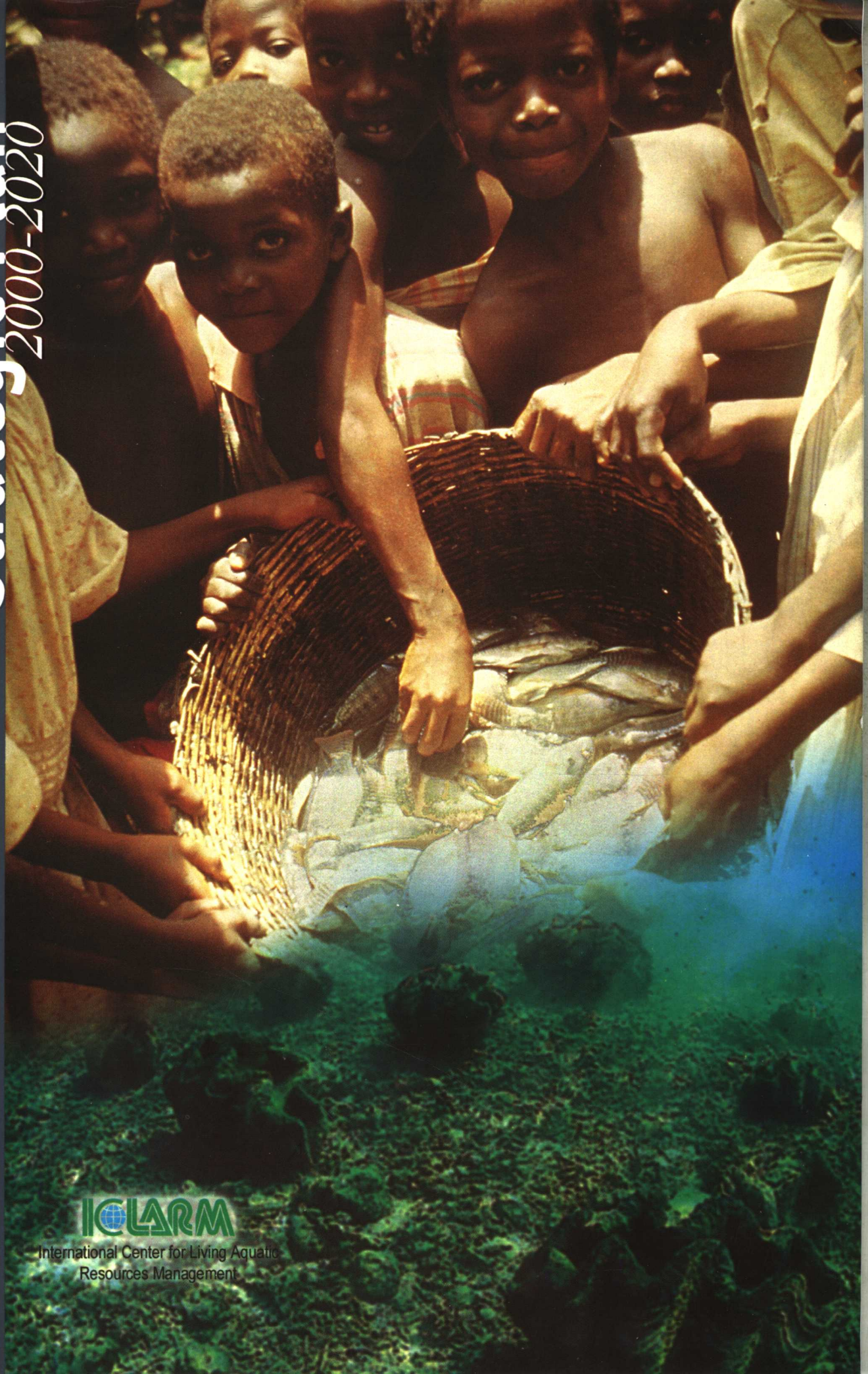
ICLARM Strategic Plan 2000-2020



ICLARM

International Center for Living Aquatic Resources Management

ICLARM
Strategic Plan
2000-2020

1999

ICLARM
International Center for Living Aquatic
Resources Management

ICLARM Strategic Plan 2000-2020

1999

Published by the International Center for Living Aquatic Resources Management
MCPO Box 2631, 0718 Makati City, Metro Manila, Philippines.

ICLARM. 1999. ICLARM strategic plan 2000-2020. International Center for Living Aquatic Resources Management. Makati City, Metro Manila, Philippines. 27 p.

Credits
Written and edited by: Peter R. Gardiner and Violeta P. Corral,
based on the collected contributions of ICLARM staff and stakeholders.
Managing Editor: Marie Sol Sadorra-Colocado
Coordinator: Sheila Siar
Copyeditor: Tan Lay Cheng
Cover Designer and Layout Artist: Mayanne A. Wenceslao

Support was provided by the Australian Centre for International Agricultural Research towards the planning process.

About the cover
Sustainable harvests from the sea and other aquatic resource systems provide food, income and livelihood to poor people in the developing world.

