



# **SUSTAINABLE FISHERIES AND RESPONSIBLE AQUACULTURE:**

**A Guide for USAID Staff and Partners**



**June 2013**

# ABOUT THIS GUIDE

## GOAL

This guide provides basic information on how to design programs to reform capture fisheries (also referred to as “wild” fisheries) and aquaculture sectors to ensure sound and effective development, environmental sustainability, economic profitability, and social responsibility. To achieve these objectives, this document focuses on ways to reduce the threats to biodiversity and ecosystem productivity through improved governance and more integrated planning and management practices. In the face of food insecurity, global climate change, and increasing population pressures, it is imperative that development programs help to maintain ecosystem resilience and the multiple goods and services that ecosystems provide. Conserving biodiversity and ecosystem functions are central to maintaining ecosystem integrity, health, and productivity.

The intent of the guide is not to suggest that fisheries and aquaculture are interchangeable: these sectors are unique although linked. The world cannot afford to neglect global fisheries and expect aquaculture to fill that void. Global food security will not be achievable without reversing the decline of fisheries, restoring fisheries productivity, and moving towards more environmentally friendly and responsible aquaculture. There is a need for reform in both fisheries and aquaculture to reduce their environmental and social impacts.

USAID’s experience has shown that well-designed programs can reform capture fisheries management, reducing threats to biodiversity while leading to increased productivity, incomes, and livelihoods. Agency programs have focused on an ecosystem-based approach to management in conjunction with improved governance, secure tenure and access to resources, and the application of modern management practices. Such programs contribute to broader development goals, including food security, adaptation to climate change, biodiversity conservation, improved governance and rule of law, poverty reduction, population and family planning, and sound economic growth.

USAID’s work in these fields has also shown that well-designed programs can reform the aquaculture sector, reducing threats to biodiversity and the environment while contributing to sound economic growth, food security, increased trade, livelihoods, and foreign trade.

The guide addresses the following questions:

- Why is it essential for reform to focus on maintaining ecosystem resilience and biodiversity, especially in light of global climate change and other global stressors?
- Why is it essential for reform to focus on sustainability and responsibility?
- What should a USAID manager know to design, implement, manage, and evaluate capture fisheries and aquaculture programs?
- How does one design activities to ensure that sustainable development goals are addressed using environmentally responsible practices?
- What are the recognized best practices for sustainable fisheries and responsible aquaculture?

## COVER PHOTO:

A small-scale fisheries landing site in Bagamoyo District of Tanzania. Photo Credit: Kathy Castro

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June 2013



## DISCLAIMER

The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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## AUDIENCES

This guide is intended primarily for USAID staff and implementing partners, but should also be useful to a broader audience, including multiple stakeholders within and across sectors.

## CONTENT

This guide addresses capture fisheries and aquaculture in separate sections, except for the discussion of post-harvest issues where many of the topics are common to both sectors. In practice, capture fisheries and aquaculture are usually dealt with as separate sectors. However, greater attention needs to be paid to the real and potential interactions between the two sectors, especially negative impacts of aquaculture on the productivity of capture fisheries. Greater attention must also be given to the growing demand for water, the loss of biodiversity, and the encroachment and ecological degradation from coastal and inland development. Much of the capture fisheries discussion focuses on coastal and marine fisheries. However, many of the approaches and principles presented apply as well to freshwater and inland fisheries found in most of the world's lakes, rivers, and seasonal water bodies.

The fisheries section of the guide focuses on nearshore marine and inland fisheries, as this segment of the industry employs more people and comprises a larger percentage of total catch, by weight and value, in most developing countries. The emphasis in the guide is on small-scale fisheries. That said, in many cases it is impossible to address problems of the small-scale sector without including analysis and simultaneous reforms in the large-scale industrial sector.

The aquaculture section concentrates on reforming the sector for environmental, financial, and social sustainability, with an emphasis on food production for the poor and the utilization of local or native species. The introductory section also emphasizes the important linkages of capture fisheries and aquaculture to other sectors such as biodiversity conservation, economic growth, food security, and public health, as well as governance reform that supports participatory democracy and conflict mitigation.

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## ACKNOWLEDGEMENTS

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# PREFACE

In our increasingly globalized and interconnected world, many people continue to suffer from a lack of food security, unequal economic development, and environmental degradation. These issues are aggravated by increasing human population pressure and global climate change. The global population climbed past seven billion in early 2012 and is projected to reach eight billion by 2027, a mere 15 years later. According to The World Bank, almost a billion people suffer from undernourishment every day. Furthermore, climate change is projected to cause a loss of agricultural production in many developing countries, leading to increased undernourishment and delaying efforts to fight poverty and food insecurity. One traditionally valued source of nutrition, fish, is becoming increasingly important in developing countries as a protein staple and nutrition source to fall back on in times of economic or climatic hardship. However, both wild capture fisheries and aquaculture are becoming stressed and unsustainable as governance and management fail to keep up with demand.

The United Nations Food and Agriculture Organization (FAO) recently estimated that 75 percent of the world's commercial fish stocks are currently being fished at or above sustainable yield. Similarly, in many parts of the world, aquaculture operations are unplanned, unregulated, and the cause of major degradation in local ecosystem services. Because of the great importance of both wild capture fisheries and aquaculture to the food security and economic needs of many people in developing nations, these sectors represent important engagement opportunities for national governments, and the development agencies and implementing partners that support them.

This document was developed to serve as a guide for USAID mission staff and implementing partners in the design of programs to reform the fisheries and aquaculture sectors. By first providing background on the variety of ways fisheries and aquaculture are practiced in USAID's partner countries and then describing the urgent need for reform, audiences will gain a nuanced understanding of the scope of the problem. The document goes on to describe a selection of possible management approaches for both the fisheries and aquaculture sectors in order to provide USAID staff and partners with a tool-kit of legal, market-based, and voluntary approaches to draw on during program planning. To assist with integrated program planning, the linkages between fisheries and aquaculture and other USAID program sectors are also described. This document emphasizes the need to build gender awareness, sustainability, and climate change considerations into all of USAID's programs.

Fisheries, uniquely among modern human food production systems, depend on the hunting of wild animals. As every timber manager or cattle rancher knows, to harvest sustainably, the stock must not be exploited beyond the point at which it can replenish itself. However, because of the poor availability of fish population data, ever-increasing fishing effort and the technological sophistication of fishing fleets, most of the world's fisheries have crossed this line. Some of the major barriers to keeping wild capture fisheries to sustainable levels include the open access nature of many fisheries and a lack of technical capacity, leading to poor management. USAID can facilitate the first step towards fisheries reform by working with partner countries to move from open access fisheries towards some form of managed access. This guide explains some types of managed access, including use rights, input and output controls, and voluntary approaches. Any managed access regime should

be undertaken as part of a larger ecosystem-based management approach. The fisheries section concludes with a guide to fisheries program planning, providing specific steps for the development, implementation, and ongoing management of a USAID fisheries reform program.

If properly managed, aquaculture provides the promise of increased food security and decreased exploitation of the world's oceans. The industry is at a tipping point, however. One path leads to healthier oceans, increased economic opportunity for small aquaculture farmers, and better nutrition in food-insecure communities. Down the other path, however, the aquaculture industry can become a contributor to habitat destruction, water pollution, and exploitation of local workers. USAID can continue to play a role in encouraging ecologically and economically sustainable aquaculture practices through improved oversight and monitoring and the integration of aquaculture into landscape-scale governance systems. This guide includes an introduction to a variety of aquaculture management approaches. Licensing and permitting of aquaculture facilities, landscape zoning, research and extension services, and best management practices can all help improve the efficiency and sustainability of aquaculture operations. As with fisheries, this section concludes with detailed methodologies for planning and implementing, and ongoing monitoring and evaluation of aquaculture programs.

USAID has been a leader in promoting sound fisheries and aquaculture management over the past several decades through dedicated programming such as the Fisheries Improved for Sustainable Harvest (FISH) Project in the Philippines, the BaNafaa project in West Africa, and Bangladesh's Management of Aquatic Ecosystems through Community Husbandry (MACH) project. In addition to these fisheries and aquaculture-specific projects, USAID builds healthy marine environments and healthy economies through support for biodiversity, natural resource management, food security and participatory democracy programs. Much remains to be done, however. Land tenure interventions, which have been used to great effect in agriculture programs in Africa, could benefit both fisheries and aquaculture practices through the use of territorial use rights fisheries (TURFS) or promoting small-holder fish farms. USAID can also employ its strength in governance reform to increase regulation and oversight in fisheries and aquaculture. Healthy oceans and watersheds also promote more resilient fisheries and improve the quality of inputs for aquaculture. Imbedding fisheries and aquaculture programs within the larger frameworks of ecosystem-based management and integrated coastal zone management encourage a broader perspective and helps preserve ecosystem services and function.

As enumerated in this guide, both wild capture fisheries and aquaculture, as practiced both in the developed and developing world, often suffer from a lack of sound scientific research, poor management, and inadequate regulatory regimes. These issues are usually more acute in developing countries. USAID is well positioned to help address these gaps. This guide was developed to facilitate the development of sound, locally appropriate fisheries and aquaculture programs.



# I. INTRODUCTION

**1.0 An Overview of Fisheries and Aquaculture**

**2.0 USAID's Role in Fisheries and Aquaculture**

**3.0 The Need for Reform**

**4.0 Contributions to Other Sectors**

**5.0 Principles for Sustainable Fisheries and Responsible Aquaculture**



# I.0 AN OVERVIEW OF FISHERIES AND AQUACULTURE

## CAPTURE OR WILD FISHERIES

“Fishing” is the capture and removal of fish and other animals such as clams, oysters, crabs, lobsters, and squid from the natural environment. It can be considered a form of hunting of wild animals in an aquatic environment, and is sometimes also referred to as “wild fisheries.” The sustainability of capture fisheries depends upon healthy and productive ecosystems and sound management. Healthy ecosystems also provide other “ecosystem services,” such as mitigating impacts from storms and sea-level rise, reducing floods, and providing other services of global economic importance, such as tourism.

Fisheries productivity is a key component of food security at both local and global scales. Appropriate and sustainable reform of the capture fisheries sector is an urgent global issue.

### MANAGEMENT OF AQUATIC ECOSYSTEMS THROUGH COMMUNITY HUSBANDRY (MACH)

One excellent example of sustainable local fisheries management is Management of Aquatic Ecosystems through Community Husbandry (MACH), a USAID-funded program in Bangladesh. By adopting conservation measures and sustainable fishing practices, villagers in Bangladesh restored and improved fisheries productivity in three degraded wetlands, leading to improved food security and well-being for 184,000 of the country's poorest citizens. Between 1999 and 2006, fish catches in target villages rose by 140 percent, consumption went up 52 percent, and average daily household incomes increased 33 percent. With increased consumption of fish – a vital source of much needed protein, essential oils for brain development, and micronutrients like vitamin A – malnourishment and hunger decreased.

A fishery depends on harvests of natural populations, and there are limits to the yields that can be sustainably produced. Yields vary from place to place according to the natural productivity and health of aquatic systems. Yields may also vary seasonally and annually as natural conditions change. Depending on post-harvest handling practices, what is utilized versus what is caught can vary. According to some estimates, loss in yields from poor handling can be as high as 30 percent. Wild fisheries have always played an important role in local food security, livelihoods, and economies, and are now increasingly important in national, regional, and international trade. At the same time, increases in the global population, especially along coasts, and improvements in harvest technology have increased humans' capability to exceed the maximum sustained yields from these systems. Global climate change is an additional stressor; its real and potential effects are not fully understood. The majority of fisheries resources are “open access” (i.e., where anyone can invest and capitalize on their exploitation), and this is a major reason for much of the overfishing that is presently of growing global concern.

In most countries, fisheries production from wild harvests has leveled off or even declined. The reasons include overfishing, poor management, the open access nature of the resource, loss of critical habitats and species, removal of juveniles, and the use of destructive fishing techniques such as bomb fishing and

poisons. Ecosystem integrity and productivity has also been compromised by removal of key species in the food chain, pollution from poor land use practices, and the poor quality and quantity of water flowing into wetlands and estuaries.

In essence, fisheries governance has not kept pace with fishing technologies, nor the increasing numbers of fishers attracted to these open resources or “common property” goods. A key message of this guide is that it is possible to reverse the decline of capture fisheries — both single-species and multi-species fisheries. There are an increasing number of examples where local fisheries are being managed wisely and sustainably.

The example in the box above, along with others, shows it is possible to improve fisheries productivity, ecosystem health, and ensure more sustainable and profitable livelihoods for the millions of people dependent on fishing. The key is having sound governance structures, proper economic incentives, secure tenure, and access rights.

## AQUACULTURE

Aquaculture is defined as the culturing or farming of animals or plants in water for any of their life stages. It is a form of agriculture, and like other forms of agriculture, inputs such as clean water and nutrients are required. Inputs vary depending upon the requirements of the target species. Species low on the food chain require few or no inputs or additives besides clean water. Examples include seaweeds and filter-feeding animals (clams, oysters), which pick up nutrients and small particles of food from the surrounding water. These species are more environmentally friendly as they require no feed inputs or habitat alterations to culture. Species higher up the food chain (such as predatory groupers, salmon, or tuna) require more inputs such as fish or fish meal, cereals, or grains. Thus, the net contribution of aquaculture to food security will depend upon the type of species chosen and the development of efficient culture methods.

A great variety of species are cultured around the globe, based on local preferences and suitability of growing conditions. Aquaculture is conducted in many locations and environments. This includes the use of streams and raceways, groundwater, rivers, ponds fed by rain, and coastal areas where tidal movements provide food and water exchange. In addition, some organisms are raised in cages placed in lakes, bays, and increasingly in the open ocean itself. Aquaculture can be conducted on an intensive (high density and high inputs) or extensive (low density and low inputs) basis.

With all its potential benefits, aquaculture can also carry risks. Aquaculture has been responsible for introducing exotic and invasive animals, plants, and diseases around the world, often inadvertently through development assistance. Ecosystems have been disrupted by these invasive species or diseases, leading to reduced productivity of natural systems, loss of local livelihoods, and threats to local or even national economies. With intensive farming and the addition of more feeds and inputs, as required with higher trophic level animals or high intensity culture, the potential for producing more effluents, disease, and pollution can rise considerably. As more species are cultured, genetic stocks are transported around the world, creating the risk of escape of cultured stocks into the wild. The use of good management practices, along with strong policy, regulation, and oversight, can help minimize these and other risks.

This guide speaks to the need for the aquaculture sector to continue to play a responsible role in addressing the food challenges of today and tomorrow by reducing impacts on adjacent water bodies, habitats, and biodiversity; and preventing conflicts over water resources and feed stocks. A key message is that there is a need for a more integrated approach to assessment, planning, and management of both fisheries and aquaculture sectors, with the goal of achieving a “systems approach” to sustainable and resilient food production.

## 2.0 USAID'S ROLE IN FISHERIES AND AQUACULTURE

USAID is a leader in integrated coastal management (ICM), integrated water resources management (IWRM) and large-scale approaches to biodiversity conservation. It is also a recognized leader in developing effective and innovative approaches to fisheries management, best framed within these broader contexts of ICM, IWRM, or seascape/landscape approaches. Concrete examples of its fisheries leadership on-the-ground include the USAID-funded Ba Nafaa project in West Africa, the USAID-funded Fisheries Improved for Sustainable Harvest (FISH) project in the Philippines, the Management of Aquatic Ecosystems through Community Husbandry (MACH) project in Bangladesh, the SUCCESS fisheries management programs in three West African countries, and the work of the Global FISH Alliance in the spiny-lobster fishery of Honduras. These programs have improved fisheries productivity, livelihoods, and biodiversity through an ecosystem-based approach to fisheries management. More information on these programs can be found at the web sites listed below.

USAID total investments in capture fisheries over the past several decades have been substantial, either as components of other biodiversity, natural resources management, and economic growth programs, or as individual projects that integrate across sectors concerned with food security, public health, and governance reform that supports participatory democracy.

There remains much more, however, that the Agency can do to address the global fisheries crisis. While USAID has been and continues to be a leader in promoting agricultural reforms through land tenure, improved governance, and market-based approaches to small-scale agriculture, it needs to make similar efforts to reform fisheries governance in developing countries. Investments in fisheries management are critical to ensuring that developing countries maintain their comparative advantage in the international seafood markets. Maintaining healthy fisheries habitat, such as coral reefs, wetlands and mangrove forests, will also contribute to sound water resources management and climate resiliency.

USAID is also making significant contributions to food security and environmentally sound economic growth by assisting needed reforms in the aquaculture sector. USAID programs have helped mitigate conflict and assist habitat restoration from the boom-and-bust cycles arising from poorly planned aquaculture. As a donor, USAID can help guide aquaculture development along a more environmentally sound and socially responsible path.

USAID missions typically implement the majority of capture fisheries and aquaculture initiatives as part of their biodiversity or economic growth portfolios. While these missions likely have expertise in fields such as conservation, natural resources management or agriculture, not all have staff with specific technical capacity in fisheries or aquaculture. However, the Bureau for Economic Growth, Education and Environment (E3) and the Bureau for Food Security (BFS) do have this expertise and can assist missions in fisheries and aquaculture program design, evaluation, and implementation. Both the E3/Office of Water and BFS manage mechanisms that missions and bureaus can utilize to design, implement and evaluate aquaculture and fisheries activities. E3/W has produced recent reports highlighting opportunities for USAID investment in fisheries and aquaculture that can provide missions with good background on the history and current status of USAID involvement and investment in these sectors.

## SOURCES FOR MORE INFORMATION

- USAID Fisheries Opportunities Assessment.  
[http://www.crc.uri.edu/download/Fish\\_Opp\\_Assess\\_Final\\_012607\\_508.pdf](http://www.crc.uri.edu/download/Fish_Opp_Assess_Final_012607_508.pdf)
- The Review of the Status, Trends, and Issues in Global Fisheries and Aquaculture with Recommendations for USAID Investments. The USAID SPARE Fisheries & Aquaculture Panel.  
[http://pdacrsp.oregonstate.edu/miscellaneous/F%26A\\_Subsector\\_Final\\_Rpt.pdf](http://pdacrsp.oregonstate.edu/miscellaneous/F%26A_Subsector_Final_Rpt.pdf)
- The Aquaculture & Fisheries Collaborative Research Support Program (AquaFish CRSP).  
<http://aquafishcrsp.oregonstate.edu/>
- The Management of Aquatic Ecosystems through Community Husbandry/Bangladesh (MACH) Project.  
<http://www.winrock.org/fact/facts.asp?CC=5498&b>  
<http://sustainabledevelopment.un.org/index.php?page=view&type=99&nr=40&menu=1299>  
<http://rmportal.net/library/content/nric/3300.pdf/view>
- The USAID Fisheries Improved for Sustainable Harvest/Philippines (FISH) Project.  
[http://transition.usaid.gov/stories/philippines/fp\\_philippines\\_fishes.html](http://transition.usaid.gov/stories/philippines/fp_philippines_fishes.html)  
[http://www.oneocean.org/fish/the\\_project.html](http://www.oneocean.org/fish/the_project.html)
- Community Partnerships for Sustainable Resource Management/Malawi (COMPASS II) Project.  
<http://rmportal.net/library/content/tools/compass-ii>
- The Sustainable Coastal Communities and Ecosystems (SUCCESS) Program.  
[http://http://www.crc.uri.edu/projects\\_page/sustainable-coastal-communities-and-ecosystems-2009-2014/](http://http://www.crc.uri.edu/projects_page/sustainable-coastal-communities-and-ecosystems-2009-2014/)
- Global Fish Alliance.  
<http://www.globalfishalliance.org/>
- The BaNafaa Project.  
[http://http://www.crc.uri.edu/projects\\_page/gambia-senegal-sustainable-fisheries-project-usaidba-nafaa/](http://http://www.crc.uri.edu/projects_page/gambia-senegal-sustainable-fisheries-project-usaidba-nafaa/)

## 3.0 THE NEED FOR REFORM

Food insecurity, impacts from climate change, high population growth rates, degraded and dwindling water resources, and increasingly globalized trade are just some of the major challenges facing the developing world. To address these challenges, more integrated and smarter approaches to development are needed based on a “systems approach” that maintains the integrity and health of ecosystems. Restoring and maintaining ecosystem goods and services will be critical to multiple development objectives. These are essential practices if we are to have any hope in achieving sustainable and resilient food production systems; mitigation of floods and droughts; maintenance of environmental flows and aquatic systems; adaptation of coastal, lake and river systems to climate change; and ensuring community well-being and social safety nets based on productive natural systems.

Reform is urgently needed to direct both capture fisheries and aquaculture sectors toward improved sustainability, profitability, and responsibility. Past investments by donors and the private sector have in many cases led to overfishing and overcapacity in fisheries sectors, environmental destruction and pollution through aquaculture, and loss of biodiversity, perverse subsidies, and boom-and-bust cycles in both. A more integrated approach to fisheries and aquaculture management is needed to ensure ecosystem integrity and conserve biodiversity. A systems approach can address the multiple dimensions of resource governance, including the enabling policies and laws, integrated coastal and water resources management, incentives to promote resource stewardship, spatial land and marine planning, land and sea tenure or access rights, and sound management at the seascape/landscape scale.

In most developing countries, investments are needed to reform fisheries governance, create the enabling conditions, and build the capacity for nations to reduce fishing effort to more sustainable levels. Fish provide much of the global population with a critically important source of high quality animal protein and serves as the staple food for many communities. Capture fisheries continue to provide livelihoods for local populations and contribute to national economies. Ensuring that fisheries can sustain these benefits, however, depends on making major reforms to the sector.

Similarly, changes are needed in the governance systems and best practices that guide aquaculture — another important source of food and income for national and global economies. Aquaculture is at a crossroads: its future direction will impact the health and productivity of wild fisheries, the survival of many smallholders’ livelihoods, and global food security. Important considerations include: Who will benefit from aquaculture — i.e., the poor in developing countries, or wealthy consumers in developed countries? In addition, growth in aquaculture may come at substantial costs to the environment and may not be sustainable over the long term. Too often the “externalities” associated with aquaculture — such as pollution, invasive species and diseases — have not been included in the production costs, but rather passed to local communities in the form of polluted waterways, damaged habitats, or introduced species.

The emerging water crisis also requires better use and allocation of water resources. Some of the most productive habitats — such as estuaries and wetlands — depend upon the proper timing, quality, and quantity of freshwater flows. Their sustainable productivity is closely linked with maintaining these environmental flows and balancing competing uses among humans, nature, fisheries, and aquaculture.

Large-scale landscape and seascape planning and zoning for specific uses and user groups is therefore needed. Zoning could protect essential fisheries habitats that are necessary for helping to expand fish

stocks and maintain ecosystem health. Future zoning should favor the “highest and most sustainable use” of various habitat types, including capture fisheries, low-trophic level aquaculture, recreation, biodiversity conservation, and ecosystem health. Ultimately, integrated landscape and seascape use designs are needed to conserve and protect ecosystem goods and services, reduce sedimentation and pollution runoff, protect terrestrial and wetland habitats, and promote integrated water resources management.

For all the reasons above and more, reform must guide fisheries and aquaculture development along a path of sustainability by creating enabling environments and offering incentives that reward good practices. In addition to providing food, jobs, income, and trade as mentioned above, reform in these sectors can also help preserve cultural values over the long term, reduce humanitarian crises, and help nations emerge from conflict and poverty. Better management can also help avoid the continuing collapse of the world’s aquatic and marine ecosystems and associated loss of biodiversity in these environments.

USAID has rich experience in addressing the governance of common property resources through co-management, community-based management, rights-based approaches, and applying proper economic incentives such as land tenure and property rights. This has included pioneering governance reform initiatives in fisheries; reforms that can help sustain and grow critical food supplies and build economies while maintaining healthy, diverse ecosystems. More, however, remains to be done in reforming capture fisheries along with the aquaculture sector. USAID is well positioned to take on this challenge.

## CAPTURE FISHERIES

Fisheries products are the world’s most widely traded foods, with commerce dominated by developing countries. The total value of world capture fisheries production in 2009 was US\$93.9 billion, a value greater than the global combined net exports of rice, coffee, sugar, and tea. Fisheries are globally important sources of much-needed high quality animal protein — the primary protein source for 1.5 billion people worldwide and an important part of the diet of many more. Fisheries is also the largest extractive use of wildlife in the world, posing major threats to marine, coastal, and freshwater ecosystems around the world, and the sustainability of the sector itself.

In spite of fisheries’ important role in the national and local economies of many developing countries, the sector is often poorly planned and regulated, inadequately funded, and neglected by all levels of government. Globally, fisheries are frequently overfished and overexploited as a result of weak governance, poor management, perverse subsidies, corruption, and unrestricted access. In addition, destructive fishing practices can rapidly degrade marine ecosystems and contribute to the loss of critical habitats and species. The declining state of fisheries resources will have disproportionately heavy consequences for developing countries and their poorest members. A recent World Bank study indicates that the fisheries sector is losing an estimated US\$50 billion annually in lost revenues due to poor management and from illegal, unreported, and unregulated (IUU) fishing.

Capture fisheries include two sub-sectors: large- and small-scale fisheries. Large-scale industrial fisheries involve fleets that can fish both nearshore and on the high seas. Meanwhile, the overwhelming majority of fishers in developing countries are small-scale, often using vessels that are un-motorized and mainly



In small-scale fisheries, fishing is a household livelihood where men, women, and even children play roles in capturing, processing, and marketing the product.

Photo: URI Coastal Resources Center



target nearshore waters. However, both large-scale and small-scale fisheries can overlap in the species targeted and areas fished, so use conflicts are common. Both sub-sectors can contribute to overfishing problems and require careful management. High seas fisheries are managed through regional fisheries management organizations (RFMOs), not by individual coastal states. Each coastal state is responsible for managing the small and large-scale fisheries that occur only within its 200-mile exclusive economic zone (EEZ).

