Assessment of the Impact of Aquatic Resources Research by ICLARM: Scope and Methodologies[1]

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Abstract

The importance of quantifying the economic returns to investments in aquatic resources research together with the social, environmental and institutional impacts of such investments is widely recognized among ICLARM's donors, trustees and beneficiaries. As with other CGIAR centers, ICLARM is being asked to provide specific accounts of the outputs of its research and their impact on farms and on fisheries, including their socioeconomic impact. Such impact information has become a necessary, though not sufficient, basis for setting priorities and allocating resources for research for the CGIAR centers.

This paper discusses the types and methods of impact assessment relevant to ICLARM's work. A three-pronged assessment approach is envisaged to capture the full range of impacts: 1) *ex ante* assessment for research priority setting; 2) assessment prior to dissemination or adoption along with monitoring and evaluation; and 3) *ex post* impact assessment. It also discusses the objectives and scope for operational impact assessment of ICLARM's research.

Introduction

For nearly two decades, ICLARM has been actively engaged in research on aquatic resources in developing countries, often in partnership with national aquatic research systems (NARS) and non-governmental organizations (NGOs). The broad aim of this research has been to contribute to achieving economic growth, reducing poverty, improving food security and promoting environmental sustainability in the developing world. A number of technology, management and policy options have emerged from ICLARM's past research endeavors, and extensive studies have been made of the relevance and usage of its scientific papers and products (such as software) using citation analyses and other bibliometric methods (Maclean 1988; Maclean et al. 1990; Maclean and Janagap 1993; Dizon and Sadorra 1995). However, relatively little has been done in monitoring the impact of its work in terms of its contribution to achieving the main economic, social and environmental goals mentioned above.

The importance of quantifying the economic returns to investments in aquatic resources research together with the social, environmental and institutional impacts of such investments is being emphasized by ICLARM's donors, trustees and beneficiaries. As with other CGIAR centers, ICLARM is being asked to provide specific accounts of the outputs of its research and their impact on farms and fisheries, including their socioeconomic impact. This information has become a necessary, though not sufficient, basis for setting priorities and allocating resources for research for CGIAR centers (Bantilan and Ryan 1996).

Regular and systematic assessment of the impact of ICLARM's research along with the identification of factors that determine the type of technologies and management solutions demanded by farmers and fishers has become important in defining and designing ICLARM's continued involvement in aquatic resources research. The assessment of impact can: (a) guide the choice of research portfolios into areas with the highest returns; (b) give feedback to researchers regarding clients' needs and improve the design of and set clear targets for research; (c) demonstrate the value of ICLARM's work in quantitative and qualitative terms; and (d) demonstrate the value of aquatic resources research to justify future investment.