Photo credits
Top photo: Mark Prein
Bottom photo: John Munro

ICLARM is one of the 16 international research centers of the Consultative Group on International Agricultural Research (CGIAR) that has initiated the public awareness campaign, Future Harvest.

CGIAR

FUTURE HARVEST

ICLARM Contribution No. 1544

ICLARM organizational statement

Our commitment
ICLARM contributes to food security and poverty eradication in developing countries.
We aim for:

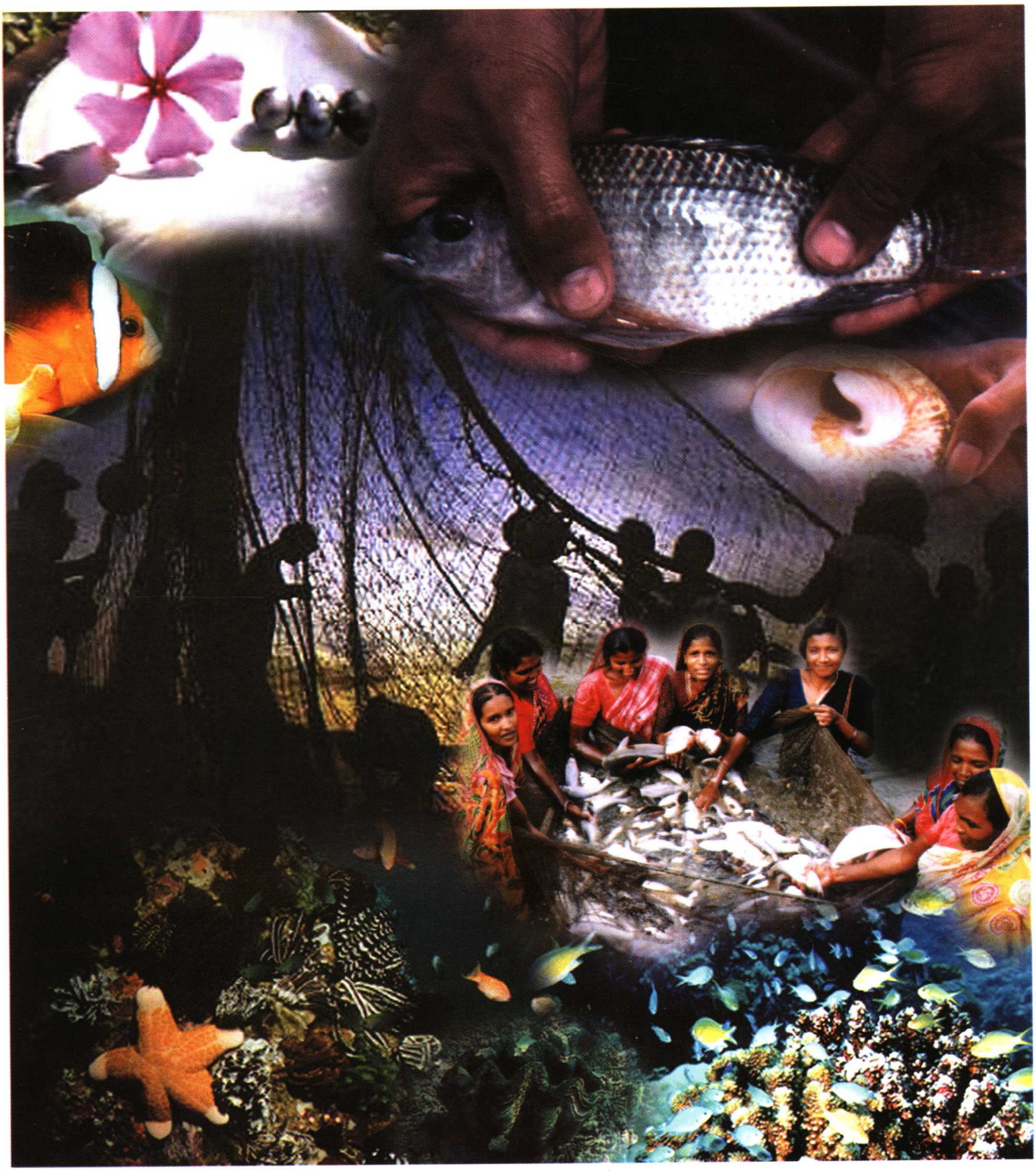
- poverty eradication;
- a healthier, better nourished human family;
- reduced pressure on fragile natural resources; and
- people-centered policies for sustainable development.

A way to achieve this
Through research, partnership, capacity building and policy support, we promote sustainable development and use of living aquatic resources based on environmentally sound management.

The research objectives are

- raising and sustaining the productivity of fisheries and aquaculture systems;
- protecting the aquatic environment;
- saving aquatic biodiversity;
- improving policies for sustainable development of aquatic resources; and
- strengthening the capacity of national programs to support sustainable development.

We believe this work will be most successful when undertaken in partnership with national government and international institutions and with the participation of the users of the research results.



The term 'fisheries' is often used broadly to include 'fisheries and aquaculture'; in the same manner, the generic term 'fish' is often used to refer to all aquatic resources including finfish, mollusks, crustaceans and aquatic plants.

