management is SIAMS – Ship Information And Management System (an EC-funded project) - developed by Dragan and Fernetti (2001).

A MapObjects application can be implemented to provide, at any given moment, information regarding position and conditions of the ships and spatial links to other services. Multimedia information kiosks at port location and on board, as well as a MapObjects Internet Map Server serving any Internet client, assist users in getting real-time ship schedules, retrieving general information on trip destinations, finding connections to other means of transportation and accessing on-line market information.

Conclusion

The aquatic renewable resources of developing countries are being depleted by the continuous demand from local and international markets. Inventories of natural resources, including their spatial dimensions, are a first step towards conservation and sustainable management. Building up a knowledge base and sharing it widely such that decisions support sustainable development.

What we call GIS technology, i.e. all the tools that can be used for constructing Spatial Decision Support Systems, are now available at relatively low cost. In SDSS development, interaction is a central "feature" as in any effective person-machine system: a real-time dialogue, including explanation, allows the user to define and explore a problem incrementally in response to immediate answers from the system. Powerful systems with modern processor technology allow to simulate dynamic processes with animated output and can provide a high degree of responsiveness that is essential to maintain a successful dialogue and direct control over the software. This is needed when the dialogue between scientists, economic and political decision makers and citizens has to be based both on facts and on possible scenarios that can be designed as alternatives likely to result from different decisions. It is important to fully understand the opportunities, but also the danger of using such technology for cost-efficient exploitation of natural resources with a very narrow time horizon without keeping factoring in the same effort, technological and institutional for conservation. This is a crucial not only in Developing Countries.

The new technologies mentioned are all tools for management with a potential to support conservation, rehabilitation and sustainable use. They can be implemented on cheap hardware and used with cheap or even public domain software. Developing countries can benefit from scientific partnerships with European teams, who should help with investment into capacity building and joint work on the new and emerging scientific concepts and analytical tools. Asking critical questions and looking for answers forms the basis for driving the development and the applications of SDSS. Education, training and scientific research into the ecological issues of aquatic biodiversity must contribute to the knowledge essential for the transition to sustainable development.

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The FishBase Information System: Key Features and Approaches [a]

by

Rainer Froese[b]

Extended Summary

FishBase is a large information system with key information on all 25,000 fishes of the world. It is available on CD-ROM and on the Internet at www.fishbase.org. Topics covered include taxonomy, population dynamics, trophic ecology, reproduction, genetics, and human uses. The Internet version of FishBase strives to give access to this information with a minimum of 'clicks', e.g. www.fishbase.org opens directly the 'Search FishBase' page. After entering a product name such as 'Bismarckhering', it takes just two clicks to arrive at the page for the herring *Clupea harengus*, with pictures and summary information on distribution, diagnosis, biology, etc. The 'More information' section of that page provides access to over 30 attached tables with key data on specialist topics such as allele frequencies, diet composition, or growth parameters. The 'Internet sources' section offers species-level links directly into other Internet databases such as GenBank for sequence data, FIGIS for FAO catch data, Zoological Record for references, and InFind for an intelligent search of the Internet. One can also access 'self-registered' sites that have attached themselves to the current FishBase page, and one can view uploaded observations of 'Fish Watchers'. More involvement of the interested public in monitoring, e.g., occurrence and abundance of species is seen as a necessity for biodiversity studies, and the FishWatcher tool is offering a publicly accessible database to store, view and analyse such observations.

New features drawing on FishBase data are various interactive graphs and maps, a biodiversity quiz, a monthly 'Best photos' page, trophic pyramids for various ecosystems, and a Key Facts page that presents best estimates with error margins for important life history parameters of a given species. The 'Fish Forum' provides a much-frequented question and answer platform and a 'Fish Chat' room allows users to schedule Internet meetings on topics of interest.

FishBase is maintained by a core team of about 10 people specialised in areas such as genetics or population dynamics. The team is supported by over 500 contributors from all over the world who have provided data or photos, or helped verify the content of the database. Since 2001, selected experts can directly add and edit data through the Internet. The FishBase Web site receives over a million 'hits' per month from a wide variety of users, including teachers, students, fisheries managers, taxonomists, librarians, aquarists, anglers, divers, translators, illustrators, consultants, as well as other Internet databases (see Fig. 1). About a quarter of users are from developing countries.

a) Based on the presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5 -7 June 2000;

b) FishBase Teamleader, current address: Institut für Meereskunde, Düsternbrooker Weg 20, 24105 Kiel, Germany. E-mail: rfroese@ifm.uni-kiel.de

European users account for about 31%, North American users for 44%. Over 150 scientific publications - including articles in the journals *Nature* and *Science* - have so far cited FishBase, and the over 700 entries in the Guest Book document a variety of other and sometimes quite unexpected uses of the information (see Fig. 2). FishBase received a number of positive reviews in leading scientific journals, including again *Nature* and *Science*. The Institute for Scientific Information has included it in its 'ISI Current Web Content' service.

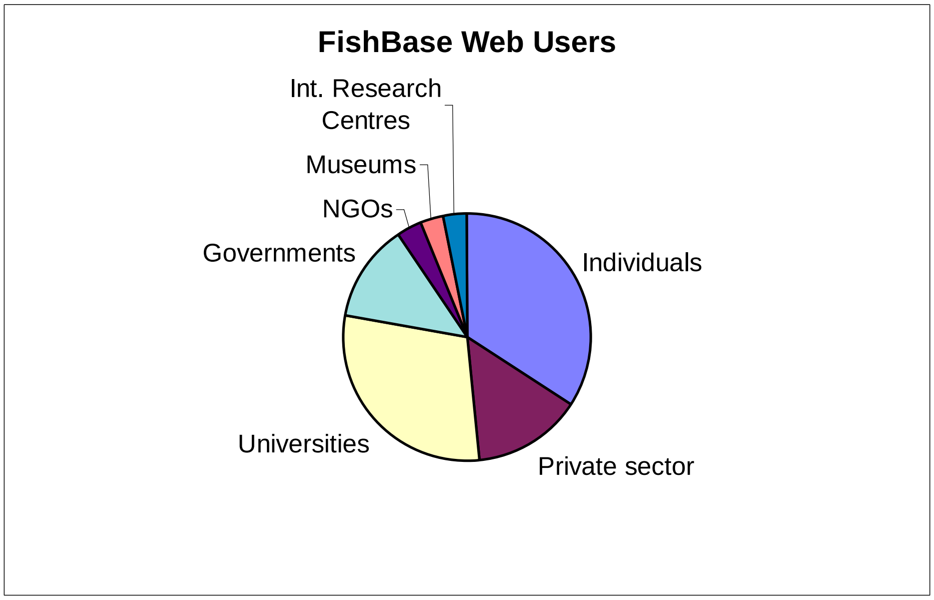

Fig. 1 FishBase web users as of 2000

Approaches and attitudes that have proven successful in the development of FishBase can be summarised as follows:

?? Have a 'science first' attitude; strictly follow scientific standards in the presentation of information and in quality standards;

?? Have a 'Yes' attitude towards people who approach you;

?? Invite, accept, and act on c riticism, even if it appears unjustified;

?? Data quantity and quality is more important than a fancy interface;

?? If you want it to be used, do it on the Internet;

?? Keep the design of the system simple; avoid coding as much as possible as software and program mers change every few years;

?? Make it run in a basic browser such as Netscape Navigator 4; use Html and JavaScipt on the user's computer rather than C++ on the server; don't use frames;

?? Follow existing standards wherever possible;

?? Have intermediate produc ts that are already useful;

?? Invest in people; have well -trained, long-term staff rather than a string of student assistants;

?? Give as much credit as possible to contributors, always more than may have been expected;

?? Make the actual use of the information the criterion for judging the success of the information system and its parts; what is not used is useless.

This bullet list may appear rather simplistic and obvious, however, it is surprising how often one encounters exactly opposite attitudes or approaches with other information system.

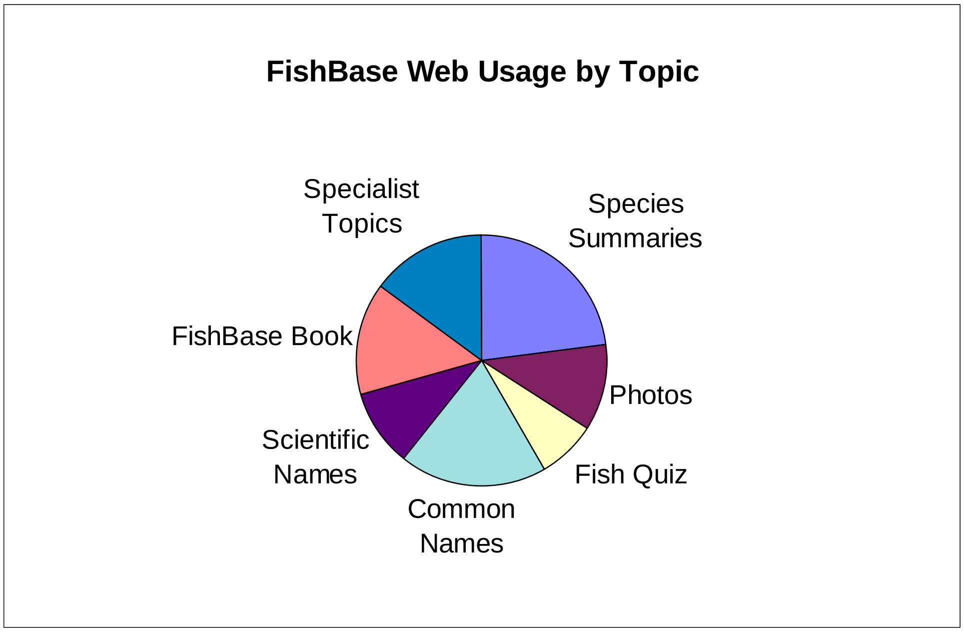

Fig. 2 FishBase web use by topic as of 2000

Recently, new 'quality links' from FishBase to several large online databases have been added. See the section 'Internet sources' at the bottom of the Species Summary page, e.g., for herring www.fishbase.org/Summary/SpeciesSummary.cfm?ID=24 . Similarly, if Food items or Predators are identified to the species level, these are automatically linked to Species 2 000, which provides onward links into the respective specialist databases. Similar integration of NISC/FishLit and IUCN Red List are in preparation. FishBase thus provides a quality gateway to other relevant information systems.

FishBase has been developed over the past 10 years at ICLARM, with major support from the European Community. Since November 2000 FishBase is guided by a Consortium of mainly European institutions that have committed themselves to long-term support of the system. FishBase is updated monthly on the Internet. It is also available on 4 CD-ROMs together with the book "FishBase 2000: Concepts, Design and Data sources".

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Cephalopods: What makes them an ideal group for an Internet database[a]

by

Uwe Piatkowski[b] & James B. Wood[c]

Abstract

Living cephalopods include cuttlefishes, squids, octopuses and the chambered nautilus. There are 703 species described today, but the status of their systematics worldwide is decades behind that of other major marine taxa. They are quite distinct from fish not only in their morphology but also in their life history. Cephalopods have short life spans, fast growth rates (exponential when young), and they tend towards semelparity Cephalopod research is of interest and importance firstly because of the intrinsic value in understanding the complex biol ogy and peculiar life cycles of these animals. While world-wide traditional fish stocks are decreasing the total world landings of all cephalopods have nearly doubled over the last decade (to 3.3 million tonnes in 1997). Cephalopods have gained an excellent market price and have become subject of global trade including developing countries. With an average value of US$ 2,100 per metric tonne, they gained a total market value of more than US$ 5.3 billion in 1989, which ranked them third after shrimp and tuna. Despite the increasing fishing pressure on cephalopods, basic knowledge of their biology and of management strategies of fished stocks lags behind that of most fish species. Hence, a widely accessible Internet database would certainly become a valuable t ool to collect and provide comprehensive information to better understand and document major aspects of cephalopod biology and fishery.

a) Presented by the first author at the INCO -DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000;

b) Institut für Meereskunde, Universität Kiel, Düsternbrooker Weg 20, D -24105 Kiel, Germany. E-mail: upiatkowski@ifm.uni-kiel.de

c) National Resource Center for Cephalopods, Uni versity of Texas Medical Branch, Galveston, TX 77555 - 1163, USA. E-mail: ceph@is.dal.ca

Relatively few species, but unsolved systematics

Living cephalopods include cuttlefishes, squids, octopuses, the chambered nautilus, and a unique species found only in the deep sea called the vampire squid (*Vampyroteuthis infernalis*). They are by far the most advanced group within the phylum of mollusks, which also includes snails, slugs, clams, scallops, oysters and mussels. All cephalopods are entirely marine and distributed throughout the seas of the world. There are more than 700 species described today (Sweeney & Roper, 1998), and that number increases every year as scientists discover new species, particularly in tropical and polar seas. However, the status of cephalopod systematics worldwide is decades behind that of other major marine taxa. The group is very attractive to taxonomists, but difficulties in obtaining adequate funding and material have resulted in a low level of understanding (Roeleveld, 1998). There are very few fossils of them since modern cephalopods do not have hard external shells like other mollusks. Consequently, the lack of a fossil record of coleiod cephalopods makes systematics much harder. In comparison with other marine groups, such as crustaceans, fishes or sea mammals, sound ecological studies on cephalopod ecology are sparse. This is not in concordance with the important position that cephalopods have in major marine ecosystems (Clarke, 1996). Two obvious shortcomings are responsible for this: (1) cephalopods are difficult to catch and mostly taken as by-catch in surveys targeting other taxa; (2) they have complicated life cycles and distribution patterns which are only roughly understood for a few species.

Physiology studies dominate ecological research

Cephalopod research is of interest and importance firstly because of the intrinsic value in understanding the complex biology and peculiar life cycles of these animals. Cephalopods are famous for outstanding physiological performance, which makes them the most highly evolved marine invertebrates. This is documented in their elaborate sense organs, large brains, active lifestyle and complex behaviour (Hanlon & Messenger, 1996). Modern research encompasses detailed studies on genetics, symbiotic bacteria and biomedical research that makes them very attractive for a variety of research fields and new biochemical technologies. The wealth of information on cephalopod physiology is in great contrast to our poor knowledge of their ecology. Nevertheless, physiological studies are important prerequisites to understanding their ecology in the field.

Cephalopod age and growth – still a mystery?

There is general agreement in cephalopod research about their exceptionally high metabolism, but still much speculation about their growth pattern and age. It is well accepted that the giant octopuses can live up to five years, and nautilus can attain ten years. But most squid and many octopuses are short-lived annual species, thus being the marine equivalent of weeds without a "robust age structure" (O'Dor, 1998). Ageing of cephalopods has always been a severe obstacle in modeling growth patterns. Reading of periodic increments within the squid statolith microstructure has developed into a routine technique to obtain individual age estimates which form the basis for most growth models that are essential in studying cephalopod population dynamics (Pauly, 1985). Validation and culture studies, although another main problem for most short-lived species, have shown that statolith increments (similar to increments in larval fish otoliths) are produced daily in a number of squid species. Statolith age analysis has revealed that temperate squids can complete their life cycle in less than two years while tropical species live for less than eight months; both following linear or exponential growth models (see review of Jackson, 1994). In contrast, growth curves generated from analysis of length frequency data suggested an asymptotic growth curve and ages in excess of three years for some tropical squid. Such analyses, therefore, appear to be inappropriate (Jackson & Choat, 1992), and point out the complete failure of state -of-the-art fish modeling software to produce realistic life spans of cephalopods. Cephalopod growth remains a biological mystery and is still a matter of some debate (e.g., Jackson & Choat, 1994; Pauly, 1998). It is curious though, that we know nothing about age and growth of the giant squid, the largest invertebrate in the world, which can attain total lengths exceeding 20 metres. Furthermore, no reliable method to age octopuses has yet been developed.

Trophic relationships

The overall role of cephalopods in the marine environment, their significance as food resources for higher trophic levels such as mammals and birds and their impact as predatory consumers of fish and other invertebrates, is only beginning to be studied (Clarke, 1996). It is a great challenge to intensify field and laboratory studies on trophic interrelationships where cephalopods are involved, because they will elucidate cephalopod ecology and form the basis for further ecosystem modeling.

Cephalopod fisheries and markets

Worldwide traditional fish stocks are decreasing due to over fishing and/or environmental changes. In response to this cephalopods have gained an immense importance in substituting the traditional marine harvest and will gain a much larger importance in the future to supply mankind with marine living resources (Caddy, 1994; Caddy & Rodhouse, 1998).

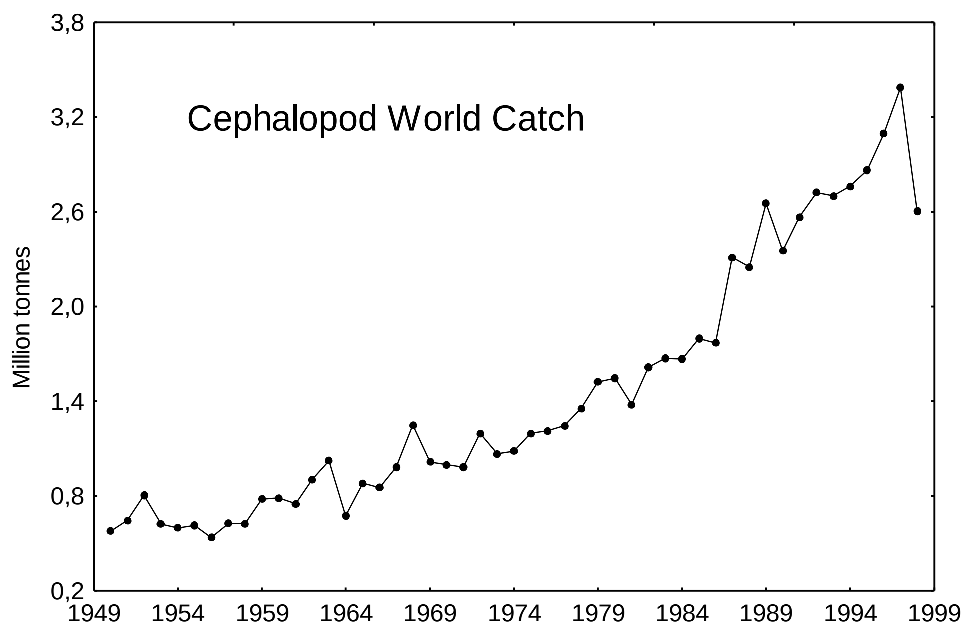

Fig. 1. Cephalopod world catch (from FAO, 2000).

As well as comprising commercially important fishery resources, selected species also show some potential for aquaculture (Nabhitabhata, 1995). Many cephalopods are very efficient in converting food to biomass, particularly protein (O'Dor & Wells, 1987) Hence, the rapid growth rate and high food conversion rates of cephalopods are both advantageous traits for aquaculture. Cephalopod landings have steadily increased worldwide since the 1950s, peaking in 1997 at more than 3.3 miollion tonnes (FAO 2000; Fig. 1). Although increased cephalopod landings may partly reflect increased market demand, particularly in the Far East nations, over fishing finfish stocks has positively affected cephalopod populations. Da ta from fifteen key FAO areas reveal that, with the exception of the north-east Atlantic, cephalopod landings have increased significantly over last 25 years while groundfish have risen more slowly, remained stable, or declined (Caddy & Rodhouse, 1998).

Table 1. Estimated total value of marine catches in 1989 (after FAO, 1993).

Species group	**Marine catch [million tonnes]**	**Average unit value [US$ per tonne]**	**Total value [billion US$]**
Shrimp	1.841	4000	7.370
Tuna	3.985	1700	6.775
Cephalopods	***2.545***	***2100***	***5.344***
Flatfish	1.193	2900	3.459
Salmon and salmonids	0.936	3500	3.278
Lobster	0.202	11270	2.275
Alaska pollack	6.259	331	2.072
Atlantic cod	1.783	1068	1.904
Herring, sardine	8.630	200	1.726
Blue whiting	0.663	66	0.044

Cephalopods have an excellent ma rket price and are the subject of global trade. This can easily be seen in a recent FAO study which compares total catch or production, respectively, average unit value and total value of major aquatic species groups (FAO, 1993; Table 1). With an average u nit value of 2100 US$ per metric tonne, cephalopods gained a total market value of more than 5.3 billion US$ in 1989, which ranked them third after shrimp and tuna demonstrating their important economic value.

Their increased economic importance may reflec t a change in their ecological importance, e.g. species replacement has been suggested as an underlying factor in changing fishery patterns in the Saharan Bank fishery (Balguerías, 2000). There is a need for development of models and forecast fishery trends in cephalopods. Ideally such models should be able to integrate environmental, biological, fishery and economic information. The accumulation of such information clearly warrants a database on cephalopods. It would form a necessary prerequisite not only for providing and intensifying biological and ecological information on as many cephalopod species as possible, but also for modeling and forecasting fluctuations of cephalopod stocks.

Management strategies for cephalopod fisheries present similar challen ges to those encountered in fisheries for finfish. However, despite the increasing fishing pressure on cephalopods, basic knowledge of their biology lags behind that of most fish species. Therefore, it is critical that fisheries workers not base cephalopod policies on what works for fish. A comprehensive database would certainly be a valuable tool to develop management strategies that adapt to cephalopod fisheries.

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Introduction to CephBase www.cephbase.utmb.edu[a]

by

James B. Wood[b], Ronald K. O'Dor[c] & Uwe Piatkowski[d]

Abstract

The combination of relational databases with the Internet allows for the exchange of information on a scale never before experienced. Database driven web sites can rapidly publish large sources of data on a platform accessible across geographic and political boundaries. This rapid and cost effective method of exchanging copious amounts of information will greatly help scientists understand the biocomplexity of natural systems.

CephBase is an example of a taxon-specific web site powered by a relational database. CephBase serves data on all 703 extant cephalopod species. It is part of the "Census of Marine Life" effort that grew out of an U.S. initiative into a wider international undertaking in support of implementing documentation requirements of the Convention on Biological Diversity.

The purpose of CephBase is to collect and provide information on life history, distribution, catch and taxonomic data on all living species of cephalopods (which includes octopuses, squids, cuttlefish and nautilus). Technical information on its current structure and access is discussed below together with an outlook on how cooperation between divergent biological databases could be facilitated.

a) Prepared for the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000;

b) National Resource Center for Cephalopods, University of Texas Medical Branch, Galveston, TX 77555-1163, USA. E-mail: ceph@is.dal.ca

c) Biology Department, Dalhousie University, Halifax, Canada B3H 4J1. E-mail: odor@is.dal.ca

d) Institut für Meereskunde, Universität Kiel, Düsternbrooker Weg 20, D-24105 Kiel, Germany. E-mail: upiatkowski@ifm.uni-kiel.de

Introduction

Cephalopods have short life spans, fast growth rates (exponential when young), and they tend towards semelparity. They are quite distinct from fish, not only in their morphology, but also in their life history. Cephalopod fisheries are a growing percentage of the world's catch. However, as is typical of invertebrates, they are understudied and much of their basic biology is still unknown. Models developed for fish have not reliably been able to estimate cephalopod life cycles (Jackson & Choat, 1992). From a fisheries management perspective, more information in needed on this resource (Piatkowski & Wood, 2000).

CephBase is a dynamic html (dhtml) relational database -driven interactive web site. The prototype version of CephBase was developed at Dalhousie University, Halifax, Canada. This project was initially sponsored by the Sloan Foundation following the Workshop on Non-Fish Nekton in Boston, Massachusetts on December, 1997. The purpose of CephBase is to collect and provide information on life history, distribution, catch and taxonomic data on all extant cephalopods (octopus, squid, cuttlefish and nautilus). This pilot project was designed to help define the goals of the Census of Marine Life and to demonstrate what was possible with emerging Internet technology (Wood *et al*., 2000). The web is an ideal globally accessible platform for collaboration and communication of data and interest in this new tool is growing like wildfire.

CephBase provides reliable referenced data on cephalopods and a platform for collaboration both within the cephalopod community and with all marine sciences. This is accomplished with a dynamically driven web site powered by a relational database. Since CephBase went online in August, 1998, it has been referenced in NetWatch twice (*Science*, 282:587 and 285:2027). CephBase and other Census of Marine Life Projects were featured in an upcoming full-length article in *Science*.

CephBase is similar in concept to FishBase (www.fishbase.org), but instead of distributing data on yearly CDs, it was designed from the outset to operate dynamically from the web. This has several advantages: 1) everyone with an Internet connection has full access, 2) the latest version is always available, 3) CephBase functions on many platforms and operating systems, 4) publication costs are extremely low.

CephBase recently received a grant for the National Oceanographic Partnership Program and is expanding its scope. We are working with the Ocean Biogeographical Information System (OBIS) to explain the diversity, distribution and abundance of marine life (Grassle, 2000). With this support, the main CephBase database will soon be moved to a Client-Server database at the National Resource Center for Cephalopods in Galveston, Texas. We are adding new types of data as well as continuing to populate existing tables.

How does CephBase work?

Under the hood of CephBase you will find a Microsoft Access database. This relational database holds the information in various tables. SQL (Structured Query Language) is used to manipulate these data. An NT server linked with Cold Fusion (an API or Application Programming Interface) serves dynamic web pages to users. This allows our database to be fully accessed by anyone with a computer linked to the Internet. Despite the complexity of CephBase, the web page is designed to be user friendly.