An assessment of the potential benefits of various research projects

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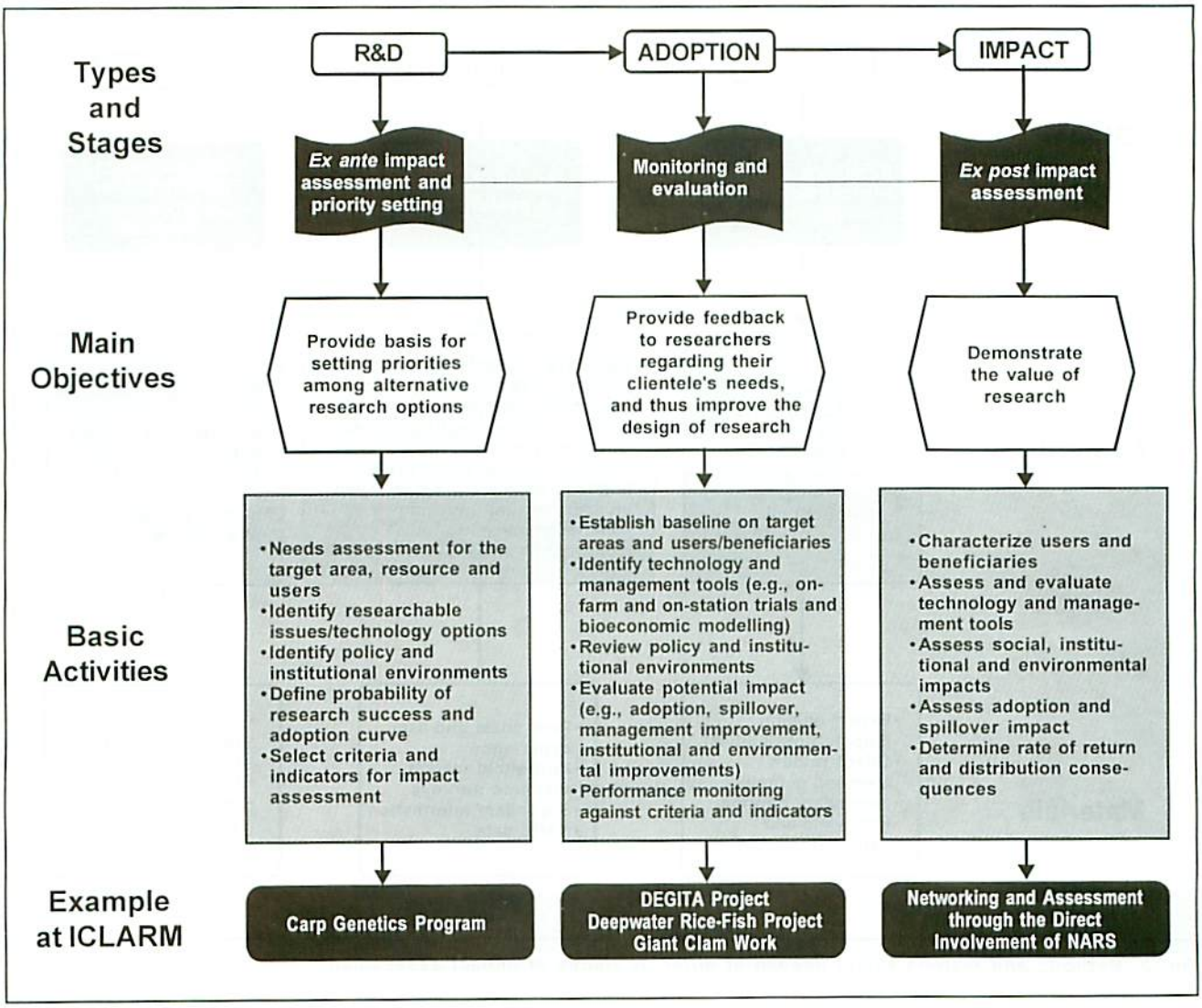

Fig. 1. Impact assessment framework.

is needed for priority setting in the initial phase of research, as well as for validating and realigning future research priorities. Indeed, there is increasing emphasis on the importance of *ex ante* assessments as a primary, though not sole, basis for deciding where to invest scarce research resources. *Ex post* impact assessments are concerned with whether and to what extent the research results, technology or information have been adopted and, where adopted, what the impact has been. To create an explicit linkage between *ex ante* assessment during priority setting and *ex post* impact studies will require consistency in approach, objectivity in methodology, and compatibility in the empirical estimation.

Given the importance of knowing and demonstrating the impact of ICLARM's work over the long term (*ex post*), and obtaining estimates of it in advance (*ex ante*) for more objective planning, ICLARM's framework for impact assessment will form an essential part of priority setting and should be able to provide measures for key indicators of impact and their dimensions. However, in developing a framework for impact assessment, we should not underestimate the difficulty of attributing impact in cases where several organizations and groups have been involved in the process and where the baseline and impact data are scarce and imprecise.

Framework and Guidelines

The impact assessment framework being adopted by ICLARM is based on the research and development (R&D) continuum, i.e., the continuum from selecting and performing research through to adoption and the impact of adoption (Fig. 1). Impact assessment is not a one-off exercise. To be effective, it must be conducted at various stages of the research-adoption-impact continuum. This means that the research process should begin with a clear projection of research opportunities and potential for impact and these be continuously monitored, evaluated and refined using