Acronyms

AFSSRN	Asian Fisheries Social Science Research Network
APAARI	Asia-Pacific Association of Agricultural Research Institutes
ASI	Advanced Scientific Institute
CAC	Coastal Aquaculture Centre
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
GCRMN	Global Coral Reef Monitoring Network
GIFT	Genetically Improved Farm Tilapia
IAA	Integrated Aquaculture-Agriculture
ICFM	Integrated Coastal Fisheries Management
ICZM	Integrated Coastal Zone Management
IFPRI	International Food Policy Research Institute
INGA	International Network on Genetics in Aquaculture
IPR	Intellectual Property Rights
LARM	Living Aquatic Resources Management
LIFDCs	Low-Income Food Deficit Countries
MPA	Marine Protected Area
NARS	National Aquatic/Agricultural Research Systems
NGO	Non-government Organization
SA	South Asia
SEA	South East Asia
SIDS	Small Island Developing States
SSA	Sub-Saharan Africa
SWBs	Small Water Bodies
SWGRP	System Wide Genetic Resources Program
SWICP	System Wide Initiatives on Common Property
SWIM	System Wide Program for Irrigation Management
WANA	West Asia/North Africa
WTO	World Trade Organization

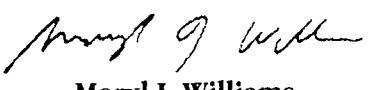
Foreword

In the last decade, the knowledge, exploitation, state of health and public concern over aquatic resources have evolved rapidly. The world context for research on living aquatic resources, including the welfare and circumstances of the people dependent on them, has changed since ICLARM developed its last Strategic Plan in 1991-1992 as the Center prepared to join the Consultative Group on International Agricultural Research (CGIAR). ICLARM's priority research has shifted over time as it responds to those rapid changes and major developments. It has been at the forefront of assessing some of these developments—e.g., the status of aquatic resources through global assessments of the decline in trophic levels in fish catches in many regions, and the first thorough assessment of the risk facing coral reefs. Where the previous Strategic Plan was strongly fisheries-oriented, our scope of work today has broadened and has been influenced by equity, sustainability and efficiency considerations. With this Strategic Plan, ICLARM reinforces its commitment to aquatic resource conservation in the coming decades.

In consultation with our stakeholders, ICLARM has adopted an aquatic resource system approach—used for the first time in the earlier Plan—and examined eight different aquatic resource systems, the special resource issues of small island developing states, and the major issues and benefits of each aquatic resource system for the poor in developing countries. These resource systems have been selected largely to respond to the needs in the tropical regions of the world. A companion volume to this Plan is also available (see ICLARM 1999 "Aquatic Resources Research in Developing Countries: Data and Evaluation by Region and Resource System: Supplement to the ICLARM Strategic Plan 2000-2020"). It contains population, poverty and aquatic resource profiles of developing countries by regional groupings; and summary data by aquatic resource systems used to frame the priority-setting process as well as in describing the process itself.

ICLARM recognizes that future research advances and new partnerships will stimulate more avenues and opportunities for success in developing country aquatic resources research. It has thus adopted an 'evergreen' approach to the current Strategic Plan which will be reviewed periodically. Based on available data and the strategic planning process in 1998, ICLARM is confident that the priorities identified in this Plan represent the optimal approach towards enhancing the role aquatic resources research can play in the lives of people in developing countries in the next two decades. Descriptions of how the Plan will be implemented will be progressively found in ICLARM's rolling three-year Medium Term Plans and the more detailed annual Operational Plans.

Kurt J. Peters
Board Chair



Meryl J. Williams
Director General

Executive summary

CLARM's research is conducted with a view to production today and tomorrow and thus aims to promote intergenerational equity of benefits. ICLARM will constantly monitor global aquatic resource issues to establish the 'evergreen' approach in its strategic research agenda. Following an analysis of the circumstances of poverty and dependence on aquatic resources in developing countries, and then noting ICLARM's comparative advantage and track record, our research portfolio in the medium-term will encompass aquaculture and fisheries and living aquatic resources management (LARM).

We will expand our research thrusts from ponds, coral reefs and coastal waters to freshwater systems, namely lakes, small water bodies (SWBs) and floodplains. This strategy will emphasize the development of aquaculture in ponds and SWBs, the sustainable exploitation of coral reefs within integrated coastal zone management (ICZM), and generic contributions to tools and knowledge to augment the performance of developing country fisheries. We will continue our focus on Asia, and enhance activities in Africa and the small island developing states (SIDS) of the Indo-Pacific and Caribbean; work in mainland Latin America will not be a principal priority (see Table 1).

We will adopt an ecosystem approach to formulate integrated models for management and governance of whole resource systems. We will also pursue aquatic genetic research that addresses critical issues in aquatic biodiversity.