There are many issues within the fisheries sector that require urgent attention including open access, excess fishing capacity, weak governance, subsidies, continued poverty within coastal communities, lack of alternative livelihoods, and the impacts of globalized fisheries trade. The failure of development agencies to adjust their strategies to this new paradigm will have significant social consequences. These include the loss of economic opportunity and food resources for millions of people living in fishing communities, and the loss of national revenues. For instance, sub-Saharan Africa loses over US\$1 billion annually in economic rents from unfair access agreements. This is a region that could significantly increase its food security through improved governance of capture fisheries. Failure to reform fisheries will also allow the continued decline of ecosystem productivity, biodiversity, and resilience to climate change.

There is a growing suite of proven strategies to reform fisheries. These include the use of co-management, community-based management, rights-based approaches, voluntary certification and codes of conduct, and proper economic incentives, including secure tenure and property rights to address the governance of common property resources. Some combination of these strategies is increasingly employed in most efforts to move towards more sustainable fisheries.

## AQUACULTURE

World aquaculture production, as a percent of overall fisheries supply, is growing rapidly at an average annual growth rate of 8.8 percent since 1970 (compared to 1.2 percent for capture fisheries over the same period). Aquaculture will continue to grow as a world food production system and is expected to rival capture fisheries production by 2030. Aquaculture production will continue to be critically important, especially in developing countries, for supplying the world's growing population with high quality animal protein. It also provides an increasingly valuable cash crop and export revenue for many nations.

The industry's explosive growth has not been without consequences. Much of the world's initial aquaculture development occurred during times when technical capacity, governance, policy, and oversight were weak. In some cases, this led to fledgling industries where inefficiencies and unguided development produced large-scale negative environmental, social, and economic impacts threatening the sustainability of the sector itself.

Too often, small-scale or family-operated aquaculture has been edged out by large industrial-scale farms. The major economic contribution of these large facilities to a local community is often low-wage jobs, such as in processing plants. In many cases, most of the benefits from aquaculture have gone to outside



Photo: Tanyo

While aquaculture is sometimes seen as a backyard activity that provides food directly to the household, it is increasingly viewed more as an economic business venture at the household or industrial scale.



investors. Another concern is the potential loss of local low-cost food production in favor of high-value commodity exports.

As global climate change contributes to water shortages in many regions of the world, conflicts over water use—including use for aquaculture—may intensify. At the same time, some important aquaculture development opportunities remain unrealized. For instance, food security in sub-Saharan Africa could be addressed by increasing its fish food supply through combined improvements in aquaculture and fisheries.

Reform is needed in many segments of the aquaculture industry in order to promote more responsible development. This in turn requires an integrated view of aquaculture, one that considers not only environmental and economic sustainability, but also social responsibility. Fortunately, just as in fisheries, there is a growing suite of approaches to help guide the industry down such a path. These include initiatives with the private sector to adopt codes of good practice and voluntary green certification schemes. But these should be complemented with better regulatory, zoning, and permitting processes, and more consideration of the impacts on capture fisheries and aquatic ecosystems. In short, better governance is the key to sustainable aquaculture.

Currently, the U.N. Food and Agriculture Organization (FAO) is developing international certification guidelines for better governance of aquaculture practices. Other regional certification schemes are also under development or are already in effect. Some countries are beginning to share proven methods for aquaculture development through regional networks.

USAID's many decades of experience in developing sustainable aquaculture policies and undertaking collaborative research on the culture of local species and food for the poor make it well positioned to support reform in the aquaculture sector.

## **INTEGRATED APPROACHES TO MANAGEMENT**

Rapid global change necessitates a precautionary approach to development. Integrated management approaches promote the essential elements of sustainable development — protecting the world's environment, fostering balanced economic development, promoting democratic participation in governance, and improving the health and well-being of people in developing nations.

There are many tools available to more effectively address these complex issues. For true reform to occur, broad-scale, integrated approaches are needed to comprehensively address issues that are both internal and external to the fisheries and aquaculture sectors. Such approaches may include integrated water resources management (IWRM) and integrated coastal management (ICM) applying ecosystem-based management (EBM) principles to address broader resource management and development issues at the seascape and landscape-scale. Land-use planning and marine spatial planning can also be used to designate appropriate resource uses to specific locations and minimize conflicts. USAID is well placed to employ these approaches in its programming to encourage reform in the fisheries and aquaculture sectors.

## **SOURCES FOR MORE INFORMATION**

- The State of World Fisheries and Aquaculture 2010. 2010. FAO.  
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- Outlook for Fish to 2020. 2003. WorldFish Center.  
<http://www.ifpri.org/pubs/fpr/pr15.pdf>

- The Sunken Billions: The Economic Justification for Fisheries Reform.  
<http://siteresources.worldbank.org/EXTARD/Resources/336681-1224775570533/SunkenBillionsFinal.pdf>
- Values of Inland Fisheries in the Mekong River Basin.  
[http://www.worldfishcenter.org/resource\\_centre/Baran%20et%20al%202007%20Values%20of%20Mekong%20inland%20fisheries.pdf](http://www.worldfishcenter.org/resource_centre/Baran%20et%20al%202007%20Values%20of%20Mekong%20inland%20fisheries.pdf)
- USAID Water and Natural Resources Management Programs.  
[http://transition.usaid.gov/our\\_work/cross-cutting\\_programs/water/water\\_natural\\_resources.html](http://transition.usaid.gov/our_work/cross-cutting_programs/water/water_natural_resources.html)
- Guidelines for Integrated Coastal Zone Management.  
<http://documents.worldbank.org/curated/en/1996/08/696319/guidelines-integrated-coastal-zone-management>
- Global Forum on Oceans, Coasts and Small Islands.  
<http://www.globaloceans.org/>
- The ecosystem-based management tools network.  
<http://www.ebmtools.org/>
- NOAA Aquaculture Program.  
<http://aquaculture.noaa.gov/>

## 4.0 CONTRIBUTIONS TO OTHER SECTORS

Smart management of capture fisheries and aquaculture not only benefits those sectors, but also directly contributes to the objectives of other USAID programmatic areas.

### **BIODIVERSITY CONSERVATION**

USAID is a recognized leader in implementing effective biodiversity conservation programs through a threats-based approach. Well-designed programs that reduce major threats to biodiversity and ecosystem health will also benefit human communities that depend on these resources. The guide entitled “Biodiversity Conservation: A Guide for USAID Staff and Partners” is an excellent reference for developing robust biodiversity programs ([http://pdf.usaid.gov/pdf\\_docs/PNADE258.pdf](http://pdf.usaid.gov/pdf_docs/PNADE258.pdf)).

Capture fisheries are a source of threats to marine and freshwater biodiversity and ecosystems. These include overfishing, destructive fishing, excessive by-catch, and use of non-selective gears. Unsustainable fishing can contribute to reduced ecosystem health and loss of key species or trophic groups from the ecosystem. This, in turn, can reduce species’ resilience to adverse impacts caused by climate change. Promoting more sustainable fishing can directly reduce threats to an ecosystem’s biodiversity while improving fisheries productivity. Fisheries management tools—such as fisheries reserves or no-take areas help conserve and protect aquatic biodiversity. Adoption of better fishing practices and more selective gear can also reduce by-catch and the mortality of protected marine species (sea turtles, seabirds, marine mammals, etc.). Fisheries programs that are designed to reduce biodiversity threats and are located in areas of biological significance may be attributable to the Congressional biodiversity directive. For more information, please see [http://transition.usaid.gov/our\\_work/environment/biodiversity/code.html](http://transition.usaid.gov/our_work/environment/biodiversity/code.html).

Aquaculture has also been documented as a major threat to marine, coastal, and freshwater biodiversity. Aquaculture threats include the loss of critical habitats due to improper siting of farms, introduction of non-native and invasive fish species, spread of diseases and pests into native populations, pollution, and divergence of freshwater resources from habitats. Conserving biodiversity and ecosystem health often requires policy and governance reforms that promote good management practices and internalize the environmental costs. These can include implementing land zoning to restrict aquaculture to appropriate sites, regulating the use of invasive and non-native species, and regulating intensive aquaculture as a way to reduce pests and diseases. Environmental performance bonds can be used to promote best practices and precautionary approaches. Land-based, enclosed, re-circulating tanks with several layers of security to prevent escapes of invasive species and filtration systems to reduce pollutants and diseases also minimize environmental impacts.

### **ECONOMIC GROWTH, ENTERPRISE DEVELOPMENT, AND PUBLIC-PRIVATE PARTNERSHIPS**

Fisheries and aquaculture offer excellent economic growth opportunities—providing jobs and income for millions of coastal households and the potential for foreign revenue investments. But poor governance and oversight present major constraints to sustained economic growth in both the fisheries and aquaculture sectors. Barriers include the lack of governance and policy frameworks, perverse incentives, inappropriate subsidies, poor practices, food safety issues, and environmental externalities that undermine sustainability. Without major reforms, developing countries may lose any competitiveness that they now

have in these sectors. Boom-and-bust cycles have led to depressed prices and unstable markets. Reforms that address these constraints could provide sustained economic growth and benefits.

One strategy for reform is to take a “value chain” approach to fisheries and aquaculture, identifying ways to add value at all points in the process from harvest to market. A useful place to start is to conduct a value chain assessment to identify the economic growth and enterprise development opportunities. Such an approach must only proceed simultaneously with efforts to achieve sustainable sourcing, lest enhanced profitability for the sector result in increased catch effort, undermining the objective of sustainability.

It is always important to consider gender dimensions as part of this process. Women play important roles in the fish marketing and processing sectors, and the opportunities for women-led enterprise development are plentiful (see next section).

Both the fisheries and aquaculture sectors are engaging in important public-private sector partnerships to promote improved management and sustainability. For example, seafood buyers (both importers and exporters) are increasingly concerned with maintaining a stable supply of seafood products to the food processing industries and restaurant chains upon which their business survival depends. This is leading to an increased number of public-private partnerships to promote sector reform, as well as certification schemes for wild-caught seafood and farm-raised aquaculture products.

Photo: Klaus Hartung



Women are key actors in reef gleaning activities, which is a wild harvest activity typically neglected by fishery managers.

## GENDER AND MARGINALIZED GROUPS

Development programs that fully incorporate women and marginalized groups into program design and implementation are more effective than those that don't. This is why all USAID development programs require a gender strategy before approval. Men, women, and children all play a role in maintaining healthy fisheries and aquaculture enterprises. For this reason, it is important that both genders be considered and consulted within the fisheries and aquaculture planning, policy, and decision-making processes leading to reform. This starts with breaking down what, until recently, have been some long-held misperceptions about men, women, and even youths' roles in these sectors.

One long-held misperception is that livelihoods in fishing and aquaculture are male-only occupations, and women are only involved in post-harvest activities.

Recent research, however, estimates that at least 50 million women in developing countries, often with children at their side, work in the fishing and aquaculture industries, performing a wide range of activities from harvest to post-harvest.

The reasons for many of the misperceptions include, but are not limited to:

- A lack of gender-disaggregated data collection and/or analysis
- Barriers to women's participation, access to resources (e.g., land, credit), and voice in decision making
- A tendency for women and children's labor in this sector to be considered as part of their "family" responsibilities vs. as a livelihood
- Women and children's activities in fisheries and aquaculture tend to be less organized and visible

Chapter II on Capture Fisheries and Chapter III on Aquaculture cover in more detail specific ways to consider the role of men, women, and children in fisheries and aquaculture. Also discussed are steps the program designer, policymaker, or practitioner can take to make the sectors more equitable for both genders and children.

## **POPULATION, HEALTH AND HIV/AIDS**

USAID has a history of successfully integrating population, health, and HIV/AIDS interventions into capture fisheries management activities. These Population-Health-Environment (PHE) programs address the complex connections between humans, their health, and their environment. The main goal is to improve access to health services — most often family planning and reproductive health care services — while helping communities to manage their environment in ways that conserve biodiversity, create sustainable livelihoods, and improve human health. In the fisheries context, it is common to see the merging of HIV/AIDS prevention strategies with coastal and marine conservation initiatives, and the integration of family planning and human reproductive health with conservation.

### **HIV/AIDS**

A growing body of evidence suggests that AIDS-affected households are less likely to use natural resources sustainably. In this context, the HIV/AIDS pandemic can have direct and indirect impacts on the sustainable use of fisheries resources and on conservation efforts in general. AIDS can result in a loss of traditional ecological knowledge, loss of labor and human capacity in resource management agencies, and a diversion of national funds away from conservation agencies to meet rising HIV/AIDS-related costs.

Fisheries and HIV/AIDS are linked in other ways as well. In some countries, fishing communities and fishers are found to have higher infection rates than the general population. Fishers often travel away from their families and communities for days or months at a time. This can lead them to engage in risky sexual behaviors. Once infected, fishers then spread the disease back to their own families and communities. Female fishmongers are sometimes forced to exchange sex for the right to purchase or sell fish. Since fishing communities are often located far from health services, access to preventative measures such as condoms and counseling or to facilities for testing and treatment (e.g., anti-retroviral drugs) is limited.

Recognizing these linkages, some resource management and conservation programs are starting to integrate HIV/AIDS prevention strategies into fisheries programs as a way to mitigate the impact of the disease. These programs provide behavior change communications strategies on both environmental themes as well as HIV/AIDS. Other integrated strategies include promoting gender equity, establishing microenterprises around selling condoms, establishing voluntary counseling and testing centers as a means of preventing infection, and establishing explicit HIV/AIDS workplace policies within conservation agencies.

HIV/AIDS may also be a concern in the aquaculture sector. For instance, large-scale farming and processing operations may use migrant or illegal foreign labor. These groups may be more likely to engage in behaviors that will put them and their sex partners at greater risk of infection.

## Population Growth and Reproductive Health

In many areas, population growth due to high fertility or immigration is increasing the demand for food. The resulting pressure on fisheries is often unsustainable. To these growing populations, open access fisheries are often viewed as a food and income-generating social safety net of last resort. In addition, these populations often live in remote areas where access to basic family planning information and services is limited or nonexistent. Even if fishing communities wanted to plan smaller and healthier families, they often lack the information and tools to do so.

Incorporating population and reproductive health approaches into fisheries management can simultaneously improve human and ecosystem health. PHE programs hold the philosophy that integrating family planning, basic health, and natural resource management creates greater synergies and impacts than do single or dual sector-only programs. Smaller family sizes contribute to better management and conservation of natural resources, ease population pressures on local resources, and increase family wealth.

Health services are often greatly needed in remote coastal areas, and are cited in the top three development priorities by communities along with education and transportation infrastructure. Family planning is a highly sought-after health service, especially by women who desire to space or limit the number of children they have and yet have no means of doing so. Integrating basic health services with fisheries management addresses a community's basic needs and can reduce morbidity and mortality that, in turn, can increase community support for fisheries interventions. The Integrated Population and Coastal Resource Management (IPOPCORM) program in the Philippines demonstrated that combining family planning and fisheries management can be more effective than separate programs.

The key to successful fisheries management is ensuring that resource management strategies are implemented hand-in-hand with family planning, education and service delivery strategies. This is particularly true in areas where population growth is high and access to family planning information and services is limited. In this way, fishing communities gain a heightened awareness of the linkages between the two interventions and how high population growth rates impact the environment and their quality of life.

## GLOBAL CLIMATE CHANGE

Global climate change poses significant threats to many developing countries, including the human communities and the natural ecosystems upon which they depend. Less developed countries, low-lying coastal areas, deltas, islands, and water-stressed regions are most vulnerable to impacts. To ensure more effective donor assistance in the face of climate change, USAID has developed a programming guide for staff and partners on mainstreaming climate change adaptation into development assistance activities and safeguarding U.S. investments. The guide is entitled *Adapting to Coastal Climate Change — A Guidebook for Development Planners*. (<http://www.crc.uri.edu/download/CoastalAdaptationGuide.pdf>)

One goal of this guide is to articulate how to integrate climate change adaptation into fisheries and aquaculture planning and management. Precautionary approaches are needed that take projected climate change impacts into account and promote more resilient ecosystems. A key tenet to adaptation is maintaining ecosystem integrity and the multiple benefits provided by healthy systems. For example, maintaining wetlands and estuaries will serve multiple purposes — from protecting fisheries nurseries to regulation of water availability and water quality, to mitigation of floods and droughts. Precautionary management safeguards ecosystems.



The impacts of global climate change on fisheries are already observable and are likely to increase over time. Changes in water temperature and current patterns will affect species' migration and range sizes. Rising sea levels may drown intertidal habitats and force their retreat landward. Preserving undeveloped buffer zones will allow for managed intertidal habitat retreat, maintaining important nursery grounds for coastal fisheries. Protecting mangrove forests, coral reefs, and coastal wetlands has multiple benefits for fisheries production and climate change adaptation; these ecosystems also provide coastal protection and storm mitigation, and can serve as buffers to sea level rise.

Similar to agriculture, aquaculture production will be affected by increasing water temperatures. The type of aquaculture varies according to local climate and the species' response to temperature changes. Thus, depending on location, climate change could have negative or positive consequences for aquaculture. Oxygen content decreases as water temperature increases, which can negatively impact productivity and require aeration of ponds. Less dissolved oxygen can also increase the occurrence of coastal "dead zones," where large areas of coastal water near river mouths and in estuaries become anoxic and unable to support sea life. Meanwhile, rising CO<sub>2</sub> levels in the atmosphere will acidify oceans. There is still uncertainty as to what the specific impacts of climate change on fisheries and aquaculture will be, reinforcing the need for adaptive ecosystem management.

Rising sea surface temperatures make coral reefs increasingly susceptible to mass bleaching events, which have long-term impacts on reef fisheries. Changing sea surface temperature may also result in changing ocean currents and productivity of fisheries systems. Increasing drought and flooding, and changes in freshwater flows in river systems is likely to affect estuarine systems that provide critical habitat for many commercially important fisheries. Rising sea level will increase the risk and vulnerability of coastal infrastructure and communities, while increased storms will place coastal ports and other fisheries infrastructure and coastal communities at increased risk. In some areas of the world, low-lying small islands (e.g., the Maldives and Marshall Islands) may become completely inundated requiring mass relocation of people and communities. In low-lying estuarine systems such as Bangladesh and the Mekong Delta, millions of people may need to be relocated as low-lying areas become permanently flooded. These flooded areas may become rich fishing areas in the future if natural systems are allowed to expand.

In cases where agriculture begins to suffer from climate change, aquaculture may offer an alternative. For example, desert coastal areas that become too dry for agriculture could become sites (if sufficient water exists) for extensive algae culture to produce biofuels or other valuable products. That said, aquaculture may suffer in areas where optimal temperature ranges are exceeded; where freshwater flows decrease; or if storms, floods, or droughts become more common or extreme. Sea level rise may also threaten to inundate both coastal aquaculture farms and associated infrastructure. Changing salinity regimes or the salinization of freshwater resources will also affect aquaculture operations.

Human systems and the natural ecosystems upon which they depend are both vulnerable to climate change. In capture fisheries, systems that are well-managed, decentralized, and use a co-management approach are more capable of adapting to changing conditions. Coral reef ecosystems are more resilient to bleaching when other stressors, especially overfishing, have been reduced. Meanwhile, integrating aquaculture systems with agriculture can make them more resilient to climate change. Competition for water—for human use, cities, industries, fisheries, agriculture, and aquaculture—will become more intense in some areas, requiring a more integrated approach to management.

## **DISASTER MITIGATION AND RESPONSE**

Natural disasters and human-induced conflict can have major impacts on fisheries, but can also present excellent opportunities for reforms. Improving governance and building community resilience through hazard mitigation and disaster planning can mitigate the impacts of disasters on fishing communities.



## INDIAN OCEAN TSUNAMI, DECEMBER 2004

An estimated 2.5 million people dependent on fisheries and aquaculture as a livelihood activity were affected in the December 2004 Indian Ocean tsunami. The most costly toll was in human lives, with an estimated 60,000 fatalities in the fishing and aquaculture sector along with countless thousands injured. Over 100,000 fishing vessels were lost, destroyed, or damaged along with supporting gears and engines. Direct losses for the fisheries and aquaculture sector have been estimated at approximately US\$420 million. Many fishing families also lost their houses and belongings. There was also considerable damage to supporting infrastructure, including fish landing sites, piers, harbors, and coastal roads that served as a main conduit for post-harvest distribution. Coastal aquaculture infrastructure was also heavily impacted, with countless fish and shrimp ponds inundated and hatcheries destroyed. Due to the need to locate fishing and aquaculture in coastal areas, these facilities are inherently vulnerable to tsunamis, cyclones, floods, erosion, and sea level rise. However, with respect to the fisheries sector, most areas impacted by the tsunami were considered overfished before the disaster struck—too many fishers and boats chasing too few fish. In the rush to rebuild the sector, poor donor and country coordination resulted in many more boats and gear donated to fishing communities than existed before the tsunami. This only exacerbated the overfishing problem and decreased fishermen's income. In many ways, this was a missed opportunity; fishing effort could have been permanently reduced by encouraging fishers to shift into alternative occupations.

However, in the aftermath of a disaster care must be taken by responders and donors not to worsen the fishing situation. Response and rehabilitation programs that improve management and governance of the fisheries sector rather than increasing its capacity will aid in faster recovery and long-term sustainability.

Post-disaster responses, in coordination with donors and local government, should consider several factors before providing any new fishing inputs to communities. In most cases, nearshore and inland fisheries are already overfished. When a natural disaster results in the destruction of large numbers of fishing craft, this actually provides an opportunity to rescale the sector back to more sustainable levels. One approach is to provide fishers with cash-for-work opportunities that restore damaged habitats and remove debris, institute sector reform, and create appropriate opportunities for fishers to leave the sector. Not all fishers will be willing to change occupations, especially at a time of hardship and emotional stress. Therefore, creating incentives that increase voluntary exit from the fishery is the most sensitive way to promote reduced fishing effort immediately following a disaster.

Coastal areas are particularly vulnerable to typhoons, cyclones, and tsunamis, while inland fisheries are to droughts. Rebuilding affected fisheries and businesses can include the repair of ports and landing facilities, or the provision of new fishing inputs such as boats and fishing gear. Often neglected, but of equal importance, is the rebuilding of post-harvest infrastructure for the processing and handling of a highly perishable product. Such infrastructure includes ice and refrigeration facilities, transport vehicles, and repaired roads and bridges to transfer product to market.

Fisheries livelihood activities can play an important role in rapid recovery after a disaster. Most individuals who work in these occupations want to return to work quickly. If appropriate boats and gear can be provided quickly, fishers can help put high quality animal protein back into the local diet and economy and start generating income again.

Many forms of aquaculture are also highly vulnerable to natural disasters. Because of their dependence on water resources, aquaculture farms and hatcheries are often located near rivers and in low-lying coastal areas, making them vulnerable to sudden flooding, coastal storm surges, tsunamis, and sea-level rise. Careful planning is needed to avoid siting facilities in these high-risk areas. Damage to aquaculture farms may harm the livelihoods and incomes of farmers and put local food security at risk. Due to seasonal crop cycles, aquaculture takes longer to rebound after a disaster. This means aquaculture households will likely need sustained help with basic needs—either through direct donations, grants, or cash-for-work efforts—until the next harvest. It may also be necessary to provide fingerlings (if local hatcheries

are destroyed) and other farming inputs (e.g., nets for cages, pumps, fertilizer or feed). As with capture fisheries, only appropriate inputs and assistance should be given that will help move the aquaculture sector towards sustainability.

## **FOOD SECURITY AND NUTRITION**

Fisheries products are the world's most widely traded foods. Fish is a significant source of protein, essential amino acids, and vitamins in the diet of 2.6 billion people around the globe. In some countries, fish supply more than half of the animal protein in the average diet. In poor and marginalized groups living along coasts and inland waterways, fish is often the staple food.

Even in small quantities, fish improve dietary quality by contributing essential amino acids often missing or underrepresented in vegetable-based diets. Fish is more than just an alternative source of animal protein. Fish oils are the richest source of omega 3 fatty acids that are vital to normal brain development in unborn babies and infants. Without adequate amounts of these fatty acids, normal brain development does not take place. For this reason, traditional infant formulas are often based upon wild fish. Fish are also an excellent source of vitamins like riboflavin (Vitamin B2), Vitamin A, Vitamin D, which prevents osteoporosis, and is a great source of necessary minerals such as calcium, iron, zinc, and potassium, and other important components of a healthy diet.

As the world population grows, the demand for protein will increase, causing subsequent impacts on fisheries and aquaculture. For capture fisheries, increasing demand could drive prices higher and place additional pressures on this natural resource. Global and local food security will be achieved only through effective management of both capture fisheries and aquaculture. Such an approach is vital, especially in communities where fish is the main source of protein.

Fish as a source of protein is not just important to coastal communities. In many countries, inland populations are equally dependent on fish food for protein in their diet. For instance, in West Africa a marine fish is processed through smoking and drying and is then transported as far inland as the land-locked countries of Mali and Niger. This food source could be lost if the management of West African fisheries is not improved.

Aquaculture production, the fastest-growing component of global food production, is helping to meet the world's demand for animal protein. If the sector can be guided towards more sustainable and responsible practices, it could play an increasingly critical role in global food security. That is particularly important in such chronically food insecure regions as Africa. Ironically, the potential for aquaculture in Africa is high, but growth there has been slower than in other regions of the world.

One problem with aquaculture is the practice of using fish meal made from wild stocks as a food source for farm-raised high trophic-level species such as salmon, grouper, and tuna. One-third of capture fisheries are converted into fish meal for livestock and farmed-fish, rather than for direct human consumption. Roughly three pounds of wild fish are needed to produce one pound of farmed fish, increasing pressure on wild fish stocks. In addition, fish that could be eaten directly by poor populations are instead used for fish feed to produce high value crops, often for export to developed countries. In addition, the high cost of fish meal is driving a trend towards substitution, with soybean and grains as new sources of protein in the feed, competing with direct consumption of these food products by people. As food demands increase over the next several decades, the debate over fish-for-direct-consumption versus fish-for-feeds will continue.