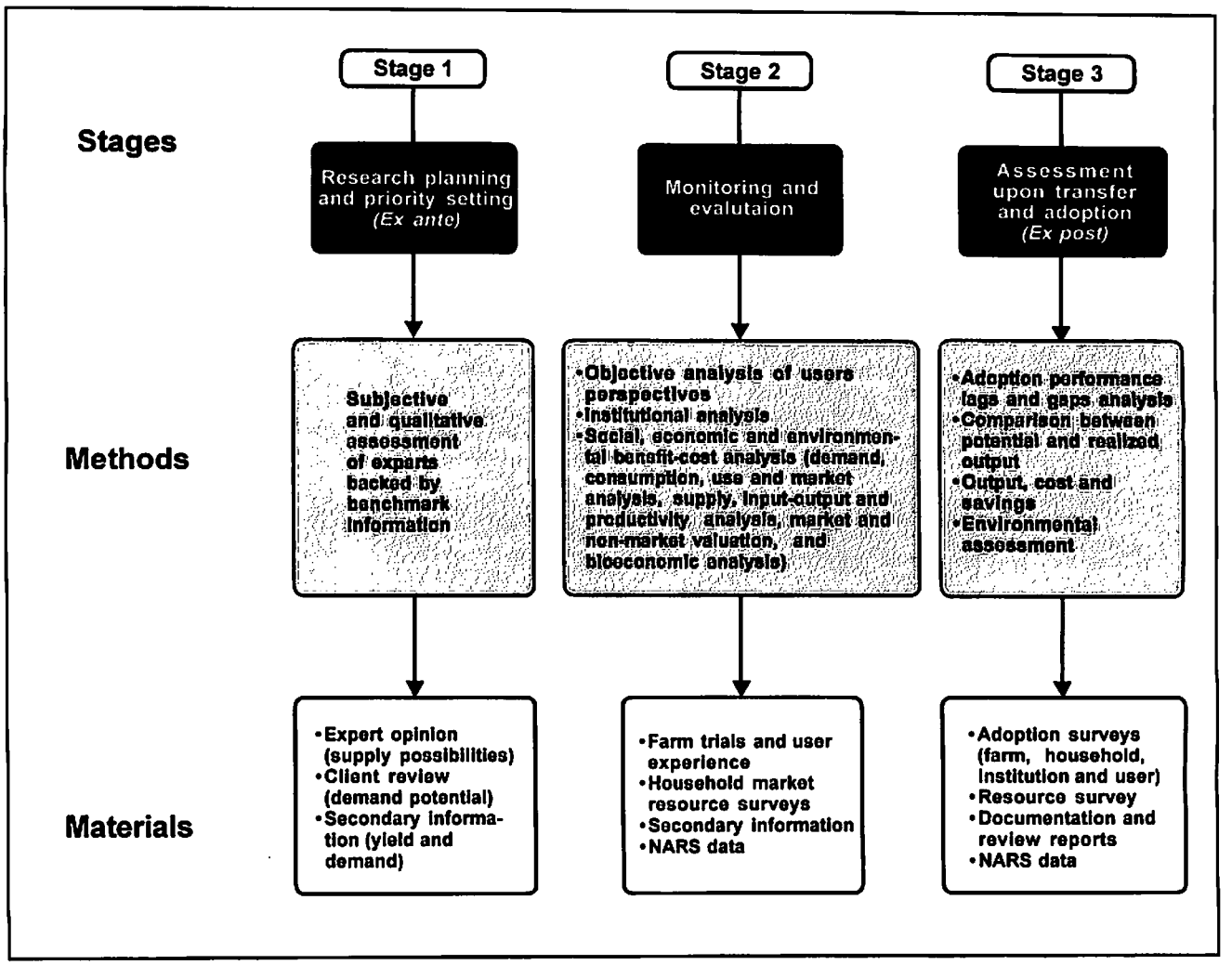

Fig. 2. Methods and materials/data needed at different stages of impact assessment.

milestones laid out in the proposals (Ahmed et al. 1997). A proposal should indicate the target beneficiaries, i.e., who the research aims to impact, what the adoption pathways are most likely to be, how that impact might be measured, and what product or output will come out of the research.