Our research outputs will be shared globally as international public goods in the form of new knowledge, databases and models, improved germplasm and aquaculture practices, and underpinning generic fisheries research. We will conduct strategic training and contribute scientific data, analysis and management advice to our various stakeholders, including national aquatic/agricultural research systems (NARS) in developing countries. We aim to help strengthen national capacities to formulate policies for the sustainable management of aquatic resources. Research and capability-building activities will be undertaken in partnership with NARS and other stakeholders, and will draw upon multidisciplinary expertise in the biophysical, socioeconomic, legal/institutional and other relevant fields. Moreover, we will continually assess the impact of ICLARM's research outputs and evaluate the value of our research on the environment, and especially to poor people in the developing world.

Evidence and public awareness of the effects of overfishing and the limitations to harvests from marine and freshwater systems have increased in recent years. Aquaculture has also experienced an unprecedented boost, representing the fastest growing agricultural industry in some developing countries. Human population growth rates are highest in the developing countries, thereby exerting increasing pressures on terrestrial and aquatic environments. Issues of increasing prominence are: degradation of aquatic resource systems due to land-based activities; competition for water and coastal space; multifunctional uses of aquatic resource systems; management and governance of aquatic resource systems; linkages between the private and public sectors with respect to fisheries' markets and ownership of rights to germplasm; linkages between fisheries and aquaculture as a result of fishmeal availability and price, world fish supply and demand; and the role and contribution of women in fisheries. The most important concerns for the future include: sustaining aquatic environments to stabilize or augment production levels for human food; protecting aquatic biodiversity on which future productivity depends; and integrating the biophysical, socioeconomic and policy elements of aquatic resources management. These key areas must be addressed against a background of increasing global concern and dispute about rights over genetic resources, the effects of intermittent or long-term climate change, a widening gap between the rich and poor, increasing globalization and changing development paradigms.

Table 1. ICLARM's priority research thrusts (2000-2020) by aquatic resource system and regional focus.

Aquatic resource system	Priority	Research thrusts	Regional focus
Ponds	Very high	• Introduce integrated aquaculture systems and impact analysis • Enhance genetic techniques	Asia, Sub-Saharan Africa (SSA)
Small water bodies, reservoirs, and lakes	Medium	• Develop knowledge base • Enhance productivity • Integrate management	SSA
Floodplains, streams and rivers	High	• Enhance yields • Develop appropriate research methods and data to evaluate the resources and improve policy decisions and institutional framework	Mekong Basin, South Asia
Coastal water (including estuaries and lagoons)	High	• Co-manage coastal and fisheries resources • Plan for integrated resource use • Introduce sustainable coastal aquaculture and stock enhancement	South East Asia (including Mekong Basin) SSA, SIDS
Coral reefs	Very high	• Integrate data on coral reefs to determine parameters of reef health • Practice better management within ICZM context • Encourage sustainable exploitation of coral reef resources through aquaculture and marine protected areas (MPAs)	SIDS (Pacific, Caribbean) South East Asia, East Africa
Soft bottom shelves	Medium	• Conduct policy analysis and study implications of changes in coastal fisheries	Asia, Africa
Upwelling shelves	Low	• Keep watching brief on productivity and influences of catch on trade and other aquaculture development	
Open oceans	Low	• Monitor world catch statistics and trade for their effects on ICLARM's target beneficiaries and other resource systems and global patterns	

Very high represents the heartland of ICLARM's research; it will be allotted between 15-30% each of ICLARM's total financial and human resources and preferentially protected from budget shortfalls. **High** priority research will be pursued by ICLARM, but usually covering not more than 15% of resources. **Medium** priority research will be pursued by ICLARM, normally covering not more than 7.5-10% of resources. **Low** priority indicates that extant data will be used from these systems to contribute to generic research (e.g., fisheries models) and any additional research will generally be conducted by collaborators.

Contents

Introduction

The present state of knowledge of most aquatic resource systems, species and culture systems lags far behind that of terrestrial agriculture and forestry systems. ICLARM has been at the forefront in efforts to improve the knowledge base of LARM and to decrease the overall state of stress on overfished and heavily degraded aquatic resource systems. We seek to contribute to scholarship in tropical fisheries science, raise awareness of key issues, conduct and coordinate international public good strategic research, and be an eminent provider of results and management methods for the sustainable use of aquatic resources by poor people. We also aim to integrate the biophysical, socioeconomic and policy elements of aquatic resources management, taking into consideration their complex issues and interlinkages. Fig. 1 illustrates the wide-ranging contexts and trends within which ICLARM's research on aquatic resource system is situated.

In this second Strategic Plan, ICLARM has endeavored to address LARM issues in developing countries for the period 2000-2020. Our research outputs will provide the means for increasing food production, sustaining aquatic environments and their diverse biological resources, and enhancing livelihoods and well-being of poor people dependent on aquatic resources. Our stakeholders range from fishers and fishfarmers through NARS and other researchers, fisheries' managers, nongovernment organizations (NGOs) and community leaders to development agencies, donors and the private sector.