## **DEMOCRACY AND GOVERNANCE**

Poor governance of fisheries resources is one of the leading causes of both overfishing in capture fisheries and of significant environmental impacts from poorly planned aquaculture development. Improving

the institutional and regulatory frameworks for fisheries management and aquaculture development contributes to the USAID goal of promoting transparent and participatory democracy. This includes strengthening the rule of law (fisheries enforcement and aquaculture regulation) and improving civil society engagement (co-management approaches).

In capture fisheries, a leading contributor to poor governance is low stakeholder participation. This is linked, in part, to conventional centralized systems of governance. Good governance, however, is about more than just the role of government. A reflection of this is the increasing trend in fisheries towards decentralized and co-management approaches where stakeholder groups including men and women, processors, wholesalers, and suppliers can all have a greater role in decision-making. Increasingly, it is fishers and their associations who are voluntarily adopting codes of conduct for responsible and sustainable fisheries.

A key international issue related to poor governance is the problem of illegal, unreported, and unregulated (IUU) fishing. IUU is a problem on both the high seas and in nearshore waters, where most small-scale fisheries operate. Illegal fishing practices work against effective management, as in the case of the widely banned practices of bomb fishing and the use of cyanide that damage important fish habitat. Poor reporting of fish landings confounds efforts to assess the status of fish stocks and apply catch limits. IUU fishing inevitably leads to overfishing of important fish stocks, and is often associated with trafficking of weapons, drugs, or persons. Many coastal countries identify IUU fishing as their main maritime security issue.

Promoting more democratic forms of governance will improve the management of both fisheries and aquaculture. Stakeholders in both sectors, including those in the private sector, are becoming increasingly involved in the governance of these sectors by assisting with the development of regulations and development plans, adopting codes of conduct and best management practices, and establishing and engaging in certification schemes.

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## 5.0 PRINCIPLES FOR SUSTAINABLE FISHERIES AND RESPONSIBLE AQUACULTURE

The following principles and best practices should be considered and, as appropriate, incorporated into the design of USAID-supported fisheries and/or aquaculture programs:

- Programs should promote ecosystem resilience to maintain ecosystem goods and services by conserving biodiversity and adopting a precautionary management approach.
- Programs should assist a fishery to move from open access to managed access and secure tenure. Capture fisheries are unique due to the nature of common property resources and the “tragedy of the commons” phenomenon. Fisheries reform requires a transition from uncontrolled open access to forms of limited entry, user rights, or catch shares. Activities should strive to secure access rights to fisheries with less reliance on external enforcement and more reliance on compliance, community co-management, and self-management strategies.
- Programs should promote comprehensive governance reform. Governance refers to how decisions are made and policies are formulated. Programs should promote open, transparent and participatory governance, with an emphasis on co-management. In this regard, programs should help governments re-define their role in sector reform and management by moving from “command and control” to an “enabling” role that promotes environmental stewardship. This will create sustainability through incentives for the private sector to invest in fisheries management and achieve a durable stake in the long-term protection of the resource.
- Programs should engage the private sector and apply value chain approaches. Programs should promote marketing of sustainably sourced, socially responsible, and high quality seafood products—either wild caught or farmed product. Through partnerships with private industry, governments, and civil society, the goal is to turn individuals involved in these sectors into business persons and stewards of the resources, and help them connect with the marketplace to achieve greater benefits. It is essential to move from maximizing catch to maximizing value, while promoting trade and marketplace reform measures that favor certified, value-added products. Harnessing the power of the entire value chain—producers, processors, wholesalers, and retailers—is a necessary step to achieving sustainable management and rational allocation of fisheries and aquaculture resources.
- Programs should promote social responsibility and equity as key objectives. Programs must protect subsistence needs and promote fair treatment of labor, including but not limited to, fair prices, prohibition of child labor, and safe working conditions. All phases of the management and decision-making process should be inclusive, involving both harvest and post-harvest segments of the industry.
- Programs should ensure equitable and broad participation. Poor stakeholder participation in management planning, decision-making, implementation and enforcement are some of the greatest constraints to improved governance. Additionally, many sectors of society such as women, youth, disabled, and the poor have limited access to the resources that would enable them to participate in fisheries or aquaculture.

- Programs should adopt codes of conduct and best management practices (BMPs). In both fisheries and aquaculture, codes of conduct and BMPs play a role in sustainable development and management. Codes of conduct are broad guidelines or statements for conducting an activity in socioeconomic and environmentally compatible ways. The BMP approach relies largely, but not exclusively, on voluntary adoption of practices that optimize production, minimize impacts, increase benefits, and reduce risks of all types. This is often expressed as a national or industry policy. Quite often, industry associations and government can work on establishing a code of conduct for responsible fisheries as a step preceding BMPs.
- Programs should commit to sector reform as a long-term process. Sustainable results in short time frames of five years or less are unlikely. To yield significant results, the focus should be on instituting reform measures today that improve the enabling environment and will set the stage for concrete and sustained results in the medium to long term.
- Programs should be adaptive. Conservation needs are complex and constantly evolving. Programs should be structured in such a way that they monitor their progress, generate timely information for management, and allow for adaptive management as needed.
- Programs should utilize science-based management. Fisheries and aquaculture management programs should be founded on good science. Programs should aim to build local scientific capacity that strengthens local management decision-making. Where adequate science is lacking, local knowledge can be a good source of information.
- Programs should foster sustainability. Programs should both focus on how achievements will be sustainable beyond the end of the activity's lifetime and seek to identify continued financing for ongoing activities. For programs that include resource extraction activities, managers should: examine the likelihood that extractive activities will be ecologically, socially, and economically sustainable; how overharvesting will be controlled; and how extractive use will contribute directly to biodiversity conservation.
- Programs should strengthen in-country capacity. Strengthening in-country capacity to increase the sustainability of interventions is key at both the individual and institutional levels. Institutional strengthening may be needed for both government and nongovernmental organizations.
- Programs should be results-oriented. Programs should clearly articulate their underlying assumptions, rationale, and methods for achieving planned results. They should also describe how program impacts will be measured and monitored.
- Programs should foster learning. Analysis of program results and dissemination of lessons learned should be part of a program's activities, particularly larger-scale programs and programs at multiple sites.
- Programs should complement other conservation and development activities. In particular, programs should examine how they will complement activities of USAID, other US agencies, other donors, host-country governments, the private sector, non-profits, and other institutions. Programs should also consider potential international obligations of the host governments. For example, some coastal fisheries such as small-scale tuna fishing are linked to international management organizations.

## II. CAPTURE FISHERIES

### 6.0 An Overview of Capture Fisheries

### 7.0 Management Approaches

### 8.0 Fisheries Program Planning



Long-tail fishing vessels in southern Thailand at port during the day. Fishing often takes place at night and can entail long hours of hard, laborious work.

Credit: Coastal Resources Center

# 6.0 AN OVERVIEW OF CAPTURE FISHERIES

## INTRODUCTION

Capture fishing is the largest extractive use of wildlife in the world, and one of the largest uses of an ecosystem “good.” It is a critical source of protein and livelihood, employing over 40 million fishers in Africa alone, and representing more than 20 percent of the animal protein in the diet of 2.6 billion people. In developing countries, where the vast majority of fishing communities and fishers are located, fishing is uniquely important to livelihoods, food security, and poverty alleviation.

This guide focuses primarily on nearshore fisheries, which take place in shallow coastal waters such as estuaries and coral reefs, as well as in freshwater lakes and river. Most nearshore fisheries require little capital investment, using relatively small fishing vessels, traditional gear and may use motors. Nearshore, small-scale fisheries are a major source of food for local consumption and livelihood for coastal households. Ninety-six percent of fishers worldwide—accounting for 58 percent of global catch—fish in nearshore waters of developing countries. It is estimated that 260 million people are directly and indirectly involved in global marine fisheries. Twenty-two million of these work in small scale fisheries, a figure 1.75 times greater than listed in previous reports from the FAO. This “invisible workforce,” is mainly unlicensed and fish for subsistence or local sale. Fishing involves all community members: men, women, elderly, and youth. However, inadequate sex-disaggregated data—at the national, regional, and global levels—means there is little recognition of the contributions of women to the fisheries sector.

Fisheries play an important role in the national and local economies of many transformational and fragile states. In spite of this, the fisheries sector—as compared to other sectors of the world food economy—is poorly planned and regulated. Overfishing occurs around the globe, threatening the ecosystem upon which productivity depends. Factors leading to overfishing include traditional systems of open access, the difficulty of monitoring landings and fishing effort, by-catch, changing environmental conditions, and a general lack of governance and effective enforcement.

Fish stocks have traditionally been regarded as an inexhaustible resource and as a social safety net. Fishing in developing countries is often open access with little or no controls, i.e., individuals enter and exit the trade at will. Fishing often serves not only as a food source, but as an income of last resort for the poor. This fact has contributed greatly to the overexploitation of nearshore fisheries resources and harm to marine ecosystems. The poor economic health of fisheries is caused by too many boats and fishers (overcapacity of fishing fleets). Improved harvest technologies, increases in marine pollution, and habitat degradation are other contributing factors.

The problems facing world fisheries are daunting, but not without solutions. Fish is a limited renewable resource. When managed correctly, it can make stable contributions to food security, livelihoods, and revenues. Reforming the governance and management of this natural resource is essential to sustainable, long-term economic development,

Seventy-seven percent of world fisheries production is from developing countries.

Net fisheries exports from developing countries in 2002 was worth US\$17.4 billion.

For 2.6 billion people, fish represents more than 20 percent of the animal protein in their diet.

Fifty million men and women are directly employed in small-scale fisheries.

Ninety-six percent of fishers worldwide are small-scale and provide 50 percent of global catch, and most reside in developing countries.

conservation of biodiversity, and in some cases, to overall peace and security. This guide illustrates examples of innovative approaches that have led to long-term solutions for sustainable fishing. Some approaches include conserving critical fish habitat, reducing destructive and illegal fishing techniques, encouraging co-management approaches, and the use of market-based approaches.

## **SOME BASIC CONCEPTS**

### **Major Fisheries Types**

There is no one-size-fits-all description of fisheries. Fisheries can be classified by what is caught, where it is caught, the scale of operation, type of gear used, and the ultimate destination of the product.

### **Target Species**

There are many animal and plant species harvested in nearshore fisheries. This includes bottom dwelling species (benthic or demersal) and pelagic (swimming) species. Another major group is marine algae and plants—e.g., nori, dulce, Irish moss, and kelp. Seaweeds can provide food for humans, or can be used as an ingredient in cosmetics, as fertilizer, and for the extraction of industrial gums and chemicals. Marine fishes make up the bulk (82 percent) of worldwide fish harvests while freshwater and diadromous (e.g. salmon) fishes constitute a much smaller percentage (1.6 percent). The remaining 16 plus percent consists of invertebrates such as mollusks (e.g., clams, oysters, mussels, squid and octopus, and scallops) and crustaceans (e.g., crabs, lobsters, and shrimp). Understanding basic biology, ecology, and population dynamics for these harvested species is necessary to developing sustainable harvest strategies.

### **Fishing Scale**

Capture fisheries can be classified by scale (industrial, small-scale, artisanal and subsistence) and intent (commercial or recreational). However, there is often confusion and overlap between these terms. The box above offers common definitions that may be useful in explaining the differences in the classifications of fisheries.

The distinction between large-scale vs. other scales of fisheries is relative. Fishing methods and scales differ between regions and socioeconomic characteristics. Boats that fall into the lower end of the defined spectrums are usually considered to be engaged in small-scale or artisanal fisheries. Those that fall into the intermediate range may be called modern artisanal or semi-industrial, and boats above that range are considered industrial. In general, artisanal fishing in developing countries is considered to be labor-intensive forms of fishing performed by men, women, and children from fishing households.

In general, fishers are categorized as subsistence fishers if they take their catch home as food for their families, with the assumption that fish is a critical component of their diet. Fishers are considered recreational if they fish for leisure and sport. Sport fishing is becoming a significant contributor to the total catch in some areas.

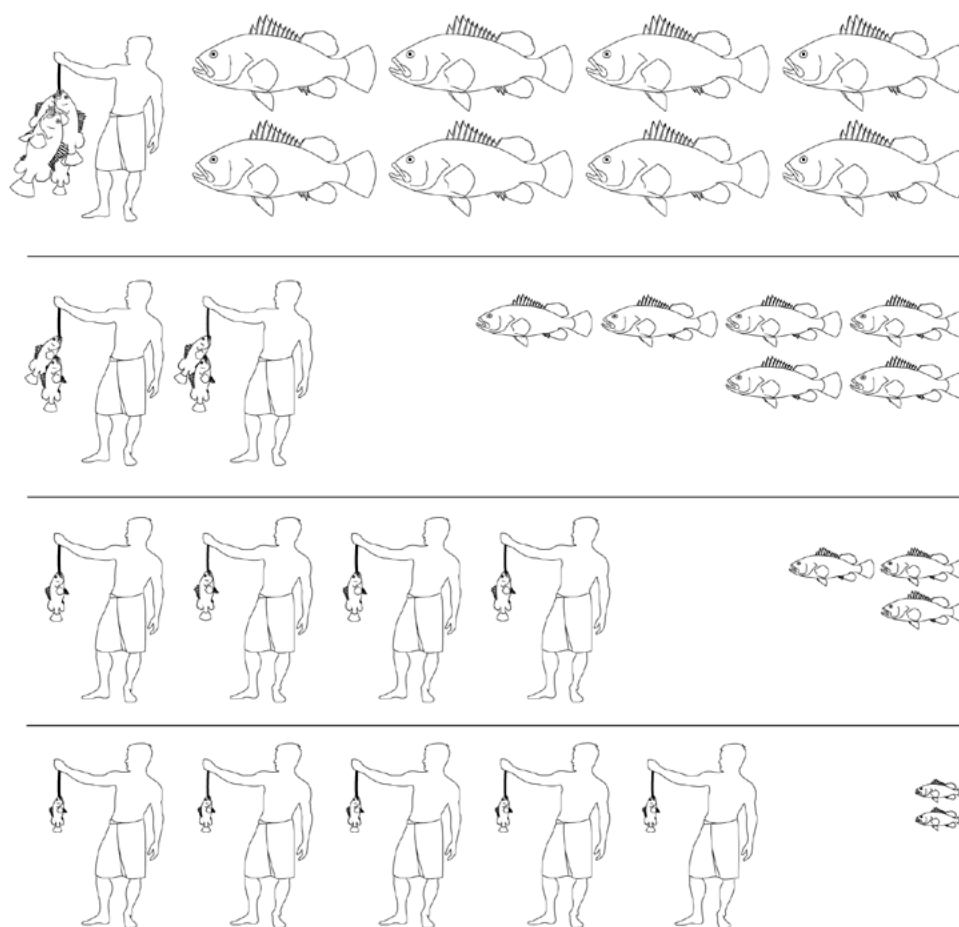
### **Fishing Location**

**Freshwater Fisheries.** Inland fisheries (river, small water bodies, and lake-based) provide a major source of food and employment for millions of individuals, especially in the developing world. Most inland fisheries make protein available in areas that might otherwise suffer from nutritional deficiencies. In some countries, freshwater fishing employs a larger portion of the population than does marine. Although freshwater fisheries are not the focus of this guide, it should be considered in countries where its importance is high.



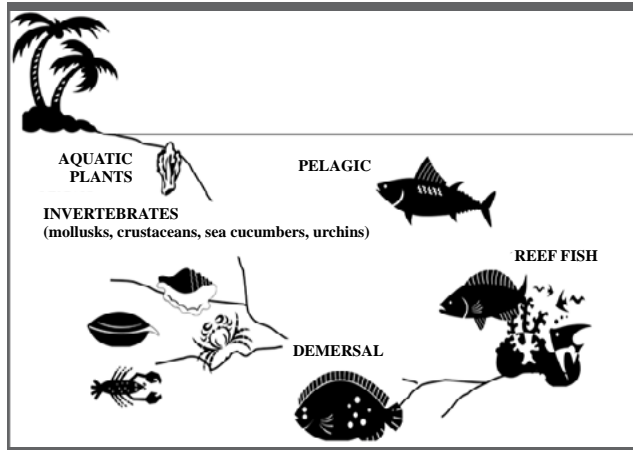
## Large-Scale and Small-Scale Fisheries Compared

Key Features	Large-Scale Fisheries	Small-Scale Fisheries
Direct employment in fishing	500,000 people	50,000,000 people
Fishery-related occupations	—	150,000,000 people
Fishing household dependents	—	250,000,000 people
Capital cost per fishing job	US \$30,000–300,000	US \$20–300
Annual catch for food	15–40 million tons	20–30 million tons
Annual fish by-catch	5–20 million tons	< 1 million tons
Annual fuel oil consumption	14–19 million tons	1–2.5 million tons
Catch per metric ton of oil used	2–5 metric tons	10–20 tons



Increased numbers of fishers over time leads to too many fishers chasing fewer and fewer fish. Some typical signs of overfishing include declining catch per fisher and decreasing sizes of fish caught. Smaller fish produce fewer offspring than bigger fish, resulting in recruitment overfishing and danger of fish stock collapse.

**Marine Fisheries: Nearshore to High Seas.** Most marine artisanal fishing occurs in the nearshore environment — i.e., estuaries, lagoons, bays, reefs, and sounds. Most of this area is under country jurisdiction, out to the 12-mile territorial sea limit. These areas usually receive high nutrients and are extremely productive, with fluctuating salinities, temperatures, and oxygen characteristics. They are important nursery areas for many species.



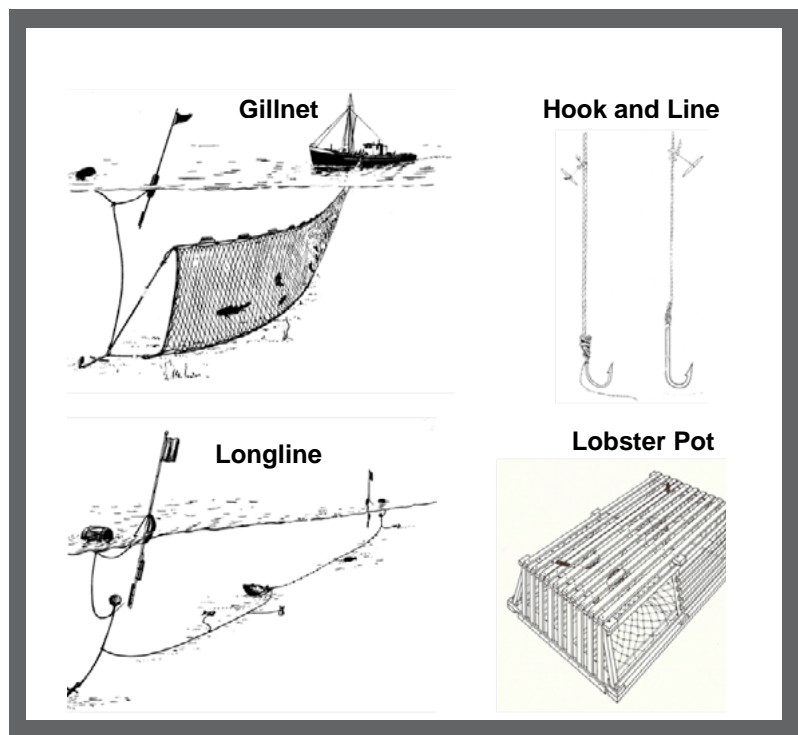
Further from shore, fisheries tend to be more industrialized with larger boats, larger crews, and different harvesting, processing, and holding technology. However, often there is overlap in areas and species harvested between the small- and large-scale fisheries. This overlap can lead to conflict and overfishing. Although a country may have legal jurisdiction to the 200-mile limit “exclusive economic zone” (EEZ), there is often no mechanism for enforcement. Also, in some cases there are no national fleets in place to harvest these resources. As such, many countries will rent or lease permits (in some cases through international instruments such as access agreements) to other countries to allow vessels

from these countries to enter their EEZ and harvest the resources for a fee.

Migratory fish do not recognize country jurisdictions and move between the national waters of different countries. Management of these “shared stocks” or “straddling stocks” require international cooperation.

## Fishing Gear

Most nearshore fishing techniques require only basic technology such as simple traps, pots, weirs, hand-lines, and masks and snorkels, although nearshore fisheries can also be industrialized, as in the case of trawl fishing for shrimp. Nets appeared early in human history, but the earliest net material was often stiff and easily broken. As fish trade became important in the Middle Ages, larger nets were utilized by distant water fleets (e.g., for whales, salted cod, and herring). With the development of heavier gear and increased manpower, fishing moved from shallow water to deep-sea fishing. Twentieth century mechanization brought new gears such as the beam trawl, otter boards, purse seines, and mid-water trawls. By the 1950s synthetic materials such as monofilament were in use, greatly increasing the efficiency of fishing gears and to the detriment of the environment and fish populations. In contrast, many gears produced today are intentionally made to be less efficient in order to help reduce catch levels and increase selectivity gear modifications include large escape openings, turtle and fish



excluder devices (TEDs and FEDs), biodegradable panels, large mesh and rope trawls, square mesh windows, and other by-catch reduction devices (BRDs).

As fishing technology improved, fishing at increasing depths became possible. Inaccessible deeper waters used to serve as refuges; however with the use of deepwater gear, these refuges have disappeared, reducing the resilience of fisheries and habitats.

Today, gear types are broken into two categories, passive and active. Passive gear requires the fish to come voluntarily to the gear. Active gear pursues the fish. Examples of different gear types include:

**Passive:** gillnets, trammel nets, hook and line, long-lining, pots, and traps, pond nets/pound nets

**Active:** spears and harpoons, trolling, trawls (beam, bottom, mid-water) and dredges (hydraulic, scallop, clam), seine nets (purse, beach, and other), rakes, hoes and tongs

**Other:** Fish Aggregating Devices (FADs)

### Fisheries Science and Management

The overall goal of fisheries science and management is to maximize the production or economic yield of the fishery while maintaining a healthy population of fish and habitat for a long-term sustainable future. There are many gaps in knowledge that impede the efficacy of science-based management, including environmental change, changes in the number of fishers, multiple landing areas, and insufficient fisheries data. The statistical nature of fisheries science means there are always uncertainties associated with stock assessment outputs.

Fisheries are a renewable resource and produce surplus biomass that can be harvested without harming the viability of the species. Harvesting fish, however, changes the characteristics of an ecosystem. In theory, the goal is to harvest fish when the growth rate produces the greatest gain in weight balanced against the mortality rate as fish age and start to die from natural causes. When such data is not available, there are many other simple indicators of species and fisheries health. Local knowledge and qualitative indicators can sometimes be used to guide decision-making in small-scale fisheries when there is a lack of quantitative “scientific” numbers.

## KEY THREATS AND MANAGEMENT ISSUES

Most fisheries in developing countries are poorly managed or not managed at all. The resulting unrestricted access and overfishing, lead to negative ecological, environmental, economic, and social



Nearshore fisheries are often conducted from small, open, unmotorized vessels using simple gear.

Credit: ECOCOSTAS



consequences. This is particularly true for nearshore fisheries, which are often overfished and over-capitalized and may use destructive fishing methods. These issues in combination reduce the overall ability of marine and aquatic ecosystems to sustainably supply fisheries products, an important high quality food. These same issues also present significant threats to biodiversity, upon which productivity and sustainability depend. Reforming capture fisheries to be economically and environmentally sustainable and socially responsible requires addressing the following issues.

Open access and the resulting tragedy of the commons has been a common feature of fisheries. The historic view of fisheries as an inexhaustible resource led to the common practice of open access. This system offers no incentives for long-term conservation practices, leading to overfishing, loss of biodiversity, overcapitalization, excess effort, degraded habitats, and depleted resources. However, the decline of fisheries and better availability of scientific information is slowly changing this ethic. New approaches to management involve secure access privileges, community-designated fishing areas, zoning, national access agreements, licenses and permits, and other forms of use rights or tenure.

Weak governance and its implications for changing open access policies are widely acknowledged as one of the biggest and most pervasive problems within the sector. Factors characterizing weak governance in fisheries include: lack of adequate policy and legal frameworks to support co-management and managed access, corruption, inadequate resources available for management (physical, human, and financial), poor enforcement, illegal fishing, unclear traceability of point of origin, lack of stakeholder participation in decision-making, lack of clear vision, and user conflicts. The inclusion of fishers in management can strengthen governance infrastructure by creating responsible, economic incentives for conservation, and reducing the need for extramural enforcement. A stronger, corruption-free institutional framework will allow for capture of economic rent and reinvestment in management.

Overfishing and overcapacity are consequences of a short-term view of fisheries in an open access structure. Overcapacity generally means that more boats are fishing than are needed to harvest sustained maximum yields, whereas overfishing occurs when fish are caught to the point that the population can't maintain itself. Overfishing of key functional groups or top predators can reduce ecosystem resilience and lead to the phenomenon known as fishing-down-the- food-chain. Introducing conservation incentives allows a longer-term strategy to be put in place, transforming fisheries from subsistence-level harvest to a more profitable economic activity that generates increased value per pound of fish harvested. This will encourage the use of less harmful gear types, reduce fishing effort, benefit ecosystem health and biodiversity, and preserve valuable habitats and ecosystem relationships.

Destructive fishing practices are those that physically harm the environment, removing or degrading the habitat and reducing productivity. Bottom trawling, considered by many scientists to be one of the most destructive fishing techniques, uproots or destroys animals and plants growing on the bottom in the course of catching fish. Trawling has resulted in major ecosystem impacts and habitat changes, eliminating essential fish habitats, fish nurseries and critical biodiversity. Some countries, such as the Philippines, have banned the use of bottom-trawls as a way to restore the ecosystem and its productivity. Other widespread destructive fishing methods include the use of explosives, such as dynamite or homemade bombs, and chemicals, such as cyanide or bleach. Chemicals are used to stun fish or flush them out of crevices, making them easier to catch. These chemicals sometimes kill other animals and coral in addition to the target fish.