What are the current features of CephBase?

1. <u>Classification of all known cephalopods</u>. We currently have all the taxa, authorities, and the year the taxa was described online for all of the 703 living species of cephalopods listed by Sweeney and Roper (1998). This information is fully searchable by using our search engine. Results are listed in a dynamic table. Simply click on any species in the table and all the taxonomy, from class to subspecies, for that cephalopod is displayed. Furthermore, synonymies, type repositories, type localities, references and common names are listed. References are listed in brief with full references only a click away. This demonstrates what can be done and it isn't hard to imagine life history, ecological and morphological data being accessed in the same manner.

2. <u>Distribution and mapping</u>. We currently have over 3,150 localities for about 320 species in our database. Maps are made on the fly using the Xerox Parc Map Viewer. All latitude and longitude data used to generate maps are from published sources and are listed in tables and referenced. In most cases, the individual specimens used to populate our database can be tracked to a museum repository.

3. <u>Ecological data</u>. These data are needed to fit cephalopods into global models. At present, our database holds 420 predator records and 979 prey records. All are referenced and all have the complete Latin name of the cephalopod involved in the interaction. Papers that just list "squid" are not included in the database.

4. <u>Pictures of selected species</u>. The Internet is a graphical medium. Providing online images of as many species as possible is a very useful resource. Cephalopods change texture, color and shape and these traits are important for taxonomic, ecological and evolutionary studies (Hanlon & Messenger, 1996). At present, links to pictures of 30 selected species are available from The Cephalopod Page maintained by J. Wood. One of our current initiatives is to place thousands of images from the National Resource Center for Cephalopods (NRCC) online.

5. <u>International Directory of Cephalopod Workers</u> is maintained to help foster global collaboration.

CephBase is global in species coverage. We made a concerted effort to include cephalopod data from all over the world, i.e. all 703 extant species are covered. However, there is likely a North American bias in the location, predator and prey data, because the initial CephBase team was based in North America. This is an area that additional partners in other regions could help to improve. Data can be fed to the existing database from anywhere in the world.

What species level information does CephBase provide today?

The following information on cephalopod species is available on CephBase:

1. A classification of the recent Cephalopoda to subspecies level.
2. Type locality.
3. Type repository.
4. Common names.
5. Synonymies.
6. Distribution and real-time plot of latitude/longitude data (from Xerox Parc Map Viewer).

~~?~~ In addition, the following information is available for some species:

1. Links to pictures of approximately 30 selected species.
2. Cephalopod predators.
3. Cephalopod prey.

Future Directions for CephBase

1. Improved on the fly mapping system.
2. Move to client-server architecture for increased security.
3. Addition of life history and fisheries data to the database.
4. Addition of more predator, prey and location data to t he database.
5. Maintain and expand the International Directory of Cephalopod Workers.
6. Establish mirror sites in other countries to improve data sets from outside North America.
7. Create a database of taxonomically and behaviorally important images.
8. Establishment of a references database.

Some ideas on future management of Internet databases

It would be a great catalyst to create and support a generic blank species level database and promote its use for higher taxa not yet covered. This would also encourage othe rs to start new database projects on groups in their area of expertise. An important additional benefit is that new projects that start from the same point and use the same protocols will be a lot easier to integrate and could cooperate with each other in the future. This idea should be a priority and needs to be well funded and supported. However, it would pay high dividends by jumpstarting new database development and facilitating collaboration of similarly set up databases (Wood *et al.*, 2000).

It would also be useful to create a more organised "family" of *.*base and have all members provide links to all other members. It would be desirable if this were done in the same placement on each site so users would have some consistency. Some minimal standards sh ould be met before a database is included. This would be most useful to developers of species level sites if it was created independent of the many sites that want to serve as portals to the sites that gather and publish actual species level data.

A list server for those who are actively involved with biological relational databases should be created. All of us are going though many of the same problems as we develop these projects and some mutual help and teamwork would go a long way to increase efficienc y.

CephBase uses maps generated in real time. While there are occasional problems with the unsupported and free Xerox Parc server we use, this method is certainly the way to go at this time. When a user clicks on a species distribution map he or she can zo om in from a global view to a local area to get details. This option alone would take scores of static maps for each species that would take up a lot of hard drive space. Furthermore, when we add a new record to the database, it is automatically and instantly included in maps requested by users. The alternative is to plot all those points by hand on scores of static maps for each species, then upload them all. Generating maps in real time from your database is the way to map specimen locations and was first done for a marine species database by CephBase. With help from the Ocean Biogeographic Information

System (OBIS) we hope to eventually move away from Xerox Parc to more powerful software where we can overlay environmental conditions (depth, temp, etc) on our distribution maps. The cephalopods are a small group compared to fish. This makes them an ideal test group for new methods.

When setting goals, scientists should keep in mind that the database structure is excellent at handling certain kinds of information and terrible at others. Databases do extremely well with hierarchical information such as classification. Standard fields, such as weight or age at maturity, also work well. Data in odd formats, data fields of widely varying size, datasets with many missing fields, or repeated data can all cause problems and do not work well (Forta, 1998). It is critical for primary investigators to have some idea about what can and cannot be done in order to set realistic goals.

Other database projects use a variety of software and hardware. CephBase is currently using MS Access and even others using the same software will have set up their tables and relationships differently. Meta data standards need to be agreed to and put in place as soon as possible; otherwise, database projects will grow apart instead of together.

Conclusion

Relational databases like CephBase provide a powerful tool for the storage and retrieval of many types of data commonly used in science. Examples of data suitable for databases include taxonomy, ecological relationships between species, catch data, growth data, and much more. HTML and the Internet provide a new media that has many benefits for scientists. Publication costs are extremely low and scientists as individuals or using a peer reviewed processes can directly control the content of the media. Large datasets and color images can easily be published and shared with colleagues. The combination of relational databases with the Internet allows for the exchange of information on a scale never before experienced. Database driven web sites can provide large sources of information that are made rapidly available on a platform accessible across geographic and political boundaries. This rapid and cost effective method for exchanging large amounts of information will greatly help scientists understand the biocomplexity of natural systems. This technology is in its infancy and a little collaboration and coordination between workers now will yield high dividends in the future.

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CLAMBASE: A proposal from MNHN-InSys within the framework of a Global Mollusca Database[a]

by

Philippe Bouchet[b] & Nicolas Bailly[c]

Summary

There are about 80-100,000 valid mollusc species described so far for some 200-400,000 names in the literature. As for other taxa, a good nomenclatural and taxonomic basis is necessary to build a database on any aspect concerning molluscs.

The numerous popular or semi-popular books published each year in various parts of the world might give the impression that molluscan taxonomy is well established. It is actually not the case: in fact, most of the guides focus on the more colourful tropical shallow-water gastropods (cones, cowries, etc.) and, conversely, several of the most specious families (>3,000 spp.) have never been revised nor even fully catalogued for many decades. A major initiative is therefore needed to overcome this situation, at least to establish comprehensive and referenced lists that will allow to link names validated under current knowledge to other types of data, with further necessary revisions later on.

So far, no global catalogue comparable to, e.g., Eschmeyer's *Catalog of Fishes* is available for molluscs. Two of the "minor" classes, Aplacophora and Cephalopoda, each with less than 1,000 species, have electronic catalogues (for CephBase, see Wood *et al*., this vol.). For the vast majority of the molluscs, however, only regional catalogues exist; some of these are accessible on the web (MALACOLOG: Western Atlantic gastropods; CLEMAM: North-Eastern Atlantic molluscs) and a few more have been published on paper (for, e.g., Japan and New Zealand). A major electronic database of the Indo-Pacific marine molluscs (funded by the Sloan Foundation under OBIS) is in progress.

a) Summary of a paper presented by the second author at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

Muséum national d'histoire naturelle (MNHN) - Institut de Systématique (InSys)
b) Laboratoire de Biologie des Invertébrés Marins et Malacologie, 55 rue Buffon, 75231 Paris cédex 05, France. E-mail: bouchet@mnhn.fr

c) Laboratoire d'Ichtyologie générale et appliquée, 43 rue Cuvier, 75231 Paris cédex 05, France. E-mail: bailly@mnhn.fr

More "files" with regional (South Africa, NE Pacific) or taxonomic (family and super-family) coverage exist in electronic or card format, but they are scattered around the world, and are accessible only to the individual specialists that created and maintain them. The perspective of a Global Mollusca Database is thus both realistic and ambitious, with the huge synonymy load creating a special challenge for mollusc species compared to most other marine invertebrates.

With the long-term view of establishing such a Global Mollusca Database, the MNHN-InSys has taken or is willing to take the initiative in collaboration for two projects complementary to those cited above. The first of these is a nomenclator of molluscan supraspecific names, covering the genus-group and family-group names for all recent and fossil molluscs (Cephalopoda excepted). This database, now containing 24,000 entries, is about 75% complete and will ultimately serve as a classificator to global and regional species catalogues. The second project is to establish a world list of bivalve species.

Bivalves represent an economically important resource in terms of aquaculture, pearl culture, fisheries, as well as shell ornaments, at both local and international levels, including many developing countries: scallops (family Pectinidae), giant clams (family Tridacnidae) and the 'kapis' shellcraft (family Anomiidae) contain many representatives of economically used bivalves. Bivalves are also the source of many food-sanitary and poisoning problems caused by toxic algal blooms. In addition, bivalves form one of the major component of soft bottom communities, both in tropical and temperate waters, and are one of the key taxa used by ecologists to describe the composition and functioning of marine benthic ecosystems. With "only" 10,000 species included in the class Bivalvia, the establishment of an authoritative list or catalogue of species is reasonably achievable with collaboration of other interested institutions and colleagues, and with the use and help of existing systems and projects.

For this, we plan to reuse and adapt the FishBase structure and to establish firmly the necessary taxonomic data background. In addition, this strategy would allow to quickly enter data of socio-economic importance during the project. This could address such issues as human use, FAO statistics, protection and conservation status, common names, some regulations, even if the taxonomy of the species involved is still not properly stabilised (e.g. the taxonomy of tropical oysters is still particularly problematic).

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Decapod Crustacea – existing databases and concepts[a]

by

Michael Apel[b] & Michael Türkay

Abstract

The Decapoda are the largest group within the Crustacea and comprise about 10,000 known species world-wide. They inhabit marine, freshwater and even terrestrial biotopes from the polar regions to the tropics, where they reach the highest diversity. Especially in intertidal and shallow water habitats of tropical regions (i.e. mangroves and coral reefs) decapods are important and often dominant macrofaunal elements and contribute considerably to the high biodiversity of these biotopes. Many decapod species are of high commercial value (i.e. shrimps and prawns, lobsters, certain crab species) and an important source of protein and income in many developing countries. Especially prawns of the family Penaeidae, but also other groups are used for aquaculture in different parts of the world.

Information on Decapoda so far is mainly scattered in the scientific literature and thus difficult to obtain for non-scientists. In order to make this information more easily retrievable, several attempts of establishing electronic information systems on decapods have been made. Most of them, however, are either quite limited regarding their systematic and/or geographical range (i.e. the "Crayfish Bibliography", the "Lobsters of the World CD ROM") or far from complete and of low data quality (i.e. the "World Biodiversity Database"). Access to relevant scientific literature is especially difficult in developing countries. On the other side taxonomic and ecological knowledge is urgently needed there to identify and tackle the problems of stock depletion and environmental degradation. We thus feel that integrated information systems in the form of accessible databases (CD ROM and Internet) are urgently needed and would be valuable tools not only for scientific research, but also for environmental and fisheries management and decision making.

The basis of such a system has to be a reliable and high-quality species catalogue, which can then be linked to information from many other fields such as ecology, fisheries, aquaculture and trade. Technically such a system should be based on a relational database system. Since such a system has been developed and is successfully used in FishBase, we would mainly follow the architecture of this database, even though adjustments are necessary in several details in order to meet the specific needs in carcinology. As a prototype of a purely taxonomic database, which could be a starting point for a DecBase project, the "European Decapod Database" has been developed by one of us (M. Türkay) and is presented here.

a) Abstract of a paper presented by the first author at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Senckenberg Research Institute, Senckenberganlage, D-60325 Frankfurt, Germany. Fax +49-69-746 238, e-mail: mapel@sng.uni-frankfurt.de

AlgaeBase – The seaweed database[a]

by

M.D. Guiry[b] and E. Nic Dhonncha[b]

Abstract

AlgaeBase is a web-searchable, 'live' database of information on taxonomy, nomenclature, distribution and common names of algae. Currently, it mainly includes information regarding seaweeds (19,000 names, 8,000 species) but it is planned to include about 27 classes of algae. Illustrations and information on the uses of algae are currently being added with particular emphasis on the sustainable uses of algae.

The paper summarises on-going consolidation of the database as well as the strategy towards expansion into directly management related areas such as resource distribution, abundance, yields, ecological impact and legal requirements. Future work is prioritised in terms of consolidation of structure and content to complete coverage on the existing basic information, product outputs to enhance usefulness for a wide range of users and expansion into other disciplinary aspects and depth.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Department of Botany, Martin Ryan Institute, NUI, Galway, Ireland. E-mail: mike.guiry@seaweed.ie, e-mail: eilis.nicdhonncha@seaweed.ie; http://www.AlgaeBase.com

Seaweed

Seaweed is a sustainable natural resource that is underdeveloped internationally. Much production of high-volume seaweeds takes place in developing countries or in underdeveloped areas of developed countries. As such, the production of seaweed raw material is already very important to many economically-deprived coastal communities. Opportunities exist for other local communities to develop production (either by harvesting or aquaculture) of this valuable, sustainable, natural resource that is, in many cases, literally lying on their shores. Opportunities also exist for existing producers to refine or expand their current mode or operation to allow them to become more economically self-sufficient in the long term. To avail of these opportunities, relevant information must be provided both to the local communities and to the relevant policy-making authorities.

AlgaeBase – objectives and origin

The aims of AlgaeBase (www.AlgaeBase.com) are twofold. Initially, via the world-wide web, it is intended to provide biological information on the economically-important algae, mainly seaweeds, to the initiators of community-based development projects to help them to choose on which species they should concentrate, and the technical information to aid them in choosing strategies and methods that have been successful elsewhere. The second major objective is to provide relevant background information to policy-makers in the form of an easy-to-access tool that would allow them to ensure that development is carried out in an environmentally friendly and sustainable manner. The project also aims to build and strengthen links within and between developed and developing countries to allow for a more accessible support network for more isolated researchers and for development personnel who do not have the technical experience necessary for this sort of project.

This project was initiated in 1996 by Professor M.D. Guiry of the Department of Botany, National University of Ireland, Galway. From the beginning it has been available on the Internet via the seaweed site (www.seaweed.ie). It currently includes data on about 19,000 Latin names of seaweeds and other algae (of which approximately 8000 species names are currently in use). It is anticipated that there are some 25,000 Latin names of seaweeds (mainly brown, red and green marine algae and seagrasses). In terms of currently accepted names of marine plants, the database is thought to be 90% complete. The synonyms are about 50% complete, the most serious lack of coverage being the older literature from 1753 to 1850. A further and much larger task will be to extend AlgaeBase to cover freshwater and terrestrial algae, particularly phytoplankton.

Subsets of the database have been and will continue to be provided to the Species 2000 annual checklist (AlgaeBase is a member of Species 2000; see www.sp2000.org), to the ERMS (European Register of Marine Species at www.erms.soton.ac.uk) and to BIOSIS, a searchable database of biological organisms (www.york.biosis.org). Most of these subsets have clickable names returned by a search and these access the AlgaeBase server separately and thus obtain ‘live’ data.

Principles used in overall database construction - taxonomy, nomenclature and distribution

Species names database

The foundation of AlgaeBase is the Latin names of families, genera, species and infraspecific categories (subspecies, varieties, formae) of seaweeds and sea-grasses. Both legitimate and illegitimate names under the current International Code of Botanical Nomenclature (Greuter *et al.*, 2000) are included. Illegitimate names (including *nomina nuda;* names without descriptions) are flagged. Names currently accepted taxonomically are also flagged. In the case of a difference of taxonomic opinion, an informed choice is made and an entry is made under taxonomic notes explaining the conflicting opinions.

Taxonomic and nomenclatural synonyms are connected internally via unique serial numbers. This model of names - whether currently accepted or not - is the basis for all operations and makes changes in taxonomic opinion very easy to execute within AlgaeBase. Names for which no current taxonomic opinion can be found are also flagged. Fields for bibliographic references supporting nomenclatural, taxonomic, and other decisions are included via a relational connection to a reference database (see 'Algal Bibliography' below).

No information is entered into this database (or any of the others) without some sort of 'paper trail'. Distributional, taxonomic and nomenclatural data cite references, all of which are freely available to enquirers so that information can be verified by reference to a paper-published work. This feature is critical to the stability of the endeavour.

Distributional data are the primary basis for information in this database. These data are entered in 15 geographical fields. A country or region is given for each reference and these will probably be very useful later should a more universal biogeographical system become the norm. The primary source of information to date has been regional floral check-lists and monographs, some of which are very comprehensive. Distribution is always recorded under the name used in the reference, although records thought to be in error are flagged with square parentheses. This geographical information is served up on the web and the inclusion of references allows for these to be checked. Some restructuring of this part of the database is probably desirable to facilitate biogeographical systems and, perhaps, Geographical Information Systems.

Generic and family names database

Generic and higher taxa names are entered into a separate genus database that includes information on these taxa. This database is a relational one, which makes a new entry whenever a genus not included in the database is entered in the species database. The relationship between the two databases allows changes in classification to be made globally and thus easily. The genus database (also recently made web-accessible) includes data on authors of genera, type species, correct names for type species, numbers of described names ascribed to the genus, number of current species and so on. As with the species database, this is a database of names that are flagged as in use, not in use, illegitimate, etc. About 1800 names of genera are currently included.

Types database

Information on type locality and type specimens are included in this relational database. Place-names are entered relationally. This part of the overall structure is still in development but currently includes about 2000 entries and provides information for the main database.

Common names database

Common names are less frequent in algae than in other groups (such as the fish) and these have been entered when encountered. However, a more systematic approach is needed with verifiable sources, as has been done for the Latin names. At present, the information that is available in AlgaeBase is most commonly accessed by phycologists and so the common-name section is less frequently searched than the Latin names. However, it is envisaged that as a wider sphere of information is included in AlgaeBase the user base will also broaden to include government agencies, libraries, museums, national and international research centres, individuals and non-governmental organisations. It is expected that as these users come online, the common names component of the database will become increasingly important. It is important that the common names database is developed in tandem with economic components so as to ensure the maximum possible accessibility of the information.

Algal bibliography database

Literature references are provided via a relational database called Algal Bibliography. This includes a unique serial number, a citation (e.g. Guiry & Nic Dhonncha, 2000), and a reference, all in HTML format and exported from a separate file in Endnote 4.0 (www.niles.com), a very comprehensive reference manager in which all of the bibliographical information (24,000 items) is kept. Algal Bibliography provides literature references for the species, genus, types, common names and planned authority names databases.

Authority names database

Authorities are the nomenclatural authorities for generic and specific epithets. At present, the nomenclatural authorities are included in the genus and species databases in full (e.g. 'Kützing' instead of 'Kütz.'). However, it would probably be very useful to give these names as standardised abbreviations. These abbreviations will probably be provided as those in Brummit & Powell (1992) and perhaps as a standard set used by phycologists, leaving the choice up to the individual.

Pictures database

Recent software advances have made it possible to include pictures in the database. At present about150 pictures are accessible, in jpeg format, via the database. Visual aids are important for identification of the different species by non-taxonomists and as such will aid in making the seaweed database more accessible to a wider sphere of end-users. Since each species will generally have only one picture but may have many common names, this section of the database will be of immediate importance while the common names component is still in its early stage.

Future databases – policy and management uses

Resource distribution and abundance

Information currently contained in the seaweed database covers the qualitative distribution of species throughout the wor ld. To allow for the development of seaweed harvesting and aquaculture knowledge of the amount of seaweed present in an area is required; in other words, not just 'where does it grow?' but 'where does it grow in harvestable quantities?' This information is readily available for many countries. Estimates of the standing crops and the quantities that are available for sustainable harvesting would also be advantageous although it is expected that this information would not be as easy to assemble.

Resource yields

Over-fishing is a serious problem in many parts of the word. At present over -harvesting of seaweeds has not been a major concern (with some notable exceptions, such as Irish Moss harvesting in Canada). Following the maxim that prevention is better than cure it is thought that the provision of the information required to facilitate the setting of quotas and so on, in advance of any problems would be beneficial. To this end it is planned to include in AlgaeBase information of the life histories, phenology of growth, mortality, reproduction, recruitment and regeneration of commercial species world -wide.

Ecological impacts

Long-term information with respect to the ecological impacts of seaweed harvesting is also required to ensure that expansion is managed in a sustainable and environmentally friendly manner. Information on the current harvesting effort, harvesting technology, associated species as well as data from studies of the effects of harvesting on the standing stocks of seaweed and the associated biodiversity will all be included. This information can be used directly by policy makers to aid in quota setting as well as to set for example organic standards for harvesting to ensure products that have attained a certifiable quality level as regards their harvesting.

Legal Requirements

Regulations governing the harvesting of seaweeds and access to the shore and to the seabed varies widely from country to country. However, in some countries no formal regulations exist, particularly in developing countries. A comprehensive database of such regulations would be useful in the formulation of future legislation.

Aquaculture

Seaweed cultivation is carried out in many areas of the world very successfully and profitably. In several cases small community -based operations have joined together to make developing countries world leaders for certain species (e.g., Philippines, Tanzania). There is huge potential to expand this sector and information on the growing conditions required for particular species, methods of cultivation, observed and expected yields would make knowledge of the possibilities that exist more accessible to a larger audience.

Priorities for future development

Priorities for future development work of the AlgaeBase information system are seen in the following directions:

- Streamlining of the existing database to ensure maximum accessibility.
- Completion of the initial phase followed by publication of an electronic and paper -based book 'Preliminary List of the Marine Algae of the World'.
- Formation of links with potential international collaborators to aid in the collation of information regarding the resource distribution, abundance and yields, ecological impacts, legal requirements and aquaculture of seaweeds world -wide.
- Initiation and development of subs equent phases of the database.

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Fish specimen databases for Asia[a]

by

Sven O. Kullander[b]

Abstract

Specimen databases are at the heart of biological inquiry and integrate with searches for major patterns of animal and plant distribution and behaviour, as has long been recognised in the developed countries, particularly in developing national databases and assigning nature conservation tasks to collection-holding institutions or consortia including such institutions.

Projects such as Neodat to build a database of Neotropical fish collection data, the widespread use of the MUSE software for digitising ichthyological collections, and spin-offs from those activities, suggest a high potential for collaborative international database building based on specimens in museum collections.

Previous experience suggests that database building should be driven primarily by researchers as scientific programmes and be based on a taxonomic backbone. Databases should be developed locally, but joined in central repositories and distributed systems for maximum usefulness.

The current state of collection availability, researcher capacity and state of systematic knowledge base in South and East Asia varies from good to poor between nations, but is overall unsatisfactory in a global perspective. The suggestion is made to digitising and linking Asian freshwater fish collections wherever located, providing a unique assessment of Asian freshwater fish distribution and building a distributed research resource platform for systematics and other biological research.

Benefits include (a) rapid access to otherwise hard-to-find international data as well as otherwise irretrievable local resources; (b) collaborative environment stimulating research by developing a common knowledge pool and rapid analytical results; (c) increase of local appreciation of the value of museum collections and specimen information; (d) establishment of a model for data sharing; (e) improvement of quantity and quality of data for conservation approaches and policy formulation for use of inland waters; and (f) revelation of significant new information concerning existence, distribution patterns, and resource uses.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Department of Vertebrate Zoology, Swedish Museum of Natural History, POB 50007, SE -104 05 Stockholm, Sweden. E-mail: sven.kullander@nrm.se

Introduction

Biological information technology or bioinformatics is commonly considered to be within the realm of molecular genetics. Most biological databases are, however, strictly organismal, and have been in existence since computers became desktops and even before. Collection based databases were being developed already in the 1970s in the US and Europe. Bioinformatics of organisms is thus an old tradition, and has been particularly progressive in ich thyology and botany.

One may distinguish between two major categories of biological databases. The specimen databases are digitised catalogues of museum holdings, and basically they are a kind of inventory lists. Taxonomic databases gather information ab out taxa, and are thus information systems. The term specimen databases is preferred here to museum or collection databases. It should be noted that what is catalogued is not individual specimens, but usually aggregates, so -called lots or samples made up o f conspecific specimens with identical collecting data, which are treated as cataloguing units or objects.

Biological specimen databases and taxonomic databases differ in two fundamental aspects:

Specimen databases contain information about taxonomy, i.e. , a determination to species or higher taxonomic category (*taxon*); the place of extraction from nature or a captive location, usually referred to as *collecting locality*; the date of extraction, i.e. the date of collecting; the name of the extractor, or *collector*. In addition there may be information about local name, time of day of extraction, method of collecting, habitat observations associated with the specimen, and also information derived from the specimen itself such as size, maturity or sex. The deta il of the locality information itself can range from "World" to finest detail including geographic co -ordinates.