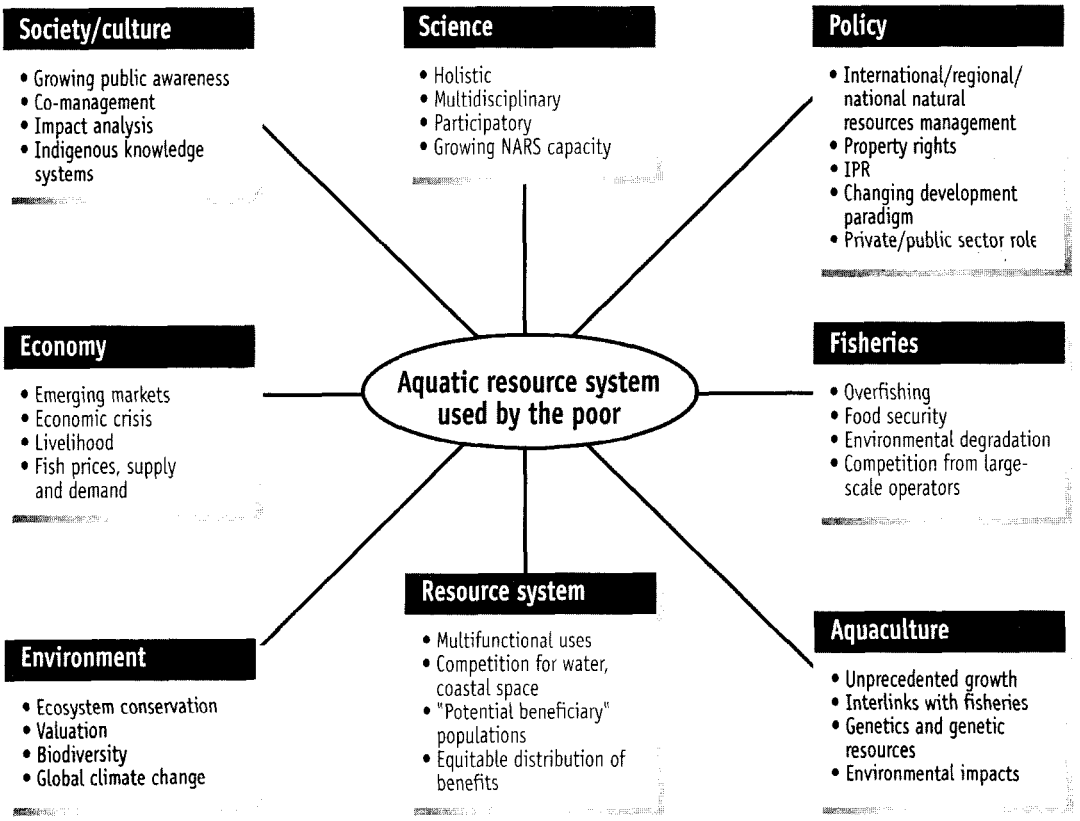


Fig. 1. Aquatic resource systems research: contexts and trends.

At the heart of ICLARM's research priority-setting process is the aquatic resource systems approach (see Fig. 2). This entails an evaluation of the problems and opportunities within eight aquatic resource systems and seven regional groupings in the developing world for the potential application of research (see Annex A). We define an aquatic resource system as the zone of convergence of the resources, their aquatic environment and the human users. We believe that this novel approach, which focuses directly on developing countries and resource system issues, provides more relevant material for analysis than global aggregates, or regional analyses based only on large continental groupings.