The aim is to develop a framework which ensures that data for impact assessment are collected as part of the research process of projects. A number of ICLARM projects have already established built-in mechanisms for undertaking impact assessment work at the early stages of the research-adoption-impact continuum. Since much of ICLARM's research effort goes into producing broad-based results (i.e., intermediate products) rather than final products suitable to all local aquatic and socioeconomic environments, greater collaboration is needed with the NARS partner institutes in assessing the impact. Fig. 2 provides a schematic description of methods and materials that will be needed for a three-pronged assessment approach to capture the full range of impact of ICLARM's work.

Ex Ante *Impact Assessment and Priority Setting*

This is *ex ante* assessment of a new research undertaking on generation of technology, knowledge or management models. It requires information on both the supply and demand aspects of research. Parameters for assessment of the supply aspects (potential outcomes) of new research need to be based on the experience and scientific judgment of well informed sources. Experts in the area with particular interest in the results and outcomes of the research will define and provide the first estimates of the parameters. However, biases inherent in these judgements and estimates will need to be taken into consideration. Benchmark information reflecting historical trends (e.g., yield, technological, social, demographic, economic, institutional and environmental) in the area of research concern will serve as a reference point in deriving and analyzing the *ex ante* potential. Data on the current and future needs of existing and potential beneficiaries will provide information on the demand aspects of research.

A priority setting working group consisting of experts from wider interest groups will review the initial

estimates and assumptions about the parameters in the light of the benchmark information. Finally, there will be a client review under which the working group will present its assessment on the potential for generation and adoption of technologies, policy and management options to the larger group of major stakeholders, including farmers, fishers, processing industry and consumers. They will review and modify the estimates and assumptions about the potential benefits, if necessary. The *ex ante* assessment will serve as a useful tool for prioritizing research projects.

An example of this type of *ex ante* assessment can be found in the carp genetic improvement project being carried out in selected Asian countries, funded by the Asian Development Bank (ICLARM 1996). The major objectives of this project are to: (i) develop criteria for prioritizing carp genetic research; (ii) identify priorities for research with specified focus on choice of species, farming system and traits (e.g., growth, survival and meat quality); and (iii) initiate and conduct research based on identified research priorities. The project has relied on knowledgeable researchers in the participating countries for assessing the potential for improving productivity of various species of carp through research. On the other hand, the project is conducting surveys of producers and consumers and using secondary data for analyzing demand for research in terms of species, farming systems and traits. This information has been used to identify research areas for improving productivity and output. Genetic research has been started after selecting species, farming systems, traits and breeding goals with maximum potential pay-off and in consideration of equity issues.

Ex ante assessment for priority setting must, however, take into account the: (i) current stock of knowledge, advances in science, and changes in policy and infrastructure; (ii) negative and positive consequences of not undertaking the research; (iii) possibility of failure of research by using some measure of probabilities of success; and (iv) trade-offs between equity, sustainability and profit.

Monitoring and Evaluation

Monitoring and evaluation methods will be used to examine the potential impact of a research outcome, for instance a newly generated technology considered ready for dissemination. Assessment at this stage will be more rigorous than the previous one as it involves the impact of a known technology or research outcome. However, methods to be used, parameters to be estimated and sources of data will be different for different types of research outcomes. For some technologies impact parameters and indicators can be estimated from assessment at the household, farm and community levels, while for others it may be necessary to obtain information at national or global levels.

An example of monitoring and evaluation for *ex ante* assessment at ICLARM is the DEGITA (Dissemination and Evaluation of Genetically Improved Tilapia in Aquaculture) project. Under the DEGITA project, evaluation of genetically improved farmed Nile tilapia (*Oreocromis niloticus*) was made to determine the potential impact of the improved tilapia breeds in terms of yield improvement, cost reduction, quality improvement and profit enhancement at the level of the producers, and in terms of supply and price changes at the level of consumers. The study utilized results of on-farm production trials of different tilapia breeds along with results of household and market surveys in five Asian countries (Bangladesh, China, Philippines, Thailand and Vietnam) where the dissemination of the improved Nile tilapia breed (GIFT strain) was made through the project (ICLARM 1998).