Illegal, Unregulated, and Unreported (IUU) fishing is of growing concern worldwide. Illegal fishing occurs where fishing vessels operate in violation of the laws of a fishery. This applies to fisheries that are under the jurisdiction of a coastal state or to high seas fisheries regulated by regional fisheries management organizations (RFMOs). Unreported fishing is fishing that is unreported or misreported to the relevant national authority or RFMO, in contravention of applicable laws and regulations.

Unregulated fishing generally refers to fishing by vessels without nationality, or vessels flying the flag of a country not party to the RFMO governing that fishing area or species. The drivers behind IUU fishing (sometimes referred to as pirate fishing) are clear, and similar to those behind many other types of international environmental crime. One key driver is the high economic value of certain species of fish, particularly those that have been over-exploited and are thus in short supply.

Loss of ecosystem productivity and resilience are two consequences of poor fisheries governance and the resulting overfishing. These are exacerbated when destructive fishing occurs. Coastal marine and freshwater environments are some of the most stressed ecosystems in the world, weakened by increasing human populations and subsequent coastal alterations, loss of critical spawning habitat, changes in water flow, and runoff that includes suspended solids, pesticides, herbicides, and other chemical and biological waste products.

Globalization of trade has also had far-reaching impacts on fisheries. Small-scale fishers often generate income through the harvest of high-price, high-demand products. However, when there is high demand but a weak management framework, these high-value species (e.g. groupers, ornamental fish) can be quickly depleted. One technique to minimize this is to adopt national trade policies requiring the development of sustainable management plans, including quotas, before a species is allowed to be traded. National fishery agencies need to adopt more precautionary approaches and establish safeguards for these critical resources to prevent boom-and-bust cycles. National policies could contain a list of “ecologically appropriate species” eligible for trade, based upon ecological criteria.

Loss of economic rents in marine capture fisheries is a consequence of open access, weak governance, and degraded ecosystems. Marine fisheries reform can recapture a substantial portion of the economic losses by reducing effort and strengthening tenure systems. This is a long-term process requiring political will and a shared vision developed collaboratively with stakeholders.

Maritime security is threatened by illegal fishing. To meet the national security challenges faced by many developing countries, maritime and coastal security requires a holistic approach. This includes border surveillance; national, local and community fisheries management; and enforcement.

Labor, health, and safety considerations should be part of any fisheries reform. Fishing often takes fishers away from home for long periods. This frequently leads to behaviors that increase public health risks such as HIV/AIDS infection. The importance of the role of women is often overlooked during fisheries reform. Economic development is only sustainable if it includes respect for worker rights and human rights. Too often in fisheries, these rights are violated—especially in regards to child labor and working conditions on boats or in processing plants. Fair trade certifications could help alleviate poor working conditions. Education about and treatment of HIV/AIDS should also be considered as part of an integrated approach to fisheries reform.

Inadequate support services are a problem in the fisheries sector. The availability of training, extension and financial services, skilled human resources, and market infrastructure are an important foundation for long-term sustainability. Support services must be accessible to both men and women. Providing this support requires considerable investment, planning, and integration of activities. Scientific and logistical support to fisheries institutions is also critical for developing sound management policies.

Increasing world populations are escalating the demand for food and seafood products, increasing seafood prices and resulting in heightened fishing pressure. Overfishing can result if access is not managed. In addition, many countries are experiencing increased migration to coastal areas where unemployment and underemployment may already be high. In open-access fisheries and those with inadequate management systems, these demographic trends exacerbate other threats to sustainable fishing. Integrated population-health-environment programs that include family planning initiatives can help address the long-term threat of population growth. In the short term, family planning and spacing of children can help

households become more economically secure. This, in turn, makes them more willing and able to engage in sustainable harvest practices. Programs that integrate family planning and fisheries management, such as the Integrated Population and Coastal Resource Management (IPOP-CORM) in the Philippines, have been found to be more effective than single-sector approaches.

Bycatch, the incidental capture of non-target animals, is a threat to many species. This problem is of special concern with regard to threatened or endangered species, especially seabirds and turtles. Incidental capture occurs in all types of fishing—longlines, gillnets, traps, trawl gear, and even single hook and line operations. Trade restrictions and public pressure have led to reforms in the fishing industry to minimize bycatch. Some countries have enacted regulations that require fishers to use turtle and fish excluder devices (TEDs and FEDs). Some fisheries have adopted a variety of gear modifications—including floating line, acoustic pingers, streamers, and modified hooks—to reduce the impacts of fishing, while others have restricted fishing activities to certain times and in certain areas.

## SOURCES FOR MORE INFORMATION

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[http://www.crc.uri.edu/download/Fish\\_Opp\\_Assess\\_Final\\_012607\\_508.pdf](http://www.crc.uri.edu/download/Fish_Opp_Assess_Final_012607_508.pdf)
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- Shifting Gears: Addressing the Collateral Impacts of Fishing Methods in U.S. Waters  
[http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Protecting\\_ocean\\_life/environment\\_pew\\_science\\_series\\_shift.pdf](http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Protecting_ocean_life/environment_pew_science_series_shift.pdf)

## 7.0 MANAGEMENT APPROACHES

Sound fisheries management is based on established goals and objectives. In the case of overexploited fisheries, a primary goal could be to reduce overfishing. This goal could be pursued through several objectives. For instance, a key ecological objective might be to restore and maintain the ecosystem health and biodiversity upon which fisheries depend. Another may be to improve the fishery's profitability. To achieve these objectives, policy and governance reforms, such as co-management approaches and secure access, can be employed to promote environmental stewardship. Limits on how much yield or harvest can be extracted on an annual basis can be implemented. Fishery management objectives will determine what type of gear and method is appropriate, and where it should be used. There should also be an evaluation of how these limits can be set within the governance structure and an assessment of existing capacity for enforcement and the development of stewardship.

Policy reforms should focus on:

- Promoting an enabling environment that encourages stewardship
- Positive incentives
- Managed access
- Fair trade agreements
- A precautionary approach
- Long-term productivity

There are many tools available that the fishery manager can apply to achieve specific fisheries objectives. These include time and area closures, use rights, no-take or fishery reserves, networks of marine protected areas, input and output controls, or a combination of these measures. Stakeholder buy-in must be achieved on aspects of fisheries management to ensure that sustainable limits are not exceeded. The decision on which tools to use will be a function of the environment, the type of fishery, the ability to enforce regulations, and the perceived benefit to the stakeholders. Once a menu of tools is selected, monitoring, control, and surveillance (MCS) programs are necessary to ensure compliance.

Fisheries management in the past largely focused on measures that controlled the size and number of vessels, fishing technology, and gear. These are referred to as “input” controls. More recently, fisheries management is focusing on letting fishers themselves make those kinds of technology decisions. Instead, it is placing restrictions on the allowable harvest — i.e., where and when fishing is permitted, as well as the amount and size of fish that can be taken. These are referred to as “output” controls.

Another, more recent evolution in fisheries management aimed at eliminating the open access problem is to allocate limited rights to fish in a particular fishery or marine area. This is referred to as a “rights-based approach” to fisheries management. There is some overlap between use rights and both input and output controls. Some input and output management measures also allow access to a fishery, for instance. These three management approaches are described in the following text. Voluntary and market-based management approaches (codes of conduct, best management practices, eco-labeling, and certification) are also commonly used methods. None of these approaches are mutually exclusive and are often used in combination. One example of this integrated approach was the USAID FISH Project in the Philippines that used a combination of growth, control and maintenance mechanisms to achieve management objectives at the ecosystem scale. Growth mechanisms enhance production, control mechanisms allocate access, and maintenance mechanisms built stakeholder capacity.

## HOW DO WE MANAGE ACCESS?

A key aspect of fisheries reform is moving from open access towards a managed access regime. An intermediate step towards managed access is secured access, which places a limit on the number of participants who have rights and responsibilities in harvesting and managing the resource.

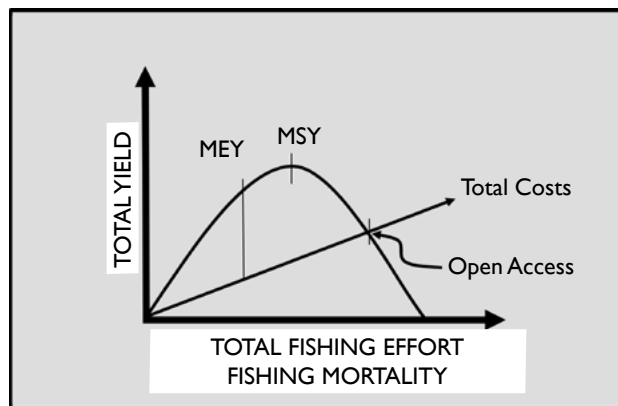
The figure below illustrates a conceptual model of an open access fishery. In the early stages of developing a new fishery, both effort and catch are low, although the catch per unit of effort (CPUE), catch per unit of gear, or catch per fisher may be high. As more fishers enter the fishery, both the total catch and catch per unit effort rise. At a point, however, increasing fishing effort no longer results in an increase in catch, and CPUE decreases. Maximum sustainable yield (MSY) is defined as the point at which the greatest yield can be taken continuously under existing environmental conditions. This is also often referred to as the maximum biological yield. However, some fisheries managers chose to adopt a precautionary approach and use the fishery's maximum economic yield as a management goal. This is the catch at which profitability is greatest.

### Fisheries Catch-Effort Relationship

Where the cost of fishing is low, such as in many small-scale fisheries, the number of fishers and boats in the system will be high. Many fishers and boats leads to over-exploitation of the fishery and eventually drives the total sustainable yield below the MSY. In some cases a complete collapse of a viable fishery results. The open access equilibrium point occurs when the total yield of the fishery equals the total costs, which include the opportunity costs of capital and labor plus all economic profits. In the absence of effort controls, a fishery may employ more people, but individual yields and wages will be low. This unmanaged equilibrium point is where most small-scale fisheries are today. Biological and economic overfishing is taking place and the fishing fleet is over-capacity. The prevalence of open access fisheries in the developing world is an ongoing challenge for fisheries management.

The relationship between catch and effort allows us to understand how a stock may respond to changes in effort. Increased effort does not always result in the catch of more fish. In an unmanaged, open access system, when fishing effort exceeds MSY, reproduction and growth of the fish population cannot replace the biomass lost to over-harvesting and natural mortality. MSY is frequently the management target of fisheries where the objective is to maximize food production. Although MSY can be calculated with only catch and effort data, because it is a maximum point, it is almost impossible to know how close the fishery is to the point until it has been exceeded. Once exceeded, the fishery is in decline and it becomes difficult to stop new fishers entering the fishery, or reduce the level of fishing effort to allow a return to the MSY equilibrium point.

If the management objective is to maximize economic profits, fishing effort should be maintained at the point of maximum economic yield (MEY). This is the point at which the difference between total yield and total costs is the greatest, and is at a lower effort level than MSY. However, if the desired management objective is to maximize benefits from non-extractive activities such as tourism and sport fishing then the goal may be to maintain fishing effort and yield close to zero.



## Alternative Livelihoods

To increase yields in cases where a fishery is beyond the MSY, fishers must reduce effort. This, however, can be extremely problematic for marginal populations that are dependent on the fisheries for food and livelihood. The challenge of reducing excess capacity in small-scale fisheries is compounded by factors such as growing populations and sluggish economies. Policies that aim to reduce the number of fishers must also create diversified, non-fishery employment opportunities for ex-fishers to transition into. However, alternative livelihoods alone will not reduce effort or prevent overfishing. A two-pronged approach is required. It is essential to: 1) provide incentives for those who are currently fishing to leave the activity; and 2) take action to limit new entry into the fishery. If the fishery remains open access, optimum biological or economic yields will never be achieved. Programs that invest in alternative livelihoods without a simultaneous reduction in the number of licenses, fishers and/or vessels will not result in reduced fishing pressure.

While the catch and effort relationships illustrated above are useful to explore basic fisheries management concepts, these relationships cannot be used as an empirical model for decision making. Even with imperfect information, there are often other clues that can be used to determine whether overfishing is occurring or not. For instance, if fishermen are increasing the length of their nets and spending more time at sea but the average fish size in a catch is decreasing and overall catches are not increasing, then the fishery is likely overfished. In these cases, fishing effort should be reduced through managed access.

Many fishers around the world view fishing as a desirable lifestyle or ancestral occupation and may be unwilling or reluctant to stop. While the ultimate goal may be for fishers to fully exit the fishery, sometimes a gradual approach may be necessary. These approaches can include encouraging fishing households to adopt supplemental income and food-producing activities to make them less economically dependent on fishing. Reducing, but not eliminating, fishing as a livelihood helps preserve the cultural heritage of fishing and reduces the socioeconomic dislocation that can come with a full exit.

Achieving a healthier, more sustainable fisheries sector often depends on changes not only from within, but also from outside the fishery sector. Effective fisheries programming will take an integrated approach that considers natural resource management along with economic and community development. This requires an understanding of how men and women adapt, the incentives that drive decision making, the behavior of the resource users, and areas of vulnerability. This holistic view of the social, economic, and environmental challenges that affect individuals, households, and communities is sometimes called a livelihoods approach.

Effort reduction is a critical first step in achieving sustainable management in overfished fisheries. There are several ways to accomplish this. One is to shift participants from full- to part-time fishing, or to use other forms of input controls and catch quotas. These are described in more detail in subsequent sections of this guide. These shifts may be biologically or economically healthy for the fishery, but almost always result in social costs to fishing communities and families, especially to those forced out of fishing. For those remaining in the fishery increased income generation becomes possible. These social concerns should be identified and mitigated as part of an overall fisheries reform package. Capture fisheries reform programs must be very clear on their objectives. Assuming a key objective is to reduce fishing effort, the program design must include strategies to garner stakeholder support for the proposed changes. It must also consider ways to ameliorate the short-term impacts on fishing communities.

## CO-MANAGEMENT

Fisheries can be more efficiently managed when fishers are involved in the process. As fisheries become self-regulated, issues of enforcement and compliance — often major factors in management failure — typically diminish. Co-management is a partnership arrangement where fishers and government share



## The 10 Commandments of Ecosystem-Based Fisheries Management

- Keep a perspective that is holistic, risk-adverse, and adaptive
- Question key assumptions, no matter how basic
- Maintain old-growth age structure in fish populations
- Characterize and maintain the natural spatial structure of fish stocks
- Characterize and maintain viable fish habitats
- Characterize and maintain viable fish habitats
- Identify and maintain critical food web connections
- Account for ecosystem change through time
- Account for evolutionary change caused by fishing
- Implement an approach that is integrated, and inclusive

Source: Hixon et al. (2007)

[http://www.csc.noaa.gov/cz/CZ07\\_Proceedings/PDFs/Tuesday\\_Abstracts/0000.Hixon.pdf](http://www.csc.noaa.gov/cz/CZ07_Proceedings/PDFs/Tuesday_Abstracts/0000.Hixon.pdf)

responsibility and authority for managing the fishery. It has many variations ranging from fishers playing a minor role to being included as major decision-makers, often supporting the science, enforcement, and management of the fishery. Community-based management is one form of co-management and is carried out at small-scales by village communities. Traditional management is a specialized form of community-based management and is also considered a co-management approach. Traditional management integrates traditional practices and often follows informal rules or community norms that fall outside of legal management regimes.

Co-management is different from, but related to, decentralization in fisheries. Decentralization can take several forms, from de-concentrated to delegated authorities. Usually decentralization refers to shifting of responsibilities from central government to lower levels of government — e.g., municipalities in the Philippines or districts and provinces in Indonesia. Administrative decentralization may or may not include delegation of responsibilities for fisheries management or clearly defined maritime jurisdictions of fisheries authority.

The Philippines is a good example of decentralized fisheries management. In the Philippines, municipalities control all fishing within 15 km of the shoreline. The central government retains control beyond 15 km, to the limits of the exclusive economic zone (EEZ). While the central government controls licensing for large-scale commercial fishing vessels, these vessels cannot fish in municipal waters without municipal licenses as well.

In Indonesia, districts manage marine resources from the shoreline out to four nautical miles. Provinces manage from four to 12 nautical miles, and the central government retains responsibility from 12 nautical miles to the limits of the EEZ. Decentralized administrative authorities can decide on the degree of co-management within their area of jurisdiction. Decentralization and co-management are often implemented hand-in-hand.

## ECOSYSTEM-BASED FISHERIES MANAGEMENT

Ecosystem-based fisheries management (EBFM) focuses on conserving the underlying health and resilience of the fishery ecosystem, thus maintaining the system's goods and services and leading to increased productivity. Developing an ecosystem-based approach to fisheries management need not be complicated. It is built around common sense principles (see box p.39) that include:

- Identifying critical fisheries nurseries, habitats, and linkages between habitats, such as between mangrove forests, seagrass beds, and coral reefs
- Understanding freshwater inflows into coastal estuaries
- Maintaining the quantity, quality, and timing of such flows that make wetlands and estuaries some of the most productive ecosystems in the world
- Understanding how human activities impact ecosystem function

EBFM can be viewed as a long-term, incremental process that over time builds increasing levels of integration and larger scales of management. Existing sectoral-based fisheries management can move towards ecosystem-based management in a number of ways. For example, fisheries can incorporate initiatives targeted at marine habitat protection, especially habitats such as coral reefs and mangroves that are important to various life stages of the most economically important fisheries. EBFM acknowledges the important role of herbivores in coral reef ecosystems and the role of top predators, such as groupers and sharks, in maintaining ecosystem resilience and integrity. It incorporates efforts to address land-based sources of marine pollution, and it can help in assessing and planning for the impacts of global climate change.

EBFM approaches to fisheries often recommend the application of the precautionary approach. In certain situations, such as when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully scientifically established. When there is scientific uncertainty on the potential impacts or consequences of a fishery project, an evaluation and risk assessment can mitigate the risks of moving ahead. Monitoring and risk assessment should continue throughout the project.

EBFM does not necessarily require a high degree of scientific understanding of marine ecosystems and fisheries. However, it does require a basic understanding of the ecosystem linkages and the political will

Elements and Variables of Marine Conservation Agreements					
Mechanisms		Parties		Benefits	
Formal	Informal	Grantor	Grantee	Incentive	Protection
<ul style="list-style-type: none"> <li>• Purchase and sale</li> <li>• Lease</li> <li>• Easement</li> <li>• Permit</li> <li>• Concession</li> <li>• Contract</li> </ul>	<ul style="list-style-type: none"> <li>• Verbal</li> <li>• Handshake</li> </ul>	<ul style="list-style-type: none"> <li>• Individuals</li> <li>• Private companies</li> <li>• Local government</li> <li>• State</li> <li>• Federal</li> </ul>	<ul style="list-style-type: none"> <li>• NGOs</li> <li>• Communities</li> <li>• Ecotourism</li> <li>• Other for-profit groups</li> </ul>	<ul style="list-style-type: none"> <li>• Direct payments</li> <li>• Social services</li> <li>• Infrastructure</li> <li>• Jobs</li> <li>• Culture</li> <li>• Pride</li> </ul>	<ul style="list-style-type: none"> <li>• Ownership</li> <li>• Access</li> <li>• Harvest</li> <li>• Management</li> </ul>

to make sound decisions. While EBFM encourages the use of best available science in decision-making, fisheries are often managed in information-poor contexts. Resources for scientific research on fisheries will always be limited. Management decision-making should therefore incorporate the precautionary approach, and also incorporate traditional and local knowledge provided by stakeholders. In some cases, local knowledge may be the only available source of information on the status of fish stocks and ecosystem function. Other nearby ecosystems or those with similar biological assemblages where better data exists can sometimes be used as a model to guide precautionary management.

## USE RIGHTS

Under a rights-based system, those individuals or groups entitled to access the fishery are said to have use rights. Use rights in a fishery define the particular actions a fisher is allowed to take and the claim the fisher has to a benefit stream. The government usually protects these rights/benefits. Rights provide fishers with an incentive to behave in a way that helps ensure long-term sustainability and greater stewardship of the fisheries resource.

Use rights systems fall into two categories. Access rights allow entry into the fishery and the right to harvest. Harvest rights provide the right to a specific amount of effort on a specific species. Licensing and total allowable catch rules, as described below, are forms of use rights. Territorial use rights in fisheries (TURFS) are often important in rural isolated locations and where tribal or traditional use practices are still respected within the local culture. Often, such traditional use rights can be codified or endorsed within “modern” management policies and laws.

Use rights can be controversial. This is especially so when a part of the fishing community is excluded from fishing. Once use rights are allocated, the next question is, “Should they be transferable?” Can they be bought and sold or handed down within families or communities? Can women as well as men buy or inherit these rights? Can rights be transferred permanently or borrowed for short times? There are major consequences to the decisions made regarding this management issue. These concerns include the economic efficiency of the fishery, the social cohesion of the community, and the potential for concentration of rights to a few.

A type of use right that is popular with economists is individual transferable quotas (ITQs). ITQs allocate annual fishing quotas to individual fishers. These can be bought and sold among fishers or conservation groups. However, in the context of small-scale fisheries, ITQs or overall total allowable catch (TAC) quotas are seen as unworkable. They require careful monitoring of individual catches and a system that can easily shut down fishing as soon as a quota is reached. Given the highly dispersed nature of most small-scale fisheries and data-poor systems in developing countries, quotas are generally not feasible.

New ideas to address these problems include allocating collective quotas or sector quotas. This form of use rights, sometimes referred to as catch shares or sector management, can be extremely useful in managing a fishery, as it confers a clear economic “asset” to the user/owner. This can create positive incentives for enhanced stewardship, self-compliance, and reinvestment into management. In these cases, a fishers’ association may own the rights to a certain transferable quota and decide collectively how it will be allocated amongst its members. When considering ITQs as an alternative, it is necessary to designate the maximum allowable percentage of the total quota that any one firm or individual can own. This is necessary to avoid too much consolidation or a monopoly in the industry. In some cases, quotas for processing plants and harvest quotas for individual fishers should also be considered.

There are also management approaches that affect the rights of owners, managers, and users. Marine conservation agreements (MCAs), for example, are understandings between governments, local communities, and fishing cooperatives. These have recently become popular among non-governmental organizations (NGOs) as a complement to other marine and coastal protection efforts as awareness grows that the creation of formal protected areas may not be sufficient to protect ocean and coastal biodiversity, particularly in areas where rights have already been granted to specific owners and users. MCAs include any formal or informal understanding in which one or more parties commit to delivering explicit economic incentives in exchange for one or more other parties (usually right-holders) committing to take certain actions, refrain from certain actions, or transfer certain rights and responsibilities to achieve agreed-upon ocean or coastal conservation goals. CAs work within the existing forms of governance to improve fisheries through the restriction and management of fishing activities.

## OUTPUT CONTROLS

Output controls are direct limits on the number or size of fish harvested regardless of the inputs used. They include such measures as a limit on harvest, total allowable catch, discards, and minimum and/or maximum allowable size. Output controls are generally linked to catch shares and individual transferable quotas (ITQs) described in the previous section on property rights.

**Size limits.** Size limits vary by the species harvested. For example, size is measured as carapace length for lobsters or crabs, head to tail fork length on finfish, or shell width for bivalves such as clams. Size limits can be a maximum or minimum size. A minimum is used to allow the population to reach reproductive age and spawn at least once before being harvested. Minimum size for a species is set relative to the average individual size at spawning maturity. A maximum size allows a certain portion of the population to grow very large and thus realize greater spawning potential (e.g., one 10-kg red snapper can produce many more eggs than 10, 1-kg red snappers. More reproductive output from large breeders means more potential for recruitment into the fishable stock.

**Prohibitions.** Certain species can be banned from harvest altogether. These can include endangered or threatened species such as sea turtles, marine mammals, hard coral, and certain types of groupers. Prohibitions can be placed on species that are not on the Convention on International Trade in Endangered Species (CITES) list (See Section V or <http://www.cites.org/eng/resources/species.html>), but whose spawning stock sizes are so small as to threaten commercial extinction.

**Total allowable catch or harvest limits.** Total allowable catch (TAC) can be a soft or hard TAC. A soft TAC is used as a reference point to assess how close actual landings are to desired levels and can be modified as necessary. A hard TAC is a limit that cannot be exceeded. It restricts the harvest to a safe proportion of the exploitable stock of fish. A hard TAC is usually less than the actual maximum yield of the fishery based on biological considerations or effort levels. This figure should be updated annually since all stocks experience natural variations in their recruitment and mortality parameters.

The use of TACs comes with challenges. If issued for an entire fishery, the TAC can lead to a “race to fish”—with each vessel trying to catch the most fish over the shortest period. Also, if there are many landing sites, it may be impossible to gather all the landings data before TACs are exceeded. In small-scale tropical countries where it is impossible to monitor all landing sites, this form of management may be inoperable unless a community-based management authority exists. TACs are also associated with the ITQs or sector quotas mentioned in the “User Rights” section. In this case, a share or percent of the annual TAC is allocated to individuals or groups. Although TACs used this way are more difficult to monitor, local management allows fishers to choose the most advantageous times to fish. For example, they may elect to fish when prices are high and/or when they can more easily reduce by-catch and discards.

## INPUT CONTROLS

Input controls are regulations directed at controlling the fishing power and total effort used to harvest fish. They can take a number of forms, including limits to the number and size of fishing vessels, limits on fishing time, and limits to the types, numbers or characteristics of gear used.

**Gear Restrictions.** Gear restrictions can range from specifying minimum mesh sizes to avoid catching juvenile fish, to outright prohibitions on certain gear types. For instance, dynamite or blast fishing, the use of poisons such as sodium cyanide, or electro-fishing should be banned outright.

**Licensing.** There are numerous ways to manage fisheries effort or catch. The way these management efforts are imposed will determine which objective(s)—social, economic, or biological—are successfully

met. Licensing provides the most basic form of effort control. Unfortunately, in some cases licensing requires little more than filling out forms and paying a nominal fee. Licensing can also create what is known as “latent” effort — i.e., where the license is purchased but not active. Matching licenses to a minimum level of landings is one way to eliminate latent effort. Effective licenses limit vessel capacity to prevent upgrading to more efficient vessels at a later date. This is especially important if licenses are transferable — that is, they can be bought, sold or transferred from one generation to the next. A licensing scheme is helpful in managing fishing effort at sustained levels and is particularly beneficial when long-term user rights are granted. Licenses confer certain rights on the user, and short-term licenses make it difficult to institute long-term solutions and to address sustainability issues.