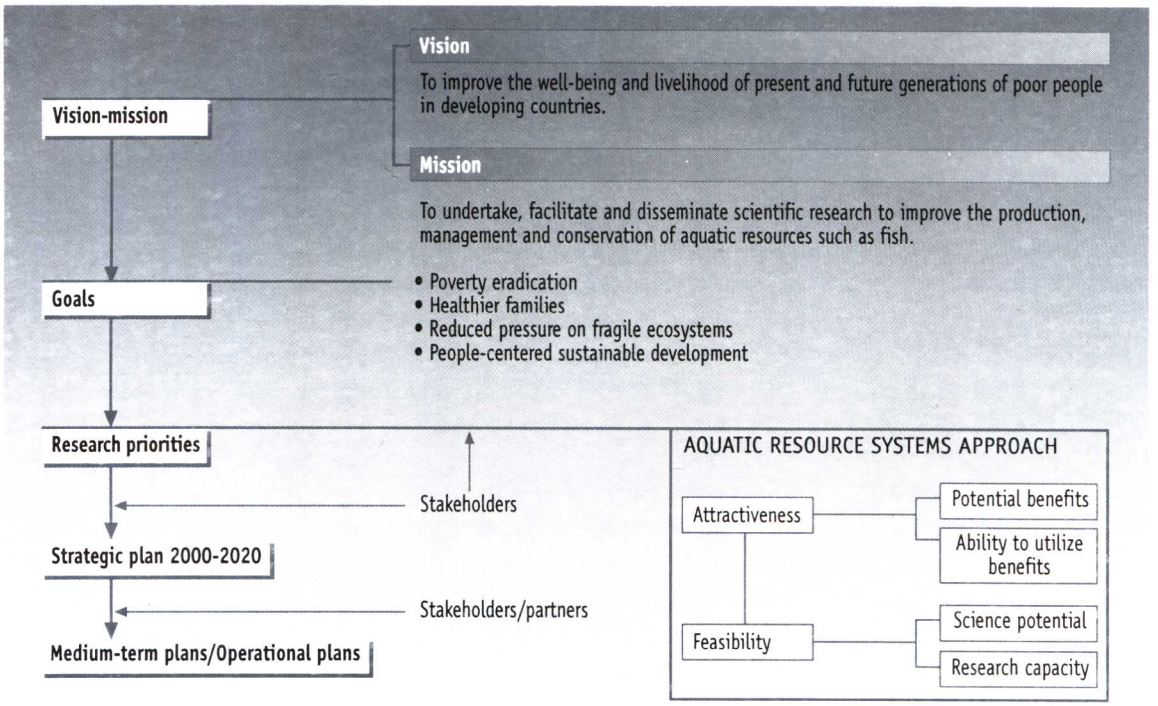


Fig. 2. ICLARM's research priority-setting process.

World fisheries and aquaculture outlook

Fish is a high quality protein source that can either be used directly as human food (food fish) or for other purposes (e.g., fishmeal). Fish and other aquatic organisms can also be used in a number of different ways, from ornaments to tourism. Fish as food comprises about 16% and 6% of total animal protein and total protein consumed, respectively. In some regions of the developing world, fish can contribute even more to the protein intake. Capture fisheries production, or fish caught from natural stocks, has not been able to keep pace with the demand for fish. Looming shortfalls have been compensated, though not adequately, by better than expected increases in aquaculture production of fish. More than half the present world catch is consumed in developing countries, but international trade is fast changing fish consumption patterns.

According to recent Food and Agriculture Organization (FAO) estimates:

- Global fish production in 1996 reached 130 million metric ton (mt), almost doubling the average per caput food fish supply from 8 kg in 1950 to over 15 kg. Food fish supply per caput in low-income food deficit countries (LIFDCs) is currently about half the world average.
- Aquaculture production contributes about 20% of the total world production of fish.
- The percentage of the world fish production from developing countries has steadily increased to roughly 70% since 1985. Asia currently dominates world fisheries and aquaculture production.
- The value of the global fish catch and international trade have increased in recent times. About 40% of the present global fish production are traded internationally; developed countries are net importers. Trade in reef species (e.g., pearl oysters, bêche-de-mer) and live reef fish has also grown sharply. LIFDCs have an excess of some US$ 8 billion of exports over imports of fish and shellfish worldwide.

Despite such crucial moves to improve stewardship of fisheries resources as the 1995 FAO Code of Conduct for Responsible Fisheries, it is doubtful that global catches will recover and resume the fairly steady production increases which marked the period from the 1940s through the 1980s. Over the next 25 years, the challenge in fisheries management will be to maintain present or near-present harvest levels while sustainably increasing aquaculture production to meet growing demands for fish and other living aquatic resources.

Challenges of capture fisheries

A downturn in global fisheries production in the early 1990s brought about by overfishing and continuing environmental degradation generated public alarm and calls for improved management schemes and sustainable utilization of aquatic resource systems. Of the world's 200 fished stocks, for instance, only a third are capable of sustaining increased harvests. An estimated 27 million mt, or about 30% of total marine production, are discarded every year (Alverson et al. 1994).

Overfishing in many areas is leading to harvests of smaller fish and lower catches per unit effort. The removal of longer-lived, piscivorous fish is changing balances within the world catches towards shorter-lived, planktivorous pelagic fish and invertebrates. Despite increases in the price of fish, these trends lower per capita income for fishers. Moreover, inadequate fisheries management has allowed the degradation of the common property resources of the oceans and failed to address the fundamental questions of rights in fisheries.

ICLARM has joined others in raising global awareness over the sustainability of marine capture fisheries:

"Present exploitation patterns are unsustainable...Fishing down food webs (that is, at lower trophic levels) leads at first to increasing catches, then to a phase transition associated with stagnating or declining catches."

—Fishing Down Marine Food Webs (D. Pauly, V. Christensen, J.Dalsgaard, R. Froese and F. Torres), Science 279: 861-863. February 1998.

"The primary production required to sustain [world fisheries catches for 1988-1991 or 94.3 million mt], plus 27 million mt of discarded bycatch, amounted to 8.0% of global aquatic primary production, nearly four times the previous estimate. By ecosystem type, the requirements were only 2% for open ocean systems, but ranged from 24 to 35% in freshwater, upwelling and shelf systems, justifying current concerns for sustainability and biodiversity."

—Primary Production Required to Sustain Global Fisheries (D. Pauly and V. Christensen), Nature 374: 255-257, March 1995.

"Overfishing is a serious problem [in San Miguel Bay, Philippines], with the demersal biomass down to 18.5% of their levels in the late 1940s...The evident biological and economic overfishing persist amidst issues of poor infrastructure, limited financial and organizational capabilities, overlapping institutional functions and lack of stakeholder participation in management."

—Integrated Management of Coastal Fisheries: Lessons from Initiatives in San Miguel Bay, Philippines (G. Silvestre), March 1996.