Two other examples of projects or activities that are seeking to determine measurable indicators, to provide a more comprehensive *ex ante* evaluation using data from trial and pilot farmers, fishers and their communities are: (i) Increasing and Sustaining the Productivity of Fish and Rice in the Flood-prone Ecosystem in South and Southeast Asia; and (ii) Impact of Giant Clam Productivity Improvement Research. The first project has generated baseline information on rice field production systems and their links to fisheries and the people involved. This was followed by experiments on integrated rice-fish farming. The second project has developed bioeconomic models of giant clam production which, together with an analysis of product and market developments, can be utilized for projections of the potential impact of productivity enhancement research on giant clams (Hean and Cacho 1997a, 1997b).

Ex post *Impact Assessment*

A full analysis of the impact of ICLARM research will only be available with *ex post* assessment of the adoption or dissemination of the research outcomes or technologies. *Ex post* assessment of research benefits will demonstrate, in both quantitative and qualitative terms, whether investment in aquatic resources research indeed does improve aquatic productivity, protects the environment and provides benefits to both producers and consumers in the developing countries. *Ex post* impact assessment will also generate information for scientists and research managers for setting directions and priorities and in allocating resources for further research.

Ex post assessment will require both primary and secondary data to capture information on the perceptions of beneficiaries of production constraints and resource management practices. Field surveys and secondary information supplied by NARS partners will be an essential source of data to make *ex post* assessment, and compare *ex post* realization with *ex ante* estimates. The

rate and extent of adoption of technologies, policy and management options can provide measures for gaps between *ex ante* estimates and *ex post* realization.

Assessment of market structures, including external trade scenarios, will also be relevant for *ex post* assessment of many technologies affecting the quantity, quality and periodicity of production. Changes in market structure have important implications for the magnitude and distribution of research benefits between producers and consumers.

Ex post assessment will also require mechanisms for monitoring the application and adaptation of technologies in the post-adoption phase. Field data from NARS and networking with the NARS at the transfer and dissemination stage will provide the information for *ex post* impact assessment. However, it should be noted that *ex post* impact will never be a complete measure nor will the impact be limited to a fixed time period. The impact of a certain technology can go beyond the time frame of the analysis and provide spillover benefits for a wider area than initially expected.

Operational Impact Assessment of ICLARM's Research

A framework for the evaluation of ICLARM's research undertakings or projects and for the assessment of their impacts, covering the economic, social, environmental and institutional dimensions, is given below. The methodology described is one of "operational impact assessment" involving both *ex ante* and *ex post* elements in research and developments based on the results of the research. It will initially be applied to the assessment of completed research projects. More importantly, it will serve as a basis for the development of an internal mechanism to include *ex ante* impact assessment in every major research initiative in the future.

Objectives

- To determine the dimensions and indicators of impact and provide estimates of these indicators for ICLARM research projects.
- To develop and adapt methodologies and databases for research impact assessment and provide inputs into research priority setting for ICLARM.
- To assess the contribution of ICLARM research results in NARS, NGO and public and private sector programs.
- To provide quantitative estimates of benefits from ICLARM's research and research-related activities.
- To integrate impact assessment into the research process in all major ICLARM projects.
- To involve NARS partners in the research evaluation process and provide them with the necessary methodology and training support.

Scope

Institutionalization and integration of research evaluation into the research process at ICLARM. This will allow a cost-effective integration of information on early adoption of research outputs generated by ICLARM and its partners, diagnosis of problem areas in ongoing research, and feedback of information to refine research strategies and priorities within projects.

Validation of ex ante estimates through ex post studies. Estimates of the economic returns from research are often made for certain assumed level-of-adoption ceilings and research-adoption lags. Validation of *ex ante* estimates through *ex post* impact studies will increase the reliability of future *ex ante* priority assessments. For this, the research project should include: (i) experimental design to measure direct and indirect changes or to compare before and after situations; and (ii) a logical framework analysis that will link project inputs with outputs (Ahmed et al. 1997).

Developing mechanisms for a systematic and comprehensive impact assessment of technologies, management options, software, knowledge and/or information resources generated by ICLARM and its partner institutions, NARS and NGOs. In this regard, ICLARM will initially conduct impact studies for a number of its key projects that have operated for some time. Most of ICLARM's research outputs are intermediate in nature, and it is more difficult to assess the ultimate value of intermediate products than to assess the impact of final products.