Taxonomic, species or taxon databases contain derived information about species (or taxa) which may or may not be correctly ascribed to the par ticular name used for the species. Taxonomic databases can theoretically contain unlimited information, and there is no way to really predict what can be extracted from or added to a taxonomic database.

Both kinds of databases are typically indexed by a *biological classification* based on hierarchical clusters of taxa reflecting phylogenetic relationships, which is the most rational mean to present biological data. The advantage of using a biological classification is that it preserves patterns of organismal and genetic similarity, as well as ecological and biogeographical contexts. Whereas classifications continuously change to reflect improved understanding of relationships, there is no other indexing system that can provide both stability and progressive c hange to the extent that biological classifications can. By comparison, library databases are not indexed by a biological classification; hence it is practically impossible to obtain useful information about taxa from them, to some extent unless the releva nt information is in the title of the publication. Using a biological classification, information can be extracted from a next higher level if a search fails for the appropriate level, and for many purposes the next level may yield sufficient relevant data to be worthwhile.

Most notably, biological classifications are researcher driven. There is no regulation, no central organisation, no standards, no coding, no elements supporting bureaucracies. Classifications and the naming of organisms are supported by the codes for botanical, zoological and microorganismal nomenclature. These codes are decoupled from systematic research, and adherence to rules is completely voluntary. The codes are nevertheless observed almost unanimously by systematists.

The index can also be expressed in what biologists call a *checklist*, i.e., a systematically arranged list of names of taxa down to the most convenient level, usually species. A checklist is a commonly encountered interface to a classification, and assigning organisms to species is in fact a part of the classification.

Taxonomic databases are relatively easy to construct as information systems. It is just a matter of typing in data and indexing the data. The usefulness of species databases depends on the choice of coverage, how complete the information set is, how easy it is to find a complete set of available information by a relatively simple query, and the precision of the indexing.

A database which only includes green fishes has limited value not only because there are very few green fishes, but also because there is no biological meaning to have a database of only green fishes. A database of cave fishes, flying fishes, or commercial marine fishes, is similarly restricted, but makes sense not least because they can be complete for their well-circumscribed coverage, and they have a biologically valid connotation. It is fairly pointless to have a set of separate databases about Dutch, Belgian, French, German and British marine fishes, because they would overlap taxonomically and provide redundant and often incomplete information. It makes more sense to have a database about North Sea fishes.

Why not include everything in one database once and for all? Because of the sheer amount of information to be considered, it is likely that a universal database will be indefensibly incomplete, slow and inadequately indexed for most purposes. Biological databases therefore tend to have a midway approach, such as Species2000, which starts with at least providing the names of organisms, the checklist or organismal index. Attention to this index is also shown in FishBase wherein the taxonomic backbone is taken seriously. FishBase also has a policy of updating itself only certain areas of information and linking into other online databases for topics such as sequence data or global catches of fishes.

Specimen databases are at the heart of biological inquiry and integrate with searches for major patterns of animal and plant distribution and behaviour, as has long been recognised in the developed countries, particularly in developing national databases and assigning nature conservation tasks to collection-holding institutions or consortia including such institutions.

Specimen databases provide largely raw, or uninterpreted data. There are two major constraints of usefulness:

(a) **Collecting bias**. Biological collections are incomplete and cover only easily accessible areas or reflect the research interests of a few persons.

(b) **Taxonomic indexing is not always reliable**. Collections are not continuously scrutinised by specialists; instead identifications are made by students or other persons who are not enough familiar with the taxonomy of the group. Names used in collections are also not continuously updated to reflect the latest advances in classifications.

To this should be added, however, that practically all biological inventories that do not save voucher specimens are unreliable because identifications are not reliable and can no longer be verified. And that the nomenclature used by non-systematic biologists even less reflects an up-to-date classification. One must also observe that museum collections are complementary. The complementarity eliminates some of the shortcomings in gaps in individual collections, and the global assembly of museums functions largely as a collective research resource.

The scientific relevance of specimen databases and their associated voucher collections, consist in:

- Most reliable information on distribution of individual species and patterns formed by aggregates, e.g., recurrent communities;
- Assistance in detecting key taxa and indicator species;
- Can be used to study environmental change over time;
- Primary source of external traits and biological hypothesis-building in less accessible areas;
- Required for identification and confirmation of identification of species in species rich areas;
- Fundamental for establishing a platform nomenclature for biology, fisheries, and other users of species;
- Option of validation of occurrence records more powerful than any other documentation.

The only reliable information about most organisms is thus what can be obtained from museum specimen vouchers.

The current tendencies concerning museum vouchers are two:

a) a mainly political tendency based on the Convention of Biological Diversity, which seeks to nationalise biodiversity and restrict its use for reason of prestige or economic potential. It strives to put charges on information about natural objects and limits access to scientific information. The efforts suffer from the drawback in that probably a very limited part of the world's biota is known to science. Estimates suggest that 1.75 million species have been named, but the total existing species is 14 million (Groombridge & Jenkins, 2001).

b) a biological strive to make available the information in global databases to expose the biodiversity, and make use of global databases to study effects such as global warming and ecosystem and biome level tendencies. This approach suffers from the fact that the underlying information is incomplete for many taxonomic groups, and also that political support for making available the information is insufficient or even hesitant.

Biologically, strategy b) makes best use of the information and provides the best feedback to countries of origin, especially since it is the technology based on biodiversity objects that could provide for some short-term gain targeted by strategy a), not the organisms themselves or basic biological knowledge about them.

The reason not more than 1.75 million species have been named since 1753 and 1758 (the start dates, respectively, of most botanical and all zoological nomenclature) is primarily lack of scientists to describe the taxa, lack of access to material and lack of co-ordination of efforts to get the work done. One or another scientist may also doubt the usefulness of simply naming organisms without knowing anything more about them, so the work underlying descriptions of organisms is considerable.

Fishes in databases

Scientists estimate that about 25 000 species of fish can be recognised as distinct (Nelson, 1994), with maybe 5000 more species still to be added following adequate surveys and taxonomic studies. More than 10 000 fish species are freshwater fishes and more than 80% of all fish species are freshwater and shallow coastal water fishes (Nelson, 1994). Whereas numbers are high, fishes still represent a manageable group in terms of numbers in a database context, as reflected by several initiatives to organise data about fishes, particularly freshwater fishes in databases. The list below is not exhaustive, but focuses on the tropical fauna.

The Americas and Neodat. A highly successful initiative for a specimen database was and is the Neotropical Database Project, Neodat, initiated in 1992 by Paulo Buckup, Scott Schaefer (Academy of Natural Sciences of Philadelphia), William L. Fink (University of Michigan, Ann Arbor), and Julian Humphries (Cornell University, Ithaca), and funded by the National Science Foundation.

The purpose of Neodat was to gather freshwater fish information from all available Neotropical fish collections in one database, this at a time when distributed databases were still difficult to implement at a larger scale. Information was gathered locally and served through a central Gopher/WAIS server. The current Neodat (Neodat II) serves data both from a central server and distributed servers using a web interface and can plot data on a map as well. Twenty-seven institutions participate and serve over 300 000 primary records. Twelve of those are Latin American institutions that became computerised as a result of Neodat participation.

Success of Neodat has two major components. One is the availability of the first major software for zoological specimen database management, MUSE, developed by Julian Humphries at Cornell University since 1988, and financially supported by the National Science Foundation. MUSE is an MS-DOS application using a Btrieve database engine and a DOS based screen interface. Despite that the underlying software is no longer being developed and other limitations of MS-DOS compared to much more widely used PC operating systems, MUSE is still in use for collection management world-wide.

A suitable, widely used collection management digitising platform is thus a requirement for co-operative database building. Whether the success of distribution of MUSE can be repeated is doubtful because it is now easier to write competing applications and it is also relatively easy for a collection manager to design an in-house system meeting highly specific requirements. MUSE was built on an English-language interface; it is likely that major language groups will prefer national language applications to applications with English-language interface, and thus restricting communicability. It is also unlikely that the simplicity, speed and ease of use of MUSE will be repeated because new applications will tend to include more features, more data fields, and allow more complex reporting than were possible with MUSE.

The second component of success was to work in a researcher-based environment. All concerned were scientists or scientifically interested collection managers. All issues thus had a scientific objective and the design of the information flow were based on scientific needs or informed curiosity. Quite clearly, the perspective of being able to find research materials and to make much more extensive distribution maps, were primary objectives driving the mostly voluntary contributions to Neodat. The participating institutions are those that have scientists actively engaged in the use of collections.

From this can be concluded that specimen databases probably fare best in an environment where there is a scientific objective and where there is a well designed channel and language platform for dissemination of the information.

Much of what has been said about Neodat will coincide with development of North American databases. Initiatives expressed in FishGopher and FishNet that are distributed databases for major North American collections, also derive from the implementation of MUSE, whereas non-MUSE collections have remained outside the co-operation. FishGopher and FishNet provide access to North American collection holdings.

Africa and CLOFFA. For African freshwater fishes, collections are concentrated in very few museums, most notably the Afrika-Museum in Tervuren, the Natural History Museum in London, and the JLB Smith Institute of Ichthyology in Grahamstown. Research has been performed almost exclusively in Europe and South Africa. There are very few natural history museums in Africa. There has thus been very little incitement to develop international co-operation projects of the scale seen in the Americas, and there has been no urge to digitise and make available data on collections to a wider circle. African fish research has largely remained within the scientific realm and required direct access to collections.

An interesting exception is the Checklist of the Freshwater Fishes of Africa (CLOFFA), published 1984-1991 under editorship of the Afrika-Museum, Koninklijk Belgisch Instituut voor Natuurwetenschappen (Brussels), and ORSTOM (current IRD, Paris) (Daget et al., 1984 -1991). It is a general catalogue with extensive bibliographies for each species known from African freshwaters, compiled mostly by specialists and taking advantage of the large libraries in Belgium. CLOFFA has not been made available online but data from CLOFFA are incorporated into FishBase. Significant African collections are being made available through FishBase. Thus, for Africa, there is an index available, CLOFFA, but no specialised databases.

Europe. European ichthyology has had a largely marine direction, expressed in the Fishes of the North Atlantic and Mediterranean (Whitehead et al., 1986) compilation, which has served as a standard catalogue of European marine fishes. Although numerous handbooks of "European freshwater fishes" have existed, the compilation of European fishes published in 1997 (Kottelat, 1997) shocked many, as it elevated numbers of valid species from estimated 170 -213 to 358, and revealed a very low level of quality of past research in European fish systematics. European fish systematics thus has had to start over again, but Kottelat's (1997) contribution has been recognised as inspiring for young systematists and ongoing work is exploratory and progressive. Assuming that status of marine European ichthyology is comparable, taxonomic databases for European fishes are not stable. The degree of digitalisation of existing European museum collections is also much less advanced than in the USA. Collections in Paris (Muséum national d'Histoire naturelle) and Stockholm (Swedish Museum of Natural History) were computerised and online in the early or mid-1990s, but others have been slow to follow, and there has been a general lack of interest in concerted efforts, probably because there was no research incentive. In light of the ease of digitalisation of fish collections, most of which contain less than 100 000 objects, it is remarkable that it is not being done. The research perspective of doing so for Europe is staggering considering the time scale under which collections have been assembled and the relatively tight geographical coverage and fairly complete taxonomic coverage that can be expected.

FishBase and global databases. International initiatives at digitising specimen collections are fairly frequent, but rarely come to production. The most recent major initiative is GBIF or the Global Biodiversity Information Facility, mainly managed by scientists. As a scientific project it has good chances of success, but is still in an early phase. A working example of an existing global database that offers a relative degree of completeness, has a working index, and combines both taxonomic and specimen databases, is FishBase, started at the Institut für Meereskunde in Kiel, Germany, but mainly developed at ICLARM, Philippines, by Rainer Froese and colleagues (Froese & Pauly, 2000). FishBase has numerous components added to the core database such as online training, interaction with other databases, survey data, observation data, discussion forum, identification keys, photos of types, point maps on demand, etc. FishBase also provides a central core of specimen data, amounting to about 1 million records that link back to more extensive information in online contributor databases.

All biological databases are likely to become interconnected because databases have more or less the same structure and can be linked. But the preferred growth is primarily bottom-up, with distributed databases and a choice of search indices. In a system of distributed databases local nodes are thus responsible for the digitising, and have complete control over their own data. FishBase is a hybrid, which has a central core but also a distributed element. Exclusively distributed global specimen database examples are FishNet in the United States and its still running precursor, the FishGopher. Distributed database systems are probably more difficult to build for taxonomic databases, and there are no examples.

Implementation and objectives of a regional Asian fish specimen database

Southern and eastern Asia holds among the most species-rich mild temperate and tropical freshwater fish faunas. China and Indonesia alone are estimated to have more than 1000 species of fishes each, and Asia, excluding the former Soviet Union states, has approximately 3500 species of fishes (Kottelat & Whitten, 1996). The information about the basic taxonomy, distribution and biology of these fishes is fragmentary and commonly of low scientific quality. In their survey of Asian aquatic biodiversity, Kottelat & Whitten (1996) report for some nations that only 50% of the fauna is known, and for several countries there are no recent surveys, no specialists and no national field guides.

Recent faunal work by a systematic specialist, Maurice Kottelat, illustrates the situation. For northern Vietnam he found 268 native freshwater species where 203 had been recognised: 20 (10%) of previously recognised species were found to be invalid, 85 (42%) were new for the area, 150 (74%) of the names in use for the area were shown to be incorrect (Kottelat, 2001a). Over the last four years, field work in the Lao People's Democratic Republic resulted in the discovery of a staggering 127 new species of fish and of 116 additional species known from neighbouring countries but not previously recorded from that country. Until this work began the number of fish known from Laos was just 219, but it has now more than doubled to 481. Even so, large tracts of the country remain unsurveyed and more species certainly await discovery (Kottelat, 2001b).

There is one major reason why Asian freshwater fishes need large-scale international co-operation similar to Neodat. Much of the collections and expertise are located outside Asia, and collections are fairly scattered. Many different countries and languages are involved, but there are few systematic specialists in the region; in some countries systematic specialists are simply lacking. Because very few systematists have worked in the region, and because work has been largely national, there are tremendous problems with nomenclature, species status, and other taxonomic issues as exemplified above with Vietnam.

The regional approach is important because the fishes are generally distributed, originally or through introductions, over several countries.

Specimen databases are virtually lacking for many developing countries. This is particularly evident throughout Asia, and holdings of Asian collections outside Asia are rarely adequately digitised.

Lack of collections and databases in Asia, and lack of access to extra-Asian information are an impediment to formulating local cost-effective research and planning, not least with regard to fisheries resources and other natural history resources of economic interest. Throughout Asia there is a strong pressure for aquatic resources going much beyond what would be considered useful in Europe and thus affecting entire aquatic ecosystems.

The fundamentals of an efficient specimen database development consists of a useful index, that is, at least a quality checklist of species. It takes also a scientific approach to develop a useful database, and it has to be researcher driven because most of the issues are intimately related to ongoing research, such as nomenclature, phylogeny, distribution and diagnostic characters.

Table 1. Status of freshwater fish systematics in Asia: Known fish species, estimated fish species, availability of country fauna, specialists (professional scientists publishing regularly in international peer-reviewed journals; otherwise in parenthesis), large-scale inventories (by initiative) and principal museum repositories (by location). Based primarily on information in Kottelat and Whitten (1996), with limited updates based on information in Kottelat (2001a,b, and pers. comm.), and Kullander (2001).

Country	Known Species	Estimated Species	Monograph	Specialist	Survey	Museum
Indonesia	1300	1900	Yes	(Yes)	Europe	Europe, local
China	900	1100	Yes	Yes	Local	US, local
India	750	820	Yes	(Yes)	Local	Europe, local
Thailand	690	750	No	Yes	Europe, local	US
Malaysia	600	675	Yes	Yes	Local	Singapore, local
Myanmar	300	600	No	No	Europe	Europe
Vietnam	450	560	Yes	(Yes)	Local	Europe, US
Laos	481	500	Yes	No	Europe	Europe, US
Papua New Guinea	330	470	Yes	No	Australia	Europe, Australia
Philippines	330	410	No	No	Europe	US, local
Cambodia	215	340	Yes	No	US	Europe, US
Bangladesh	260	290	Yes	No	US	US
Pakistan	160	170	Yes	(Yes)	Local	Europe, local
Japan	150	160	Yes	Yes	Local	US, local
Afghanistan	84	160	No	No	No	Europe
Nepal	130	155	Yes	(Yes)	Local	Europe
China:Taiwan	224	240	Yes	Yes	Local	US, local
Korea	196	220	Yes	Yes	Local	US
Sri Lanka	90	95	Yes	(Yes)	Local	Europe
Brunei	55	75	Yes	No	Local, Singapore	Singapore, local
Mongolia	56	60	Yes	No	Russia	Russia
Singapore	45	45	Yes	Yes	Local	Europe, local
Maldives	0	0	No	No	No	No
Bhutan	?	?	No	No	No	India

Digitising Asian freshwater fish collections will provide a unique assessment of Asian freshwater fish distribution and can support other resea rch. Specific scientific objectives of registering one of the world's most species rich fish faunas include:

?? Understanding geographical and ecological distribution of Asian freshwater fishes.

?? Improved tools for conservation and management of Asian freshwa ter fishes;

?? Analytical outlook into large scale biological patterns:

  ?? changes in distribution over time. Analyses can be performed for several parts of Asia, which have been subject to collecting since the East India traders in the 18 th Century. There is practically no documentation of any faunal changes in the region except what can be read from the preserved museum specimens, because of identification uncertainty, lack of permanent local collections, and lack of monitoring.

  ?? indicator species and communiti es, which will show up as repeatedly occurring taxa or species assemblages, and which can be addressed as potential environmental monitoring organisms. Such are important key taxa in European environmental biology, but are not used much in the tropics, par ticularly because of problems of identifying their distribution especially in a multinational geographic setting.

  ?? biogeographic history, as revealed by the combination of phylogenetic studies and distribution data

?? Improved access to specimens and baseline data, to improve on research potential on Asian freshwater fishes.

One can also hope that the effort will illustrate the usefulness of specimen repositories and thus to improve on the persistence of existing local collections. To be useful for this purpose it will be required to digitise, clean-up and integrate all relevant fish collections, with emphasis on Asian and European museums.

Obstacles include the many and widely different languages and character sets in the region, a plethora of transcription me thods used for locality information world -wide, poor state of documentation, lack of trained museum specialists and taxonomists, uncertainty of persistence of existing local Asian collections. There exists currently no central resource for analysing Asian fish distribution. Whereas US museums and a few European museums are computerised and several of these make available collection data on the Internet, Asian museums are not computerised, and some important European museums are also not computer catalogued. Even where computer catalogues are available, the quality of the identifications of the fishes is not up to standard, and it is true for all museum catalogues and similar sources of information that they use geographical descriptors marked by a diversity of transcriptions, and profusion of non -standard transcriptions. An important city like Guangzhou may be called Kwanchou, Kanton, Canton, …. Particularly in Myanmar, China and Vietnam, there has been a massive reform of toponyms over the years, making searches based on locality names very difficult.

Benefits include (a) rapid access to otherwise hard -to-find international data as well as otherwise irretrievable local resources; (b) collaborative environment stimulating research by developing a common knowl edge pool and rapid analytical results; (c) increase of local appreciation of the value of museum collections and specimen information; (d) establishment of a model for data sharing; (e) improvement of quantity and quality of data for conservation approach es and policy formulation for use of inland waters; and (f) revelation of significant new information concerning existence, distribution patterns, and resource uses. There is surely something to be gained from co -operation in the Information Age.

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Progress towards an information and communication system for aquatic animal diversity[a]

by

Roger S.V. Pullin[b]

Abstract

Information on the diversity of aquatic animals ("fish" for short) is a dynamic field. Existing information systems have insufficient coverage at the genetic level. There are no equivalents, for fish, of the global information and communication systems established for plant and domestic animal genetic diversity. The FAO Commission on Genetic Resources for Food and Agriculture wishes to include fish genetic resources within its scope of work, and full implementation of the FAO Code of Conduct for Responsible Fisheries, and of some recent decisions of Parties to the Convention on Biological Diversity, require information on fish genetic resources.

An Expert Consultation on the Development of an Aquatic Animal Diversity Information and Communication System (AADIS) was convened by FAO and The World Fisheries Trust (WFT) in Rome, 13 – 17 November, 2000, with support from the Istituto Centrale per la Ricerca, Italy. This Consultation confirmed the need for such a system and recommended its establishment, linked to existing information systems in FAO and elsewhere. An AADIS will add value to these, by improving access to authoritative and standardised information at the genetic level. The proceedings of the Consultation will be published by FAO. FAO and WFT will continue to develop an AADIS in partnership with other organisations that manage and utilize information on genetic resources; for example, the Consultative Group on International Agricultural Research.

This paper provides a summary of the progress to date in developing an AADIS, and refers to some of the existing information systems which it will complement and with which it will link, including the Fisheries Global Information System (FIGIS) of FAO and FishBase. The name AADIS will probably change.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5 -7 June 2000 and subsequently updated (with material used with kind permission of FAO)

b) Ecotrack, 7A Legaspi Park View, 134 Legaspi St., Makati City, Philippines. Fax +63-2-840 2630; E-mail: karoger@pacific.net.ph

Introduction

An Expert Consultation on the Development of an Aquatic Animal Diversity Information and Communication System (AADIS) was convened by FAO and the World Fisheries Trust (WFT) in

Rome, 13 – 16 November 2000, in response to the global need for improving availability of information on the diversity of aquatic animals (hereinafter called fish), especially at the genetic level. This information is needed for use in fisheries and aquaculture and for the conservation of fish genetic resources in ecosystems and in gene banks. There are as yet no equivalents of the global information and communication systems established for plants and dom estic animal diversity.

The FAO Commission on Genetic Resources for Food and Agriculture (CGRFA) wishes to include fish genetic resources within its scope of work. Full implementation of the FAO Code of Conduct for Responsible Fisheries (FAO 1995) require s easy access to genetic information. Moreover, some recent decisions of Parties to international conventions, especially those of the Convention on Biological Diversity (CBD) for the conservation and sustainable use of aquatic biodiversity in marine, coas tal and inland waters, recognise the need for sustainable management of fish genetic resources. This will depend upon accurate, authoritative information.

Pullin (2000) suggested actions towards more effective management of fish genetic resources. These can be summarised as: manage for both conservation and sustainable use; utilize professional genetics expertise widely; share information; raise the profile of fish genetic resources in education and policymaking; determine and communicate the value of fish genetic resources; standardise terminology; and foster partnerships among all stakeholders. All of these actions require accurate, accessible and up to date information. AADIS is being designed to facilitate the flows of such information.

This paper descr ibes the background to the concept of an AADIS, and provides examples of some of the existing information systems that it will complement and with which it will link. This is covered more fully by FAO (in press).

Background

In 1995, the FAO's CGRFA conclud ed that: "The aquatic sector must become a full partner in the Commission". The member States of FAO also adopted a voluntary "Code of Conduct for Responsible Fisheries" (FAO 1995). This Code requires States to:

?? "compile fishery-related and other scientific data relating to fish stocks….;

?? promote responsible aquaculture, including (its) impacts on genetic diversity,… based on the best available scientific information…; (and)

?? conserve genetic diversity and maintain the integrity of aquatic communities and ec osystems …; (and)

?? enhance the research capacities of developing countries, *inter alia*, in the areas of data collection and analysis, information."

In 1998, the Conference of Parties to the CBD took Decision IV/5 concerning the conservation and sustainable use of marine and coastal biodiversity. Its Operational Objective 2.2, is "To make available to the Parties information on marine and coastal genetic resources, including bioprospecting". The WFT (Harvey *et al.*, 1998) and ICLARM in partnership with FAO (Pu llin *et al.*, 1999a) convened international conferences on the conservation and use of fish genetic resources, and the ACP-EU Fisheries Research Initiative convened an "International Workshop on Sustainable Use of Fish Biodiversity: Data, Tools and Cooperat ion" (Pullin *et al.*, 1999b). In 2000, the Network of Aquaculture Centers in Asia (NACA) and FAO made detailed recommendations for the responsible development of aquaculture (NACA/FAO 2000). All of these abovementioned meetings foresaw the need for increasing the availability of information on fish genetic diversity. Moreover, the globalisation of fisheries and trade issues, and the complexity of related legal instruments are increasing the need for accurate genetic information.

Progress towards AADIS

The proponents of AADIS learned much from the systems that have been established for plants (e.g., FAO, 1996) and domestic animals (e.g., FAO, 1998) and from the System Wide Information Network for Genetic Resources (SINGER) of the Future Harvest Centre of the Consultative Group on International Agricultural Research (CGIAR). FAO has begun to create a Fisheries Global Information System (FIGIS) (http://www.fao.org.fi/figis) but not covering fish genetic diversity *per se*. FIGIS and FishBase (Froese & Pauly, 2000) are prominent among the international systems that have substantial existing and planned coverage of fish diversity. FishBase includes nearly all known species of finfish (over 25,000 species).

In these international systems, and in many others at national level (Tables 1 and 2), there is information on fish diversity but, with rare exceptions (e.g., GenBank, Table 1) *genetic* information is not widely covered or easily accessible. AADIS is evolving as a guide to this complex map of information, through a web-based, metadatabase approach, and will facilitate wider coverage of fish genetics. Its key features will be flexibility; decentralization; benefits to contributors; standardized protocols and terminologies; accurate, updated and authoritative content; and responsiveness to users.