In many fisheries more licenses are issued than the fishery can sustain, leading to overcapacity in the fleet. When this happens, governments must reduce licenses in some equitable fashion. However reducing the number of licenses may not reduce effort unless there are also restrictions on the number and/or size of vessels and gears. Another option to help reduce effort is designating shorter fishing periods. All these measures are difficult to manage effectively and may even exacerbate the situation by creating a “race to fish” atmosphere, as described in the “Output Controls” section. Licensing is a necessary precondition for addressing overcapacity issues if a TAC and associated ITQs or catch shares is to be considered as a management option.

**Area and Time Closures.** Area and time closures and size limits are typically the primary management tools when the key objective is to rebuild stock biomass in an overfished system. In most instances, these tools can be combined with other input and output controls.

Several terms are used to define area closures. The most commonly used term is “protected area.” Protected areas range from no-take of all species, to restrictions only on selected species, to restrictions on gear types, or seasonal closures such as during spawning season. An important element of the protected area tool is its clearly stated objectives for closure.

Time and area closures are a simple and effective way to protect species. They function well in data-poor environments and protect sensitive bottom habitat. Some disadvantages include the high transaction cost of inter-agency negotiation, the difficulty in getting resource users to comply with protected area rules and regulations, and the high cost of monitoring and enforcement.

An important step in improving fisheries management in overexploited ecosystems is rebuilding the standing fish stock biomass. Without a sufficient spawning stock left in-situ, fisheries populations cannot reproduce, leaving too little for people to harvest for food and income. For certain long-lived species it is important to retain a population of large-sized adults. These larger, older fish produce more eggs per unit weight and are an important component of a healthy fishery.

## **NO-TAKE OR FISHERY RESERVES**

No-take reserves, a specialized form of area closure, deserve special mention. Increasingly, they are a tool of choice for biodiversity protection and fisheries conservation and management in developing countries. No-take reserves are also sometimes referred to as locally managed marine areas, sanctuaries, or core areas within a marine protected area (MPA), ecological reserve, or fishery reserve. No-take reserves may be controversial, often facing strong initial opposition from the fishing community. However, once the ecological and economic benefits of the reserve are demonstrated, fishers can become strong proponents of reserves. In all cases, it is important to educate stakeholders and include them in the decision-making and implementation process.

In a no-take reserve, all extractive activities—including fishing—are permanently prohibited. Some no-take areas allow for other non-extractive activities to occur, such as SCUBA diving or snorkeling. Marine

## OBJECTIVES OF AREA AND TIME CLOSURES

### Fishery Purposes:

- Protect spawning locations or individuals; or protect juveniles
- Protect depleted stocks during a rebuilding period
- Protect genetic reservoirs
- Protect habitat
- Restrain excess fleet capacity and optimize the value of the catch

### Conservation:

- Protect benthic habitats of high conservation value
- Limit bycatch
- Protect attributes important for maintaining ecosystem function

### Equity:

- Provide a mechanism for resolving conflict over multiple use areas
- Reserve economically important marine and coastal resources for traditional users

conservationists are increasingly advocating for no-take reserves as they typically result in high biodiversity as well as fisheries benefits. Although no-take marine reserves are a form of marine protected area (MPA), the two may have differing management goals. Since the design of MPAs and no-take reserves should be informed by the management goal, this should be clearly identified early in the process.

No-take reserves used for conservation purposes are intended to:

- Protect valuable habitats and preserve biodiversity within the reserve's boundaries
- Generate greater species diversity
- Increase overall biomass, size, and abundance of individuals
- Result in higher levels of reproductive output than areas open to extractive uses (e.g., fishing)
- Protect ecologically resilient areas that can help the larger ecosystem rebound from natural or man-made disasters

Effectively managed no-take reserves influence adjacent areas that are open to fishing through the mechanisms of adult spillover and larval transport. "Spillover" occurs when adult fish swim out of the reserve and become available to be caught by fishers. As fish abundance and size increase inside the reserve, crowding and competition for food and space force some fish to move outside the boundaries of the reserve. It is not unusual to see fishers concentrating their effort along the edge of the reserve, a practice known as "fishing the line." Here, the catch rates are often higher and fish are larger than in more distant areas. "Larval export" or "larval recruitment" refers to the movement of fish or invertebrate larvae from the reserve to adjacent areas through the action of currents. By sheltering older, more fecund individuals, the reserve allows an overflow of eggs and larvae to seed neighboring areas. As these larvae grow, the result is larger numbers of individuals available for capture. No fishing pressure in a reserve allows greater biomass and fish size within that reserve, and thus greater spillover of adult fishes and greater potential of larval export.

Most conservationists use the rule-of-thumb that at least 30 percent of aquatic habitats should

## TURFS (TERRITORIAL USE RIGHTS IN FISHERIES)

TURFS are marine areas that are allocated to a particular group with exclusive rights over how the fishery is managed. In some ways they can be considered a type of area closure, but one that also imparts a form of use rights – not to an allocation of catch, but to an area that can be fished. Fishermen who do not possess the TURF can be excluded from fishing in the area. Examples of TURFS include reef areas in Southeast Asia and the Pacific where a traditional leader determines fishing rules for people in his community, and who can deny or approve access to fishing by outsiders. It is important to note that TURFS by themselves will not prevent overfishing. TURFS still require some combination of input and/or output controls to maintain fishing at maximum biological or economic yields. Similar to property rights over a catch share, TURFS allow a long term management perspective and are generally thought to foster more sustainable and non-destructive practices.



be set aside as reserves if they are to fully achieve conservation and fisheries management objectives. However, most experts stress that, in addition, sites need to be carefully selected and individual reserves should be nested within large-scale networks. Networks of reserves are often part of larger-scale seascape programs. Many conservationists argue that large-sized reserves ensure self-replenishment of species within the reserve. Another argument for large reserves is that adults—which have the greatest potential for reproductive output—are less likely to exit the reserve and be caught. Where the objective is fisheries management rather than conservation, the preference is often for smaller-sized reserves. These provide more spillover and edge effect and are more readily accepted as legitimate by fishers.

**The Use of No-Take Reserves.** Among the array of fishery tools, no-take reserves may be the easiest to implement, especially in developing countries. They can be a good choice for tropical developing nations, where multi-species fisheries are common and where the institutional capacities to successfully apply alternative management techniques are weak. An important factor for success for reserves is high compliance with no-take rules. Many existing reserves are established by national mandates and are centrally planned, often with little local stakeholder involvement. They are then poorly managed with inadequate resources, weak enforcement, and strained relations with local stakeholder groups. Top-down approaches such as this—i.e., that impose reserves on fishers with little or no consultation—invariably result in poor legitimacy, low compliance, and high levels of poaching. At the other end of the spectrum are reserves that are locally managed—by local governments, private sector groups, nongovernmental organizations, communities, and/or traditional groups. High levels of local stakeholder involvement in planning and implementation lead to more successful reserves.

Key stakeholders, especially fishers, must perceive tangible benefits if reserves are to be sustainable in the long term. Reserves established for tourism or conservation cannot be assumed to automatically benefit fishers. For this reason, impacts on fishers must be carefully assessed.

The local context should be taken into consideration when determining the shape and size of the reserve and the choice of institutional arrangements for its management (e.g., centralized vs. community-based or traditionally managed). A permanent no-take arrangement may not be feasible in the local context. Ecological considerations may need to be compromised in order to accommodate the social, economic, and political considerations necessary to achieve fisheries management outcomes. For example, in the traditionally managed reserves of Eastern Indonesia and Papua New Guinea, the permanent no-take rule may not be absolute. Rather, the reserves are opened for short periods (one to two days) during cultural celebrations. This accommodation has led to high compliance with no-take rules for the rest of the year, resulting in lower overall poaching levels and a higher degree of conservation and fisheries performance.

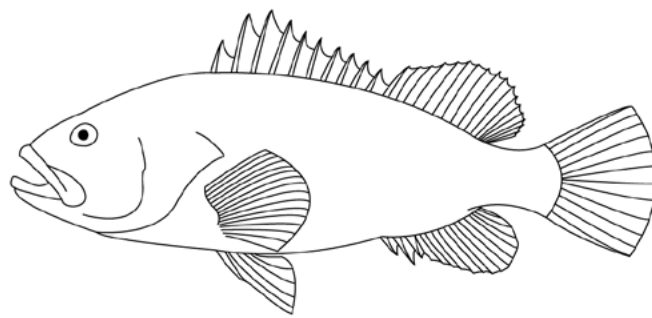
Marine protected areas (MPAs) and no-take reserves are recognized as important tools for managing and conserving our ocean and marine resources. By improving environmental governance and management, no-take reserves can be used in fisheries management and biodiversity conservation to enhance ecosystem resilience and safeguard ocean resources for future generations. Over the last decade, our increasing understanding of the interconnectedness of marine habitats and processes has highlighted the importance



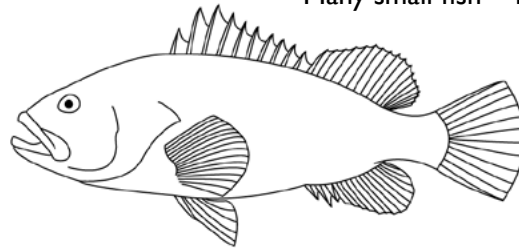
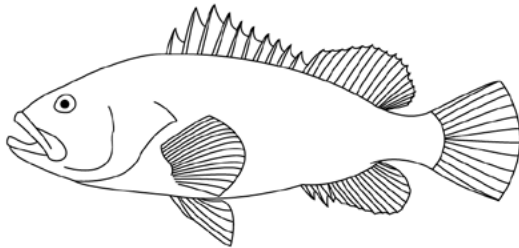
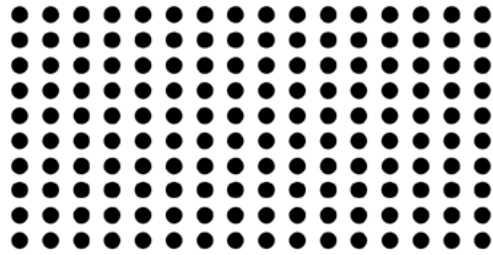
Photo: Klaus Hartung

Women cockle gatherers on Zanzibar have established community-managed no-take reserves inside the Mnai Bay Conservation Area. The reserve helps rebuild spawning stock biomass and populations of bivalves in adjacent areas that are important sources of income and food security.

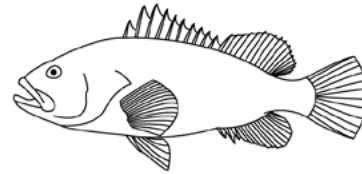
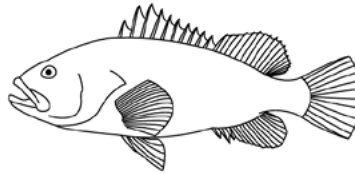
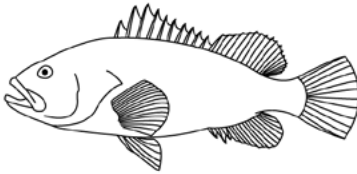




One large fish = many eggs



Many small fish = few eggs



Immature fish (not of breeding age) = no eggs

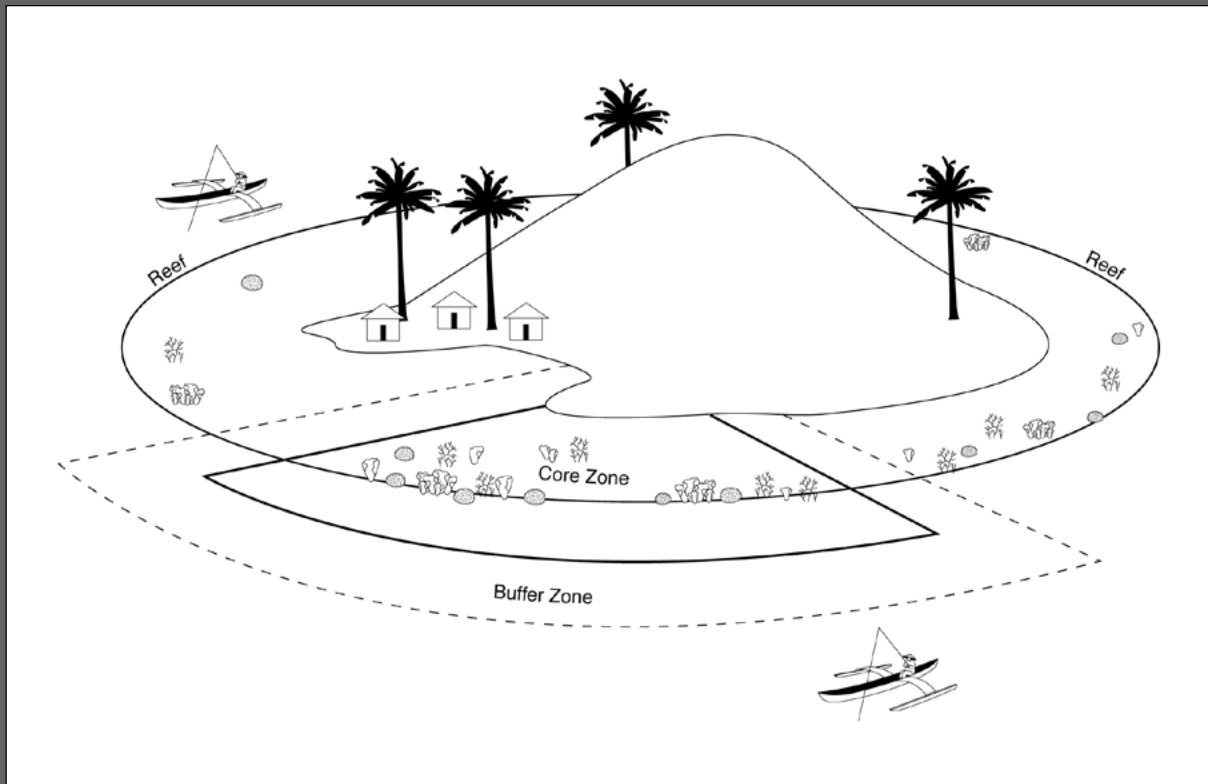


Why a build-up of big fish in marine reserves helps increase reproduction.

of moving beyond managing individual MPAs. Networks of MPAs on an ecoregional scale are necessary to protect and conserve ecological processes.

## VOLUNTARY AND INCENTIVE-BASED APPROACHES

Regulatory approaches have their limits and may require high implementation costs for monitoring and enforcement. In contrast, voluntary and incentive-based approaches encourage fishers to “do the right thing” through moral suasion, peer pressure, or for economic reasons. There are two types of voluntary

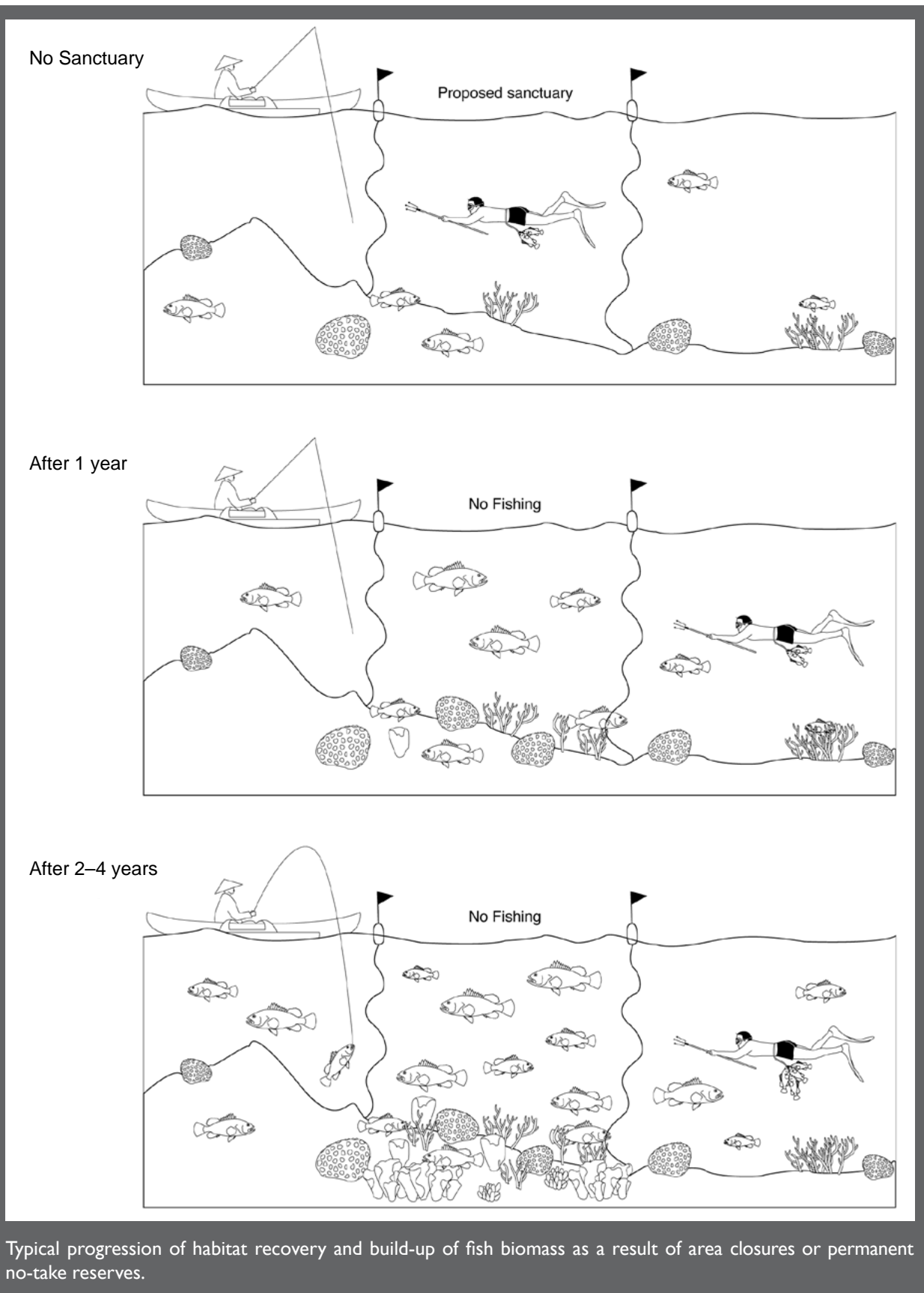


Typical design for a community-based marine reserve showing core no-take zone and a buffer zone.

and incentive-based approaches. One involves codes of conduct and/or best management practices (BMPs). The second is eco-labeling or certification schemes. Incentive-based and voluntary approaches can be categorized as market-based approaches. Some market-based approaches address the problem of sustainability from the consumer demand side.

**Codes of Conduct and Best Management Practices.** Codes of conduct are broad guidelines for conducting an activity in socioeconomically and environmentally compatible ways, often expressed as a national or industry policy. The BMP approach relies mainly on voluntary adoption of practices that optimize production, minimize impacts, increase benefits, and reduce risks of all types. Quite often, industry associations and government lay the ground work for BMPs by establishing a code of conduct for responsible fisheries. Training and extension at all levels is essential in prompting individuals and industries to implement BMPs and other voluntary forms of compliance.

**Eco-labeling and Certification.** Some countries have introduced traceability and labeling schemes as an incentive for sustainable fishing practices. An eco-label is a tag placed on a product certifying that it was produced in a sustainable, environmentally friendly way. These tags allow consumers to make informed choices about their purchasing decisions, choosing seafood products based on specific criteria and to ultimately promote sustainable fishing practices. Consumer-based approaches can promote mass movements to buy only sustainably sourced seafood from retailers or patronize restaurants that serve only sustainable green or eco-labeled seafood. Fishers may benefit from new and more consistent markets. In some cases, but not always, fishers may also benefit from higher prices associated with eco-labeled fish products.



Certification is another voluntary and market-based measure gaining in popularity and related to eco-labeling. Certification encompasses three processes: 1) standard setting; 2) accreditation; and 3) certification. Rigor, neutrality, and transparency must be inherent in these processes for certification to be effective and accepted by the stakeholders. In certification programs, an independent body — e.g., the Marine Stewardship Council (MSC) — sets sustainability standards against which a particular fishery is audited. If a fishery meets the standards set, it can be certified and use the eco-label on its products. Certifying bodies work through the private sector's value-added chain of buyers and producers. They charge fees for their certification services and for the use of the eco-label. Initially, the incentive for the eco-label is the potential price premium that consumers will pay for the eco-labeled vs. non-labeled products. Currently, however, it is unclear how much of a price premium actually exists and whether it compensates for the costs of certification. That said, wholesalers and retailers can view certification as part of their corporate responsibility to be good environmental and social stewards and help ensure there is a consistent and continuing supply of product on which their businesses depend. An increasing number of seafood wholesalers, retailers and restaurants are committing to purchase sustainably sourced seafood. The demand for this type of seafood product is expected to continue to grow.

For some countries, the costs of complying with certification standards may be excessive. In addition, certification demands data on the resource that often is lacking and costly to collect. As such, small-scale fishers in particular lack the financial or human resources to meet certification demands—even when they are organized into larger producer groups. Even at the country level, many lack the human, institutional, or infrastructural capacity to participate effectively in international trade. In addition, some fisheries, particularly those with many species and a diversity of collectors, do not have the characteristics necessary for successful certification. The trade in marine ornamental fish, for instance, has not yet achieved a credible certification scheme.

Certification and eco-labeling schemes are generally geared to large-scale commercial and industrial fisheries in developed northern countries, or for specific high-value species exported from developing countries to developed countries. Increasing fish trade moving from developing to developed countries creates additional opportunities for these types of schemes. Currently, eco-labeling and certification are not useful for the vast amount of seafood harvested for local consumption in developing countries, where fish are often a basic commodity and account for the majority of protein consumed. Further, poverty and the lack of environmental/nutritional awareness will likely make developing country consumers resistant to the higher prices that come with eco-labeling. In an effort to assist developing countries in meeting sustainability standards, the MSC has developed tools including a risk-based assessment framework for data-poor fisheries, a policy guidance document to ensure that informal and traditional management approaches are considered in assessments, and guidance tools to support fisheries that want to make improvements before doing a full assessment. Whether certification standards are used to obtain the eco-label or not, the standards can be used as a useful benchmarking tool for any fishery and help to identify key challenges and pathways towards sustainability.

## **TRADE**

Trade approaches can be used to combat illegal, unregulated, and unreported (IUU) fishing and bycatch of protected living marine resources. For example, an increasing number of RFMOs have adopted procedures for listing vessels that have engaged in IUU fishing. These lists have been created to attach certain penalties to vessels included on them, including restriction of port access or unloading prohibitions. Some of these lists include only fishing vessels while others can include transport vessels as well. NOAA Fisheries, on behalf of the U.S. Government, issued a rule to implement obligations to apply certain penalties to vessels that are included on the IUU vessel lists of RFMOs to which the United States is a party. U.S. fishing and support industries are prohibited from engaging in commercial transactions with the vessels on the IUU vessel lists.

One tool currently in use is port state controls. Under this mechanism vessels known to be involved in IUU fishing can be sanctioned by the port state (the home country where fish is eventually landed and offloaded). Port state controls can be a cost effective strategy that denies offending vessels access to ports and port inspections, and can even result in detention or sanction. Countries that do not take steps to address problems of IUU fishing and bycatch of protected species may find that the import of certain fisheries products to the United States has been prohibited.

Developing countries, however, often see importation measures aimed at achieving more sustainable fisheries as obstacles to trade. For example, U.S. law requires that wild caught shrimp imported into the U.S. be certified as caught in a manner that does not result in significant mortality of marine turtles protected under U.S. law and international treaties. This requires the use of devices such as turtle excluder devices (TEDs) or other methods that can demonstrate comparable bycatch mitigation results. The State Department certifies countries that meet these standards. Of the 38 nations that currently qualify, 13 require the use of TEDs and 25 have shrimp fishing environments that do not pose a danger to sea turtles. This legislation has positive conservation benefits to endangered sea turtle species around the world.

Other countries may welcome import regulations as a way to promote more sustainable resource management and to prevent illegal exports.

International trade can lead to overfishing and the use of destructive fishing practices. Source countries should be encouraged to establish appropriate policies to address international trade pressures. Some countries have adopted policies that prohibit export of a given species until a management plan is in place for that species. This allows the country to take a more precautionary approach and avoids boom-and-bust cycles, where the trade targets one species after another as they are depleted. Australia has such an export policy.

## **ACCESS AGREEMENTS**

Access agreements are an understanding between two countries that allow distant water fleets (DWFs) from one country to fish in the Exclusive Economic Zone (EEZ) of another country. These agreements generally involve access to the fisheries resources in return for a financial contribution or in-kind benefits. Access agreements can be an important source of revenue for developing countries and provide additional fishing opportunities for the DWFs. However, they can also have detrimental effects on fish stocks and local fisheries, and may result in corruption. In some cases, access agreements have been negotiated without adequate knowledge of the state of the fish stocks or knowledge of a fair price. Many developing states lack the capacity to manage their fisheries or provide monitoring and enforcement. Access agreements may inhibit host countries from developing their own capacity to generate economic benefits—e.g., development of a local fleet or drawing economic rent from the foreign fleets. Agreements may also create conflict between the foreign vessels and the local fishers as they compete for resources and market share. A country's dependency income from DWFs may create reluctance to limit fishing opportunities even when stocks are overexploited.