"Fifty eight percent of the world's reefs are potentially threatened by human activity—ranging from coastal development and destructive fishing practices to over exploitation of resources, marine pollution, and run off from inland deforestation and farming."

—Reefs at Risk. A Map-Based Indicator of Threats to the World's Coral Reefs (D. Bryant, L. Burke, J. McManus and M. Spalding), June 1998.

"Overfishing is not a recent issue. It was formally recognized internationally in the early 1900s and was the subject of the London Conference on Overfishing in 1947. Subsequently, it has become prevalent in most fishing areas and affects capture fisheries in developing and developed countries, often becoming particularly severe in densely populated coastal areas and in very productive offshore areas."

—FAO, The State of World Fisheries and Aquaculture, 1996.

"The meeting urged governments and international organizations, inter alia, to reduce fishing to sustainable levels in areas and on stocks currently heavily exploited or overfished and to adopt policies, apply measures and develop techniques to reduce by-catches, fish discards and post-harvest losses."

—The Rome Consensus on World Fisheries Adopted by the FAO Ministerial Meeting on Fisheries, Rome, 14-15 March 1995.

"World fish stocks are in crisis. Almost two-thirds of marine stocks in the Pacific and Atlantic oceans are being fully exploited or have already been overfished, even if some are recovering slowly. Future projections predict a steadily widening gap between the world's demand for fish and the ability of the oceans to meet it."

"Many scientists claim that the situation is the inevitable result of the failure of governments to heed their warnings of the dangers of overfishing; and where they have listened to their message, failing to adopt and forcefully police policies designed to prevent this."
—Nature, March 1997.

"Asia's fish stocks are dwindling because of over-exploitation and pollution."
— Far Eastern Economic Review, March 1997.

In the 21st century, however, new opportunities will abound due to increased pressures to create new management regimes, particularly over coastal and inland fisheries.

- ICLARM's research in fisheries co-management has generated a large body of knowledge and information on the institutional approaches that are potentially available to developing countries and has demonstrated that co-management may be an equitable, efficient and sustainable management strategy.
- Opportunities for improved management will require research on the resources themselves, establishing historical levels and stock dynamics, on the people who fish, who consume the products and others who affect the quality of aquatic habitats, and on the human institutions which affect resource exploitation including the nature of rights to the resources.
- Opportunities also exist to make a fundamental shift and move from a species by species approach to an ecosystem approach that includes people and their livelihood strategies.
- The widespread establishment of small reserves or MPAs seems promising, and can be facilitated through simple 'best practice guides' which ICLARM has developed.

Growth of aquaculture

An unprecedented boost in aquaculture has occurred in many countries in recent times. Aquaculture appears to be one of the last frontiers to increase contributions to food security in the developing world. It now represents the fastest growing agricultural industry in some countries, with freshwater aquaculture dominating total aquaculture production. Although Asia currently leads aquaculture production, FAO studies (Kapetsky 1994, 1995) show that Africa and Latin America have much potential, indicating an opportunity to improve food security, nutrition and income among the poor. Many predict a continued growth of the aquaculture sector well into the next century.

According to FAO estimates in 1996:

- LIFDCs are the dominant producers in aquaculture, with overall statistics heavily influenced by developments in China, which accounts for 68% of world output.
- The total production of cultured finfish, shellfish and aquatic plants reached 34 million mt (valued at US$ 46.5 billion). Aquaculture contributed between 14 and 62% to national aquatic production in the top 14 producing countries.
- Carps are the major cultured aquatic organisms. Three finfish species groups—carps, salmonids and tilapias—account for 82% of total finfish production.

Research in small-scale aquaculture can make fish more widely available and affordable to consumers. By increasing harvests and improving efficiency of production methods, fish farmers can profit and contribute to the household economy and rural development. Women can also be provided livelihood opportunities through aquaculture. Viable strategies include small-scale integrated aquaculture-agriculture (IAA) practices, integrated approaches to coastal management and genetic improvements in farmed species. Enhanced fish can be consumed locally to increase productivity and ensure food and nutritional security, especially at the household level. Planned intervention, however, is needed to help the poor share the benefits of aquaculture technology more equitably.

Further research needs to be directed at such key issues as ecosystem interactions, indicators of sustainability, resource valuation, extension methods for aquaculture, governance theory and influencing transnational management and equity. Participatory research tools should be developed to ensure that the target beneficiaries of such research are involved and/or consulted in critical stages of the research process.

Research should also address potential threats to the effective use of aquaculture that include the increasingly poor water quality and reduction in fresh water availability globally. Additional factors are land prices and alternative land use, feed costs for developing country practitioners, the competition between aquaculture and livestock feed markets, diseases, and labor costs.