Next steps

The FAO/WFT Expert Consultation in November 2000 (FAO in press) recommended a stepwise approach to developing an AADIS. In 2001, subject to continued availability of the necessary funds, FAO, WFT and consultants will work further on the structure, linkages, protocols and terminology for an AADIS, which will then, hopefully be established in pilot form.

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Table 1. Some examples of existing international (A) and national (B) information and communication syst include, fish genetic information. There are many other such information systems, including tho NGOs, clubs and societies and the private sector etc. Some of the information p resented here ma very dynamic field. Source: modified from FAO (in press).

Name	Type/Scope	Organisational/linkages	
A. INTERNATIONAL			
Biodiversity Conservation Information System (BCIS)	Metadatabase – facilitates access to global biodiversity metadatabases and specialized databases	Operates as a consortium of IUCN (The World Conservation Union) bodies and others (including Wetlands International)	http:/
Bionet International/ Global Taxonomy Initiative (GTI)	Global taxonomy program	Network linking over 120 countries, with regional and subregional 'loops; the GTI is a major CBD initiative and will use this network and loops	http:/
Clearing House Mechanism (CHM)	The CBD's umbrella mechanism for facilitating access to and exchange of biodiversity information; includes webpages on access to genetic resources, exchange of information, and biosafety; helps Parties to build national CHMs (see B below)	CBD Secretariat with multiple linkages to Parties and others	http:/
CODATA	The Committee of the International Council of Scientific Unions (ICSU) that seeks to improve quality and accessibility of scientific database and information systems	ICSU and partners	http:/
FishBase	Relational biological database (InterNet and CD-ROM) on over 25,000 species of finfish; includes cytogenetic, DNA, population and quantitative genetics	An international consortium, including museums, universities, FAO, the International Center for Living Aquatic Resources Management (ICLARM-the World Fish Center), with over 300 collaborating institutions and individual experts worldwide	www.

Fisheries Global Information System (FIGIS)	FAO's integrated information system on fisheries and aquaculture	Under development at FAO, with global linkages	www.
Global Biodiversity Information facility (GBIF)	An interoperable, distributed network of biodiversity databases, with initial focus on species- and specimen-level data and future links to genetic and ecosystem levels	Initiated by the Organization for Economic Cooperation and Development (OECD) Working - Group on Biological Informatics	Jledw
International Networ k on Genetics in Aquaculture (INGA)	Network of 13 developing countries and 11 advanced aquaculture genetics institutions; members share germplasm and related information and methods	Coordinated by ICLARM – the World Fish Center; has developing-country members, and scientific institutions as associate members.	http:/
Species 2000	Comprehensive list of known species using valid names; Internet gateway to species databases	The International Union of Biological Sciences (IUBS), CODATA, and others; linked with the CHM; to be linked with GBIF	http:/
Species Information Service (SIS)	Software for the 120 specialist groups of the Species Survival Commission (SSC) of IUCN's to share information; does not yet much genetic data	IUCN/SCC, coordinated by a unit in the University of Rome	l.boit
System-Wide Information Network for G enetic Resources (SINGER)	SINGER (InterNet and CD -ROMs) connects the genetic resources databases of the CGIAR's genebanks for crops, forage species and (to a very limited extent) research collections of aquatic animals (ICLARM)	A project of the CGIAR's Sys tem-Wide Genetic Resources Programme in which ICLARM – the World Fish Center is the participating aquatic genetic resources center	http:/
World Conservation Monitoring Centre (WCMC)	Coordinates IUCN's biodiversity and conservation databases	The database arm of IUCN	www.
B. NATIONAL (a few examples)			
Bundes Informationssystem für Genetische Ressourcen (BIG)/German Centre for Agriculture Documentation and Information (ZADI) and Information Centre for Genetic Resources	BIG is a federal system for genetic resources in Germany, linking databases on wild and farmed species; ZADI is the information technology partner.	Federal Government of Germany	http:/
Mexican Network of Biodiversity Information (REMIB)	Consortium of Mexican institutions and others to share data on Mexican biodiversity on -line; part of CONABIO	Government of Mexico, and in ternational linkages	www.

Multi-state Aquatic Resources Information System (MARIS)	MARIS shares information on fish populations and fisheries nationwide (USA) including lake datasets	US universities and national organizations	http:/
National Biological Information Infrastructure (NBII)	A metadata clearing house for biological datasets	US Geological Survey, with multiple US partners	http:/
National Center for Biotechnology Information (NCBI): GenBank	GenBank is the US National Institute of Health's genetic sequence database of all publicly available DNA sequences (approx. 3 million sequence records)	National Institute of Health, USA; linked to the DNA Data Bank of Japan and the European Molecular Biology Laboratory, exchanging data daily	http:/
National CHMs	National CHMs have been developed by many Parties to the CBD (see, as examples, addresses here for Finland and Germany), as two examples among many	Established and operated by an increasing number of the CBD's 138 National CHM focal points	http:/ Germ http:/ Finla http:/ nsi.ht

Table 2. Some examples of bioinformatics institutions and companies: condensed from *Biotechnology and Development Monitor*, Vol. 40(December 1999):10 -13; "Bioinformatics and the Developing World."

Institutions and Programmes	**Internet address**
Bioinformatics Centre, University of Pune, India	http://bioinfo.ernet.in/
Biosafety Information Network and Advisory Service (BINAS)	http://binas.unido.org/binas/
European Bioinformatics Institute (EBI)	http://www.ebi.ac.uk/
European Molecular Biology Laboratory (EMBI)	http://www.embl-heidelberg.de
European Molecular Biology Network (EMBnet)	http://www.embnet.org/
International Centre for Genetic Engineering and Biotechnology (ICGEB)	http://www.icgeb.trieste.it/
Munich Information Center for Protein Sequences (MIPS), Germany	http://www.mips.embnet.org/
National Center for Biotechnology Information (NCBI), USA	http://.ncbi.nlm.nih.gov/
South African National Bioinformatics Institute (SANBI), University of the Western Cape, South Africa	http://www.sanbi.ac.za/
Companies	
The Institute of Genomic Research (TIGR), USA	http://www.tigr.org/
Genetics Computer Group (GCG), USA	http://www.gcg.com/
Molecular Simulations Inc. (MSI), USA	http://www.msi.com/
Lion Bioscience AG, Germany	http://www.lion.ag.de/

Social and economic database for analysis of fisheries policies: A conceptual framework[a]

by

U. R. Sumaila[b] and R. Chuenpagdee[c]

Abstract

Although a vast amount of biological data exists in the public domain for the analysis of fisheries policies at national, regional and international levels, the same cannot be said about social and economic data. With the recent push for ecosystem-based approach to resource management, it is increasingly recognised that human dimensions of fisheries need to be incorporated into ecosystem models. Humans play a significant role in causing problems in fisheries, and in developing structures for solving such problems. Unfortunately, these interactions and relationships between human activities and the marine environment are not easily understood. Yet, the immediate measure that can be taken to facilitate this understanding is to develop social and economic database that can be used to analyse fisheries policies, at national, regional and global levels. This paper aims thus to provide a conceptual framework for such a database, and suggests how it can be used to determine the effectiveness of proposed policy options, using societal objectives such as economic efficiency (maximising profits), social concerns (diversity in employment and equity), and ecosystem stability and sustainability.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000;

b) Fisheries Centre, University of British Columbia, 2204 Main Mall, Vancouver, B.C., Canada V6T 1Z4. E-mail: r.sumaila@fisheries.ubc.ca and Chr. Michelsen Institute, Fantoftvegen 38, P.O. Box 6033, Postterminalen, 5892 Bergen, Norway.

c) Department of Coastal and Ocean Policy, Virginia Institute of Marine Science, Virginia, USA. E-mail: ratana@vims.edu and Coastal Development Centre, Kasetsart University, Bangkok, Thailand

Introduction

Fisheries management is conceivably one of the most advanced resource management regimes currently applied, with several top scientists contributing significantly to the development of new approaches and management strategies. Recent innovative contributions include adaptive management (Walters, 1987) and ecosystem modelling using Ecopath with Ecosim (Walters *et al*., 1997). In addition, fisheries have the most comprehensive database, FishBase, publicly available on the Internet (Froese & Pauly, 2000; www.fishbase.org). It would be thus natural to develop a database on social and economic aspects of fisheries that can be used in conjunction with, and complementarily to, FishBase and Ecopath with Ecosim (or EwE).

FishBase contains key data on the biology and ecology of fish species of the world. The database has a wide variety of uses in research and management of commercially harvested fish, as it compiles information on population dynamics and catches trends for major fish stocks in each region/country of the world. The geographic coverage and the well-structured organisation of FishBase makes it particularly suitable as a counterpart for economic and social data on fish species by country, region and globally. Although the proposed social and economic database can be used independently to provide socio-economic information about the fisheries, it offers two other important functions. First, it provides a linkage that makes the already large and effective biophysical database, such as FishBase, even more powerful as a tool for the study and the analysis of the world's fishery resources. Second, it serves as an input database to EwE models, and facilitates the exploration of policy options in the ecosystem-based fisheries management plan.

The need for a social and economic database that will complement the biological data in FishBase cannot be overemphasised. First, such a database will enable researchers to extend their studies of global fisheries from fishery catches in terms of quantity to fishery catches in terms of values. Second, it allows for an estimation of the net economic benefits from the world's fishery resources, after market and non-market values and costs have been considered. Finally, it provides an understanding of social benefits and values of fisheries at local, regional and global levels. These values will be made available to policy makers so that they could incorporate them in the design of fisheries policies, particularly those related to the allocation of fisheries resources among competing users. Further, the socio-economic database will enhance and facilitate the use of analytical and modelling tools for the evaluation of fisheries policy.

A strong relationship currently exists between Ecopath with Ecosim models and FishBase, with FishBase providing data for the parameterisation of Ecopath models. EwE is now capable of evaluating ecological, economic, social benefits of fisheries (including mandated rebuilding of various ecological groups), in a broad ecosystem context, with its optimisation routine on policy options (Christensen *et al*., 2000). The proposed database will, therefore, make readily available social and economic data needed in the analysis, including information on current policies and regulations, institutional arrangements and other legal aspects of the fisheries. Thus, it will enable timely assessment of various policy options, while creating conducive environment for the scientific analysis and development of new managerial options.

Data needed for the proposed database

Currently, a number of economic databases for fishery resources and products are available, but most of these contain only market prices. The proposed database should include non-market values and other social characteristics of the fisheries, which, we argue, are crucial inputs to rational decision-making regarding the sustainable use of marine resources. This database would facilitate information sharing and understanding between producer nations and consumer nations, acknowledging the impacts of trade and globalisation at the local and national levels.

Two sets of data need to be incorporated in this database, i.e. economic data, including market and non-market data, and social data. Market data include prices, costs, and discount rates. Market prices, both ex-vessel and direct-selling prices, can be categorised by country, species and types of operation, i.e. captured vs. cultured. Cost data include market costs, such as cost of fishing effort (e.g. harvesting costs for different gear types), operating costs (for cultured species) and transaction costs. Finally, discount rates, consumer price index data, both real and nominal, and interest rates, should be incorporated as well as information on local currencies and exchange rates. Data on prices can be easily obtained from secondary sources, for example, the Food and Agriculture Organization of the United Nations (FAO), the Organisation for Economic Co-operation and Development (OECD), Fisheries and Oceans Canada (DFO), the US National Marine Fisheries Services (NMFS), and the Southeast Asian Fisheries Development Centre (SEAFDEC). However, cost data are not readily available and will require more work to collect than in the case of prices.

In addition to market data, a suite of non-market data, specifically, values associated with fisheries must be incorporated. These include ecosystem function values, such as biodiversity, and non-use values, such as, value from knowing that the resources exist (existence value), and value obtained from leaving the resources for future generations (bequest value). Values of fisheries resources to the ecosystem, particularly, in their contribution to biodiversity, are measured using indicators such as species composition, level of productivity, changes in trophic levels, etc.

Non-use values can also be inferred from the amount of payments or compensation ordered by the courts in the case of incidents or damages to the fisheries resources, particularly those related to oil spills. The database should thus involve documentation of existing cases of incidents, using information from insurance companies, oil tankers federation, etc. This should include information on the location and size of spills, types of oil, the bio-physical impacts on marine animals and environment (e.g. amount of dead fish and other animals, dead or injured seabirds, etc.), measures taken to mitigate the impacts and related costs, methods used to assess the damages, the level of damages identified for pecuniary and non-pecuniary resources, and amount of damage payments or compensation charged to polluters. Information on these issues can be obtained mainly from the literature. Other techniques such as Rapfish (Pitcher & Preikshot, 2001) and Damage Schedules (Chuenpagdee *et. al*., 2001) can also be used effectively to identify these non-use values.

In terms of social data, the starting point is the information on the number of fishers in the fisheries, which should be classified using characteristics, such as scale of operations, nature of operations (commercial vs. subsistence), origin (locals vs. migrants), gear-type, and gender. Additionally, data on number of employers in fishing related sectors, amount of taxes and subsidies, demographic data about fishers, and other information about the fishing community, for example, historical and cultural importance of the fisheries, should be included. Similar to the economic data, some of this information should be available, in the forms of fishing household surveys and fishery census, as well as in government reports and the existing literature. In addition to the social data, information related to current regulations and fisheries policies, at the national, regional and international levels, such as management objectives, legal barriers to international trade and harvest distribution regulation, should also be compiled to provide a comprehensive understanding of the social structure and limitations in management of fisheries resources in each ecosystem.

Policy analysis using Ecopath with Ecosim

Fisheries management strategies for regional development require frameworks that integrate the social, economic and ecological dimensions of fisheries. The proposed social and economic database can be used in an ecosystem-based fisheries management model, such as Ecopath with Ecosim, using the basic and advanced approaches suggested by Sumaila (1998). In the basic approach, appropriate prices, discount rates and cost data are applied to the biological results (catches and fishing effort) generated by the ecosystem models under different scenarios. This will allow a computation of the net discounted economic rent that is achievable under the different scenarios, which in turn will assist decision-makers to determine the scenario that best meets their objectives for the management. Note that at this level, economic motivations do not enter into the decisions made regarding how much of what species to harvest, and when the harvest should be taken. This limitation is overcome by including non-market benefits, as determined by the social data, non-market values, and the institutional data in the proposed database. This provides a combined market and non-market value to help management come to a comprehensive total value-based decision.

For the advanced approach, a new optimisation routine in Ecosim can be applied to evaluate various policy options. Management objectives include the maximisation of ecological, economic, and social benefits, and the ability to meet the mandated rebuilding requirements imposed by national, regional and international governing agencies. When ecological benefits alone are considered, the benefits are usually maximised when the system is restored to its carrying capacity. The maximisation routine for economic value is based on the assumption that the rent provides the best measure of benefits, while considering externalities and opportunity costs. Social benefits are expressed mainly by the number of jobs in all sectors related to the fisheries, i.e. jobs/value landed by a given fleet. However, other considerations that might be important to the society, such as preferences for certain lifestyles, cultural and historical values of the resources and equity issues, can be captured as well in the optimisation routine for mandated rebuilding. In other words, the national and international mandates should correspond to the societal values.

While data for optimising economic and social benefits can be obtained from the proposed database, the trade-offs between these policy options need further investigation. One possibility is to use methods such as the Delphi technique (Lindstone, 1975) to obtain consensus from scientific experts and decision makers on the most desirable outcomes, which will then indicate appropriate policy options. Experts' decisions could be used to identify applicable sets of policy options as well as the potential impacts of such options on the ecosystem. It is, however, preferable to simplify the exercise to obtain the preferences and values of resource users and stakeholders, using methods like the damage schedule approach (see Chuenpagdee & Vasconcellos, 2000). This method basically would take results from EwE to simulate various ecosystem scenarios corresponding to different management regimes. The scenarios are then presented to resource users and stakeholders in the form of discrete choices. Their task is to use several criteria, such as ecological, economic and socio-cultural benefits to judge the importance of these ecosystems, which are then used to construct the schedules. These schedules can assist policy makers in defining the objective function that best captures the values that the community attaches to its ecosystem. Combining the public values with the experts' judgment could lead to the formulation of better fisheries policies and, consequently, better ecosystem-based fisheries management models.

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Economic drivers and approaches to integrate economic factors into policy formulation and management - key problems[a]

by

Ussif Rashid Sumaila[b]

Abstract

This presentation consist of two main parts. First, I identify economic drivers by discussing a number of reasons why people care about fish. Second, I state the kind of information and research that is needed to help integrate economic factors into policy formulation and management. People care about fish because of many reasons including, (i) fish as food, (ii) fish for a living, (iii) fish as a profit making business, (iv) fish as recreation, (v) fish as an object of study, (vi) fish as part of nature and therefore deserve to exist in their own right, and (vii) fish for cultural and ceremonial purposes. Given above drivers, is it possible to use fishery resources sustainably through time? The answer to this question depends on a number of factors. In general, the many trade-offs implied by the reasons listed above is an indication of the difficulties and challenges of ensuring the sustainability of fishery resources.

As a result there is a need for the collection, compilation and aggregation of ecological, social and economic data. With respect to economic data, there is the need for readily accessible prices, costs, and discount rates. In addition, non-market values must be included in the database to allow for the analysis of policy relevant research for sustainable fisheries use. Another important piece of information and analysis needed for informed decision making relates to the valuation of all the benefits, that is, social, economic and ecological, of fishery resources. It is important to note that even though there are many databases floating around, they contain mostly commercially related data. Therefore, there is a great need to fill the gap by collecting and identifying non-market values for socially responsible management of the world's fishery resources.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Chr. Michelsen Institute, Fantoftvegen 38, P.O. Box 6033, Postterminalen, 5892 Bergen, Norway. E-mail: r.sumaila@fisheries.ubc.ca

An overview of economic valuation techniques:

A highlight on information needed for their application in developing countries[a]

by

Akhmad Fauzi[b]

Abstract

The paper provides a brief overview of economic valuation techniques in the two broad categories of approaches based on a demand curve and those, which are not. A rich literature and case study history has developed around the development and use of the different families of valuation techniques.

However, they all face some problems in developing countries where national accounting systems do not provide extensive coverage of data required to use them realistical ly and where other knowledge and value systems, particularly local knowledge, need to be much more adequately represented to give realistic and acceptable results. Furthermore, current valuation techniques still have serious limitations in capturing adequa tely different temporal and spatial scales that govern real and perceived values derived from goods and services and from the presence of natural resources in developing countries.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Department of Fisheries Economics & Center for Coastal and Marine Resource Studies, Bogor Agricultural University, Indonesia. E-mail: fauzi@ipb.ac.id

Introduction

Natural resources play an important role as a backbone of economic development providing goods and services for human being both directly or indirectly. Natural resources such as fisheries and other coastal resources, however, are constantly under pressure from the growth of economic development. Thurairaja (1994) showed that some mangrove forests in Southeast Asia are under serious threats due to a large-scale conversion of the forest for coastal aquaculture. For example, in Thailand the area of mangrove forest has decreased by more than 50 percent since 1960. Similarly in Indonesia a significant conversion of mangrove for fish ponds has been taken place. It is estimated that more than 700,000 ha of Indonesia's mangrove had been converted to brackiswater fish pond (Gomes, 1993). It is commonly believed that economic activity, especially in developing countries, has led to serious economic as well as environmental damages such as coral bleaching, deforestation and water pollution. For example, an estimated of 80% of coral reefs in eastern part of Indonesia are being damaged by blast fishing and cyanide fishing (Lundin & Linden, 1993). Cesar *et al*. (1997) estimated that the economic lost to society due to these destructive fishing practices was estimated around US$ 46 million over four years. These environment and economics impacts arise due to a lack of appreciation of the overall benefits provided by the natural resources since many of these benefits are not marketed.

Valuation techniques have been widely used for assessing non-pecuniary values of goods and services derived from natural resource and environment. By general definition, a valuation technique is an effort to place a quantitative (monetary) value of goods and services produced by natural resources regardless whether market prices exist or not. This technique is often used as inputs in deciding the use of resource, making policy formulations, setting prices as well assessing losses and gains from the alteration of resource use.

There are several areas, however, that the valuation techniques may reveals some inadequacies. Knetsch (1993) for example noted that the valuation technique poses some practical problems especially in determining time preference, the disparity between gains and losses and the use of contingent valuation method.

This paper will give an overview of some valuation techniques used in assessing natural resource such as fisheries and aquaculture and highlights some issues which may arise from their application as well as information needed for using such an analysis, especially for developing countries.

The concept of economic valuation

One of the difficulties in measuring the values of goods and services of natural resources is that , natural resources pose attributes, which have no observable market prices, so that their real values cannot be measured properly. Recognising these difficulties, Krutila (1967) introduced the concept of total economic value. This concept is an attempt to capture all values both use and non-use values from natural and environmental resources. According to this concept, total economic value is then defined as the sum of the use values and non-use values.

The first component, i.e., the use value is basically the value derived by individuals who interact directly with the resource such as in fishing, hunting, etc. This is a straightforward explanation. Included into this category is the commercial use of the goods and services such a fish, wood, game, which are sold in the market. Use value can be further broken into direct use value and indirect use value. Direct use value refers to the direct use of consumption of goods and services either commercially or non commercially. Indirect use values, on the other hand, refer to the values or benefits, which cannot be observed directly from the consumption of goods and services. An example of the indirect use value is the benefit of flood prevention and nursery ground of a mangrove ecosystem.

The non-use value is a problematic and a fuzzy concept. This class of value is more difficult to measure since it is less tangible and is based on individual preference rather than consumption. In more detail, the non-use values can be classified into the following sub-classes. These are, existence value, option value and bequest value. The existence value is the value placed on the resource for its very existence. Option value on the other hand is the value of having options for the availability of the resource in the future (e.g. to cope with global change). The bequest value is the value placed by current generation over the resource for the availability for future generations, including the unborn generations.

Valuation techniques

There are many methods available for doing valuation techniques. Dixton *et al*. (1988) for example, provide detailed explanations of these techniques. In general, however, the valuation techniques can be classified, following Turner *et al*. (1993), into two categories: those, which value goods and services through a demand curve, and those, which do not.

Garrod and Willis (1999) classified the demand curve approach into revealed preference and expressed or stated preference methods. The revealed preference or surrogate market technique is an attempt to capture the value of goods and services from natural resources by examining the expenditure of related goods in the private markets. The stated preference, on the other hand, is a direct method since it asks individuals explicitly how much they value goods and services from the natural resources. Some techniques which fall into revealed preference methods are: first, the travel cost method which was initiated by Hotelling in 1941 (reported in Garrod & Willis, 1999) and developed further by Wood and Trice in 1958, and second, the hedonic price method which is based on theory of attributes developed by Lancaster in 1966.

The valuation techniques based on non-market demand approach have been widely used in environmental impact assessments to determine the costs and benefits as well as the policy responses associated with natural resource projects.

One of the most popular of the non-market techniques is the effect on production (EOP) or opportunity cost approach. This technique examines the effect of resource productivity due to human intervention. Accordingly, this technique views resource quality as a factor of production. Therefore, change in environmental quality will affect resource productivity and cost of production, which lead to changes in price and output. As an example, pollution discharge to a river will affect water quality negatively. This in turn will reduce the fishery's production.

In the EOP approach, it is the direct use value, which is mostly measured. There are numerous applications of this technique for developing countries' coastal resources. Ruitenbeek (1991), for example, used this approach to assess the values of mangroves and their linkage with fisheries in Irian Jaya, Indonesia.

Other methods, which fall into non-market-based approaches are preventive expenditure and replacement cost. Preventive Expenditure (PE) or defensive expenditure places values of the resource and environmental from people's willingness to pay to prevent environmental degradation or to reduce adverse effects on the resource. In the replacement cost technique, the value of the resource is approximated by the costs for or expenditures made in restoring the resource at least close to its original state. For example, the reduction on the productivity of the fishery resource can be attributed to the loss of mangrove forest. The costs of replanting trees damaged due to the mangrove conversion might be used as a minimum estimate of the presumed benefit of protecting the resource.

Valuation Approach and the perspectives from developing countries

Even though valuation techniques have been widely used to examine the total values of goods and services derived from the natural resources and environment, they are based on the neoclassical theory of economics developed from perspectives of developed countries. In developing countries, it is sometimes difficult to apply the valuation techniques due to various circumstances including the difficulties of incorporating local knowledge. It has now been recognised that local (indigenous) values or knowledge play a pivotal role on sustainable resource use and in planning and decision making process. A framework of integrating these values into valuation techniques, therefore, needs to be adequately addressed.

In developing countries, as Colby (1990) suggested, two extreme paradigms are often found with respect to resources and environmental perspective. These paradigms are Deep Ecology and Frontier Economics. The Deep Ecology paradigm views the natural resources as highly valuable resources providing goods and services not only for human consumption but also for nonhuman benefit as well. This is a very "naturalist" view, which places the values of non-human above humans' value. The Frontier Economics paradigm, on other hand, views the natural resource as an infinite supply of goods and services for human use and consumption. This paradigm is mostly taken by developing countries in Asia. They have a priority to achieve a sustainable economic growth so that they cannot afford to constrain it to protect the natural resources.