When developing countries have effective governance and management in place, including an open and transparent process for granting the agreements, access agreements can provide the following benefits:

- Providing access to surplus stocks only through well-developed access agreements
- Providing effective enforcement through monitoring control and surveillance (MCS) systems which generally include on-board observer programs
- Developing port and processing infrastructure to capture a greater portion of the potential value-added from the agreement
- Providing reliable stock assessment data

The lack of transparency in access agreements can also fuel overfishing and corruption within the host government. Granting of access can be very lucrative for individuals in the position to grant licenses. Programs can address this corruption by making the process more transparent and equitable. Approaches such as the use of E-Government tools and bar-coding of products can be used for the purpose of tracking and recording transactions.

## **SUBSIDIES**

A fisheries subsidy is a government intervention (or lack of) that affects the fishing industry and has economic value. Subsidies affect the profitability of the fishing industry. They can include interventions such as fuel tax rebates, subsidized fuel prices, landing site facilities, eliminating access fees, and provision of free gear, boats and engines to fishermen through grants. Subsidies may also impact trade regulations and exchange rates. Global fishing subsidies are currently estimated at US\$30 to \$40 billion annually.

While not all subsidies are harmful, many do contribute to overfishing and overcapacity. Fisheries subsidies may also distort competition. Some fisheries may not be profitable without subsidies. Under certain conditions, a subsidy can benefit developing countries struggling to develop their local fisheries, especially in the international trade market. Research on the impacts of subsidies is on-going, and a vigorous discussion on the appropriate criteria for subsidies continues.

## **RESEARCH AND EXTENSION SERVICES**

Fisheries extension services promote the transfer of information and technology, and providing support for policy implementation and improvement. Extension services are an institutionalized means of supporting fisheries by providing new information and methods, and linking fishers and managers with researchers. Agents are usually based at universities or government agencies, and in the case of the U.S. Land Grant or Sea Grant agencies, may play both a research role and an extension role. Extension agents may also assist with non-technical topics such as institution building, management techniques, marketing, or financing. Some countries have little or no extension capacity. Strengthening this capacity is an important step to achieving improved fisheries management.

The challenge of financing extension work is a major constraint in developing countries. Lessons learned from the agricultural sector have shown the importance of private sector financing in making extension work sustainable. Extension services may be best provided through cooperatives or associations built around joint financial business interests.

Fisheries require extensive research support—especially with regard to stock assessment, gear technology, and management techniques. Research and extension support are critical in helping to move fisheries towards environmental and social sustainability. In some fisheries a single operational practice can have implications for production, environmental impacts, and profitability. Hence, efforts to improve practices of all types through research, extension, and education have multiple benefits. In most cases, the research role will fall to university and government scientists, but sometimes will involve environmental NGOs. For over 20 years, USAID has played a key role in guiding and sponsoring fisheries research through its Collaborative Research Support Program (CRSP), the World Fish Center, environmental NGO partners, and other organizations. USAID support to fisheries has included the development of partnerships between U.S. and foreign universities to deliver training programs, fund graduate students, and link extension and research.



## SOURCES FOR MORE INFORMATION

### **Management / Managed Access**

- A Fishery Manager's Guidebook. 2009.  
<http://www.wiley.com/WileyCDA/WileyTitle/productCd-1405170859.html>
- The knowledge base for fisheries management in developing countries-alternative approaches and methods. Report to Nansen Programme. Bergen, Norway. Institute for Fisheries Management and Coastal Community Development.  
<http://www.oceandocs.org/bitstream/1834/802/1/Co-Man67.pdf>
- Understanding Fisheries Management. 2005.  
<http://nsgl.gso.uri.edu/masgc/masgch00001.pdf>

### **Co-Management**

- Fishery Co-Management: A Practical Handbook.  
[http://www.idrc.ca/en/ev-92339-201-1-DO\\_TOPIC.html](http://www.idrc.ca/en/ev-92339-201-1-DO_TOPIC.html)
- Devolution and Fisheries Co-Management.  
<http://www.capri.cgiar.org/pdf/pomeroy.pdf>
- The Fisheries Co-Management Experience: Accomplishments, Challenges and Prospects.  
<http://www.amazon.com/Fisheries-Co-management-Experience-Accomplishments-Challenges/dp/1402014279>

### **Use Rights**

- Territorial use rights in marine fisheries: definitions and conditions.  
<http://www.fao.org/docrep/003/T0507E/T0507E00.htm#toc>

### **Ecosystem-based Fisheries Management**

- Ecosystem-based fisheries management.  
<http://www.nmfs.noaa.gov/sfa/EPAPrpt.pdf>
- Implementation of Ecosystem-based Management in Marine Capture Fisheries.  
[http://assets.panda.org/downloads/wwf\\_ebm\\_toolkit\\_2007.pdf](http://assets.panda.org/downloads/wwf_ebm_toolkit_2007.pdf)

### **Marine Protected Areas and Marine Reserves**

- Marine Protected Areas as a Tool for Fisheries Management (MPAs).  
<http://www.fao.org/fishery/mpas/en>
- The science of marine reserves.  
<http://www.piscoweb.org/outreach/pubs/reserves>
- When can marine reserves improve fisheries management? Ray Hilborn et al.  
<http://www.sciencedirect.com/science/article/pii/S0964569104000250>



### ***Sustainable Livelihoods Approach***

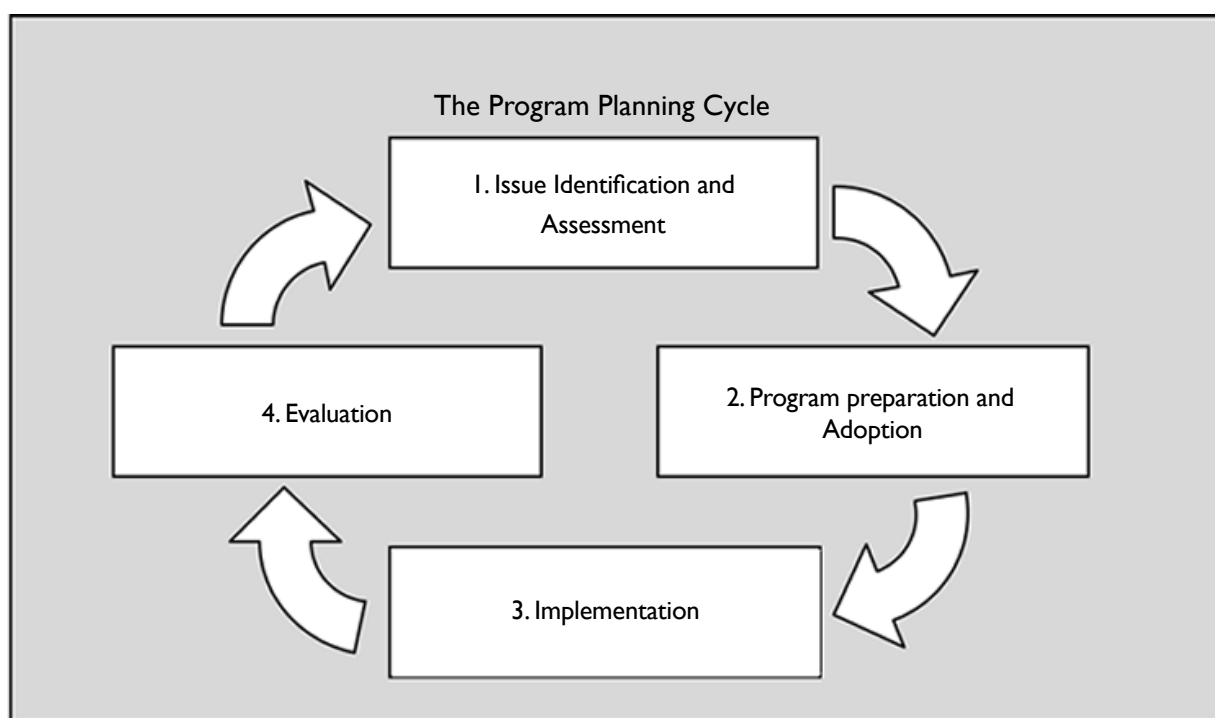
- The sustainable livelihoods approach.  
<http://www.fao.org/fishery/topic/14837>
- FAO Code of Conduct for Responsible Fisheries.  
<http://www.fao.org/docrep/005/v9878e/v9878e00.htm>
- Strategy for Market-Intervention Tools to Conserve Marine Fisheries.  
<http://www.packard.org/wp-content/uploads/2011/02/Marine-Fisheries-Strategy.pdf>
- Marine Stewardship Council.  
<http://www.msc.org/get-certified/restaurants>
- Ecolabeling in fisheries management.  
<http://www.fao.org/fishery/topic/12283/en>

### ***Trade-Based Approaches***

- Shrimp embargo legislation for marine turtle conservation.  
<http://www.nmfs.noaa.gov/pr/species/turtles/shrimp.htm>
- Fisheries Subsidies: A critical issue for trade and sustainable development at the World Trade Organization. An Introductory Guide. May 2008.  
[http://www.unep.ch/etb/areas/pdf/UNEP-ETB\\_Brochure\\_on\\_Fisheries\\_Subsidies\\_May2008.pdf](http://www.unep.ch/etb/areas/pdf/UNEP-ETB_Brochure_on_Fisheries_Subsidies_May2008.pdf)
- Promotion of Sustainable and Equitable Fisheries Access Agreements in the Western Indian Ocean.  
<http://awsassets.panda.org/downloads/fisheriespartnershipagreementsreport.pdf>

## 8.0 FISHERIES PROGRAM PLANNING

Fisheries management planning, not unlike planning in other sectors, follows several basic steps as shown in the figure below. These include: Issue assessment (Step 1); Program preparation and adoption, (Step 2); Implementation (Step 3); and Evaluation (Step 4). Planning and implementation are not necessarily linear, but cyclical and iterative. Fisheries management planning is a strategic process of identifying important fishery and aquaculture issues, setting priorities and articulating specific goals, selecting appropriate activities that address key issues, and developing systems to monitor impacts. This section of the guide is structured around the steps of the planning cycle as they apply to capture fisheries.



### CONSIDERATION OF SCALE

One of the first considerations in program planning is “scale.” Scale can be viewed in several ways:

- Size scale (i.e., small-scale versus large-scale fishing)
- Geographic scale (i.e., communities or municipalities involved in a fishery, or the fish stock itself)
- Implementation scale (i.e., small pilot demonstration, large-scale sector reform using social networks or seascapes approaches or working with large marine ecosystems or regions)

While this guide concentrates on nearshore fisheries operations, in many cases it is impossible to deal with the small-scale sector without also considering the commercial large-scale or industrial sector. The same is true geographically, especially when management authorities operate at different levels (village, state, international). Scale can mean targeting one fisher, a cooperative, one or several villages,

middlemen, or markets. Often middlemen aggregate the products of many small-scale fisheries for export, increasing the scale beyond that of the original sector.

Fish stocks do not respect local, national, or administrative boundaries, so management systems should be designed to rationalize management across many jurisdictions. This is increasingly the case even within a nation, where decentralized management authority may be delegated to the village, municipality, or district level. Yet another consideration is the type of scale: temporal, spatial, political, or economic scale. Fishery scientists think about scale in biological or ecological terms. Meanwhile, resource users and managers will also be concerned with social implications. A well-delineated physical space, such as a bay, may be used to bring surrounding municipalities and fishers together as a management unit.

USAID programs have typically taken one of several implementation approaches to scale:

- Pilot projects in a small geographic setting that then replicates best practices on a larger scale
- Targeting an entire sector or particular fishery for reform by engaging representatives throughout the value chain (see box on “SCALE Approach”)
- Using a seascape approach to identify critical fish habitat and design networks of marine protected areas to minimize risk from overfishing and climate change

Some practitioners recommend the broader approach of comprehensively addressing large marine ecosystems or regional fisheries issues. This, however, is often beyond the scope of USAID programming, requiring high levels of institutional capacity that is often lacking and a time scale of decades to see tangible results.

Alternatively, there are models for diffusion of innovation that enable smaller projects to achieve behavior change quickly and to more rapidly scale-up good practices. The Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fishing provides many such opportunities for behavior change.

In some cases, however, a larger effort may be the only way to achieve the desired impact. USAID has recently promoted the scaling-up of programs for these greater impacts. Outreach, education and the transfer of information, technology, and alternative ideas can play a key role in fostering behavior change and can help programs achieve their long-term goals.

To decide what scale to use for implementation, one must:

- Clarify program goals
- Assess funding levels
- Identify the extent of the fishing grounds and critical fish habitats
- Identify a cohesive or natural set of communities with a governance unit—i.e. identify how the fishing groups are socially connected

#### NEARSHORE FISHERIES AND TRAWLER CONFLICTS IN TANZANIA

Small-scale fishers in the District of Bagamoyo complain about reduced catches due in part to excessive by-catch from shrimp trawlers fishing near shore. There is also concern about the incidental capture of threatened marine turtles from trawl gear. The Tanzania Coastal Management Partnership is working with commercial and small-scale fishers, conservation groups and government agencies to devise strategies for testing smart gear designs that can reduce trawl by-catch of finfish species targeted by the small-scale fishing sector and at the same time address incidental mortalities of marine turtles. Other options under discussion include rethinking times and locations where trawlers can operate to try to maintain separation between the near-shore small-scale fishery and the trawl fishery, but in a manner that can maintain the economic efficiency of the trawling sector. The Department of Fisheries recently instituted a moratorium on shrimp fishing until a new management approach is developed.

## STAKEHOLDER PARTICIPATION

Changes in human and institutional behavior occur slowly and only when shown to be desirable. For instance, efforts to conserve fish stocks will only be effective if a large majority agrees to harvesting restrictions and understands the long-term economic benefits of a healthy environment. If mandates are imposed from above with no stakeholder understanding and buy-in, they are certain to be undermined by widespread illegal activities and heavy enforcement costs. A good strategy is to change the paradigm of “you are the problem” to “you are part of the solution.” Participants-in-change start to accept responsibility for the design, implementation, and assessment of interventions and become tied to the outcomes. Even if the intervention runs into problems, an adaptive approach allows for adjustments and improvements mid-stream.

There are many techniques for ensuring an inclusive and participatory approach — e.g., stakeholder mapping, context mapping, open space formats, participatory rural appraisal, vulnerability and capacity analysis, and others. It is important to recognize that fishers are not a homogenous group. They may differ simply by nature of the fishing gear and techniques they use. For example, the gear used by gillnetters may put them in conflict with handliners, while industrial and commercial interests may conflict with small-scale fishing interests. In addition, fisheries stakeholders include not only fishers, but also those involved in the marketing and processing of fish. Often, the capture sector is dominated by men while the marketing and processing sector by women. Therefore, mainstreaming gender equity issues and gender inclusivity in participatory and decision-making processes is also essential. All interests need a voice in decision-making. Getting those voices heard, however, may require adapting how, when, and where the planning, decision-making, and implementation processes occur. Differences in men and women’s lives, family responsibilities, and schedules mean they often cannot lend their voice at the same time and place.

### Maintaining an Inclusive and Participatory Process

Successful fisheries management requires active stakeholder involvement in forming and implementing management measures. Yet, the lead agency responsible for fisheries management may not prioritize stakeholder involvement, or may lack the skills needed to carry out inclusive processes. Further, fisheries management is time consuming, with its requirements for assessment, stakeholder dialogue, consensus building, and monitoring, control, and surveillance. Even simple measures must be widely accepted by fishers and stakeholders; enforcement through command and control actions is costly and, alone, is not sufficient. Stakeholder involvement is hard to sustain; it waxes and wanes based on the issues themselves and multiple other external factors. Keeping stakeholders involved and engaged over a long time period can be

### THE SCALE APPROACH

The Global FISH Alliance is applying the SCALE methodology to reform the spiny lobster fishery in Honduras and Nicaragua. SCALE, which stands for System-wide Collaborative Action for Livelihoods and the Environment, helps people at national, regional, community, and household levels find new ways to work together. SCALE combines best practices from various disciplines to catalyze and support collaborative action toward common goals by as many stakeholders in the system as possible — individuals, groups, organizations, businesses, institutions, partnerships, and coalitions. The SCALE approach provides stakeholders with a common road map to initiate, implement, and evaluate system-wide collaborative actions for large-scale impact. The end result is committed stakeholders ready to implement jointly created action plans and share resources, thus transferring ownership of the issue to local leadership structures while ensuring strategic and efficient support from the program team.

### STAKEHOLDER PARTICIPATION AND BUY-IN ARE CRITICAL

There are no regulations written that cannot be circumvented by ingenious fishers if they do not believe in them. When communities and fishers are included as partners in the planning, design and implementation of the regulation, then they will be active participants in legislation, enforcement, and self-compliance.

challenging. Too often, stakeholder participation ends at the completion of the planning process. This is a mistake. Stakeholder participation must be sustained during all phases including implementation, monitoring, and evaluation.

What can be done to maintain fishers and other stakeholder involvement?

- Before designing the program, ensure the support of the primary stakeholders in the fishery
- Allow the stakeholder process to design, or have major input to, the work plan and activities
- Build in participatory management, including a high level of transparency in decision-making and information dissemination
- Promote community involvement and leadership to build a sense of ownership
- Consider constraints on women's ability to participate at the same times and in the same capacity as men
- Conduct small, manageable activities that build support for a larger effort
- Educate fishers and the public, and encourage them to be active in the stakeholder process in order to keep sustainable fisheries on the public agenda
- Seek top level government support and leadership to build trust and make participation and negotiations with stakeholders worthwhile



Stakeholder participation can take place in official settings of government offices and meeting halls, but often informal settings are equally important to put all stakeholders at ease with expressing their viewpoints and concerns.

Credit: URI Coastal Resources Center

In addition to the above, for actions that need formal adoption by multiple entities (e.g., no-take reserves), treat the entire process as a serious public policy formulation effort right from the start.

## ISSUE IDENTIFICATION AND ASSESSMENT

### Local Context

It is essential to understand the local context for fisheries reform and sustainable development before commencing programming activities. This issue identification and assessment includes defining (at a minimum):

- Current status and trends of the fisheries resources
- Key drivers of change
- Governance structure and management rules in place
- Types of fisheries involved
- Local and export markets
- Lifestyles and aspirations of the fishing community



- Diversity of livelihoods
- Other demands on the marine environment—e.g., tourism, and natural gas and oil extraction

Key issues, and the best strategies to address them, will differ across communities, regions, or countries. Therefore, the design of USAID programs must be tailored to these different priorities and contexts. Some issues can be addressed quickly. Others require more time. In either case, the key issues must be considered within the broader framework of overall fisheries planning. This is necessary to minimize or avoid unexpected consequences resulting from program decisions.

A fishery system can be examined from many angles. What is the cultural context? At what scale does fishing take place? How important are fisheries for food and income? What are the different roles of men and women in the industry? What are the policies and legal and institutional frameworks that govern it? What are the individual and institutional capacities and willingness to manage the fisheries? Answering these questions and others is essential to understanding the present situation, a prerequisite to defining a path to a more sustainable fishery. Additional considerations include:

- State of physical infrastructure, technological capabilities, institutions, and/or human productivity in the system
- Effectiveness of systems in place to collect, analyze, and disseminate data on fisheries to support fisheries management and development activities
- Effectiveness of the fisheries management system(s) and measures in place to sustain the fishery
- Inherent vulnerability of the species to fishing pressure
- Impact on marine habitats and ecosystems, including bycatch of endangered species

## **Stock Assessment**

An important part of the assessment phase is understanding the status of the fish stocks to be managed. This is essentially a biological assessment — similar to a threats assessment in biodiversity planning. A first step in selecting the best approach to managing a fish stock is to collect as much information as possible. A stock assessment is designed to give managers and decision-makers detailed information about the past and current status of a fish stock. Is the fishery overfished? If “yes,” to what extent? How big is the stock? Is it growing or shrinking? A stock assessment also provides data on how the stock might respond to future management actions.

Most developing countries have poor data on fisheries on which to base assessments of the status of the stock. However, this does not have to prevent fisheries projects from moving forward. Various strategies can be employed in what are known as “data poor” fisheries including qualitative approaches to assessing whether fisheries are overfished or not. It is also important to understand the fisheries governance arrangements, how to involve stakeholders in stock assessment programs, how to communicate a value assessment to the community or nation, and how to determine if there is potential loss of economic rent.

A complete stock assessment provides a vast array of information on both the fish population and the fishery itself. A population is defined as a group of individual fish of a single interbreeding species located in a given area. This area could be as large as the Atlantic Ocean or as small as a single river. A fish stock is defined not only by biology, but also by management concerns—e.g., jurisdictional boundaries or harvesting location.

A stock assessment will provide information about past, current, and likely future stock conditions. This data can be used to consider possible outcomes of different management options. A stock assessment should also quantify the risk—i.e., the probability that the option will not achieve the goal. A careful and

complete stock assessment should provide the manager with the information necessary to select the best options for managing the fishery successfully into the future.

To produce a stock assessment, a fishery scientist applies appropriate biological and mathematical models to the available data, examines the uncertainty in the models' outputs, and tests the sensitivity of the outputs to changes in the underlying assumptions. This can be done in several ways, include bio-economic models, index models (e.g., catch per unit effort/CPUE), yield per recruit models, spawning stock biomass models, and virtual population and cohort analysis. Each approach has its strengths and weaknesses, depending on the type of fishery being managed and the availability of information. Many stock assessment models are geared to single-species fisheries. However, tropical developing country fisheries are mainly multi-species, where dozens if not hundreds of fish species may be harvested for sale and consumption. This complicates stock assessment.

Performing a stock assessment may entail building the scientific capacity of the institutions in the country in question. Many developing countries may have little fisheries data, and the capacity to perform stock assessments may be weak or non-existent. This is especially true when attempting to address fisheries issues on a local scale in rural settings. In such cases, qualitative information on the status and trends of stocks can be gathered by asking questions of local fishers. These can include:

- Has the number of fishers and/or boats increased in the past five to 10 years?
- Has the catch per fishers declined?
- Has the size of the fish decreased?
- Have vessels recently been motorized?
- Has the size of vessels and gears changed?
- Have new and more efficient gears been introduced recently?
- Do fishers need to go further and take longer days or use longer nets to catch the same amount of fish compared to several years previously?
- Are there fewer targeted species, such as groupers or large pelagics, being caught?
- Are an increased numbers of species lower down the food chain being caught instead?

If the answers to most of these questions are “yes,” the fishery is likely overfished or headed in that direction. More proactive management and more restrictions on fishing effort are needed. In these data-poor fisheries, management objectives can employ qualitative measurements such as reduced number of boats or increased net mesh size, rather than a precise biological target such as an annual maximum yield or a fishing mortality rate not to exceed a certain number. However, because anecdotal information is limited in use and reliability, efforts should be made to strengthen the scientific capacity of local institutions and governance structures. There are many ways to gather data for stock assessments — drawing on port samplers, fisheries-independent data (research surveys), and fisheries-dependent data (i.e., observers, logbooks and electronic logbooks).

Stock assessments are linked to what are often called reference points. Reference points explain, in broad terms, the management objective of the fishery, and are designated as either target reference points (TRP) or limit reference points (LRP). TRPs are indicators of the status of a desired stock, such as biomass levels or fishing mortality rates. Fishing effort that achieves two-thirds of maximum sustainable yield (MSY) is an example of a target reference point. Fishing effort at MSY can also be considered an LRP. An LRP may correspond to a minimum condition (e.g., dangerously low spawning biomass) or a maximum condition (e.g., a high rate of decline in stock size or a high mortality rate).



## Socioeconomic Assessments

Stock assessments focus on understanding the biological component of the fishery system. However, it is equally important to understand the human dimensions of fish harvesting, handling, processing and marketing. Socioeconomic assessments provide baselines on the social and economic conditions of fishing communities— information that can be later used to assess performance in meeting certain social or economic goals of fisheries management. Socioeconomic assessments can also provide insights into how proposed regulations may impact fishing communities, allowing management interventions to be tailored to better suit local conditions.

Socioeconomic information can be collected in a number of ways, including rapid participatory appraisals, using existing information from a national census or published fisheries statistics, detailed household and individual surveys, focus group sessions with stakeholders, or through a combination of these and other techniques. Information should be collected at the same scale at which management interventions are proposed—i.e., at scales ranging from the village level, a bay, or for an entire nation.

Basic information that should be collected in socioeconomic assessments includes:

- Physical geography of the coastal and marine system
- Settlement patterns and population trends, including long-term and seasonal migration
- Occupational patterns of fishing villages and numbers of full and part-time fishers
- Indicators of economic or material wealth of fishing households—i.e., income, household structure and contents or other physical indicators of wealth
- Locations of landing sites and other fishing infrastructure (e.g., ice or processing plants, markets)
- Types of fishing gear, vessels, and crew used
- Disaggregated data on who is doing the fishing (men, women and/or children)
- “Lay” systems for how shares of fish catch and profits are distributed among crew and vessel/gear/engine owners
- Types of fish caught, handling and processing methods, and marketing channels within the value chain
- Social groups—existence and functionality of fishermen organizations, management groups and other existing community organizations
- Traditional or customary management practices in addition to those contained in conventional regulations and laws
- Perceptions and role of fisheries stakeholders concerning issues and problems within the fishing sector and the community, including trends in conditions of the fish stocks, legitimacy of regulations, degree of compliance with rules, and the prevalence of use of illegal and destructive fishing practices

Gender and other stakeholder dimensions must be considered in socioeconomic assessments. Disaggregated and well-assembled data will provide project managers with valuable economic insights for achieving sustainable fisheries management.

## Value Chain Analysis

Sound fisheries management is about more than just catching fish in a sustainable way. It is also concerned with the handling, processing, distribution, marketing, and sale of fish. Value chain analysis is a method for analyzing the series of activities that add economic value to fish products. This analysis also

helps identify opportunities for value-added activities, challenges in the industry, and potential leverage points for fishery reform. One key challenge is finding ways to ensure that the increased value of fishers' products serves as an incentive to increase the sustainable management and reform of fisheries, rather than as an incentive to catch more fish.