The following are major trends and suggested directions for the growth of aquaculture:

- Freshwater aquaculture as a contributor to food security and rural development will become more important in the less developed countries of Asia.
- Aquaculture in South Asia will raise its profile still further as it provides relatively high returns compared with other agricultural products.
- Environmental factors will continue to play a key role in aquaculture development throughout the East Asian region.
- The crisis in the shrimp culture industry has led either to the adoption of less resource dependent practices or diversification into other high value finfish species in Southeast Asia. These will likely remain beyond the means of the poor unless alternative feeding regimes can be developed.
- Aquaculture in mainland Latin America is highly commercial and not integrated into government structural policy frameworks that might target the poor.
- SIDS have few natural resources other than terrestrial and mangrove forests, and aquatic resources. There is a wide scope for enhancement of coral reef and marine aquaculture, which may have the dual role of protecting important high value species and generating food and income opportunities.
- The West Asia/North Africa (WANA) region is affected by perennial water shortages. Other human/agriculture pressures will mean that aquaculture development should involve the use of water for multiple purposes.
- Smallholder aquaculture in Africa, initially integrated with agriculture, will evolve toward partly or completely commercial systems as the demand for fish increases.
- The number of SWBs and reservoirs brought into fisheries and aquaculture will increase along with pond aquaculture.

Emerging issues in aquatic resources management

The exploitation of aquatic resources generates tension over such issues as trade, local and international market competition, demands for fisheries access by foreign fleets, illegal cross-border fishing, and management of shared stocks. Public alarm raised over genetic technologies and intellectual property rights (IPR), as well as global climate change, have added to the already complex issues.

Multifunctional uses of aquatic resource systems

Aquatic resource systems perform direct functions towards assuring food security, reducing poverty and sustaining the natural environment:

- Produce food and non-food products.
- Provide income and livelihoods.
- Provide valuable ecological services (see Box 1).
- Provide non-fisheries-based uses such as shipping and navigation, subsea mining, communications, industrial siting, waste disposal, off-shore artificial island construction and recreation.

These human activities create further challenges to the sustainable utilization and management of the coastal zone.

Increasing conflicts over multiple use

Relieving the anthropogenic threats to aquatic resource systems is the greatest challenge since up to one third of the world's population lives in proximity to a coastline and the bulk of the population resides close to either freshwater or marine systems.

- Rapid developments in the coastal zone that alter environments for human uses present potential conflicts in its sustainable management.
- Coral reef ecosystems abound in tropical seas but human uses of the reefs are now leading to overexploitation and degradation.
- Freshwater fishes are considered the most threatened group of vertebrates. They are heavily exploited and their habitats are stressed.
- For SWBs, communal management has often been established without including fish production. For large water bodies (reservoirs and lakes), management can be complicated by cross-border issues so that an ecosystem approach must be linked to sociopolitical considerations.

Box 1 Ecological services from aquatic resources systems

A recent study (Costanza et al. 1997) has indicated that about 83% of the global value of ecosystem services comes from marine waters, wetlands and lakes/rivers.

The important ecological services derived from these biomes include: habitat, refugia and nutrients for commercially important food and other useful species; protection of adjacent and downstream land such as agricultural land and villages from erosion, siltation, storm damage, floods and droughts; nutrient cycling; tourism and recreational value; carbon sinks and greenhouse gas regulation; and stores of global climate records (e.g., some massive corals).

Increasing conflicts due to the multisectoral use of aquatic resources and other related developments have led ICLARM to suggest co-management arrangements as one of the most appropriate governance options for many aquatic resources systems.

Women in fisheries

ICLARM recognizes that women (and children) make highly significant but undervalued contribution to fisheries, aquaculture, fish processing, retailing and fisheries-sector services. Our research shows that IAA technologies adopted by women's groups of poor rural households led to improved income and nutrition. In developing assistance programs for women (e.g., training, micro-credit, access to water bodies), there needs to be a greater understanding of gender roles and relations within the family or household and the institutional contexts within which these roles have evolved through time.

Aquatic genetic resources, biodiversity and IPR

Policymaking for aquatic biodiversity and genetic resources is far behind that for exploited plant species and terrestrial animals. Proprietary technology and IPR issues, however, will increasingly affect the poor's access to privately held knowledge in biotechnology, potentially denying them the benefits to be derived from such information.

Given the increasing private sector involvement in breed development and vaccine research, ICLARM in continuing its highly successful genetics research must work towards benefiting the smallholders and poorer sections of producers/consumers. ICLARM will place emphasis, for instance, on the genetic enhancement of carps and tilapias in Asia and Africa to produce better stocks. The introduction of genetically improved species, however, has raised new concerns about their possible impact on natural genetic diversity. Biotechnology activities must hence follow high standards of biosafety.

Another issue of general importance to enhanced fisheries is the potential loss of biodiversity as the makeup of the stocked fish can be governed by restricted genetic pools of fish selected for grow-out rates and survival in hatcheries.

Impacts of global climate change

Climate change will impact aquatic resources, and consequently those who depend on them through changes in precipitation patterns and in atmospheric carbon dioxide concentration; increase in temperature/chemical reaction rates affecting aquatic production; changes in wind and ocean circulation patterns affecting fishing operations and the distribution and abundance of aquatic resources; rising sea levels and shifting coastlines; and increasing scarcity of freshwater. Many of these factors are researchable issues and will have as yet unpredictable impacts on aquatic resource systems.