With the existence of these paradigms, it is challenging to assess the total value of the goods and services derived from resources. For example, in Indonesia there are local cultures that place a high value on a certain species of fish for ceremonial purposes. And yet people do not realize that this species is an endangered species. They are thinking that there is an infinite supply of this fish. Therefore, an appropriate assessment as well as relevant information is needed as how to place the monetary value of the cost of protecting the species and its benefit to society. These cultural values are sometimes ignored in the calculation of total economic values.

An important feature emerged from the above discussion is that it is important to ensure community participation in the resource management decision making process through, for example, a co-management (see for example Sumaila & Bawumia, 2000). Thus, when an economic valuation is carried out, the assessments of the revealed preference will not be under-estimated. This in turn, will help to reduce biases, which may otherwise occur when using survey-based methods such as contingent valuation method.

It is also important to note that there are some practical difficulties in using valuation techniques in developing countries. Garrod and Willis (1999), for example, noted that the application of economic valuation in developing countries is often superficial. The problem is mainly due to lack of data and poor data collection systems. For example, Ruitenbeck (1991) used a rough measurement when he estimated the use value of fisheries from a mangrove ecosystem in Bintuni Bay, Irian Jaya, Indonesia. There is no record of catch and effort data available for the study area. This will undoubtedly lead to serious underestimates of the real values of goods and services derived from the fishery in the area. Therefore, it is equally important to build a standard data base and information system for supporting realistic economic valuation in developing countries.

Concluding Remarks

While the use of valuation techniques had been increasing recently with improved accuracy and robustness, it is important to note that improving methodology alone is not sufficient to capture a holistic view of resource and environmental values. There are spatial, cultural and time variations in resource valuations. Therefore, seeking alternative approaches in economic valuation is encouraged. For example with respect to developing countries, understanding local-based knowledge (LK) combined with geographical information system (GIS) could be used for valuing a particular resource system (Rahman, 1998). Similarly, Garrod and Willis (1999) argued that a Bayesian perspective and game theory might be used in assessing environmental value for decision making process.

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Introducing ITQs in Icelandic fisheries: Information needs[a]

by

Thorolfur Matthíasson[b]

Abstract

The historical development towards a generalised system of individual transferable quotas (ITQs) in four Icelandic fisheries is outlined. The characteristics and individual pathways of the fisheries from collapse or near-collapse to the introduction of ITQs were specific to the cod, herring, capelin and ground fish fisheries respectively. However, they had in common the exclusion of others from access to the resource once the need for the introduction of ITQs had been recognised and sanctioned by legislation.

Data requirements of the individual fisheries under old and new regimes are discussed. The need for continued research on the ITQ system is underlined in order to secure the economical viability of the industry and to rebuild the productivity of the resource base.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Faculty of Economics and Business Administration, University of Iceland, Odda v/Sturlugotu, 101 Reykjavik, Iceland. fax: 354-552.6806, E-mail: totimatt@rhi.hi.is.

1 Introduction

Iceland is surrounded by waters that have potential for producing valuable fish -species in large quantities. Icelanders have extended the Exclusive Economic Zone around the island to 12, then 50 and finally 200 nautical during the period from 1959 to 1975. Icelandic politicians have used much of their time and effort during the fourth quarter of the 20[th] century to debate how to organise the utilisation of the resource and in what way one should distribute the rents from its harvesting. I will in the following paper give a short account of the development of the regulatory reforms in four types of Icelandic fisheries and outline information needs associated with this approach.

1.1 Fjord shrimp

Fishing for shrimp in the Ísafjörður area was initiated in the early 1930s. Shrimp had not been utilised before that as Icelanders had not previously been aware of the potential economical and culinary value of the specie. For most of the period from 1935 until the early 1950s, the fishery was conducted by one to three vessels and catches were processed by one plant situated in the small town of Ísafjörður. A second plant, utilising quick freezing of the peeled shrimp was established in 1949. The introduction of quick-freezing enabled more vessels to enter the f ishery. The introduction of automatic shellers in 1959 reduced considerably the cost of utilising small (young) shrimp. Hence, shrimpers brought more juvenile shrimp ashore. The shrimp fishery collapsed in 1962. The Ministry of Fisheries responded to the collapse of the fishery by introducing quotas. Vessels were restricted to bring no more than 600 kg of shrimp on shore per day and the total catch for the whole fleet was not to be more than 400 tons. Hence, the shrimp fishery became the first fishery in Ic eland to be regulated by a total allowable catch (TAC) quota. Legislation passed in 1975 empowered the Ministry to regulate new building of new capacity in processing as well as in fishing of shrimp. The act also empowered the Ministry to allocate quotas t o individual vessels. In 1980, the owners of vessels in Ísafjörður explicitly asked the Ministry to allot the shrimp-TAC per vessel. Vessels were divided into three categories based on size. Vessel in each of the categories was allotted a quota of equal size.

1.2 Herring

Herring catches in Icelandic waters varied between 100,000 to 150,000 tons until 1958 when total catches in Icelandic waters increased to more than 200,000 tons. Catches grew every year after that and reached an all-time peak of 625,000 tons in 1964 and 1965. Catches in 1966 were almost 500,000 tons, but declined to 100,000 tons in 1967. The catch in 1968 was only 30,000 tons or less than 1/20 of its peak value few years earlier. The fishery had collapsed.

Fisheries biologists identified two separate small local stocks and one large stock (the Atlanto - Scandian herring) that spawns off the coast of Norway but feeds in the plankton -rich areas off the eastern coast of Iceland. The high -catches of the 1950s and the 1960s were based on the feeding migration of the Atlanto-Scandian stock. As they increased during the 1960s a growing concern emerged that the catches were at a non -sustainable level. Hence, landings of small herring were banned in 1966. A partial moratorium was introduced in 1967. A TAC on catch of herring was introduced in 1969 and a full moratorium in 1972. The Icelandic moratorium (1972 -1975) affected only the fishing from local Icelandic stocks.

Fishing of the stock of Icelandic summer spawners resumed in 1975 as the estimated size of the stock had grown from virtually zero to 50,000 tons and has since increased to about 500,000 tons. This fishery was exercised by drift netters and purse -seiners. The drift-netters were allotted some

30-40% of the TAC and fished from a common quota. The Ministry for Fisheries decided in 1975 that purse seiners (“herring vessels”, “síldarbátar”) had to apply for the right to participate in the herring fishery. The purse-seiners’ quota was divided equally between the 44 vessels that applied for quota. Fishing with stationary nets was open and unrestricted for any vessel below a given size limit (50 GRT). Vessel owners were allowed to concatenate two purse-seiner quotas effective from 1979. Quotas were made partially transferable in 1983, when vessel owners were allowed to transfer 50% or 100% of allotted quota to other quota-holding vessels. Herring became part of the general system of Individual Transferable Quotas (ITQ) as all other regulated fisheries when The Fishery Management Act (Act 38/1990) came into force in January 1990. Each vessel was allotted a share in the permanent herring quota in accordance with its last allotted yearly share, according to the Fishery Management Act.

1.3 Capelin

Large-scale utilisation of capelin in Icelandic waters started in 1965. Initially, the fishery was based on the spawning stock migrating in coastal waters to the spawning grounds during late winter. The fishery was extended, first to the spawning migration in deep waters east of Iceland in winter in the early 1970s and then to the feeding migration in the area between Iceland, Greenland and Jan Mayen in the mid-to-late 1970s. The fishery collapsed suddenly in 1982/1983. The stock was quickly rebuilt. Norway, Iceland and Greenland reached an agreement on sharing of the TAC in June 1989.

In Iceland, the right to catch capelin was limited to 52 vessels by a Ministerial decree issued August 11, 1980 in the wake of the settlement with the Norwegian government regarding catches in the Exclusive Economic Zone (EEZ) of Jan Mayen. The vessels as well as a provisory quota per vessel were listed in the decree. Half of the provisional TAC was divided equally between the 52 vessels. The rest of the TAC was distributed according to the transport capacity of each of the 52 vessels. The vessel owners suggested in 1985 that the rule should be changed so that 2/3 of the TAC should be distributed equally and 1/3 according to transport capacity. The Ministry complied.

Fishing for capelin was prohibited in 1982. The Ministry used the 1980 model for allocating quotas to 51 vessels when fishing resumed in 1983. The Act 97/1985 on Management of Fisheries in 1986-1987 opened the way for the transferability of capelin quotas. Capelin became a part of the general ITQ system in 1990.

1.4 Demersal fisheries

The Marine Research Institute (MRI) in Reykjavik issued a report in October 1975 on the status of the cod stock (*Gadus morhua*), according to which the stock was about to collapse. The MRI recommended that the total catch of cod in Icelandic territorial waters should not exceed 230,000 tons for 1976. Yearly aggregated Icelandic and foreign catches in those waters had been 400,000 tons in previous years. The 230,000 tons of catch suggested by the MRI was grossly exceeded. The old methods of relying on making gear less effective or more selective by increasing mesh size and/or restricting use of the least selective gear did not do the job. The Ministry introduced a decree on July 14, 1977 aimed at restricting effort particularly concerning the cod fishery. The basic measures were three: a) 30-codless-days for trawlers each year; b) an introduction of a cod-less week for all vessels; and c) a ban against increasing the carrying capacity of the fleet. By 1983, it was evident that cod-less days and effort restrictions failed to keep the effort of the fleet in line with the productive capacity of the cod stock.

The Minister of Fisheries thus put a proposal for a new legislation to the Parliament December 12, 1983. The new provisional law was effective as of January 1, 1984 for one year. The general rule established was that vessels of 10 GRT or more were allotted a quota based on the catch history during the previous 3 years. But special rules applied for vessels that entered the fleet during the 3 year period or if vessels had been absent due to major repair. These vessels could choose a quota equal to the average quota for its category or an effort quota with maximum catch limit. The catch limit was 115% of the average quota for the given vessel category. In 1985, the provisional system established by the 1983 Act was extended for one more year, but liberalising conditions under which vessel owners could choose effort quota with maximum catch limit. The quota system were extended for two years by Act 97/1985. Effort quotas were made more attractive and conversion of effort-quota based catch history into catch quotas was made possible. Vessel owners were also allowed to forward unused quotas to next year.

The hybrid effort-and-catch-quota system was prolonged for the 1988-1989 period by Act 3/1988. The only noticeable change in the text of the Act was inclusion of the following in §1 of the Act: "The fish stocks around Iceland are the property of the Icelandic people". The last substantial contribution of the Parliament came with Act 38/1990, The Fishery Management Act. The domain of quota-management was extended to cover pelagic species and crustaceans in addition to the demersal species. Quotas were made permanent and owners of vessels over 6 GRT could no longer choose effort-quotas. Quotas were made fully transferable temporarily as well as permanently with the restriction that a vessel was required to fish at least 50% of its permanent quota every other year. The quota system was furthermore extended to cover all vessels 6 GRT or bigger. Owners of vessels smaller than 6 GRT were allotted a TAC of cod that was a given percentage of the overall TAC for cod and each vessel was allotted a given number of sea-days. If the small-vessel TAC was over-fished next years number of sea-days was to be reduced accordingly. This rule represented a loophole that many small-scale fishers were quick to utilise.

2 Collection of catch data

Prior to the erection of the ITQ system public authorities provided buyers and sellers of fresh catch with authorised scales at every fishing harbour in Iceland. The scales were and are operated by the local harbour authorities. The scale operator is now required to be certified as such, reflecting increased importance as weight data are vital for the implementation of the ITQ system. Until January 1st, 1999 the Fisheries Association of Iceland (an association of fishermen and vessel owners) collected data from the local harbours and published a very detailed overview of the Icelandic catches on a regular basis. Hence, prior to the invention of the ITQ system, catch was metered at port in order to reduce possible disputes between buyers and sellers of fresh catch.

An ITQ system requires a comprehensive and reliable system for collection, compilation and verification of catch data. Hence, the Directorate of Fisheries, a public organisation assigned as the law enforcement authority, has received the responsibility to collect, verify and organise catch data. The point of measurement is still the same: The port of landing. All fresh catch must be metered at an authorised landing scale and a landing declaration issued. The landing declaration contains information about the name and registration number of the vessel, port and date of landing, recipient of the catch, amount of catch by weight for each species, type of fishing gear used and amount of undersize catch. Processing vessels do bring processed catch to port. Hence, realignments must be made in the case of processing vessels and in the case that catch is landed in a foreign port. According to present regulation and directives processing vessels that process their catch on board must regularly collect data on their utilisation (conversion) factors and keep samples for verification. The processed (frozen) product is then metered when the processing vessel enters harbour and the weight of the fresh catch estimated from the utilisation factors and the weight of the landed product. The quota of the processing vessel is reduced by the estimated fresh weight of the processed product brought ashore. Scales at a few auction markets in continental Europe have been authorised by Icelandic authorities. The quota of Icelandic vessels bringing catches from Icelandic waters to those markets is reduced by the weight reported co rrecting for transport weight reduction (and in some cases taking a “fresh fish export penalty factor” into account). The Directorate of Fisheries has invested vast resources in securing swift collection of data in order to have a comprehensive overview of quota situation of every vessel in the Icelandic fishing fleet at the end of each day. The quota situation of every vessel is accessible for the public on the web (www.fiskistofa.is).

Buyers and processors of catc h are required to report purchase of catch to the Directorate of Fisheries detailing quantity and species of the purchase. The purchase declaration also details value of purchase and the type of fishing gear used. Buyers and processors are also obliged to declare in a second set of document how the purchase is processed. The purchase and disposition declaration enables the Directorate to trace the path of catch from vessel to final processor even if catch is the subject of several transactions. The purchase and disposition data enable the Directorate to double - check the original landing reports. Any discrepancies are actively investigated by the Directorate. False reports imply severe penalties in the form of fines, withdrawal of commercial fishing permit and imprisonment in the most serious cases.

3 Conclusion

From the evidence presented about the four types of fisheries in Iceland it is apparent that no one of the reformatory processes can be said to be a clear replica of the any of the other processes. The shrimp fishery in Ísafjarðardjúp is very limited in terms of geographical area. The herring and the capelin fisheries are characterised by a short season and fishing in rather limited geographical area at each point in time. The demersal fishery is a year -round fishery involving large number of stakeholders and large sums of money.

It should be evident from the earliest history of regulatory reforms that the ITQ system was not the intended outcome. It came to be, eventually. There is a common pattern for a ll the fisheries. First of all, the serious attempts to reform the management practise started only when a fishery had collapsed or was close to a collapse. Secondly, the first thing that stakeholders seem to get done is to close the club that has access t o the given fishery.

The shrimpers in Ísafjörður tried time and again to restrict the group of those who can obtain a permit. The capelin case is also rather clear cut: The club was closed by a Decree issues by the Ministry. The valuable multi-stakeholder demersal fishery was much harder to close. It has taken 15 years or more to do so. When a fishery has been closed the permit holders can speculate, without having to take outside opinion into account, how best to organise the fishery with respect to the economy of fishing firms and sustainability of fish -stocks. It was at this stage that the ITQs became an obvious choice. Thirdly, a variety of rules was used to allocate participation rights when the club of participants had been closed. Note in particular that the rules used in the shrimp, the herring and the capelin fisheries are egalitarian towards the members of the club. Lastly, management of fisheries by ITQs rather than some form of taxes or fees may have historical rather than logical roots.

The Icelandic authorities have established a comprehensive and swift system for collection of catch data. The system is partially based on data collection systems in operation prior to the setting up of the ITQ system. Data collectors of the present system have m uch broader authority than their counterparts had earlier. The data collection is comprehensive as no catch in Icelandic waters can be brought ashore legally without being registered.

The historical development that led up to ITQs in Iceland should be the subject of further research. Fishing industry leaders did not like the idea of ITQs when it was first presented. Now, their pipe is playing a different tune. Understanding that transformation of attitude can help when one is to design management system tha t have other aims than just securing the financial health of the fishing sector.

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Ecosystem based approaches to policy and management - key problems[a]

by

Guy Fontenelle[b]

Summary

The ecosystem appro ach acknowledges explicitly the dynamic linkages among its components, and most importantly, humans are included as ecosystem components. But most living aquatic that integrity of all species arrangements and links within their ecosystem lead to the resour ce concept after settings different values. But most of living aquatic resources are defined as common pool resources to which many individuals claim entitlement to use. Assessment is difficult in aquatic ecosystems because many components are highly mobil e, hidden and difficult to monitor.

As uncertainty and complexity are two main characteristics of aquatic ecosystems, three key questions have to be addressed in relation to:

1. **Conservation of functional ecosystems**: what total impact can be tolerated, and ho w much impact is generated by each envisioned use?
2. **Allocation of productivity**: how to distribute to users parts of a given ecosystem according to different sets of values (economic, social, cultural, aesthetics)?
3. **Management**: Who should take charge of mana gement decisions, and monitor the results?

Because the current management practices have not addressed these questions effectively, an ecosystem-based approach to management requires new ways of integrating the appropriate knowledge (i) of ecosystem functi oning (space and time) and, (ii) in ways that the users be more involved in the decision process and accept responsability for implementation.

Lack of good communication of information among all "partners" in this exercise lead to a knowledge asymmetry, he nce to decline in trust in the management process and in management failure on the long term. This has been termed ‘knowledge management crisis’. It should be solved by using innovative tools (simulation and new technologies of information and communicatio n) in appropriate ways.

Some such tools exist already. Interest for them is growing in order to consider ecosystems levels. One of the best known is the package Ecopath with Ecosim (http://www.ecopath.org) with more than 1, 200 registered users world-wide.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000;

b) ENSAR, Laboratoire halieutique, 65, Rue de St. Brieuc, 35042 Rennes cedex, France. E-mail: fontenel@roazhon.inra.fr

The multispecies model OSMOSE: Key features and link with FishBase[a]

by

Yunne Shin[b] and Philippe Cury[c]

Extended summary

At present, essentially two multispecies models are use d in fisheries science: Multi-species Virtual Population Analysis (MSVPA) and the Ecopath family of models (with EcoSim and EcoSpace). Developed in a complementary way to those models, the OSMOSE model (Object -oriented Simulator of Marine ecOSystems Exploi tation) aims at representing and studying the spatial, age - and size-structured dynamics of marine fish assemblages. Its structure and formalism allows to:

?? associate and articulate species and ecosystem dynamics;

?? investigate the role of biodiversity by mea ns of different diversity indices, either cardinal (e.g. species richness, Shannon index, evenness) or ordinal (e.g. size spectrum and derived indices);

?? simulate different fishing scenarios and management measures (minimal length at catch, target species, fishing mortality, quotas, MPAs);

?? provide output variables that can be compared to those produced by existing multi -species models such as MSVPA (fish numbers by age and size, recruitment, mortality rates);

?? use biological and ecological data and informatio n that are widely available in the literature or in databases such as FishBase.

The OSMOSE model is based on the hypothesis that predation is an opportunistic process, depending on fish size rather than on its taxonomy. Predation opportunism is implemented by allowing predators to feed on any fish species provided that the prey size does not exceed a threshold value, and that it is located in its vicinity. From FishBase data, the upper predator/prey size ratio is estimated at about 3.5 (Froese & Pauly, 2000). Such a predation process can account for cannibalism, omnivory and variability, which are frequently observed in fish diets (Smith & Reay, 1991; Rice, 1995). Furthermore, the strength of both predation and competition relationships vary according to changes in relative species abundance. Thus, rather than being represented from pre - established species interactions, trophic webs are considered as being fundamentally dynamic.

a) Based on a presentation at the INCO -DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5 -7 June 2000

b) IRD, Centre de Recherche Halieutique Méditerranéenne et Tropicale, avenue Jean Bonnet, BP 171, 34 203 Sete cedex, France. Email: shin@ird.fr

c) IRD Research Associate at University of Cape Town, Oceanography Department, 7701 Rondebosch and Marine & Coastal Management, Private Bag X2, 8012 Rogge Bay, Cape Town, South Africa. Email: curypm@uctvms.uct.ac.za

To represent such behaviour, an individual-based approach is chosen, which involves following the fates of all individuals within a population by considering local interactions with their environment (DeAngelis & Gross, 1992). In OSMOSE, fish interact with each other through predation. For technical purposes, the unit of interaction is not a strict individual but a "super-individual" in the IBM terminology (Scheffer *et al*., 1995), that is a group of fishes with similar attributes. The architecture of OSMOSE is hierarchical since a "fish group" belongs to a cohort, which in turn, belongs to a species. Four model classes, which represent particular ecological entities, are used: the class "system", the class "species", the class "age class", and the class "super-individual" In addition, two classes represent the spatial environment of fish: the classes "grid" and "cell".

The hierarchical structure of OSMOSE enables the investigation of some key variables at different levels of aggregation, in particular the abundance, the spatial distribution of fish by species and age or the ecosystem size spectrum. Indeed, as the state of each individual fish group is known, the state of the population or other aggregated entity can be generated simply by summing (or calculating the mean, variance, etc.) the attributes of all individuals of similar characteristics (e.g. age, size, species). Within each time step, fish groups move through a two-dimensional grid, with local movements guided by the highest concentrations of prey. Variability in fish length and reproductive capacity depending on food ration is accounted for and three sources of mortality are considered: predation, starvation and fishing mortalities. A detailed presentation of the model is provided in Shin and Cury (2001).

OSMOSE is developed in the object-oriented language Java (JdK 1.1.3, SunMicrosystems). A graphical interface allows a specific definition of the simulation framework. When initialising the model, the simulated system is characterised by its species richness, by the type of species assemblage, by a carrying capacity (type of dynamic and mean value), by a spatial area (coastline) and by a fishing scenario. The objects "species" are then created, by specifying, for each of them, a set of growth and reproduction parameters. At this input stage, a coupling with FishBase database is very useful. Indeed, the "class" species is characterised by several parameters such as survival parameters (longevity, mortality rates), growth parameters (von Bertalanffy model parameters, condition factor) and reproduction ones (age at maturity, relative fecundity), are key parameters that are reported in FishBase, and available for many species.

However, for initialising the OSMOSE model, FishBase lacks an important information that indicates the mean spatial distribution of the species by age. This information is often provided, but only qualitatively and at an inappropriately large spatial scale when considering a particular ecosystem. Far beyond the potential interest for the OSMOSE initialisation, this spatial information may perhaps be incorporated into FishBase in the future, as it concerns an important trait of species ecology. Moreover, coding species areas in spatial coordinates would provide an important source of information that could be used as input to many spatial models. Apart from this constraint, OSMOSE represents a model that can easily be linked to FishBase and produce quantitative ecosystem indicators expected to become useful for fisheries management.

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Seafood health standards and trade - key problems[a]

by

Carlos A. Lima dos Santos[b]

Abstract

Consumers perceived that foodborne disease of fisheries and aquacultured products has increased in tune with the extra-ordinary expansion of international trade now involving more than 40% of global aquatic production. This is despite international efforts by Codex Alimentarius and GATT to bring these under control.

National measures to implement regulations on the basis of Sanitary and Phytosanitary Standards (SPS) have frequently been perceived as technical barriers to trade (TBT) and have been addressed in a specific TBT Agreement under the World Trade Organisation (WTO). An amendment of the SPS is in preparation to allow developing countries more time to adjust.

Access to relevant information on characteristics of aquatic raw material and products, regulations, technical conditions required for safe products and monitoring of accumulating experience in international trade is still fragmented and international cooperation in this arena would contribute to developing countries improving their benefits from international trade. Regional market intelligence services collaborating under FAO's Globefish umbrella produce a variety of highly relevant information for producers, traders and buyers. Discussions are underway to explore useful ways of expanding this information source and making it more widely available. European, Japanese and U.S. surveillance databases and information systems, thus covering the principal import markets, should be linked to share public health information of international concern.

a) Invited paper to the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000; up-dated subsequently;

b) Consultant Food Safety & Quality, Av. Afranio de Melo Franco 365/501, Leblon, Rio de Janeiro, RJ 22430-060, Brazil. Tel. +55-21-239 6759, E-mail: dossantoscarlos@highway.com.br

Introduction

With the globalisation of food production, manufacturing, and marketing, the risk of foodborne disease transmission has become greater. In the past two to three decades, public health authorities in industrialised countries have been faced with an increasing number of food safety problems, with the Food and Agriculture Organization (FAO) and World Health Organization (WHO) acknowledging that illness due to contaminated food was perhaps the most widespread health problem in the contemporary world and an important cause of reduced economic productivity. Economic globalisation has also increased the need for governmental budget austerity, and consequent national preparedness has been eroded. The emergence of new infectious diseases, as well as the reemergence of old ones, complicates furthermore this crucial transnational policy issue. These problems cannot be resolved by national governments alone; they require international cooperation (Käferstein *et al.*, 1997)

Seventy percent of the world's catch of fish and fishery products is consumed as food. Fish and shellfish products represent 15.6% of animal protein supply and 5.6% of total protein supply on a worldwide basis. Globalisation has pushed the international seafood trade towards significant levels of increase in the last years, when more than 40% of total world production entered international trade according to FAO, with industrialised countries accounting for 84% of total imports in 1997. It should be noted that fish and fishery products represent the category of food commodities which has the highest share in international trade and at the same time constitutes a major source of foreign exchange earnings of developing countries (Josupeit, 1999; Ruckes, 1999).