In conducting a value chain analysis of small-scale fisheries, the following questions are relevant:

- Where are the fish sold, who sells them, and what is the distribution system?
- Who are the buyers, both wholesale and retail?
- How does the price vary as fish move through the market chain from the fishermen to the end consumer?
- Where do inputs for producers and marketers enter the value chain and from where are they obtained?
- Are there opportunities to improve cooperation among buyers and sellers and to transport the fish to larger markets where prices are more competitive?
- What can be done to improve quality control?
- Are the fish processed?
- Are there opportunities for improved processing, marketing, packaging and adding value?
- Where are the leverage points for instituting management reforms to ensure ecological sustainability?

Value chain analysis is particularly important when eco-labeling or certification schemes are being considered.

## **PLANNING AND PROGRAM DESIGN**

Once an initial assessment has revealed the current context, resource trends, and policy environment of the nearshore capture fisheries sector, a strategic plan of action can be defined. This involves the selection of specific fisheries management issues, management goals and objectives, and activities.

### **Identify Priorities and Select a Course of Action**

An assessment will likely identify a number of problems with fisheries—often more than can reasonably be acted upon based on resource, institutional, or technical constraints. Therefore, a fisheries development and management program must be strategic. The first step is to clearly identify the priority issues upon which to focus effort and resources. The nature of these priorities will determine the choice of implementation actions.

Program priorities must be selected using an inclusive and on-going process that involves fishers, fishing groups, other major stakeholder groups, and decision-makers. Encouraging broad collaboration and cooperation between different groups, including both men and women, promotes public and political support for fisheries reform and leads to more effective implementation in the short- and long-term. Good practices for effective program design include:

- Identify and involve governmental agencies and other formal institutions—e.g., universities and user groups—that have an interest in the condition and use of the marine ecosystems being considered
- Solicit the views of major stakeholder groups as well as the views of other groups and, to the extent possible, the general public (e.g., through focus groups and surveys)

- Identify potential leaders and the stakeholder groups that will be involved in the implementation of fisheries reform measures
- Ensure that the scope and complexity of the fisheries issues selected as priorities for management are appropriate to the capacity of the institutions involved

There are four general categories of activities, listed below, that USAID could implement to achieve fisheries management goals. One or more of these may be part of the project design and part of the processes described in the policy and planning cycle on page 52.

**1) Policy reform.** Strengthening the enabling environment is a key objective of policy reform. Policies and laws at any governmental level, but especially at the national scale, may need adjustment to allow for changes in an approach at the operational and to enable more rapid progress. Needed reforms typically include changes in laws or policies to allow greater decentralization of management authority to local government units or regional management bodies. This also allows for varying degrees of co-management, whereby fishers and other stakeholders have a greater role and responsibility in planning and management. As argued in this guide, policy reforms can also allow for the implementation of rights-based fisheries management regimes.

**2) Planning and implementing site-based fisheries management plans.** Fisheries management is typically implemented through management plans for specific sub-national administrative regions such as a municipality, district or province; for specific fisheries ecosystems such as an entire bay or coral reef system; or for a major single species fishery such as crabs, lobster or tuna. In most cases, a USAID program would focus on developing or reforming management strategies at the operational level for one or several site-based locations. Local-level site-based management initiatives can also run parallel to efforts being made on broader national level or fishery sector reforms. In such cases, site-based initiatives should be viewed as pilots (adaptive and innovative experiments) that can inform national policy and serve as demonstrations for widespread replication and scaling-up.

Management plans for small-scale fisheries may be geographically defined by administrative boundaries such as a municipality, district, or province. Additionally, they may be based on ecosystem units or units of stocks, or upon the scale of a specific fishery. Plans can be small scale (e.g., a coral reef system or island) to very large scale. Large-scale plans are appropriate for dealing with pelagic and highly migratory species such as tuna. Often, the geographic management unit that is selected is a compromise between ecological, legal, and administrative characteristics and the practicalities of implementation. The larger the scale of a management plan, the more complex and difficult the planning and management becomes, and the greater the need for strong institutional capacity to implement the plan. A small pilot site, however, may be at the mercy of outside influences acting on the system.

**3) Capacity building and training.** Capacity building and training activities are essential for engaging stakeholders in a participatory and sustainable process. These activities should be targeted at government agencies, fishers, and other stakeholder groups. They must target women as well as men, as research shows women are the least likely to receive this much-needed support. It is also essential to strengthen the technical capacities of local fisheries scientists to conduct stock assessments. Fisheries personnel, including those from universities, NGOs, or governments, may still be focused on the old paradigms of fisheries development, emphasizing increasing fishing effort through technology and gear improvement, and on subsidies for larger vessels or motorization campaigns, rather than on sustainable use. In such cases, there may be a need for specialized training in the full repertoire of fisheries management. This includes training in new concepts of co-management, rights-based approaches, catch shares, and ecosystem-based management.

Capacity building can also be viewed as more than just human resource development. It should consider the institutional development needs of fisheries management agencies and authorities. This includes

strengthening their internal operating procedures and management systems. In many countries, fisheries management authority has become increasingly decentralized, and there may be numerous local fisheries management committees. These and other factors point to the need for capacity building at not only the national level but at multiple local levels. Capacity building should focus resource economics, development of access agreements, and reinvestment of revenues into management.

**4) Reducing bycatch or habitat destruction.** As part of an ecosystem-based approach, it is necessary to consider the interaction of fisheries with non-target species and the protection of important habitats. Some habitats may be essential to various life stages of fisheries' target species — e.g., an important feeding, spawning, or nursery area. In addition, certain technological innovations and fishing gears may increase bycatch of non-target species. For example, this might include marine turtles that are caught in trawl or gill nets, seabirds caught by tuna long lines, or undersized fishes caught at different life stages by other gear, such as juvenile fish caught in trawls. These issues can be mitigated through the use of regulatory measures or more selective gear.

### Gear Innovations that Reduce Bycatch

TECHNOLOGICAL FIX	HOW IT WORKS	FISHERY
Turtle excluder devices	A large metal grid in the neck of a trawl net that physically excludes turtles from the base of trawl nets while allowing shrimp to be caught effectively	Shrimp Trawl
Tori (bird scaring) lines	Keeps seabirds from baited hooks	Pelagic longline
Weighted lines	Sinks hooks out of reach of seabirds	“
Side-setting devices	Reduces the scavenging area by half	“
Line-setting devices	Places baited hooks immediately underwater	“
Large circle hooks (48mm or greater) with whole finfish bait	Reduces frequency of deeply ingested hooks and limits gut perforation	“
Pingers	Acoustic devices that alert marine mammals to the presence of gillnets to prevent entanglement	Gillnet
Medina panels	Fine-mesh net aprons that reduce the probability of dolphin entanglement during net retrieval	Purse seines

### Set Management Goals and Objectives

Lasting impacts are achieved only when goals and objectives are clearly defined, and activities are designed to produce impacts that are measurable and monitored. Activities should link directly to management objectives.

Fisheries management goals often fall into five broad categories: biological, ecological, economic, social, and governance. Examples include:

- Maintain target species at or above a threshold level of spawning stock biomass or standing stock to ensure continued productivity

- Minimize the impacts of fishing on the physical environment and on non-target species
- Maximize the economic incomes of the participating fishers
- Maximize employment opportunities for men, women, and other marginalized groups
- Secure access and tenure rights to improve governance, reduce conflicts, or increase maritime security

Objectives define how to achieve fisheries management goals and guide the selection of specific management measures. Objectives should be specific, measurable, achievable, realistic, and timely (SMART). They should be established through a participatory process that involves well-informed key stakeholders. A transparent process based on the best available science, coupled with a realistic assessment of the potential tradeoffs associated with different sets of priorities, is more likely to produce goals and activities that have broad stakeholder support. Each project should clearly list its objectives, which should have measurable success criteria and clearly show the connection between the objective(s) and outcome(s).

Fisheries management objectives allow the selection of an appropriate reference point. Most reference points are biological and become more complex when additional data on the species is available. The simplest reference points are those obtained through catch or catch-and-effort monitoring. If average individual growth, mortality, and gear vulnerabilities are known, then a yield per recruit model can be used with its corresponding conservative target reference point.

### **Program Adoption and Funding**

Management plans require some type of formal adoption to have full legal legitimacy. This could involve approval by the Director or Minister of the fisheries agency, or adoption as an ordinance by a municipality or traditional ruler. Once a rule has been formalized, it can be enforced and penalties for violations can be imposed. Formalization also demonstrates that the management plan has political support. Formal institutional arrangements for implementation often take the form of a management committee tasked with carrying out various management functions, including monitoring, surveillance and enforcement. The management committee has a responsibility to periodically update the plan and associated rules needed to meet plan objectives. Formal adoption may require the signatures of government officials and in some cases may also require publication in an official government registrar or gazette. In other cases, formal adoption could consist of a verbal edict expressed by a traditional ruler in a community meeting. Formal adoption may also make funding available to the management agency or a co-management committee to carry out its functions. This can include the authority to collect fines or charge licensing fees for fishing rights.

## **IMPLEMENTATION**

Many fisheries management efforts fail or encounter major barriers when making the transition from assessment and planning to implementation. Attending to the issues below can help avoid problems while entering the program implementation phase.

### **Managing in the Context of Data-Poor Fisheries**

Information on catch rates and effort for small scale fisheries is typically quite poor. In some cases, this is due to the weak capacity of the management agencies. However, it also simply reflects the nature of small-scale fisheries. The lack of highly centralized landing centers means there is often little information available to managers regarding the resource base or fishing rates. In part, this is due to the highly dispersed nature of small-scale fisheries—within one country there may be hundreds of fish landing sites and thousands of small-scale fishers.

In the data-poor systems that characterize most developing country contexts, traditional and local knowledge is an underutilized asset for fisheries managers. In some cases it is the only information available for making management decisions.

Data-poor fisheries managers can: 1) use simple statistics to manage the fishery, 2) rely on the knowledge of local fishers and 3) use management approaches that are simple to implement and require less intensive information gathering. It may also be necessary to help improve the overall fisheries data system, including data collection, management, assessment, and reporting. Whenever possible, the data should be disaggregated by gender.

### **Incorporating a Precautionary Approach**

Fisheries are unusual among economic activities in that there is no way to know with certainty the number of fish available for harvest in a given year. Nor is it possible to know with certainty the effects of consumer and market demands on the resource. Given these uncertainties, the management framework can minimize risk by using the “precautionary approach.” The precautionary approach promotes erring on the side of caution when faced with uncertainty. It calls upon managers to act in a more cautious or conservative manner relative to the level of uncertainty, adequacy, or reliability of the information. However, the precautionary approach does not imply that the absence of adequate scientific information is a reason for postponing or failing to take conservation and management measures. In implementing the precautionary approach, managers should take into account:

- Uncertainties related to the size and productivity of the stocks
- Reference points
- Stock condition in relation to such reference points
- Levels and distribution of fishing mortality
- Impact of fishing activities, including discards, on non-target and associated or dependent species
- Environmental and socioeconomic conditions

### **Strengthening the Enabling Environment and Governance**

Governance can be thought of as the sum of the many ways individuals and institutions manage their affairs. The core governance challenge in fisheries management is to establish and maintain institutions that put forth the norms and rules to guide decision-making.



Credit: Maria Haws

An extension agent in Nicaragua prepares to undertake participatory monitoring with women cockle gatherers to evaluate the effectiveness of the no-take zones established by the community.



The policies, laws, and regulations of governments and other organizations provide the framework in which people make decisions that affect fisheries. This mix of laws, policies, and regulations is often referred to as the “enabling environment” under which governance is carried out. The enabling environment is also affected by the political will and capacity of management institutions to carry out their mandates.

Since more than 90 percent of the global fish catch is taken in zones under national jurisdiction, a strong enabling environment at the national level is essential for effective governance at the operational scale. Weak governance plagues many capture fisheries, which are often characterized by corruption, conflicts of interest, inadequate management resources (physical, human, and financial), poor enforcement, illegal fishing, lack of stakeholder participation in decision-making, lack of clear vision, and user conflicts. Weak governance is responsible for the failure to control industrial fleets, while strong governance has led to empowerment of small-scale fishers. Weak governance also prevents the establishment of a coherent system of regulations that limit entry, reduce capacity, establish appropriate fisheries management reference points, enforce gear regulations, define spatial and time restrictions, redirect subsidies away from production, and conserve biodiversity.

## **Monitoring and Control**

A fundamental component of sound fisheries management involves enabling compliance not already achieved during the development and application of fishery management regimes. This is accomplished through instrumental measures such as monitoring, control, and surveillance (MCS) actions. While monitoring gathers information on the fishery, surveillance uses this information to measure compliance with regulations. The MCS system chosen will be specific to the structure of the fishery— i.e., it will depend on who pays for the MCS; what allowances there are for flexibility in the stocks and the fishery; how the system’s performance will be assessed; and the defined roles of resource users. In the smallest fishing communities, enforcement may be taken on by the fishers themselves on a rotating basis.

Strategic considerations for shaping the MCS strategy include:

- Type of fishery: industrial or small-scale, multi-user, gear types, single and multispecies
- Type of management measure: use rights; input, output, and technical controls
- Legal framework: fisheries acts, regulations, rules, and regulations
- Human resources: qualified personnel to administer and implement the system
- Time dimension: before fishing, during fishing, landing, and post-landings
- Financial requirements: cost effectiveness, who will pay, donor support, low -cost options, and regional and bilateral strategies

Some actions will make facilitation of a MCS plan easier, more efficient, and more cost effective. This includes registration/licensing of fishers, use of a vessel marking system, a ban on the transfer of catch between vessels at sea, a limit to the number of landing sites, and a possible zoning of fishing areas.

With “buy-in” from fishing sector stakeholders, it is possible for fishers themselves to become valuable partners in research and monitoring activities. The use of private fishing vessel time and fishers’ expertise facilitates the incorporation of local knowledge into management models. In some countries, fishers have gone as far as to conduct activities that complement monitoring or take over the monitoring activities completely from government. There are cases in which fishers’ organizations even fund research—allowing them to serve as principal players in setting priorities and defining issues. New technologies such as cell phones, remote sensing, and vessel tracking systems have made at-sea monitoring and surveillance more timely and accessible for those who can afford to incorporate such technology.

In some situations, co-management systems involve fishermen in enforcement actions. For instance, in the Philippines, local fishermen can be trained and deputized as fish wardens and engage in surveillance and enforcement actions including arrests and seizure of evidence. Surveillance groups made up of volunteer fishermen are called Bantay Dagat or “Sea Watch” groups. Other factors can influence fishermen compliance with rules. These include social and peer pressure among fishermen themselves, sanctioning through informal means by a traditional leader or ruler, or an individual fishermen’s belief that the rules are legitimate and will have tangible benefits.

## EVALUATION AND ADAPTIVE MANAGEMENT

Adaptive management is another crucial concept for successful fisheries management—especially in data poor contexts. The adaptive management approach sets out explicit management hypotheses and then tests them through actions. A lack of information is not considered a reason for inaction. As actions are implemented the development hypothesis can be assessed by observing whether they are having their intended effect. If an action does not have the intended effect, managers must decide whether the problem is due to poor implementation, or whether the hypothesis must be reformulated and new actions identified. Adaptive management requires that decisions be made quickly and actions adjusted accordingly, often before the next fishing season begins. This management approach is especially suited for decentralized management contexts and data-poor situations, but can be applied at any scale of operation.

Learning is a key element of adaptive management. Monitoring and evaluation can be useful tools in the learning process—providing feedback about what works and what does not, so that activities can be adjusted as necessary. When designing a project, a key question is “what needs to be monitored?” Once that is determined, it is important to identify indicators directly linked to project goals and objectives.

Indicators should be:

- Useful: the information provided can help inform programming decisions
- Measurable: assesses the appropriate quantitative and/or qualitative changes
- Attributable: the change measured can reasonably be ascribed to the activities
- Realistic: practical, cost-effective, and feasible to collect and record
- Timely: data is collected at reasonable time intervals to effectively show change; and data is available when it is needed
- Reliable: uses standard data collection methodologies, and data is robust and verifiable
- Direct: closely tracks the results it is intended to measure; assumptions are clearly stated

Additional guidance on selecting strong performance indicators can be found at:

[http://pdf.usaid.gov/pdf\\_docs/PNABY214.pdf](http://pdf.usaid.gov/pdf_docs/PNABY214.pdf)

Using adaptive management and making iterative adjustments can sometimes help projects reach their stated goals sooner. However, adaptive management also requires time—enough for its learning-by-doing approach to be effective and to see real behavior change. For example, when fishing efforts for a given fishery are reduced (changed behavior), the result should be measurable changes in the standing stock biomass. For some activities the time frame for realizing change is longer and/or the causal link between the project activities and the result more difficult to state. The impacts of policy reform measures, for example, are likely to be harder to attribute to tangible changes in the specific fisheries being managed.

USAID uses a number of standardized indicators for congressionally earmarked programs. Many of these are relevant in the context of evaluating the performance of USAID fisheries projects, including the following standard biodiversity indicators:

- Number of policies, laws, agreements or regulations promoting sustainable natural resource management (e.g. a fisheries co-management plan approved, new net mesh size or size limit adopted or gear prohibited as a regulation)
- Number of people with increased economic benefits derived from sustainable natural resource management and conservation (e.g., improved benefits derived from fishery value chain improvements in product quality, price, or increased catch rates per person—but see cautionary note below)
- Number of hectares of biological significance and/or natural resources under improved natural resource management (e.g. number of hectares covered by a fisheries planning process and associated management plan)
- Number of hectares of biological significance and/or natural resources showing improved biophysical conditions (e.g. increase in catch per unit effort, reduced fishing mortality, increase in average size of fish caught, increase in relative abundance or estimate of stock biomass in the water)

This final indicator on improved biophysical conditions should be used with caution as it would require showing a causal link between new management measures, such as a reduction in fishing effort or new net mesh size, to changes in catch per unit effort, relative abundance/biomass of fish in the water, or reduction in fishing mortality. These biological indicators require intensive data collection over a time period longer than life of the project to show reasonably conclusive impacts. This indicator would be difficult to demonstrate for most pelagic species, but might be appropriate for in some instances for short-lived, localized, small-scale stocks of some demersal reef fish or sedentary species such as oysters or clams. It is necessary to incorporate these sorts of quantitative indicators or other qualitative measures into management plans. Strengthening government and stakeholder capacity to contribute to such monitoring and assessment for long-term sustainability and promotion of adaptive management is a more important outcome for USAID projects than the collection of the data itself.

For USAID projects aiming to improve the economic benefits of fisheries, a word of caution is warranted. Value chain improvements tend to increase demand for a fish product, thereby indirectly resulting in increased fishing effort and eventually overfishing. Therefore, actions to improve value chains must be matched with improvements in sustainable use practices to prevent overfishing. If not, lasting economic benefits from the project cannot be assured and, in the long term, negative outcomes could result.

Indicators from USAID's Feed the Future initiative could also be used in capture fisheries projects if they are contributing to food security or agriculture enabling environment objectives. These indicators include:

- Number of policies, regulations, and administrative procedures in development, passed, or being implemented as a result of U.S. government assistance
- Number of hectares under improved technologies or management practices as a result of U.S. government assistance (this can include management and cultural practices such as sustainable fishing practices—e.g. ecological fishery reserves, improved fishing gear, establishment of fishery management plans)
- Number of farmers [or fishermen] and others who have applied new technologies or management practices as a result of U.S. government assistance including sustainable fishing practices
- Number of private enterprises, producers organizations, water users associations, women's groups, trade and business associations and community-based organizations that applied new technologies or management practices

The same caveats mentioned for the biodiversity indicators apply to these indicators as well. Additional information on USAID's Feed the Future Initiative can be found at: <http://www.feedthefuture.gov/>

## SOURCES FOR MORE INFORMATION

### **General**

- Learning and Models of Behavior Change. Class on line.  
[www.pitt.edu/~superl/lecture/lec4241/index.htm](http://www.pitt.edu/~superl/lecture/lec4241/index.htm)
- Stakeholder Mapping.  
[http://changingminds.org/disciplines/change\\_management/stakeholder\\_change/stakeholder\\_mapping.htm](http://changingminds.org/disciplines/change_management/stakeholder_change/stakeholder_mapping.htm)
- FAO Code of Conduct of Responsible Fishing.  
<http://www.fao.org/docrep/005/v9878e/v9878e00.HTM>

### **Fish Stock Assessment**

- Introduction to Tropical Fish Stock Assessment.  
<http://www.fao.org/docrep/W5449E/W5449E00.htm>
- Fish Stock Assessment Manual. 2003.  
<http://www.fao.org/docrep/006/X8498E/X8498E00.HTM>
- Sustainability reference systems and indicators for responsible marine capture fisheries: a review of concepts and elements for a set of Guidelines. 2000. Garcia, S.M. and Staples, D.J. Marine Freshwater Research 51:385-426.  
<http://cat.inist.fr/?aModele=afficheN&cpsidt=1482496>
- A Guide to fisheries stock assessment— from data to recommendations, New Hampshire Sea Grant.  
<http://www.sefsc.noaa.gov/sedar/download/stockassessmentguide.pdf?id=DOCUMENT>
- Counting Fish 101: An Analysis of Fish Stock Assessments.  
<http://www.americanprogress.org/issues/green/report/2012/09/27/39347/counting-fish-101/#.UGSidrQ0oH4.email>

### **Value Chain Analysis**

- Revenue Distribution through the Seafood Value Chain. FAO. 2006.  
<http://www.fao.org/docrep/009/a0564e/a0564e00.htm>
- The Kenya Capture Fisheries Value Chain: an AMAP-FSKG Value Chain Finance Case Study. USAID. microreport #122.  
[http://pdf.usaid.gov/pdf\\_docs/PNADN416.pdf](http://pdf.usaid.gov/pdf_docs/PNADN416.pdf)
- Analysis of the fisheries sector in Sri Lanka: Guided case studies for value chain development in conflict-affected environments. USAID.  
<http://www.scribd.com/doc/17434012/mR-100-Analysis-of-the-Fisheries-Sector-in-Sri-Lanka>

### **Smart Fishing Gear Design**

- World Wildlife Fund Smart Gear Program for a living planet.  
[http://smartgear.org/smartgear\\_bycatch/bycatch\\_solutions/](http://smartgear.org/smartgear_bycatch/bycatch_solutions/) and [http://smartgear.org/smartgear\\_bycatch/index.cfm](http://smartgear.org/smartgear_bycatch/index.cfm)
- The Eliminator Trawl Design.  
[http://www.smartgear.org/smartgear\\_winners/smartgear\\_winner\\_2007/smartgear\\_winner\\_2007grand/](http://www.smartgear.org/smartgear_winners/smartgear_winner_2007/smartgear_winner_2007grand/)

***Adaptive Management***

- Margoluis, Richard and Nick Salafsky. 1999. Adaptive Management-A Tool for Conservation Practitioners.  
<http://www.fosonline.org/wordpress/wp-content/uploads/2010/06/AdaptiveManagementTool.pdf>

***Monitoring Control and Surveillance***

- An introduction to monitoring control and surveillance systems in capture fisheries.  
<http://www.fao.org/DOCREP/003/V4250E/V4250E00.HTM>
- Monitoring control and surveillance.  
<http://www.fao.org/fishery/topic/3021/en>

# III. AQUACULTURE

## 9.0 An Overview of Aquaculture

## 10.0 Management Approaches

## 11.0 Aquaculture Planning



Credit: Aviti Mmochi

Mr. Kirago, a salt works operator, cooperated with the Institute of Marine Sciences to pilot milkfish farming trials by converting one hectare of salt evaporation ponds to milkfish production. Since trials demonstrated commercial feasibility of farming this endemic species of fish in Tanzania, the number of ponds cultivating milkfish has increased from five to approximately 100 in less than five years, providing an important source of income and food source to local coastal communities.



# 9.0 AN OVERVIEW OF AQUACULTURE

## INTRODUCTION

The future of aquaculture is truly at a crossroads: the sector requires major reforms to redirect it along a more environmentally sound and socially responsible path while at the same time realizing its full potential as a development opportunity. The course of aquaculture development will influence the health and productivity of wild fisheries, the survival of many smallholders' livelihoods, and global food security. There are many issues to consider when developing environmentally sound and economically feasible aquaculture projects—both at the operational/farm level as well as the policy and programmatic levels. Strong management will be required to ensure that ecosystem health, resilience, and integrity are not compromised by unsound and inappropriate aquaculture endeavors while at the same time developing aquaculture in economically viable ways that benefit the poor.

Aquaculture includes the culture of aquatic plants, animals, and microorganisms at any stage of their life cycle in freshwater, brackish water, and seawater. The industry ranges from backyard fish ponds that produce small quantities of protein for poor families to large-scale, commercial operations that are the basis for national and regional industries. Aquaculture currently provides a critically important source of food for much of the world's population. The practice also produces a wide variety of non-food products ranging from microalgae for food supplements to pearl farms producing high-priced gems. The true potential of aquaculture, however, can only be realized through sustainable development. This means the use of appropriate species, technologies, and practices that reduce negative social and environmental impacts.

Aquaculture production has grown as a percentage of overall fisheries supply from 4 percent in 1970 to 46 percent in 2009. The industry is growing faster than any other food production sector, with an annual growth rate of 6.6 percent in 2008. While capture fisheries production has slowed as fish stocks have become over-exploited due to poor management, aquaculture as a world food commodity is continuing to grow to meet increasing demand driven by population growth. In 2006 aquaculture produced 52.5 million tons of plant and animal materials with a value of US\$98.4 billion. Per capita consumption of aquaculture products rose from 0.7 kg in 1970 to 7.8 kg in 2006. Over the next several decades, aquaculture will continue to be an economic growth opportunity in tropical developing countries, where warm temperatures provide year-round growing conditions.

Aquaculture products are critically important to many developing nations, primarily for food security, but also increasingly as a valuable cash crop and export product. The U.S. is one of the major global importers of aquaculture products, importing approximately 80 percent of its fish and seafood, of which over 50 percent is from aquaculture production.