Interaction with NARS and other sibling CGIAR centers. Continued exchange of information on approaches and methodologies will help achieve the objectives. Involving ICLARM and NARS biological and social scientists jointly in both *ex post* and *ex ante* studies can serve to institutionalize the process and work to the mutual advantage of the partners.

Develop an impact database that will allow storage, retrieval, and integration of primary and secondary impact data. Primary data will include results of adoption and information on adoption variables from formal and informal surveys at the levels of farm and fisher households and the community. Secondary data will be based on documentation and review reports, and will include variables pertaining to resources and habitat (e.g., reef health), the products and benefits from the resources, and the state and dynamics of socioeconomic conditions. Primary data will provide a comparison for the projections made during *ex ante* priority setting. Primary data from farm and fisher surveys can also confirm the extent of adoption of research outputs across wider groups. Research and adoption lags assumed during the *ex ante* assessment can be verified from results of *ex post* assessment based on field data.

Dimensions and Indicators of Impact

The focus of most of the current ICLARM research projects is toward improving productivity, protecting the environment, saving biodiversity, improving policies and strengthening national programs. The choice of methods of assessment and indicators of impact will differ according to the focus of each project or program. Methods of assessment, data, and information required will also vary (Fig. 2). It will, therefore, be difficult to follow a generic method for assessing the impact of various projects and their outcomes at each stage of evaluation.

It can be argued that research in CGIAR centers, such as ICLARM, is an economic activity that involves investment of scarce resources in the production of knowledge. This is done with a view to increasing and maintaining aquatic productivity and thereby contributing to a range of economic (e.g., efficiency), social (e.g., equity) and environmental (e.g., sustainability) objectives. Relevant indicators or indices will include:

Efficiency - growth rate, increased productivity, cost reduction/saving, multiple cropping/harvesting, risk reduction and reduced rate of degradation;

Equity - income, employment, food security, poverty reduction, participation and empowerment in relation to both general beneficiaries (e.g., poorer households) and specific target groups (e.g., women);

Sustainability - habitat protection or rehabilitation, erosion and pollution control, waste management, recycling and integration, and protection/improvement of biodiversity.

Not all of the dimensions and indicators noted above are relevant to the whole range of research programs undertaken by ICLARM. Broadly, the research programs fall into three main categories: (i) resource management and environmental research (e.g., aquatic habitats, fish stocks, and biodiversity); (ii) fish breeding and integrated fish farming; and (iii) policy and information. While standard efficiency and equity indices can be used for assessing the impact of the second category of research (Alston et al. 1995), it is difficult to define and measure these for the other two categories, particularly for resource management and environmental research. The benefits of natural resources management and environmental research are often not expressed through the market mechanism and there is a wide divergence between social and private benefits and costs.

Due to the low state of knowledge of how aquatic resource systems behave, the R&D process is often caught in a dilemma between creating a body of knowledge and the production of a usable 'technology'. In the case of resource management and environmental research, the impacts will be measured through key indicators referring to: (i) the resource itself, such as biomass, relative abundance, average trophic level of the stocks, year-to-year variation, water quality and biodiversity; (ii) products of the resource, such as catch and catch per unit effort; and (iii) economic and social benefits, such as employment, income, health, nutrition, services, community harmony and equity (including gender benefits).

Quantitative data on many of these key indicators is not available at the scale or precision required for impact studies. Many natural resource management questions require fundamental, often location specific, knowledge. Generating such knowledge will create no immediate impact and yet without the knowledge little progress can be made. Trial-and-error management approaches are usually high risk. Valuation and bioeconomic modeling can be used to provide such measures for natural resources.

Concluding Remarks

Investment in impact assessment activities will not only generate information on the indicators or measurements of impact, but will also contribute to ICLARM's natural resources research program in general.

It should be noted that the impact of research depends on various exogenous factors beyond the purview of the research process itself. There could be a divergence between the actual and potential impact of research outcomes. For instance, when a 'technology' package is advised for management and policy formulation, many variants of the package and the strength or completeness of its adoption are possible. Researchers can have some impact on this process by learning how to better package their advice in useable forms for management but they ultimately have little control over whether and how it is adopted. This suggests that qualitative assessments of the technology transfer step should be used in addition to quantitative methods.