Seafood-borne disease or illness outbreaks affect consumers both physically and financially, and create regulatory problems for both importing and exporting countries.

Total costs of foodborne illness where the vector was seafood have been estimated at just under 8% of the value of fish and fishery products in industrialised countries in the earlier 90's, but are more difficult to assess in developing countries (Ruckes, 2000). The costs and benefits of seafood safety must be considered at all levels, including the fishers, fish farmers, input suppliers to fishing, processing and trade, seafood processors, seafood distributors, consumers and government. Major developments within the last two decades have created a set of complex trading situations for seafood. Current events indicate that seafood safety and quality can be used as non-tariff barriers to free trade (Cato, 1998).

Hazards associated with the consumption of all food (including seafood) can be categorised into three areas: product safety; food hygiene (clean vs. dirty plants, wholesome vs. unwholesome products); and mislabeling or economic fraud. Traditionally, the food safety risks of seafood products (aquacultured and wild-caught) have been subcategorised by environment, process, distribution, and consumer-induced risk; the environmental risk category is further subdivided into natural hazards (e.g., biotoxins) and anthropogenic contaminants (e.g., polychlorinated biphenyls) (Garrett *et al.*, 1997).

Products from aquaculture on the other hand have sometimes been associated with certain food safety issues, as the risk of contamination of products by chemical and biological agents is greater in freshwater and coastal ecosystems than in the open seas. Food safety issues associated with aquaculture products will differ from region to region and from habitat to habitat and will vary according to the method of production, management practices and environmental conditions. Foodborne parasitic infections, foodborne disease associated with pathogenic bacteria, residues of agro-chemicals, veterinary drugs and heavy metal contamination have all been identified as hazards of aquaculture products. The origins of such food safety concerns are diverse, ranging from inappropriate aquacultural practices, environmental pollution and cultural habits of food preparation and consumption. (Lima dos Santos, 1999; Reilly *et al*., 1999).

The Draft Recommended Code of Practice on Fish and Fishery Products (Codex Alimentarius Commission, 2000) is being considered at the 23rd Session of the Codex Committee on Fish and Fishery Products being held in Alesund, Norway, 5-9 June 2000. Section 4 of the Draft includes the most important fish safety hazards to be considered (see Appendix).

Seafood safety and trade issues

It is generally recognised that it is the sovereign right (and the duty) of a country to protect its consumers. With small differences the major importing countries of fishery products have therefore adopted health regulations based on Codex Alimentarius aiming at protecting the health of consumers. Global trade in seafood not the least between developing countries and industrialised countries, has been greatly affected by the application of such sanitary standards in the major importing markets.

But not all national standards are perceived as legitimate consumer health protection. An example of what was interpreted as a trade barrier (regulations which limit or prohibit imports) was the attitude of some EC countries and by the EC as a whole in facing the cholera outbreak that affected Latin America. The Decision of Commission No. 92/356/CEE of 19 June 1992 prohibits the imports of raw aquaculture products from Brazil, on the basis that there is no guarantee to assure that these products would be free from the presence of *Vibrio cholerae*. Was this a non-discriminatory decision, if raw aquaculture products, in particular shrimp, was regularly imported by EC countries from a number of other countries also affected by cholera (Thailand, India, Bangladesh, Ecuador, just to mention a few)? The measure was lifted by Decision of Commission No. 94/199/CEE after bringing the problem under control. However, one may even ask as a matter of principle, why look out for anything but very high levels of a micro-organism, which is a natural inhabitant of brackish water where tropical shrimp is generally cultured? (Reilly *et al*., 1992; Lima dos Santos *et al*., 1993; Cato & Lima dos Santos, 1998; FAO/NACA/WHO, 1999).

Another example of trade barrier (imposition of administrative measures which affects trade) is the need for sanitary certificates plus extra-certificates indicating that a product does not contain *Salmonella*, *Vibrio cholerae*, mercury, cadmium and/or histamine. This pre-shipment requirement promotes all kinds of unnecessary procedures, is valueless from the public health point of view, puts an extra burden on exporters and may considerably delay imports.

As a result of The Uruguay Round of Multilateral Trade Negotiations the WTO (World Trade Organization) came into being January 1, 1995. The Uruguay Round negotiations were the first to deal with the liberalisation of trade in agricultural products; an area excluded from previous Rounds of negotiations. The Uruguay Round also included negotiations on reducing non-tariff barriers to international trade in agricultural products. It resulted in two binding Agreements: the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) and the Agreement on Technical Barriers to Trade (TBT Agreement).

The SPS Agreement confirms the right of WTO Member countries to apply measures necessary to protect human, animal and plant life and health. The purpose of the SPS Agreement is to ensure that measures established by governments to protect human, animal and plant life and health are consistent with obligations prohibiting arbitrary, unjustifiable discrimination on trade between countries where the same conditions prevail. Otherwise such measures are considered a disguised restriction on international trade. The Agreement requires that, with regard to food safety measures, WTO Members base their national measures on international standards, guidelines and other recommendations adopted by the Codex Alimentarius Commission (CAC).

Seafood Non-safety and trade issues

Over the last few years, international trade in seafood is also met with increasing public concern for over exploitation of natural resources, environmental concerns with regards to aquaculture, and yet others. Eco-certification has been one of the hotly debated subjects of the Sub-Committee on Fish Trade of FAO on the subject of publications and pronouncements by many organisations, including by those of fish workers in developing and industrialised countries. Underlying are often equity and justice issues within and between societies and the difficulties of finding environmentally and socially acceptable solution to the increasing number of conflicts. These are ultimately engendered by unprecedented demographic growth and associated pressure on natural renewable resources and production and consumption models out of tune with a rapidly changing world.

Under the dispute settlement procedure of WTO various disputes already deal with seafood products. By way of example, in 1996, India, Malaysia, Pakistan, the Philippines and Thailand complained against the US ban on shrimp and shrimp products, which had been imposed on grounds of the lack of enforcement of Turtle Excluding Devices on shrimp trawlers. The WTO panel ruled against the US in 1998 (Ruckes, 1999).

The need for international co-operation on information systems

Fishery products contribute a major though in many regions decreasing share to the animal protein supplies in developing countries and at the same time they constitute substantially to their foreign exchange earnings through exports in a very varied range of product forms. In order to maximise these revenues it is essential to have knowledge about and connection with the most profitable markets and to exploit the opportunities of gaining through value addition as much as possible. Safety and quality assurance activities are key elements to achieve such goals. Information and technical know-how are therefore essential (Ruckes, 1999).

"While some attributes are already subject to regulatory systems, the scale and pace of trade and technological innovation warrant additional efforts, e.g. for various types of indicators, to build trust between parties. As the perceptions about those issues vary widely, addressing the demand for non-discriminatory, technically sound and transparent labelling brings with it the need for reliable and readily accessible information and dialogue. Applications need to operate at least at individual species level and require such information as national catches/production, imports, exports (converted to live round weight), national allowable catches under international agreements, handling and processing systems, species-specific infections, disease and contamination information (e.g. parasites, ciguatera, histamine levels). Information will also have to include status in relation to threatened or protected species lists (e.g. IUCN and CITES designations) and link such information through scientific species-specific names to local or commercial and trade names in different countries. Such an information system, possibly covering other attributes as well, would be a major step forward" (Na uen, 1999).

The FAO GLOBEFISH data bank covers information on fish marketing in a broad sense including trade regulations, prices, imports, exports, consumer preferences, aquaculture, production, and company profiles. The databank comprises articles from newspapers, specialised magazines, correspondent's reports, etc. It also holds statistics on the major seafood commodities of importance. It involves the co-operative work of 4 regional intergovernmental organisations INFOFISH in Asia, INFOPESCA in Latin America, INFOPECHE in Africa and INFOSAMAK in Arab countries. FAO projects EASTFISH (regional targeting mostly Eastern Europe) and INFOYU (national in China) also collaborate under the leadership of FAO GLOBEFISH.

The subject of a super-data base on fish safety is an issue under considerable discussion within the Fish Utilisation and Marketing Service (FIIU) of the FAO Department of Fisheries, Rome, Italy. The mapping of the existing databases (accessible or not), as a first step, should not be a difficult exercise. It would include the US Food and Drug Administration's (FDA) "Fish and Fisheries Products Hazards & Controls Guide" (Second edition available from Internet site FDA/CFSAN). This database contains information on safety regarding all the species that enter the US market, this means it contains information on many species from developing countries (Lupin, pers. comm. 1999).

The information system proposed by FAO/FIIU should be more an information source to provide data on specific safety problems related to fish products worldwide. This should help the industry and regulatory agencies undertake more realistic and accurate risk analysis for specific products. Therefore, the database would include:

1. Epidemiological data on outbreaks and sporadic cases related to fish products. This includes products, fish species, origin of products, problem, number of cases, etc.;

2. Results of inspection analysis and/or detentions/rejection lists: samples, origins, result;

3. Results of surveys conducted in different countries and giving incidence of hazards in specific products and fish species. This could include both data published and also results of routine surveys done by many inspection and control services.

This database could not also have the additional benefit of helping to identify "dark areas" where there is lack of knowledge/information and where research is necessary. It should include information already generated by potential partners like WHO, national inspection and health authorities, the Centres for Disease Control and Prevention (CDC – the lead US federal aagency for protecting the health and safety of people providing credible informationto enhance health decisions), research institutions, etc.

A database (PROXIM) for proximate composition of fish species was developed under a collaborative research project sponsored under the EC's 3rd Science and Technology for Development Programme. It is an MS Access database, which contains already 350 sets of proximate composition data for over 200 different fish species. Included is as much information as possible like the season when the fish was caught, the geographic position, sex, size, etc. PROXIM was developed by the former Natural Resources Institute (NRI), United Kingdom (Ben Embarek, pers.comm).

With the diffusion of technology, internationally networked electronic public health surveillance systems are gaining in importance. Their existence clearly facilitates the rapid collection, analysis, and dissemination of vital public health information and promotes the establishment of effective international public health policies.

Examples of successful existing networks are

(1) *Salmnet*, a laboratory-based surveillance system designed to include an on-line network database, was established in 1994 to improve the prevention and control of human

salmonellosis and other foodborne infections in the countries of the European Union through the Intra-European Cooperation in Science and Technology.

(2) *NETSS* (National Electronic Telecommunications System for Surveillance), a parallel electronic surveillance system in the United States for electronically collecting, transmitting, analysing, and publishing weekly reports of notifiable diseases and injuries from 50 states, New York City, the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Mariana Islands.

(3) *PHLIS* (Public Health Laboratory Information System), is used by public health department laboratories in all states, New York City, the District of Columbia, and Guam to report laboratory isolate-based surveillance data to CDC.

Advances in information technology now allow much easier linkage of decentralised information sources. This creates a real potential to improve information services to producers, traders and sellers, not to mention the regulatory authorities and with wider public provided information collectors can agree on sharing information resources in a more systematic fashion.

European, Japan and U.S. surveillance databases and information systems should be linked to share public health information of international concern. To that end, Communicable Disease Surveillance Centre (CDSC) and CDC are developing a cooperative communications information system that will use the Internet to mirror vital public health documents (e.g., CDSC's Communicable Disease Report [CDR], CDC's Morbidity and Mortality Weekly Report [MMWR], and selected surveillance data sets). This network is the beginning of a larger international network that will share data, exchange information, and improve public health. This larger network could link such systems as *Salmnet*, *NETSS*, and *PHLIS* to create a virtual on-line library of international surveillance data and information for public health (Vacalis & Bartlett, 1995).

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Draft Recommended Code of Practice for Fish and Fishery Products

(Extracts from a Document presented at the 23rd section of the Codex Committee on Fish and Fishery Products, Alesund, Norway, 5-9 June 2000)

SECTION 4: GENERAL CONSIDERATIONS FOR THE HANDLING OF FRESH FISH AND SHELLFISH

Unless they can be reduced to an acceptable level by normal sorting and / or processing, no fish should be accepted if it is known to contain parasites, undesirable microorganisms, pesticides, veterinary drugs or toxic, decomposed or extraneous substances. When fish and shellfish determined as unfit for human consumption are found they should be removed and stored separately from the catch, and disposed of in a proper manner. Potential hazards, which have been known to be associated with fresh fish and shellfish are described in Section 4.1. All fish and shellfish deemed fit for human consumption should be handled properly with particular attention being paid to time and temperature control.

4.1 Potential Hazards Associated with Fresh Fish and Shellfish

4.1.1 Biological Hazards

4.1.1.1 Parasites

The parasites known to cause disease in humans and transmitted by fish or crustaceans are broadly classified as helminths or parasitic worms. These are commonly referred to as Nematodes, Cestodes and Trematodes. Fish can be parasitised by protozoans, but there are no records of fish protozoan disease being transmitted to man. Parasites have complex life cycles, involving one or more intermediate hosts and are generally passed to man through the consumption of raw, minimally processed or inadequately cooked products that contain the parasite infectious stage, causing foodborne disease. Freezing at -20°C or below for 7 days or -35°C for about 20 hours of fish intended for raw consumption will kill parasites. Processes such as brining or pickling may reduce the parasite hazard but will not eliminate it. Candling, trimming belly flaps and physically removing the parasite cysts will also reduce the hazards but will not guarantee elimination.

Nematodes

Many species of nematodes are known to occur world-wide and some species of marine fish act as secondary hosts. Among the nematodes of most concern are *Anisakis* spp., *Capillaria* spp., *Gnathostoma* spp., and *Pseudoteranova* spp., which can be found in the liver, belly cavity and flesh of marine fish. An example of a nematode causing disease in man is *Anisakis simplex;* its occurrence is rare as the infective stage of the parasite is killed by heating ([60°C] for 1 minute) and by freezing ([-20°C] for 24 hours) in the fish core.

Cestodes

Cestodes are tapeworms and the species of most concern associated with the consumption of fish is *Diphyllobotrium latum*. This parasite occurs world-wide and marine fish are intermediate hosts. Similar to other parasitic infections, the foodborne disease occurs through the consumption of raw or under-processed fish. Similar freezing and cooking temperatures as applied to nematodes will inactivate the infective stages of this parasite.

Trematodes

Fish-borne trematode (flatworm) infections are a major public health problem that occur endemically in about 20 countries around the world, particularly in Southeast Asia. The most important species with respect to the numbers of people infected belong to the genera *Clonorchis* and *Ophisthorchis* (liver flukes), *Paragonimus* (lung flukes), and to a lesser extent *Heterophyes* and *Echinochasmus* (intestinal flukes). The most important definitive host of these trematodes is man or other mammals. Freshwater fish are the second intermediate host in the life cycles of *Clonorchis* and *Ophistorchis*, and freshwater crustaceans in the case of *Paragonimius*. Foodborne infections take place through the consumption of raw, undercooked or otherwise under-processed products containing the infective stages of these parasites. Freezing fish at -20°C for 7 days or at -35°C for 24 hours will kill the infective stages of these parasites.

4.1.1.2 Bacteria

The level of contamination of fish at the time of capture will depend on the environment and the bacteriological quality of the water in which fish are harvested. Many factors will influence the microflora of finfish, the more important being water temperature, salt content, proximity of harvesting areas to human habitations, quantity and origin of food consumed by fish, and method of harvesting. The edible muscle tissue of finfish is normally sterile at the time of capture and bacteria are usually present on the skin, gills and in the intestinal tract.

There are two broad groups of bacteria of public health importance that may contaminate products at the time of capture - those that are normally present in the aquatic environment, referred to as the indigenous microflora, and those introduced through environmental contamination by domestic and /or industrial wastes. Examples of indigenous bacteria which may pose a health hazard are *Aeromonas hydrophyla*, *Clostridium botulinum*, *Vibrio parahaemolyticus*, *Vibrio cholerae*, *Vibrio vulnificus*, and *Listeria monocytogenes*. Non-indigenous bacteria of public health significance include members of the Enterobacteriaceae, such as *Salmonella* spp., *Shigella* spp., and *Escherichia coli*. Other species that cause foodborne illness and which have been isolated occasionally from fish are *Edwardsiella tarda*, *Pleisomonas shigeloides* and *Yersinia enterocolitica.*

Indigenous pathogenic bacteria, when present on fresh fish, are usually found in fairly low numbers, and where products are adequately cooked prior to consumption, food safety hazards are insignificant. During storage, indigenous spoilage bacteria will outgrow indigenous pathogenic bacteria, thus fish will spoil before becoming toxic and will be rejected by consumers. Hazards from these pathogens can be controlled by heating seafood sufficiently to kill the bacteria, holding fish at chilled temperatures and avoiding post-process cross-contamination.

Vibrio species are common in coastal and estuarine environments and populations can depend on water depth and tidal levels. They are particularly prevalent in warm tropical waters and can be found in temperate zones during summer months. *Vibrio* species are also natural contaminants of brackish water tropical environments and will be present on farmed fish from these zones. Hazards from *Vibrio* spp. associated with finfish can be controlled by thorough cooking and preventing cross-contamination of cooked products. Health risks can also be reduced by rapidly chilling products after harvest, thus reducing the possibility of proliferation of these organisms .

4.1.1.3 Scombrotoxin

Scombroid intoxication, sometimes referred to as histamine poisoning, results from eating fish that have been incorrectly chilled after harvesting. Scombrotoxin is attributed to *Enterobacteriaceae* which produce high levels of histamine in the fish muscle when products are not immediately chilled after catching. The main susceptible fish are the scombroids such as tuna, mackerel, and bonito, although it can be found in other species. The intoxication is rarely fatal and symptoms are usually mild. Rapid refrigeration after catching and a high standard of handling during processing should prevent the development of the toxin. The toxin is not inactivated by normal cooking temperatures or by canning. In addition, fish may contain toxic levels of histamine without exhibiting any of the usual sensory parameters characteristic of spoilage.

4.1.1.4 Viral Contamination

Molluscan shellfish harvested from inshore waters that are contaminated by human or animal faeces may harbour viruses that are pathogenic to man. Enteric viruses that have been implicated in seafood-associated illness are the hepatitis A virus, caliciviruses, astroviruses and the Norwalk virus. The latter three are often referred to as small round structured viruses. All of the sea food-borne viruses causing illness are transmitted by the faecal-oral cycle and most viral gastroenteritis outbreaks have been associated with eating contaminated shellfish, particularly raw oysters.

Viruses are species specific and will not grow or multiply in foods or anywhere outside the host cell. There is no reliable marker for indicating presence of the virus in shellfish harvesting waters. Seafood-borne viruses are difficult to detect, requiring relatively sophisticated molecular methods to identify the virus.

Viral gasteroenteritis can be prevented by controlling sewage contamination of shellfish farming areas and pre-harvest monitoring of shellfish and growing waters. Depuration or relaying are alternative strategies but longer periods are required for shellfish to purge themselves clean of viral contamination than for bacteria. Thermal processing (85 -90°C for 1.5 min.) will destroy viruses in shellfish.

4.1.2 Chemical hazards

Fish may be harvested from coastal zones and inland habitats that are exposed to varying amounts of environmental contaminants. Of greatest concern are fish harvested from coastal and estuarine areas rather than fish harvested from the open seas. Agro-chemicals and heavy metals may accumulate in products that can cause public health problems. Antibiotic residues can occur in aquaculture products when correct withdrawal times are not followed or when the sale and use of these compounds are not controlled. Fresh fish can also be contaminated with chemicals such as diesel oil, when incorrectly handled.

4.1.2.1 Biotoxins

There are a number of important biotoxins to consider. Around 400 poisonous fish species exist and, by definition, the substances responsible for the toxicity of these species are biotoxins. The poison is usually limited to some organs, or is restricted to some periods during the year.

For some fish, the toxins are present in the blood; these are ichtyohaemotoxin. The involved species are eels from the Adriatic, the moray eels, the lampreys. In other species, the toxins are spread all over the tissues (flesh, viscera, skin); these are ichtyosarcotoxins. It concerns tetrodotoxic species responsible for several poisonings, often lethal.

Biotoxins are often heat-stable and the only possible control measure is to check the identity of the used species.

4.1.2.2 Ciguatoxin

The other important toxin to consider is ciguatoxin, which can be found in a wide variety of mainly carnivorous fish inhabiting shallow waters in or near tropical and subtropical coral reefs. The source of this toxin is dinoflagellates and over 400 species of tropical fish have been implicated in intoxication. The toxin is known to be heat stable. There is still much to be learnt about this toxin and the only control measure that can reasonably be taken is to avoid marketing fish that have a known consistent record of toxicity.

4.1.2.3 Phycotoxins

These toxins concern especially the bivalve shellfish; the toxicity is due to the ingestion by the shellfish of phytoplanktonic species, which are able to synthes ise toxic substances. The shellfish concentrates the toxin to a level such as it becomes potentially toxic. The principal toxins are the Paralytic Shellfish Poison (PSP) produced by dinoflagellates genus *Alexandrium*, the Diarrheic Shellfish Poison (DSP) produced by other dinoflagellates genus *Dinophysis*, or domoic acid produced by a diatom *Nitzschia pungens*.

All these toxins are known to keep in general their toxicity through processing, even in canned fish products, so the knowledge of the species identity and/or origin of fish or shellfish intended for processing is important.

4.1.3 Physical Hazards

These can include material such as metal or glass fragments, shell, bones, etc.

Sanitary and Phyto-Sanitary Standards (SPS) and relevant environmental regulations in relation to trade in fishery products[a]

by

Amadou Tall[b]

Abstract

The world total fisheries catch amounted to 110 million metric tons in 1998 of which 40 per cent entered the international trade at a market value of US$ 50 billion. Developing count ries accounted for 50 per cent of fish products supplied in the international markets, contributing to their income to the tune of US$ 17 billion. FAO has set up a Seafood Information System based on its info network in order to support the expansion of gl obal trade in fish and fisheries and aquaculture products.

The international fisheries and aquaculture trade is becoming increasingly associated with the application of Sanitary and Phyto-Sanitary (SPS) standards e.g. the HACCP (Hazard Analysis Critical Control Point) and frameworks such as Technical Barriers to Trade ("TBT"). Eco -labelling and other certification systems are being promoted to preserve the environment.

A number of key information needs have been identified to promote equitable trade and at least a beginning has been made in identifying suitable data and information sources to this effect. It is estimated that significant efforts will be required to harness currently scattered sources into a performing system that would reflect the needs and constraints of developing countries adequately. Given the relative weaknesses of national institutions in many developing countries concerned with information, SPS and trade, it may not be realistic that they take a lead in developing such a system. Howeve r, interested parties from developing countries must be associated as partners in any such effort, which could be spearheaded by the international institutions or national institutions in industrialised countries as these have already developed partial inf ormation resources for their own needs.

a) Abstract of a paper presented at the INCO -DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5 -7 June 2000

b) Director, INFOPEC HE, 01 B.P. 1747, Abidjan 01, Côte d'Ivoire. E -mail: Infopech@ci4.africaonline.co.ci

Developing country participation in FishBase. Critical biodiversity, fisheries management and trade issues.[a]

by

Boris Fabres[b]

Abstract

The Project „Strengthening Fisheries and Biodiversity Management in ACP Countries" is a collaboration between African, Caribbean and Pacific (ACP) countries and European and international partners implemented by the International Center for Living Aquatic Resources Management (ICLARM). It focuses on enabling ACP partner institutions to use the global FishBase information base for biodiversity and management purposes, while enhancing content and user interfaces. While dissemination on CD ROMs served to counteract the limitations of early Internet penetration particularly in African ACP countries, other weaknesses impeding full use are identified.

The paper recognises furthermore that many more types of information, particularly those on socio-economic issues, will need to complement the existing biologically focused information base. Given the importance of trade for economic development, a range of technical, legal and other enforcement and institutional types of information would form an invaluable set to complete the picture needed particularly by economic and political decision makers. Much of the required information exists, but is currently scattered and not even available in machine readable formats. FishBase is the most advanced and global system and could be used as an authority to network other essential types of information and knowledge.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Network Coordinator, ACP/EU Project ("Strengthening Fisheries & Biodiversity Management in ACP Countries"), ICLARM, Los Baños, Philippines. E-Mail: b.fabres@cgiar.org

Introduction

The historical development of FishBase, arguably the most complete global database and information system (including spatial tools) on fishes is documented in Froese and Pauly (2000). Operationally initiated in 1990 through European Commission funding, FishBase has rapidly evolved in content and design to now be utilised both in Compact Disc (CD) and Internet versions (http://www.fishbase.org), with English, French and Portuguese documentation, and a Spanish documentation expected in 2001. Implemented through the International Center For Living Aquatic Resources Management (ICLARM), FishBase has been able to develop collaborative linkages with a number of world museums, national and international agencies, including the Food and Agriculture Organization (FAO) of the United Nations, individual scientists and collaborators world-wide.

It has facilitated the repatriation of biodiversity, fisheries biological, and ecological data to countries, consolidating their use for conservation-oriented analyses on a single-species basis, while providing data input linkages to ecosystem analyses (e.g Ecopath with Ecosim analytical tools). In particular, recent software developments have allowed users to undertake more customised queries, analyses, graphing, and prepare products that are immediately usable for research and resource management.

FishBase in developing countries

While these advances have been recognised as spectacular, the development of FishBase has reached a pivotal point in terms of future sustainability (organisationally and financially), technical direction, modes of collaboration, and its possible options in servicing the needs of developing countries. These considerations have been concretely discussed in the current European Commission project (under the Africa, Caribbean, Pacific (ACP)/European Union (EU) Lomé Agreement) that currently supports FishBase (*"Strengthening Fisheries and Biodiversity Management in ACP Countries"*). In particular, evolving changes in European Union and developing country relationships away from the traditional "donor-recipient" approach towards a collaborative framework are germane to these considerations.

The definition of "developing country" is evasive, elastic, and subject to interpretation (sometimes conveniently). Notwithstanding the above, the harsh realities of rapidly increasing poverty in tropical countries, vulnerability of small states, small island developing states (SIDS), globalisation in its many economic and cultural forms, and negative impacts of climate change and environmental degradation, particularly on socially disadvantaged sectors, require re-focusing of collaboration, joint actions, and re-definition of priorities (UNEP, 1999; World Bank, 2000; Commonwealth Secretariat & World Bank, 2000). In this context the special socio-economic hardships and conflicts of coastal communities, the unique dangers of capture fisheries and the organisational status of government agencies are factors that can significantly influence attempts at restoration of aquatic biodiversity, ecosystems and fish stocks through external project interventions (Bailey, 1987; Glesne, 1984; Nielsen & Roberts, 1999; Poggie & Pollnac, 1997).

The ACP/EU Project (*"Strengthening Fisheries and Biodiversity Management in ACP Countries"*), initiated in 1997, has persevered in introducing the FishBase software (initially CD's and now promotion of the internet version) to countries (both "developing" and "developed") following on earlier initiatives. Annual updates (CD-ROMS) are sent to government agencies, para-statals, universities, libraries, museums, national and international research centers, individuals, and non-governmental organisations. The project, from 1997-1999, also introduced the software to participants at five regional training courses in Africa, the Caribbean and the Pacific and continues to support regional training nodes in Senegal, Namibia, Kenya, Belize and New Caledonia to extend further support to interested partners in their respective sub-regions.

Through these efforts a list of contacts world-wide has been compiled. Some of these have become active collaborators with contributions including the provision of technical documentation to populate the database, images and photos, authoritative expertise on fish taxonomy and other specific subject areas. FishBase, through its Internet version, also has the capacity to receive comments and criticisms and error detection for database improvements through E-Mail, and also to attract respondents offering suggestions as to database improvements and information to expand the database. Its open structure has allowed its use for educational and other multiplier purposes, not necessarily the principal focus initially, but demonstrating its potential to render socially valuable services.

Areas inviting improvements

An analysis of user feedback and other data indicates, however, that while FishBase updates (CD-ROMs) continue to be circulated annually, interactions from developing country recipients are less than those from developed countries, approximately in line with lesser Internet penetration compared to industrialised countries. In terms of the use of FishBase, however, these statistics probably under-represent developing country usage, due to non-reporting and Internet domain names residing in developed countries (primarily the USA).

FishBase use, interaction and development within an external project framework in developing countries needs to be interpreted in terms of the ecology of development projects: a project's competition with other projects (and the institution's regular work programme) for client/partner time; and its ability to address the immediate demands of institutions (including the software's "usability"; completeness of coverage of needed information; accessability e.g. computer availability, connectivity considerations; affordability i.e Internet time). Solutions to some of these are beyond the capacity of any one project or a "project solution". Bringing about more fundamental change would require comprehensive institutional support, and in some cases, policy action beyond the partner institution and beyond normal project time horizons.

In the particular context of the ACP/EU Project, the experience has been that FishBase, while offering singular possibilities for aquatic biodiversity and fisheries management, and already making exceptional advances towards these goals is relatively young in its development. Africa, as the biggest group of ACP countries, is estimated as having only 1.9 million Internet users at the end of 2000. However, rates of increase together with explicit policies for promoting information and communication infrastructure in several countries operate in favour of growing use, albeit more slowly than in industrialised countries.

In order to yield full impact of FishBase on fisheries management, it requires significantly widening and/or linkages and inputs to/from other aquatic databases. Examples comprise coral reefs, wetlands, river systems and inland water bodies. Particularly critical appear information on social science issues related to fisheries management e.g. socio-economics, commerce, non-fisheries aquatic uses, and interacting terrestrial impacts. For optimal support for decision making, these should be presented spatially. Collaboration to build these linkages will require additional expertise in the FishBase team, beyond biological knowledge and fish population dynamics skills.

FishBase as a pool of publicly available basic information for a variety of uses

One fruitful area of joint activity and collaboration lies in the development of a FishBase module or linkages related to responsible fish trade (national and international – see also Lima dos Santos, this vol.; Tall, this vol.). No other database or information system is equally comprehensive or has the elements to capitalise on this. Approximately 40% of global fish production is exported (being more than the combined value of tea, coffee, rice and rubber combined), mainly from developing to developed countries (the European Union accounting for 39% of imports) and the global export value of fish and fish products being US$ 51 billion, with net earnings of US$ 16 billion for developing countries (FAO, 2000). This represents a logical extension to FishBase, with possibly significant receptivity for development by developed and developing countries, and international agencies.

Global trade in fish and fish products, is being increasingly associated with the application of Sanitary and Phyto-Sanitary Standards (SPS) e.g. the Hazard Analysis Critical Control Point (HACCP) and similar monitoring systems. These include monitoring for critical limits of hazardous substances, chemical additives, microbiological and chemical contaminant limits. Labelling issues (content and format) and related regulations have also emerged through the World Trade Organization (WTO) Technical Barrier to Trade (TBT) requirements. Similar market-driven conservation efforts have resulted in Eco-Certification requirements e.g. exports of Swordfish (*Xiphias gladius*) into the USA. More recently there is increasing demand for safety-related documentation on biotechnological applications involving genetic manipulations and transgenic fish products, particularly for freshwater and cultured species.

International trade sanctions are also now being applied by the International Commission For The Conservation of Atlantic Tunas (ICCAT) related to exceeding national Total Allowable Catches (TAC's). These requirements operate at least at the individual species level. Data to support these conservation measures are required (a) on national fish catches (converted to live round weight); (b) species nomenclature clarifications and (c) listings of local/common names, and related to such international quotas and allowable catches under management regulations of national and international agreements, designations in the IUCN Red List, optimal harvesting lengths, lengths at first maturity.

Handling and processing systems also require such species-specific information (e.g. length and weight conversion factors by geographical area; specific capture, handling processing and storage conditions related to each species; species-specific infection, disease and contamination information (e.g. parasites, histamine levels, toxic algal levels).

FishBase as an authority to network other specialised data sources on fisheries, aquaculture, conservation and trade

Access to these diverse data and compiled information sources through a database system, or linked systems, with the facility to generate specific queries, profiles, reports, including images (for species identifications and disease detection, including parasites) will be a significant achievement. The system could include, for example actual nutritional proximate composition information, texts of regulatory documentation, procedures, required forms, conservation guidelines, institutional contacts (the "Competent Authorities" for health or conservation information or necessary governmental approvals for trade), required labeling, consumer guides, commercial web site linkages for auctions or current prices and E-Commerce, bibliographic information (including full texts). Many components exist, but few have the global coverage FishBase offers already.

Such a linked and consolidated system of conservation and trade information will facilitate both trade and conservation, and save significant time for governmental administrations and business interests. Such a system could also be modified and adapted to national interests. To which exte nt and when such a much more ambitious and diversified information system can be built will critically depend on the interest of institutional holders of key information and the economic and social value they attach to sharing it.

FishBase already contains many of the elements necessary to build such a responsible trade system in an innovative way, and offer this system globally on the Internet through collaborative efforts. Even currently available technology enables new steps in the direction of desirable data and information sharing and integration. It may reasonably be assumed that forthcoming developments will offer ever more interesting opportunities.

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Common names in FishBase: Key to more information on fish[a]

by

Maria Lourdes D. Palomares[b] and Daniel Pauly[c]

Extended Summary

Claiming that the common (or 'local') names of fish are one of their most important attributes is an understatement. In fact, common names are all that mos t people know about most fish. This is evidenced by the increasing number of people accessing information on fish from the FishBase website through common names (19% of 1.6 M hits in February 2001; http://19893.230.6/WebUse.cfm). The facility of searching information using common names is made possible by the compilation in FishBase of about 109,000 common names in 205 languages for 64% of the more than 25,000 species of fish in the world (Froese & Pauly, 2000) .

In FishBase, the common names of a species used in different localities and languages are associated with its valid scientific name (see Froese, this vol.; Froese & Pauly, 2000). The most obvious use of common names in FishBase is thus to identify the sc ientific name of a fish, and thence to key biological information on the species, images depicting the species (with some in their normal habitat), maps showing its geographic range as well as global catches and aquaculture production data if any (from FAO databases). FishBase staff has strived to ensure that common names (at least the official English names and their variants) for the commercially important species of fish in the world are well covered in the database (see Palomares & Pauly, 2000). FishBas e also includes common names used in trade as well as names of products, e.g., 'hamsi macunu' (Turkish; OECD, 1990), i.e., ground anchovy (*Engraulis encrasicolus*) packed in stone jars, covered with a mixture of common salt, saltpetre, bay salt, sal prunell a, and a few grains of cochineal and allowed to ripen for 6 months before canning.

a) Updated version of a paper presented at the INCO -DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) FishBase Team, ICLARM, Collaborators' Center, IRRI, Los Baños, Laguna, Philippines. E -mail: m.palomares@cgiar.org;

c) Science Advisor, FishBase Project, and Professor, Fisheries Centre, 2204 Main Mall, University of Britis h Columbia, Vancouver, B.C., Canada, V6T 1Z4. E-mail: d.pauly@fisheries.ubc.ca.

Other, less obvious, uses are to:

- ?? Preserve and make widely accessible ethno-ichthyological knowledge from endangered cultures (Palomares & Pauly, 1993; Palomares *et al*., 1993; Pauly *et al*., 1993);
- ?? Test qualitative and quantitative hypotheses about traditional classification schemes (see, e.g., Hunn, 1980; Berlin, 1992; Palomares *et al*., 1997);
- ?? Enable mutual verification of facts from ethno-ichthyology and its scientific counterpart (see Johannes, 1981); and
- ?? Follow the evolution of the linguistic subset represented by fish names, in space and through history and test related hypotheses.

Since common names in FishBase are each assigned to a specific country and language uniquely defining a culture, a large fraction of what people belonging to a certain culture know about fishes (i.e., traditional, or local knowledge) can be captured through the common names page. Such knowledge on fish comes in various forms. One of the most useful to fish biology is the differentiation of species from one another, similar to the concept followed by scientists in giving scientific names to species. One example of local knowledge in this form is the information provided by an old Soninké fisher from Bakel (Senegal), Diabé Sow, who differentiates the 'silanne' (*Bagrus docmak*) and the 'dibbabe' (*Bagrus bajad*) as not belonging to the same species, due to differences in their barbels and adipose fin (Adams-Sow, 1996).

Another form of local knowledge is the etymology of common name. One example is the Shuswap name 'tcoktci'tcin' (used in British Columbia, Canada) for *Mylocheilus caurinus,* which is a Secwépemc word meaning, "having a bloody mouth" (see Compton *et al*., 1994). Another is the Nass-Giksan (Canada) name, 'ha la mootxw', for *Thaleichthys pacificus* meaning 'for curing humanity' and refers to the oil which is extracted from this fish and used as medicine and as food preservative (Drake & Wilson, 1991).

Biological information on fish species accumulated by fishers through years of experience and living near or at the sea can also be captured through common names. This is best exemplified by the work of Johannes (1981) who reports, e.g., that according to fishers, the 'bebael' (Palauan name for *Siganus punctatus*), spawns in schools around new and full moons, during the low tide, near the outer reef edge with spawning activity peaking in October or November.

In the same manner, ecological information by experienced fishers is recorded. One good example is the differentiation applied by the Soninké (spoken in and around Bakel, Senegal) names given to white colored *Labeo senegalensis* living in sandy bottoms, 'dolla', and the black colored ones living in rocky areas, 'dolla binne' (Adams-Sow, 1996).

A final, amusing example is provided by a poem for school children penned by Mr. Javier C. Carceler (a retired teacher) in Mapun (the language of the Cagayanon people from Pawalan, Philippines), where he recounts how the 'tul-ungan' (i.e., 'bumphead'), *Cheilinus undulatus*, got the bump on its head:

"Daw ano kasagbak di danen en tanan, Nakabatyag tul-ungan kanen dumalagan, Ta iya na kakulba manunggol pasanggaan, Bumalikid kanen takong din may paryo apugan."

"Everyone was happy and made a lot of noise, and even the humphead wrasse ran to join the fun, but it crashed into a brain coral because of its haste, and that's how he got the bump on his head" [translation by Yasmin Arquiza and Ernesto Sta. Cruz; see Arquiza & White, 1994].

Information potentially useful from traditional or local knowledge is considerable and cannot be put aside. FishBase provides the infrastructure to capture and preserve such knowledge for future use, to the extent that it pertains to fishes. However, since this knowledge is language- and culture-specific, FishBase staff hope that collaborators wishing to widen the coverage of their own ethno - ichthyological knowledge as captured in the common names page of FishBase will eventually take in the responsibility of improving its contents, especially now that the facility of entering and/or modifying common names records is available through the Internet (www.fishbase.org/search.cfm).

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Africa: Bypassed or sidelined?[a]

by

Kim N.I. Bell[b]

Abstract

The Los Baños workshop focused on the means of distributing information of a scientific and technical nature. This assumes a capacity to absorb and use such information. But the capacity environment is not uniform worldwide, and Africa has a severe capacity shortfall. Africa is thus at risk of being bypassed by new developments, or sidelined by technical exchange formats that are suitable to the global knowledge society in general but too new and too expensive for users in Africa. This is a pressing problem because Africa is the repository for a significant portion of global biodiversity, with much of it as yet undocumented.

Official development aid (ODA) programs have unfortunately not managed to correct Africa's capacity shortfall. The shortfall threatens the region's economic and biodiversity resources and thence its social and political stability. The efficacy of global measures and standards, as addressed in the Los Baños workshop, is also compromised. Some key ODA problems in the African context are identified in UN statements. The paper identifies points that are efficiently addressable by ODA to rectify the capacity shortfall. Key features in many ODA structures that discourage such initiatives are also identified, and adjustments that could make ODA more effective are suggested.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Dept. Ichthyology and Fisheries Science, Rhodes University, South Africa & J.L.B. Smith Institute of Ichthyology, Private Bag 1015, Grahamstown 6140, South Africa. E-mail: K.Bell@ru.ac.za

Introduction

The present paper highlights key constraints to the inclusion of African researchers and their institutions in the global knowledge society. These pertain both to the 'hardware' and 'software' of research and knowledge production and dissemination systems.

Information systems for policy and technical support, the focus of this meeting, are undoubtedly needed by Africa. However, shortfalls in scientific and technical capacity in Africa to access, absorb and apply such information need to be considered and may require specific intermediary steps. The present paper submits that while the capacity to tap into global information systems in support of management and policy is largely lacking in Africa, certainly in a quantitative sense (see UN comments below), the first steps to correcting the structural basis of incapacity are readily addressable.

Science in Africa

> "... large scale environmental degradation threatens to undermine political stability in many regions and countries" (Environmental Change and Security Project Report **2**, 1996)

The state of science determines the ability of all nations to meet resource and biodiversity conservation targets. The following UN comments address Africa's science capacity:

> Enhancing the capacity of the state "must be considered one of [Africa's] critical challenges," -- Ethiopian Prime Minister Meles Zenawi. (http://www.un.org/ecosocdev/ geninfo/afrec/vol13no4 / 13eca1.htm, July 20, 2000)

> "Africa has seen hundreds of information technology projects that are synonymous to pipes without water. The focus on technology, not information, and emphasis on tools, not people, will continue to have drastic consequences for organisational development. The future success factor of organisations, nations and individuals is not high-level technology, but rather innovative and well-managed content. Thus it is important to continue to focus on information management, its collection in digital format and qualitative processing and dissemination." -- UN Economic Commission for Africa (http://www.un.org/ecosocdev/geninfo/afrec/vol13no4/13eca1.htm, July 20, 2000)

From a UN website comes the comment that "an estimated 30,000 Africans holding Ph.D. degrees are living outside the continent" (UNESCO Director-General Federico Mayor), and the following summary of the dismal situation:

- The skills and training capacity of nearly all African states has steadily declined since the "boom years" after independence.
- Africa has only 20,000 scientists and engineers, or 0.36 per cent of the world total, according to a 1992 study.
- Parts of Africa have only one scientist or engineer for about every 10,000 people, compared to 20-50 in Japan, the United States and Europe.
- Africa produces only about 0.8 per cent of total world scientific publications.
- Africa's world share of patents is close to zero.
- Government spending for R&D is among the lowest in the world - about 0.2 per cent of gross national product. (http://www.un.org/ecosocdev/geninfo/afrec/vol12no4/unesco.htm, July 19, 2000).

Mr. Mayor suggested "courses of short duration, rather than long courses for students going to study abroad, as one way of minimising the possibility of a brain drain." But the 'brain drain' is merely a symptom of a deeper problem. Would it not be better to combat the 'brain drain' by making Africa professionally attractive to its own scientists?

What are the consequences of the status quo?

Science is the key tool for monitoring and prediction; resource management is a key example. The lack of an independent science capacity precludes anticipation of hazards and preventive measures to deal with them. The consequences therefore are beyond serious: they are grave. The damage is expressed at several levels.

Firstly, through government. Without a high calibre independent science capacity, governments may have to adopt inappropriate models, or simply let matters take their own course. Damage can also result if the science is not independent: even G7 countries can eliminate major resources, as did Canada with its Atlantic Cod resource, substantially as a result of political conditioning of the science and over-riding of scientific recommendations. This was called "managed commercial annihilation" (Steele *et al*., 1992). Over 40,000 people were put out of work and the compensation program alone was CDN$2 billion.

Also, as alluded to in this workshop's guidelines, intergovernmental negotiations are hampered by lack of scientific capacity. Lack of parity in technical and scientific capacity can lead to difficulties in establishing trust and finding common ground on trade or conservation protocols.

Secondly, through society's conceptualisation. When science is not a part of the culture and the thinking process, and decision-making can be correspondingly unstructured. To involve the public in conservation it helps a great deal if citizens and civic officials can invoke scientific thinking in order to better understand systems, resource dynamics and conservation plans. Scientific capacity has implications also for the training of teachers, and thence the training of the citizenry; and thence implications for democracy and stability.

Thirdly, through direct local scientific results. Data on a country's own resources provide a basis for projection and management. Existence of data over a long term helps protect against "shifting baseline syndrome" in management (Pauly, this vol.), and begins to attract dialogue with other scientists, so that the entire community (the global skills base) of scientists can potentially be accessed to solve problems -- provided there is an effective means of communication. On the other hand, if there is no local base of scientific capacity monitoring will be incidental if not absent, and will rely on visiting scientists and "start-stop" projects. Capacity shortfalls imply future biodiversity losses: it is estimated (from mathematical treatment of rates of discovery of species) that there are 1,000-2,000 freshwater fish species still to be discovered (Kullander, this vol. and pers.comm.). Yet in many countries where these unknown species are expected, there are no scientific staff to carry out surveys or evaluate the samples; the implication is that we will continue to lose that biodiversity component without ever having recognised it.

Shortfalls in scientific capacity (infrastructure, personnel, frameworks to link government planning with the best scientific advice) means that conservation, biodiversity and ultimately sustainability all stand to suffer. Knock-on effects are those of poor management: resource loss, erosion, desertification, loss of productivity; even famine, disease, political instability, etc. Biodiversity losses are early warnings of these highly undesirable consequences.

Discussion of constraints and opportunities in relation to aquatic resources and biodiversity research

What limits productivity? The productive approach is not to seek blame for circumstances but to understand (in the present tense) the constraints, their consequences and costs, and the need for a change, and then to explore remedies with a good appreciation of how critical it is that they succeed.

While financial resources are patently inadequate, especially in aquatic resources and biodiversity research, and especially in Africa, simply throwing money at the problem will not solve it. My focus is a related and additional handicap for scientists in Africa: their isolation from information and discussion. Library and information services are inadequate and/or inaccessible. Also, in Africa there are relatively few scientists in any one place, and with travel being expensive it is difficult for groups of scientists to meet and develop synergies to put good ideas into practise. International contact is likewise hampered by distance and poor communication. The consequence is as described in the UN list: scientific productivity in Africa is extremely low.

Is there hope? Of course: many scientists work with dedication in Africa under difficult circumstances. They can be helped by addressing their isolation from information and discussion. This is an inexpensive key to motivating and facilitating science. If key information needs can be met and scientists can be brought into dialogue with the global scientific community, their work and effectiveness will benefit, and biodiversity and biological resources will be better preserved and managed. In more detail, the key constraints are:

1. **Financial** limitations (contributing to many items below);
2. Low access to primary **literature searches, literature itself, textbooks, methodological manuals**, support materials;
3. Low access to **collegial contact and advice;**
4. Low numbers of trained personnel;
5. Limited exposure of trained personnel to world standards and world paradigms in their fields;
6. Low access to up-to-date scientific equipment;
7. Low access to up-to-date computers and software (especially statistical analysis).

I have highlighted a few items that are capable of rapid remedy; it does not take decades to deal with these. Remedying these can indirectly address the remaining limitations.

Financial management (item 1) has often been poor, and while in a proximate sense this can often be laid at the door of recipient bureaucracies, the responsibility for addressing it must be shared by donors. Items 2 & 3 could be economically provided through a single reliable structure, and could provide benefits independently of how item 1 is addressed.

Scientific capacity shortfall is also, in the ultimate sense, underlain by restrictions on how official development aid (ODA) is delivered: via discrete projects, each with a short life. This is the "start-stop" problem in development, and it is disruptive to the development process just as boom-bust cycles are to economics. Lack of conceptual continuity arises because projects are often run by people other than those who originated them; this limits opportunity for adaptive redirection in response to changing conditions. Success is variable even in terms of projects' own stated objectives and budgets.

More specifically, restrictions that reduce ODA's success in science in Africa are:

i. Intellectual property rights of project originators are ignored in the ODA community. This is in contrast to intellectual property rights being the focus of many recent international negotiations. Instead, projects are put out to tender and may become separated from originators. Unless the philosophy of the originators is shared by the implementors, original goals might not be realised. Potential originators become disenchanted. With fewer originators, the pool of project concepts available for donors' consideration is less diverse; ultimately, the funding program itself becomes less effective.

ii. Although long-term needs exist, long-term projects to meet them are difficult to fit into existing funding regimes. In consequence, most projects are "start-stop" and their objectives are vulnerable to difficulties that arise in transferring leadership to the host countries at their conclusion.

So, firstly, ODA needs to adopt mechanisms that will actively promote the conceptual continuity of projects. Safeguarding the intellectual property rights of originators is a direct, proper and effective way to do that.

Secondly, the need must be recognised for a funding system that can support long term projects. Regular evaluation is preferable to regular termination and re-inception with all the consequent inefficiencies and loss of effectiveness that that implies. An analysis of setup and windup costs compared to running costs may reveal the financial efficiencies in the "start-stop" system.

As a positive example of a long-term information need addressed by ODA, the FishBase project (Froese & Pauly, 2000; Fabres, this vol.) successfully integrated a large body of biological and ecological information and made it globally available at no charge (a highly democratic approach). The project seems to have been more than successful despite that maintaining key staff in place under an uncertain funding regime imposes an additional challenge and must have had a cost in efficiency. Key factors behind the success of FishBase are the continued involvement and tenacity of the originators, as well as their ability to adapt to changes in distribution opportunities and to an increasingly computer-literate client community (see also Froese, this volume). Africa lags behind here and is effectively in danger of being left behind as newer communication technologies become incompatible with Africa's outdated infrastructure.

As long as science in Africa is left to drift, the problem snowballs (pardon a snowball metaphor in Africa): the best people quit Africa's compromised scientific infrastructure in favour of more productive careers elsewhere, and their loss further contributes to under-capacity and compromised infrastructure. The cycle needs to be broken.

What can be done? Supporting the information and science service needs is, compared to many other ODA thrusts, straightforward. For example, under a proposal called NIFASSA (Network for Ichthyological, Fisheries and Aquatic Science Support in Africa), a main centre with a cooperating institution can begin to serve a wide net of scientists. The target is motivated scientists in Africa. A modest investment can deliver these basic science support services.

NIFASSA proposes to help African scientists with: literature searches; obtaining the literature itself; data analysis; data backup and archiving; manuals on key methods and techniques; training materials for technicians and extension work; mentorship and exchanges through a network of scientists, etc. The project emphasises intellectual and information infrastructure.

Learning from earlier attempts at science support through ODA that have not worked fully to expectation, a few principles have been extracted for NIFASSA:

1. NIFASSA's key services are to be delivered free of charge. Why? Because that is the only way to ensure that the services will be available to those who need them. Too many researchers in Africa have zero or meagre funding, or have a discouraging amount of paperwork to complete for even a token payment out-of-country. Services basic to the development of science must be provided free in any serious effort to foster development of independent scientific capacity in Africa.
2. If the needs are long-term, so must be the project and its funding. Capacity building in science, research and education is a long-term need. NIFASSA seeks to provide on-going support, just as does a library, a school, or a hospital.
3. Networking and mentorship are key to strengthening intellectual and information infrastructure able to deliver high quality science to meet Africa's resource-management needs.
4. Motivated participation: mentorship and networking are to be provided by staff and through joint mobilisation of scientists, in developing and industrialised countries, sharing this understanding and commitment. This simply seeks to extend to Africa some of the services, networking, and mentorship that are taken for granted in industrialised countries.