Finally, existing natural resources and governance regimes will have a strong influence on the utilization of research knowledge and technology, and much of the research knowledge and technology produced may require changes in the institutional and policy environments. There will often be considerable lags in adoption, making the time-frame for full *ex post* impact assessment very long and highly variable according to the nature of the product provided and the type of resources and governance involved.

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ERRATA

In "Marine Fisheries of Karnataka State, India" published in the April-June 1998 issue (Vol. 21 No. 2) the y-axis on Figs. 4, 5 and 7 were incorrectly labelled. The corrected figures are as follows:

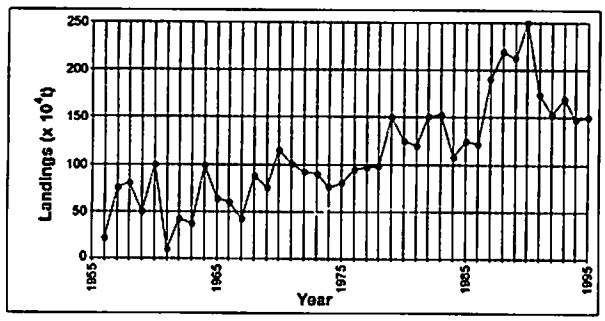

Fig. 4. Estimate of marine landings in Karnataka State, India, from 1956 to 1995.

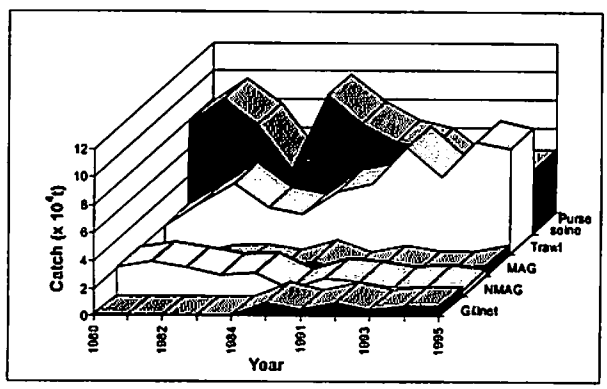

Fig. 5. Catch by fishing gear/group in Karnataka State during the periods 1980-1984 and 1990-1995 (MAG: mechanized artisanal gears; NMAG: non-mechanized artisanal gears).

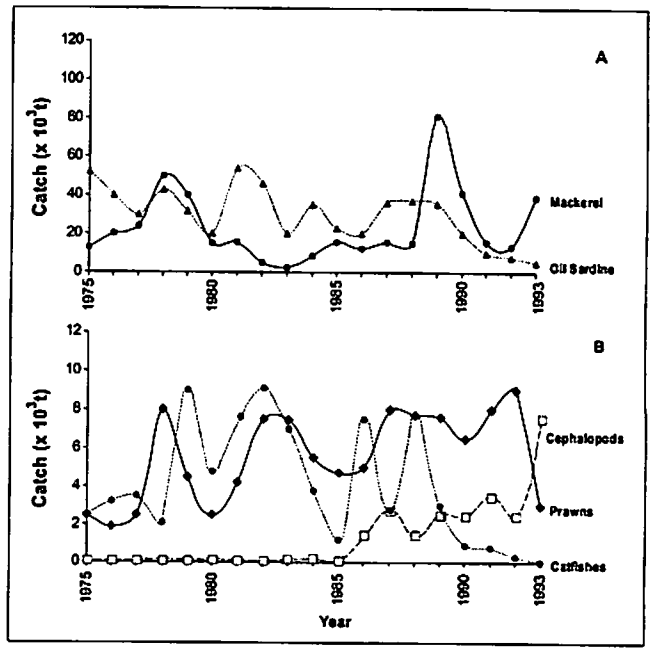

Fig. 7. Catch of selected (A) pelagic and (B) demersal groups in Karnataka State (1975-1993).

In the article "Length-weight relationships of demersal fishes from the Gulf of Salamanca, Colombia" published in the July-September 1998 issue (Vol. 21, No.3, p. 30 and 32), the author's name should read "L.O. Duarte" instead of "J.O. Duarte" and the authors are from INVEMAR, not INVEMER.