These key principles, if followed, have the capacity to build trust between institutions in developing and industrial countries and a shared commitment for sustainable development which are the most effective foundations for African research to catch on.

Conclusion

The institutional and human capital in African science, including science and research on aquatic biodiversity and resources is extremely limited. Furthermore, that capital is handicapped by isolation from a suite of information and advice resources. This is a major constraint to Africa joining the global knowledge society and preparing for the 21st century, and is particularly relevant as scientific assessments are increasingly key to decisions taken from local to global levels.

Conventional aid approaches have had limited success in building the necessary scientific infrastructure and promoting high quality science. A key problem is that funding mechanisms tend to separate projects from their originators -- the projects become intellectually and motivationally orphaned. The trust of project originators is essential for ODA; if lost, it reduces the diversity of development avenues. In the context of ODA operations, rigour and transparency to support this trust will enhance effectiveness. Whether or not it can do that has implications for Africa's management of its resources, and for regional stability.

In the context of international relations, the parity of scientific capacity is a key element in understanding, goal formulation and communication. These are essential for the negotiation of durable international agreements. Support for development of parity must therefore be a priority in order to support the building of international trust and cooperation on a troubled continent.

The international cooperation programme on science and technology for sustainable development pioneered by the European Commission 18 years ago has the ability to support desirable scientific relationships outlined above (European Commission, 1998; Nauen, this vol.). It should be much strengthened in the future to meet a greater share of the enormous un-met demand in Africa. Most importantly, it must also be complemented by massive aid projects investing into basic and hig her education in order to broaden the foundations of African science and bring it up to par with other parts of the world. This is necessary to enable productive dialogue about information systems for policy and technical support that will serve producers and users of science in all continents.

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Information needs of small-scale fishing communities in South India[a]

by

Satish Babu[b]

Abstract

The small-scale marine and freshwater fisheries sector of South India employs about 750,000 fishworkers and their families. These fishers constitute one of the most backward communities in the region, with little or no mobility to take up alternative oc cupations. Further, these fishers are by and large involved in subsistence fishing.The total fish landings of the region have remained more or less constant for the last few years. However, this masks several important processes that have been going on, for example redistribution within different sub -sectors, changes in length frequency and species shifts. The reasons behind some of these trends are processes such as: unregulated coastal trawling; increased fishing effort on account of population increase; use of over -efficient fishing technologies; and overfishing of export species The State has been somewhat reluctant to adopt a proactive role in resolving these issues, probably because it calls for hard decisions. The fishermen themselves are caught up i n a struggle for survival, and therefore reluctant to sacrifice their short-term interests. The crisis is accentuated by different forms of degradation of the coastal zone such as pollution, erosion. The process of globalisation has resulted in the penetra tion of the Market into even the remotest corners of the world. Most artisanal fishworker communities, and women of these communities in particular, have been rendered vulnerable by this process.

Firm and realistic fisheries management regimes are required to ensure the livelihoods of these populations. Information forms a crucial input for evolution of such management frameworks. Information is required also for equipping these communities to tap the positive effects of globalisation (e.g., HACCP certifica tion, labelling). There is also a need for a mechanism for efficient dissemination of information - the Internet is the most promising of such mechanisms.

a) Abstract of a paper presented at the INCO -DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Chief Executive, South Indian Federation of Fishermen Societies (SIFFS), Trivandrum – 695 002, Kerala, India. E-mail: sb@siffs.org

Coral Reef Information System and management in Hainan Province[a]

by

Wang Lu[b]

Summary

Hainan is the most important island of Hainan Province, the southernmost special economic zone in China. Aquatic resources are of great importance for the econ omy of the island. Fishery and aquaculture are the most important economic activities in the coastal area, however, the beauty of the coral reef ecosystem represents a great economic potential for tourism development. Of the about 80 genera and 500 coral r eef species listed for the South China Sea, about 200 are present around the Hainan Island. However, in the last 10 year, the coral reef ecosystem developing along about one fourth of 1,611 km long coastline of Hainan Island has suffered destruction or ser ious degradation. It is for this reason that in 1998 the central government of China approved the establishment of the Sanya National Coral Reef Reserve to protect the coral reef biodiversity. It is for the same reason that the Marine and Fishery Departmen t of Hainan Province started to develop an information system for supporting decision makers in managing the coral reef ecosystem. For the moment the information system is mainly composed by different databases that can be easily connected.

Databases of the Marine and Fisheries Department of Hainan Province

The databases of the Marine and Fisheries Department of Hainan Province are structured around the following biological, environmental, socio -economic and use features:

Coral reef properties:

- Reef geography: position of the coral reef ecosystems in coastal areas;
- Coral species: list of the coral species and description of their environment;
- Bio-species: lists of fish, invertebrate and crustacean species;
- Ecosystem: communities in coral reef ecosystems;
- Environmental condition: climate, wave, tide, temperature, salinity, transparent, seabed, water quality.

a) Presented at the INCO-DEV International Workshop on Information Systems for Policy and Technical Support of Fisheries and Aquaculture, Los Baños, Philippines, 5-7 June 2000

b) Marine and Fishery Dept. of Hainan Province, 69 Haifu Rd., Haikou City, 570203 Hainan, China. E-mail: wanglu@public.hk.hi.cn

Reef related social-economic information:

- Social community information: village, population, etc.;
- Main industries: fishery, aquaculture, seaweed culture, tourism;
- Environment information: human infrastructures and activities;

Reef planning, management and educational information:

- Reef degradation situation: list of damages;
- Protection situation: management methods and rehabilitation measures;
- Planning: protected areas, construction and other planning.
- Legislation: laws and regulation rules such as the Fishery Law of China (1984), the Environment Protection Law of China (Revised, 01.04.2000), the Environment Protection Regulation of Hainan Province (05.03.1990), the Nature Reserve Management Regulation of Hainan Province (20.09.1991), the Coral Reef Protection Rule of Hainan Province (24.09. 1998);
- Environment education material: booklets, museum and park descriptions, education activities.

Coral information system structure

The information system is structured in such a way to be able to:

- store the information collected in the field in a coral reef database;
- present coral reef data and features by multi-media tools (author-ware platform) and by the coral reef GIS (MapInfo platform);
- offer additional information from scientific surveys, monitoring of nature reserves also by satellite observations.

Use of the information systems in different lines of activity

The information system has multiple uses, namely to:

- manage the Sanya Coral Reef Nature Reserve (national level). This reserve was established in 1990 at Sanya with an area of 5,600 ha. Since over two million tourists per year visit the area, the reserve aims to protect the coral ecosystem including the near-shore fringe reef and six coral reef islands. Some parts of the reserve are better protected than others, but unfortunately some parts were destroyed by human activities before the protection became effective. The reserve has currently about 15 full-time field officers. In the reserve the activities focus on the identification of coral species and coral transplantation. A national park is being built for tourism and educational programmes.
- assist monitoring activities in seven marine stations in Hainan Province to provide feedback for management.
- promote education and scientific research; and
- involve the public in information networking and public discussions with private and public enterprises.

Serving the information needs for Philippine aquatic resources research and development: The role of PCAMRD-DOST[a]

by

Cesario R. Pagdilao[b], Rudolf Hermes[b] and Ester C. Zaragoza[b]

Extended Summary

The Philippine Council for Aquatic and Marine Research and Development (PCAMRD) is one of the sectoral planning councils of the Department of Science and Technology (DOST). It is mandated to set priorities and directions, to plan, coordinate, monitor and evaluate aquatic and marine R&D projects and programs in the country. PCAMRD is also the national focal point for aquatic science cooperation programmes within ASEAN and also for bilateral collaborative programmes (e.g. with France, Germany, Australia, Korea). In order to prevent costly duplication and to increase the efficiency of R&D programmes, it has formed and continues to coordinate the National Aquatic Resources Research and Development System (NARRDS). This is a network of approximately 50 institutions (state colleges, universities, regional offices of government line agencies) all over the country responsible for implementing the R&D programmes in aquatic and marine sciences.

In discharging these functions, particularly in networking, PCAMRD utilizes aquatic resources information and ecosystem knowledge as important inputs, e.g. in policy formulation. It also generates information and new knowledge, packages available information and makes it accessible or usable to its network partners and clients in government, academia and private sector. PCAMRD, through its Aquatic Technology Management Program, provides the venue for a systematic storage, retrieval, packaging and delivery of information. Under this programme, four of these information and network systems are briefly presented.

Aquatic Resources Management Information System (ARMIS)

The information resources of PCAMRD are at present still located in decentralized databases of its technical and administrative divisions and management units. In response to the increasing demand for comprehensive, reliable, and timely provision of information, the establishment of the ARMIS was recently commissioned, preparing PCAMRD to become a one-stop-shop agency for aquatic resources and environment information.

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b) Philippine Council for Aquatic and Marine Research and Development, Los Banos, Laguna, 4030, Philippines. E-mail: dedo@laguna.net; mrd@laguna.net

The full operation of the ARMIS will enable PCAMRD to better provide information to guide policy makers in the formulation and implementation of strategies and programmes concerning the country's aquatic and marine resources R&D.

The ultimate goal of implementing the management information system is to contribute to the sustainable development of the country's aquatic and marine resources through well-informed policy making and management. PCAMRD will serve both as repository and clearing-house of sectoral R&D information.

When fully operational, the ARMIS will consist of (a) a research management information system including an inventory of on-going and completed research and accomplishments and budget releases; (b) a technology and resource-based information system, consisting of packaged information on available, tested technologies in aquaculture and post-harvest fisheries, and on priority resources or commodities; (c) a geographic information system; (d) a database on aquatic resources related phenomena, e.g. red tides, oil spills; (e) a scientific literature abstracting system; and (f) an administrative support system. Redesigning and/or integration of the following existing databases will form part of the activity: (a) Basic information on the physical and biological features of Philippine lakes, (b) Bibliographic databases of researchers done on inland waters (IARBase), (c) aquaculture commodities (AquaBase), (d) literature materials on fisheries and aquatic resources, abstracts of fisheries socio-economic and policy researches (ARSEPDIS), (e) database of statistical information on selected commodities (Data Series), and (f) the Laguna de Bay Management Information System (LDBMIS). Development of other databases such as Technology transfer Information, Market Information Review, and Commodity Review will also be included.

Coral Reef Information Network of the Philippines (PhilReefs)

Commissioned by the then Ministry of Natural Resources (now: Department of Environment and Natural Resources), between 1976 and 1982 several universities, among these the University of the Philippines Marine Science Institute (UPMSI) and Silliman University Marine Laboratory (SUML), conducted extensive coral reef surveys as a nationwide effort to assess the status of these important marine habitats. During the following decade, reef assessment was continued as component of a number of fisheries and coastal environment conservation programmes. Responding to the need for consolidation of the numerous data sets of reef survey information, in 1996 the Coral Reef Information Network of the Philippines (PhilReefs) was conceptualised and started as a project based at UPMSI and funded by PCAMRD-DOST. PhilReefs also aims at facilitating exchange and communication among scientists and other concerned parties.

The objectives of PhilReefs are to collate published and unpublished information on coral reef surveys in the country, to document this information in the form of a web-based database, to propose a protocol on data access and use of the network, and to facilitate networking among coral reef researchers in the country. At present, the PhilReefs website (www.philreefs.org) contains a database on reef assessments, the online-version of *Unos*, the official newsletter of PhilReefs, and a coral reef atlas, a comprehensive description of the state of coral reefs in the Philippines, completed in 1997. PhilReefs, recently relocated at PCAMRD, has approximately 250 institutional members and generates nationwide publicity through coral bleaching monitoring campaigns and sponsorship of a 'reef award' initiative.

National Environmental and Resource Information Center (NERIC)

Managing the coastal zone is a very complex task and requires the availability and access to, as well as efficient utilisation of, data and information pertaining to, among others, the activities of the stakeholders, and distribution and status of the resources and habitats. The establishment of the NERIC was undertaken by the National Mapping and Resource Information Authority (NAMRIA) of the Department of Environment and Natural Resources (DENR) as one of the components of the Coastal Zone Environmental and Resource Management Project in 1997. PCAMRD was chosen as the permanent residence of NERIC due to its network of agencies whose mandates involve the coastal zone environment and resources. NAMRIA and PCAMRD staff were trained in information technologies, e.g. GIS and metadatabase development. NERIC is the central repository of coastal zone data sets in the country and serves as a referral system for users. It attends to the information needs of coastal zone managers by providing a more efficient transfer of data and information from data producers and custodians to the users: resource managers, planners, policy and decision-makers.

The objectives of NERIC include answering to the information needs of coastal zone managers by providing and making available data through the use of information technology, thereby facilitating a more holistic approach in managing the country's environment and natural resources. Beyond its contribution to better coastal management, NERIC also aims at increasing the awareness on information technology and enhancing the willingness among agencies concerned to share and exchange data and information. Apart from DENR-NAMRIA and DOST-PCAMRD, other institutional stakeholders in NERIC are the University of the Philippines Marine Science Institute (UPMSI), the Department of Agriculture - Bureau of Fisheries and Aquatic Resources (DA-BFAR) and the International Center for Living Aquatic Resources Management (ICLARM).

Marine Information and Data Analysis System (MIDAS)

This database was developed in 1998 by UPMSI as a component of the DOST-PCAMRD supported research programme on marine biodiversity assessment entitled 'Influence of the South China Sea on the Philippine Shelf Reef System'. Apart from the design of a marine information system, other components of this programme were investigations on biomass, species richness and abundance as well as recruitment dynamics of reef organisms. Current data holdings of MIDAS include oceanographic data from several research cruises conducted in the South China Sea region, a bibliography database of the South China Sea and Sulu Sea, on-line catalogues of the Marine Biodiversity Resource and Information Center and the G.T. Velasquez Phycological Herbarium, LANDSAT images of the Kalayaan Island Group (Spratly Islands), and regional extracts from global databases. MIDAS also contains the analysis tools to produce and extract data products relevant to the seas around the Philippines. The goal of MIDAS is the establishment of a regional node for information on the marine biodiversity of the South China Sea.

Serving the information needs for Philippine aquatic resources research and development is one of the main thrusts of PCAMRD to assist in the planning and decision-making process of R&D and industry managers. In this way, PCAMRD provides support to a globally competitive industry, promotes sustainable use of aquatic resources and encourages environmental conservation.

LIST OF PARTICIPANTS International Workshop on Information Systems for Policy and Technical Support in Fisheries and Aquaculture Los Baños, Philippines, 5-7 June 2000			
Name	**Institution / Workshop function**	**Address**	**Tel/Fax/mail**
Mr. Oludare ADEOGUN	NIOMR	Nigerian Institute of Marine Research, P.M.B. 12729, Victoria Island, Lagos, NIGERIA	okeo@chevron.com dadeogun@hotmail.com
Dr. Rashid Abdi AMAN	National Museums of Kenya	Director of Research and Scientific Affairs National Museums of Kenya P.O. Box 40658 Nairobi, KENYA	Raman@africaonline.co.ke Tel.: +254 2 744 233 Fax: +254 2 740 122
Dr. Michael APEL (for Dr. Michael TUERKAY)	THEMATIC AREA LEADER (Decapods)	Senckenberg Research Institute Senckenberganlage 25 D-60325 Frankfurt GERMANY	Mapel@sng.uni-frankfurt.de Tel.: +49 69 7542344 Fax: +49 69 746238
Dr. Satish BABU	South Indian Fishermen Societies	Chief Executive South Indian Fishermen Societies Karamana, Trivandrum Kerala 695 002, INDIA	sb@siffs.org Tel: +91 471 343 178
Dr. Nicolas BAILLY (for Dr. Philippe BOUCHET)	THEMATIC AREA LEADER (Bivalves)	Muséum National d'Histoire Naturelle Laboratoire d'Ichtyologie 43 rue Cuvier, 75231 Paris Cedex 05 FRANCE	bailly@mnhn.fr Tel.: +33 1 40 793 763 Fax: +33 1 40 793 771
Dr. Kim N.I. BELL	JLB Smith Inst. of Ichthyology AND Dept. of Ichthyology & Fisheries Science, Rhodes University	J.L.B. Smith Institute of Ichthyology Private Bag 1015 6140 Grahamstown SOUTH AFRICA	k.bell@ru.ac.za Tel.: +27 46 636 1002 Fax: +27 46 622 2403
Dr. Susan CABRERA YETO	Dept. of Economics	Dept of Economics, Univ. of Malaga, Pl. el Ejido, s/n 29013 Malaga SPAIN	Yeto@ema.es Tel.: +34 5 2132075 Fax: +34 5 2131 251

Dr. Ratana CHUENPAGDEE	Coastal Development Centre, Thailand	Current address: Department of Coastal and Ocean Policy, Virginia Institute of Marine Science, College of William and Mary, P.O. Box 1346, Gloucester Point, VA 23062, USA	Ratana@vims.edu Tel.: +1 804 684 7335 Fax: +1 804 684 7179
Dr. Philippe CURY	STEERING COMMITTEE	UCT Oceanography Department, Rondebosch 7701 SOUTH AFRICA	Curypm@uctvms.uct.ac.za Tel.: +27 21 650 3281 Fax: +27 21 650 3979
Dr. Lewie DEKKER	ASEAN Regional Center for Biodiversity Conservation (ARCBC)	ASEAN Regional Center for Biodiversity Conservation (ARCBC) College, Los Baños Laguna PHILIPPINES	ARCBC@laguna.net Tel.: +63 49 536 4042
Mr. Boris FABRES	ICLARM	International Center for Living Aquatic Resources and Management c/o IRRI, College Los Baños, Laguna PHILIPPINES	b.fabres@cgiar.org Tel.: +632 8450 563 local 6852 Fax: +632 8450 606
Dr. Ahmad FAUZI	Dept of Fisheries Economics	Faculty of Fisheries & Marine Sciences Bogor Agricultural University (IPB) Kampus IPB Daramaga, Bogor 16680 INDONESIA	Fauzisy@indo.net.id Or Fauzi@sei-ipb.dhs.org Tel.: +62 251 624 594, 627 935 Fax: +62 251 627 935
Prof. Enrico FEOLI	COORDINATOR	Department of Biology Univ. of Trieste Via L. Giorgieri, 10 34127 Trieste ITALY	Feoli@univ.trieste.it Tel.: +39 040 676 3879 Fax: +39 040 568 855
Prof. Guy FONTENELLE	Dépt. Halieutique	Dépt. Halieutique Ecole Nationale Supérieure Agronomique de Rennes 65 Rue de St. Brieuc CS 84215 35042 Rennes FRANCE	Fontenel@roazhon.inra.fr Tel: +33 2 2348 5533 Fax: +33 2 2348 5535
Dr. Rainer FROESE	HOST, STEERING COMMITTEE	International Center for Living Aquatic Resources and Management c/o IRRI, College Los Baños, Laguna PHILIPPINES Current address: Institute of Marine Research Düsternbrooker Weg 20 24105 Kiel , GERMANY	r.froese@cgiar.org Tel.: +49 431 565 876 Fax: +49 431 597 3907 Rfroese@ifm.uni-kiel.de

Dr. Rudolf HERMES (Senior Research Fellow)	PCAMRD	Philippine Council for Aquatic and Marine Research Development - DOST Los Baños, Laguna PHILIPPINES	mrd@laguna.net Tel./Fax: +63 49 536 1566
Mr. M.V. KAPELETA	Fisheries	Dept. of Fisheries P.O.Box 593 Lilongwe MALAWI	Sadcfish@malawi.net Tel.: +265 826 918 Fax: +265 743 614
Dr. Sven O. KULLANDER	Swedish Museum of Natural History	Dept. Vertebrate Zoology Swedish Museum of Natural History POB 50007 SE-10405 Stockholm SWEDEN	Sven.Kullander@nrm.se
Dr. Carlos Alberto LIMA DOS SANTOS	STEERING COMMITTEE (unable to attend at last minute)	Av. Afranio de Melo Franco No. 365 apto.501 Leblon, Rio de Janeiro - RJ 22430-060 BRAZIL	Dossantoscarlos@highway.com.br Tel.: +55 21 239 6759 Limadossantos@hotmail.com
Dr. John MACKINNON	ASEAN Regional Center for Biodiversity Conservation (ARCBC)	ASEAN Regional Center for Biodiversity Conservation (ARCBC) College, Los Baños Laguna PHILIPPINES	Jrm@laguna.net Tel.: +63 49 536 4042
Dr. Thorolfur MATTHIASSON	Fac. Economics and Business Admin.	Fac. of Economics and Business Admin. Univ. of Iceland Odda v/Sturlugotu IS-101 Reykjavik ICELAND	Totimatt@rhi.hi.is Tel.: +354 525 4530 (direct) Fax: +354 552 6806
Dr. Cornelia E. NAUEN	EC REPRESEN-TATIVE	European Commission Directorate General Research 8 Square de Meeûs 1049 Brussels BELGIUM	Cornelia.nauen@cec.eu.int Tel.: +32 2 299 2573 Fax: +32 2 296 6252
Dr. Eilis NIC DHONNCHA (for Dr. Guiry)	THEMATIC AREA LEADER (Seaweeds)	Irish Seaweed Industry Organisation Martin Ryan Institute NUI, Galway IRELAND	eilis.nicdhonncha@seaweed.ie Tel.: +353 91 512 022 Fax: +353 91 750 539
Mr. Cesario PAGDILAO	PCAMRD	Philippine Council for Aquatic and Marine Research Development - DOST Los Baños, Laguna PHILIPPINES	dedo@laguna.net Tel./Fax: +63 49 536 1566

Dr. Ma. Lourdes D. PALOMARES	ICLARM	International Center for Living Aquatic Resources and Management c/o IRRI, College Los Banos, Laguna PHILIPPINES	m.palomares@cgiar.org Tel.: +63 2 845 0563 Fax: +63 2 845 0606
Dr. Daniel PAULY	FISHBASE	Fisheries Centre University of British Columbia, 2204 Main Mall, Vancouver British Columbia, CANADA V6T 1Z4	D.Pauly@fisheries.ubc.ca Tel.: +1 604 822 1201 Fax: +1 604 822 8934
Dr. Uwe PIATKOWSKI	THEMATIC AREA LEADER (Cephalopods)	Institut fuer Meereskunde Duesternbrooker Weg 20 D-24105 Kiel GERMANY	Upiatkowski@ifm.uni-kiel.de Tel.: +49 431 597 3908 Fax: +49 431 565 876
Dr. Roger S.V. PULLIN	Genetic Resources	1A Legaspi Park View 136 Legaspi St. Makati City PHILIPPINES	karoger@pacific.net.ph Tel.: +63 2 818 0870 Fax: +63 2 840 2630
Dr. Ussif Rashid SUMAILA	STEERING COMMITTEE	Chr. Michelsen Institute, Fantoftvegen 38 P.O. Box 6033 Postterminalen, 5892 Bergen, NORWAY And Fisheries Centre University of British Columbia, 2204 Main Mall, Vancouver BC CANADA V6T 1Z4	R.Sumaila@fisheries.ubc.ca Tel.: +1 604 822 0224 Fax: +1 604 822 8934
Dr. Amadou TALL	INFOPECHE	INFOPECHE 01 B.P. 1747 Abidjan 01 COTE D'IVOIRE	Infopech@ci4.africaonline.co.ci Tel.: +225 2021 3198 Fax: +225 2021 8054
Dr. WANG Lu Deputy Director	Department of Marine and Fishery	Dept. of Marine and Fishery of Hainan Province 69 Haifu Rd., Haikou City 570203 Hainan CHINA	Wanglu@public.hk.hi.cn Tel.: +898 532 3905 Fax: +898 677 2575
Ms. Ester C. ZARAGOS A	PCAMRD	Philippine Council for Aquatic and Marine Research Development - DOST Los Baños, Laguna PHILIPPINES	mrd@laguna.net Tel./Fax: +63 49 536 1566

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The ACP-EU Fisheries Research Initiative

The ACP-EU Fisheries Research Initiative was requested by the ACP -EU Joint Assembly, composed of Members of the European Parliament and Representatives of African, Caribbean and Pacific (ACP) Countries, in a Resolution on Fisheries in the Context of ACP-EEC Cooperation, adopted in October 1993. A series of dialogue sessions was conducted between ACP and European aquatic resources researchers, managers and senior representatives of European cooperation, using a draft baseline paper for the Initiative produced by intra-European consultation.

The Initiative aims at promoting sustainable economic and social benefits to resource users and other stakeholders, while preventing or reducing environmental degradation. It has set an agenda for voluntary collaborative research based on mutual responsibility and benefits. It promotes commitment to addressing the most crucial problems of rehabilitating complex resource systems and their ecological and economic productivity with the objective of informing and supporting more directly economic and political decision making, through pro-active and high quality research.

Suitable instruments to fund such research are, among others, the European Development Fund (EDF), International Science Cooperation (INCO -Dev) as part of the EU 5th Science Framework Programme, European Member States bilateral research and cooperation programmes and ACP institutions' own resources.