Aquaculture is often thought of as a source of luxury seafood products, such as salmon and shrimp. However, the bulk of global aquaculture production consists of basic fish commodities, including carp and tilapia. These two species comprise 40 percent of world aquaculture production by weight, most of which is produced in China. The top 10 species groups (e.g., carps, oysters, mollusks, tilapia, salmonids and shrimp) account for 90 percent of world production. Removing salmonids and shrimp from the equation, the remaining eight groups still provide 89 percent of world production by weight and are primarily produced and consumed in Asia, largely in China. Note that top cultured species, such as oysters and other bivalves, are much more environmentally sound: They require no feed inputs and rarely require

habitat alteration to create farms. In addition, bivalves are a nutritious source of high-quality protein in many areas, thereby improving food security.

Aquaculture provides 46 percent of all fish production, including 78 percent of inland production and 20 percent of marine production, and employs 44.9 million people. Small-scale aquaculture is the predominant form of aquaculture on a global basis, especially in Asia. Other regions, particularly Africa (representing only 1.8 percent of global production) and Latin America (only 3.3 percent) have yet to fully recognize aquaculture's potential to contribute directly to food security for rural populations. Aquaculture is widely recognized as a leading development opportunity, particularly in regions where its potential has not yet been fully realized.

In addition to providing low-cost, high-quality food to the world's poor, aquaculture provides:

- A variety of employment opportunities ranging from manual labor to skilled labor
- Employment for marginalized sectors of the population such as women and youth
- Creation of associated economic activities — e.g., processing, transportation, and feeds manufacture
- Export products and bilateral trade opportunities
- An alternative source of food when fishing fails or crops are bad
- Benefits from organisms that require little or no feed, or can utilize waste products
- Non-perishable aquaculture products (e.g., seaweed, pearls) that can provide income for remote areas where producers are unable to preserve or transport the perishable products
- New opportunities such as production of biofuels, pharmaceuticals, or fibers

The positive contribution of aquaculture to development is clear. At the same time, poor planning can cause both large-scale and small-scale aquaculture development to fail or have unintended consequences. In Africa alone, there are over 100,000 abandoned fish ponds. Failed ponds represent wasted time and money, as well as potentially leaving valuable land in a damaged condition. Uncontrolled and poorly operated aquaculture farms can cause environmental and social impacts.

Aquaculture has the potential to negatively impact biodiversity, ecosystem integrity, and ecosystem productivity. International development programs have sometimes been a pathway for the introduction of exotic and invasive species, and in some cases, aquaculture facilities have had significant adverse impacts on local capture fisheries and estuaries. Major classes of potential threats from aquaculture include:

- Introduction of exotic or invasive species that disrupt natural populations and ecosystems
- Conversion and loss of critical habitats



Shellfish provide an important nutritional protein source in Pacific coastal communities of Nicaragua which are some of the poorest in the country.

Credit: Nelvia Hernandez

- Transmission of disease and pathogens to wild populations of fish and other animals
- Release of antibiotics, pesticides, antifungal agents, and pollutants
- Diversion of freshwater
- Eutrophication of waters
- Overfishing of local fish or invertebrates for aquaculture feed
- Over-extraction of wild larvae as seed stock

When done properly, aquaculture can play a subsidiary role in biodiversity conservation. For example, aquaculture can serve as an alternative livelihood for communities participating in conservation efforts, and provide incentives for protecting key habitats or species. For example, in the Pacific Islands, assistance is provided to culture pearls, sponges, and giant clams (endangered species) to communities that voluntarily support Marine Protected Areas in their fishing grounds.

The aquaculture sector holds great promise, but there are also many challenges that must be overcome to achieve sustainability. Aquaculture is a relatively new form of food production, and unfortunately in some countries, there has been insufficient oversight and management, or sound policy development. The aquaculture industry uses a wide variety of technologies and scales of production. Aquaculture is also used to produce hundreds of different plant and animal species.

Most aquaculture operations consist of small- or medium-scale farms, and there is often little organization among producers. Aquaculture also involves interactions between a number of sectors, and there are often significant gaps and overlaps in research, extension, and capacity. A lack of coordination between sectors interferes with sustainability, which must be integrated into aquaculture development programs or projects from the very beginning to take best advantage of the industry's potential.

There continues to be a role for USAID, other donors and the private sector to assist the reform of existing aquaculture operations where problems exist. There are many issues to consider when developing environmentally sound and economically feasible aquaculture projects — both at the operational/farm level and the policy and programmatic levels.

## **KEY MANAGEMENT ISSUES**

While the aquaculture industry is growing and has become a mainstay in world food production, its history has not been without failures. Aquaculture's rapid growth has come with a wide range of problems that vary depending on the species, culture system, and socioeconomic context. A common cause of aquaculture development failure has been an over-emphasis on demonstrating culture technologies without attention to governance and policy frameworks, proper siting, oversight, processing, transportation, marketing, and sales.

To be successful, aquaculture development endeavors must consider the full value chain along with the larger landscape-scale management. The planning process must encompass all stages of a project — from the point of initiation to final marketing. A common pattern in some types of aquaculture development is a “boom” phenomenon, when a particular type of aquaculture grows rapidly with little growth in technical capacity, policies, or governance structures. Uncontrolled growth can lead to unwanted environmental, economic, or social impacts.

For example, aquaculture has led to large-scale habitat alteration in coastal regions of Southeast Asia and Ecuador, where extensive areas of mangrove forests were removed for pond construction during the latter half of the last century. Overfeeding, over-fertilization, and poor water quality management have resulted in effluents contaminating receiving water bodies. Social impacts occur when large industrial-scale farms out-compete smaller farms, which most often lack the technical and economic resources to participate in

the industry. Disease outbreaks can occur due to poor management and lack of biosecurity, defined as the ability to exclude pathogens listed by the World Organization for Animal Health from farm operations, threatening wild fish stocks and the economic viability of large and small farms alike. On the positive side, global attention to the issues associated with habitat destruction by coastal pond construction led to reforms in which many nations' shrimp industries adopted and implemented Codes of Conduct and Best Management Practices, minimizing future negative impacts.

Even in cases where an aquaculture industry develops more slowly, negative impacts can still occur. For example, certain algae species were introduced around the world for aquaculture purposes. Many of these later escaped from aquaculture facilities and became invasive species, threatening valuable coral reef ecosystems. It should be noted that even sustainable aquaculture may fail to thrive when there is insufficient technical, financial, or regulatory support.

USAID has played a major role in supporting research, development, extension, and capacity building around the world to help make many forms of aquaculture both technically and environmentally viable. Much work remains to be done, however. USAID and other donors continue to promote responsible aquaculture and reduce the threats posed to biodiversity and ecosystem integrity through improved governance. Effective USAID programs will work to establish strong governance systems that provide adequate oversight and monitoring, and ensure that aquaculture activities are incorporated into the larger, integrated, landscape-scale governance systems. The overall objective is to develop resilient food production systems that integrate fisheries, aquaculture, and agriculture. The following sections highlight some of the more common aquaculture practices that can result in significant impacts to coastal/marine biodiversity.



Credit: Dan Miller

Proper aquaculture siting involves consideration of on-water aspects of the operation as well as shore-based facilities.

## Facility Siting, Design, and Construction Practices

Proper siting of aquaculture facilities is critical to reducing environmental and social impacts, and to improving long-term operations. For example, improper siting has led to the loss of millions of hectares of productive mangrove forests, critical habitat for wildlife and marine organisms. Due to high dependence on good water quality, aquaculture operations are highly vulnerable to impacts from other economic activities. Unfortunately, most countries lack the legal and regulatory framework necessary for responsible siting and permitting.

The proper siting of aquaculture facilities can minimize negative alterations to habitat and conflicts with other economic activities. Poor design and construction practices can also affect farm management. Often, these poor practices are a result of a lack of technical capacity or experience, or are due to financial constraints that prevents adequate pond design and construction. For example, including settling basins into the design of aquaculture facilities can effectively reduce effluent loads, but also incurs higher costs. Aquaculture managers and operators should be trained in appropriate siting practices, and must understand the legal, regulatory, or voluntary means of adhering to them. Clearly, having the technical and financial support to plan and build state-of-the-art operations results in both economic and environmental benefits.



The proper planning and siting of clusters of operations or industries is especially important. While there may be little impact from one farm properly sited near an estuary, dozens of farms completely surrounding a water body will have cumulative and additive impacts. This problem can be mitigated by limiting the number of operations allowed in one area, or through the use of measures to reduce the volume of effluents released into adjoining water bodies. Some examples include using settling ponds to reduce effluent sediment loads, or reducing the use of feeds and fertilizers to prevent eutrophication.

Biosecurity concerns are also heightened when farms lie close together. This issue can be addressed through the development of regional biosecurity plans, establishing buffer zones between operations, or requiring additional water filtering by farm operators. Developing a formal aquaculture park in a pre-designated area or encouraging farms to cluster together in the most appropriate sites can reduce threats to biosecurity. This practice allows farmers to share some common development costs, such as road maintenance. Sustainable siting, construction, and operation of aquaculture facilities will be enabled by the presence of sound regulation and good governance. Farms should be sited to reduce the pollution risks to sources of drinking water or other productive habitats, such as wetlands and mangroves. Integrated approaches to water resources management will be necessary to balance the competing needs for clean water, including for wetlands and estuaries.



Credit: Simon Ellis

Pearl oysters being grown from spat collected from the wild. This farm requires no feed inputs and collecting wild spat does no harm to wild stocks of pearl oysters.

## Introduction of Non-Native and Invasive Species

Non-native and invasive species pose some of the greatest threats to biodiversity and ecosystem integrity. Non-native species are those that were not originally found in a specific locale, but were introduced through human actions. Invasive species are non-native species that become pest species in their new range. Not all non-native species will become invasive (i.e. proliferate and cause environmental damage), but caution is recommended when introducing new species. The introduction of Nile perch into Lake Victoria or snakehead fish into U.S. waters are examples of accidental introductions that have negatively affected native species. The introduction of Nile perch led to the drastic decline of at least 200 native species and the disruption of local fishing communities in three countries bordering the lake. Moving non-native species from one region to another for the purpose of aquaculture should be avoided due to the risk of accidental release or escape of these non-native species into the local environment.

For this reason, the U.S. strictly regulates or bans the use of many non-native and invasive species for aquaculture. USAID is a member of the U.S. Invasive Species Council, an interagency task force with the mission of preventing and mitigating impacts from invasive species. Not all introduced species will become invasive. It is important to carefully assess and consider past history when determining whether or not to allow introductions. When non-native species are allowed, it is usually under contained conditions with multiple safeguards to reduce the risk of escapes, or after a careful assessment indicating that risks are minimal.

Genetic differences between farmed organisms and locally present individuals of the same species may also be a concern. This is one of the most complicated topics in modern aquaculture, and requires a

good understanding of genetics in order to assess the potential impact of specific cases. The introduction of new genetic material into wild organisms can dilute or change the character of wild, native stocks. Foreign genetic material can come from a variety of sources, including from individuals from another area, selectively bred organisms, or novel genetic combinations. Movement of genetic strains from one region to another should be approached with caution due to the danger of accidental release into the local environment and the resulting genetic dilution of wild, native stocks.

Genetically Modified Organisms (GMOs) are a separate issue. GMOs are organisms that have had new DNA introduced into their genomes and subsequently expressed in their phenotype. While several genetically modified fish (salmon and tilapia) have been developed, only one species (a GMO Atlantic salmon) has been approved for use in the U.S., and none are widely cultured. The use of genetically modified organisms in the aquaculture industry should be considered only after a careful environmental review and under strict controls. It is important to recognize, however, that major advances will no doubt be made in the genetic modification of many food organisms. These developments, if properly assessed and managed, hold great potential for increased food security.

### **Use of Wild Organisms in Aquaculture Operations**

Wild organisms are used in two ways in aquaculture operations: the capture of larval or juvenile fish for rearing—sometimes referred to as “ranching,” and as a food source for carnivorous fish. The aquaculture of many organisms, especially estuarine and marine species such as milkfish, grouper, and shrimp, rely on the young of wild stocks to supply production facilities. Although this dependence has been reduced through the use of hatcheries, wild harvesting still poses threats to local biodiversity and the sustainability of wild stocks. Wild harvesting of the juveniles of some species can result in significant bycatch. With certain exceptions (see box), the use of wild larvae should generally be avoided to protect wild fisheries and reduce negative impacts on the ecosystem.

### **Use in Aquaculture Feeds**

The use of wild fish in the manufacture of aquaculture feed is a major concern. This practice began in a time when waste materials from fish processing was a cheap source of high-quality protein for artificial livestock feeds. As aquaculture developed and expanded, this same practice was adopted. As both animal husbandry and aquaculture expanded on a global basis, many fish began to be captured specifically for use in animal feeds. Today, one-third of all captured, wild fish is used as feed for terrestrial livestock and aquaculture. Thus, farming of higher trophic-level fish results in a net loss of protein, with significant implications for local and global food security. There is great concern as to whether this is a sustainable use of precious fish stocks.

#### **USE OF WILD FISH STOCKS**

There are cases where there is little negative impact from using wild fish to provide stock for aquaculture farms. For example, shellfish farmers regularly practice “spat collection.” The farmers make “collectors” from natural or artificial materials and set these into the water where juvenile bivalves will attach themselves. Since recruitment of juvenile organisms is often limited by substrate or territory availability rather than the number of juveniles, removal of a small percentage of juveniles does not appear to affect wild populations.

Fresh fish are also used as an aquaculture feed. Some farms that culture species such as grouper, crustaceans, and other fish high on the food chain rely on “trash fish” from local capture fisheries as a source of feed. In Asia, this practice has had enormous impacts on local coral reef fisheries through the depletion of fish populations. It is worth noting that the term “trash fish” is a misnomer. All fish, in fact all species, have a role to play in the ecosystem, and fish lower on the trophic level are a critical component of the food web. Nearly all fish can be raised on artificial feeds. This is the recommended practice. The culture of species lower on the food chain, especially filter-feeding species such as oysters and clams, require little or no feed, thus are more environmentally and economically sustainable.



## Improving the Sustainability of Aquaculture Feeds

Although there is concern about fish being specifically harvested to make animal feeds (known as reduction fisheries), it is important to realize that in comparison to terrestrial animals, fish are much more efficient converters of feed to animal flesh for a number of reasons, the foremost being their cold-blooded nature.

Table 1 compares the feed conversion ratios (FCR) of terrestrial livestock to fish. The figures clearly show that fish are much more efficient users of feed. FCR is the standard measure of how efficiently an organism converts one pound of dry feed to one pound of flesh and is used to make comparisons between species and to assess feeding practices. It can also be used to make comparisons between different species of fish. FCR is somewhat limited in terms of its usefulness in assessing the sustainability of a particularly form of aquaculture because it is based only on the total pounds of dry feeds used to produce one pound of meat. FCR is often erroneously interpreted as the amount of wild fish used to produce one pound of cultured fish, which is not correct. It only illustrates how much total feed is used.

Fish feeds are made up of five main components, each of which can come from multiple sources. These components are: protein, lipids (fat), carbohydrates, minerals and vitamins. Protein and lipids are the most expensive components, and their use is usually carefully limited by manufacturers because of their high costs. Proteins and lipids can come from many plant (e.g. soy) and animal sources (e.g. processing wastes). Aquaculture feed producers and farmers have made considerable advances in replacing fish meal and fish oil in aquaculture feeds. Complete substitution may not be possible, however, since other protein and oil sources may have serious limitations. Many plant sources of protein contain toxins or growth-limiting compounds that restrict their use. Similarly, some protein sources do not have the correct ratio of essential amino acids for aquatic organisms. The flavor and texture of fish flesh can also be adversely affected by feed components.

New measures are being developed to assess and compare how much fish meal and fish oil are used in formulating feeds for specific species. Much debate surrounds the use of these new measures, however, because the data used to calculate them is difficult to obtain and may be unreliable. One new measure being slowly adopted is the “fish in, fish out” ratio, i.e. how much of the protein and lipid ingredients come from fish meal and oil, rather than other sources. Aquaculture practitioners must still take care to distinguish between how much of the fish ingredients come from reduction fisheries (i.e. fish targeted for fish meal production) versus from fish processing waste.

TABLE 1.  
FEED CONVERSION RATIO (FCR)

FCR is defined as the net amount of feed (dry weight) used to produce one pound or kilo of animal product (wet weight). For example, a 1:1 ratio would mean that one pound of feed (dry) was used to produce one pound of fish. A low ratio indicates high feed conversion efficiency.

Typical FCR for farmed animals, (pounds of feed required to produce one pound of flesh)

Cattle/sheep	8:1
Pigs	3.4–3.6:1
Poultry	2–4:1
Rabbit	2–3:1
Atlantic salmon	1.5–2:1
Tilapia	1.6–1.8:1
Shrimp	1.5–2:1

Aquatic organisms are by far the most efficient in converting feed to flesh. In some cases, FCR can drop as low as 0.8:1 for some aquatic animals such as tilapias and shrimp. How is it possible that they require less than one pound of feed to produce one pound of flesh? The answer is that if they are also eating algae, zooplankton, and other small aquatic creatures that grow in ponds, some portion of their food needs will be met in this way and less feed is needed. Hence, managing a pond's primary productivity is critical to decreasing the need for manufactured food inputs.

TABLE 2. FISH-IN, FISH-OUT RATIOS

Species	FM in Diet %	FO in Diet %	Yield of FM from wild fish %	Yield of FO from wild fish %	FIFO ratio	Wild Fish used
Salmon	30	20	22.5	5	2.3	3,329
Trout	30	15	22.5	5	2.0	1,293
Eel	55	5	22.5	5	3.1	827
Marine fish	32	8	22.5	5	2.0	3,014
Shrimp	20	2	22.5	5	1.3	3,958
FW crustaceans	15	1.5	22.5	5	0.6	618
Tilapia	6	0.5	22.5	5	0.3	757
Catfish	10	1.7	22.5	5	0.5	820
Milkfish	3	1	22.5	5	0.1	68
Carp	5	0	22.5	5	0.2	1,539
Misc FW	40	5	22.5	5	0.5	407
<b>Total of fed farmed fish and shellfish</b>						<b>16,631</b>

The World Wildlife Fund uses the Fish-in, Fish-out (FIFO) standard in their aquaculture dialogues, although they recognize that accurately measuring the FIFO is difficult. To learn how FIFO might differ between species in the following graphics, Table 2 presents calculations that take into account waste sources as much as possible. For example, salmon have a high FIFO of 2.3 and require approximately 3.3 tons of wild fish per ton of cultured fish produced. As one moves further down the food chain to more omnivorous species (e.g. tilapia), the FIFO is reduced to 0.3 with 0.76 tons of wild fish used to produce one ton of cultured fish. Source: (<http://www.iffi.net/downloads/100.pdf>)

In a world where food is scarce and fisheries are under pressure, fish meal, fish oil, and grain should be used efficiently and sparingly for any animal husbandry purpose. This is particularly true for aquaculture due to its rapid growth and use of carnivorous fish, which require a higher percentage of protein in their feed than do omnivorous/herbivorous fish. Juvenile fish also require more protein than do adults. The culture of species lower on the trophic level, especially filter-feeding species such as oysters and clams, require little or no feed, and are thus more environmentally sustainable.

Development efforts can promote more sustainable use of feeds by encouraging the culture of appropriate species (i.e. low on the food chain) and providing training to farmers to help them adopt improved feeding practices. In the case of omnivorous or herbivorous species such as tilapia and milkfish, the use of feed can be minimized by fertilizing the pond, since these species will eat the resulting plankton bloom. Additionally, aquaculture science is making rapid progress towards developing improved feeds with less fish meal and fish oil. Selective breeding for strains which make more efficient use of feed will also help.

## Food Safety

Food safety is a key issue in aquaculture, particularly since many aquaculture products are high-protein, low-acid foods that are particularly susceptible to decomposition. Aquaculture often takes place in geographic areas where there is a lack of knowledge and resources (e.g., potable water, ice) to address issues of food safety. Aquaculture products, whether for local consumption or export, are like any other

food commodity in that food safety must be considered during both production (especially for bivalves such as oysters) and post-harvest handling.

Additional food safety issues may arise due to polluted waters associated with waste build-up, the use and accumulation of antibiotics, antifungals, and pesticides, and chemicals added during processing.

### **Transmission of Disease and Parasites to Wild Populations**

When aquaculture operations were few and most farms used extensive (low density) production methods, aquaculture diseases were far less common. However, in the last three decades, repeated epidemics of disease have struck nearly every aquaculture industry including fish, shrimp, and mollusks. Most aquatic diseases are provoked by stress, either due to the environment and/or poor management practices that promote over-crowding. Globalized trade has allowed diseases and parasites to establish and spread widely around the world. To counter the increase in disease and parasites, some aquaculturists have turned to a variety of chemicals and antibiotics, increasing pollution to receiving waters.

Understanding of aquatic diseases and methods of prevention have advanced rapidly. Also, the development of biosecurity measures, or at least the recognition of the need for them, has revolutionized the aquaculture industry. Biosecurity measures at the farm, national, and international levels should be required in aquaculture planning and development.

Transmission of diseases and parasites from fish farms pose major threats to local wild fisheries. Large-scale outbreaks of diseases and pests among wild populations have resulted from infection by farmed fish, threatening local fish populations and causing economic decline among fishing communities. Increased pollution also poses threats to the surrounding ecosystems.

### **Impacts from water pollution**

A major concern for aquaculture operators is effluent waste resulting from overuse of feeds, fertilizers, and chemicals in aquaculture ponds. High nutrient levels in effluents can lead to increased biological oxygen demand and eutrophication. Most problems can be avoided by improving input efficiency, which also improves economic viability. Structural solutions such as sedimentation basins or management practices such as slowing pond drainage are also effective. Mitigating other potential pollutants such as chemicals or antibiotics requires their proper use and complying with specific use guidelines.

Aquaculture is also highly vulnerable to pollution from other sources, which should be considered when siting farm operations. If other sources of pollution arise after the development of an aquaculture facility, steps can be taken to either help farmers mitigate the pollution (e.g., by reducing water exchange) or to work with the polluters to decrease the level of effluent emission.

Likewise, aquaculture farms must bear responsibility for preventing and reducing pollutants from their own operations. Vastly reduced environmental impacts can be achieved by utilizing enclosed recirculating tanks with adequate filtration systems. Reduced use of chemicals and antibiotics can be achieved by more extensive (low-density) farming or through organic farming.

### **Poor Management Practices**

Aquaculture planners and farm investors and operators may not always completely understand the technical aspects of aquaculture. Technical mistakes can lead to economic failure and harmful environmental impacts. Better governance, policies and regulations, along with training, technical assistance, extension services, and monitoring at all levels of production are essential to minimize threats to the environment. Another technique for increasing the chance of success is to select well-known and established forms of aquaculture that require either less technology or well-proven technology over innovative or highly technical forms of aquaculture.

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# 10.0 MANAGEMENT APPROACHES

The issues discussed in Section 9 (An Overview of Aquaculture) demonstrate the importance of taking a proactive and integrated approach to aquaculture development and management in order to optimize potential benefits and reduce negative impacts. Management measures include establishing policy frameworks, laws, and regulations; zoning and permitting; codes of good practice; and voluntary certification of best practices. USAID's many decades of experience in developing sustainable aquaculture policies and collaborative research on the aquaculture of local species and increasing food security for the poor make it well positioned to support reform in this sector.

## LICENSING AND PERMITTING

Sound policy frameworks are needed to establish environmentally sustainable regulations, permitting, and licensing. Aquaculture permits and licenses should be required for any development or operational activity that may reasonably be thought to have potential economic or environmental impact. At the same time, efforts should be made to streamline the process and make costs transparent and not prohibitive. For very small farms, permitting may be cumbersome and ineffective, and thus inappropriate. The permitting process associated with planning, design, and building of the facility should ensure that the facility is properly sited and constructed in a way that does not cause environmental damage or threaten natural habitat. For example, permits to clear an area for construction are normally common place, but should not be allowed in valuable habitats such as wetlands and mangrove forests. An expert should examine the farm plan to ensure it includes features that promote good management and environmental protection, for instance, that the plan includes settling basins to reduce sediment load in effluents.

Operational aspects of a facility should also require permits. These usually focus on activities necessary to obtain and use inputs to the farm (e.g., permits to utilize the water, capture wild spat, or otherwise alter the natural resources). Sound policies are needed to ensure that the permitting process reduces threats to natural resources, biodiversity, and water resources.

Permits should also be required for effluent and waste management. The business management, labor, and commercialization aspects of the farm will require a separate suite of permits. These are usually administered by different government agencies than those overseeing the building and operational phases. Each type of permit should require clear, rigorous, and appropriate standards and criteria. Additionally, the government might charge a reasonable fee to cover their costs of issuing the permits.

It is common to find that the permitting scheme is confusing, poorly defined, and complicated by having multiple agencies involved. Gaps may also exist. Therefore, it is often necessary to clarify, simplify, or harmonize permitting procedures. In some cases, this may require developing new permits or permitting procedures. This is best done through a multi-institutional process that involves all agencies responsible for aquaculture development and with input from the private sector.



Young women in the Marshall Islands being trained to graft pearl oysters.

Credit: Maria Haws

It is important to consult industry members to ensure standards and criteria are technically appropriate and achievable by the industry. Streamlining the permitting process is helpful, particularly for small operators who may find it difficult to understand or comply with complex procedures. Permitting procedures that are easily understood encourage compliance. It is important to have outreach materials that clearly outline what permits are needed and how to obtain them. When procedures are unclear, applicants may choose to either abandon aquaculture or proceed without the legal permits. The latter is especially common when surveillance and enforcement are also weak.

Many countries have attempted to establish a “one-stop” permitting process — an application is submitted to a single institution, which then facilitates review and approval by other institutions. However, it is important that a one-stop permitting process coordinate the review and conditions imposed by all agencies or departments that have planning or regulatory functions related to the broad topic of aquaculture. It is also helpful to establish “trigger” conditions that indicate the level at which a particular activity requires a specific permit. For example, in the U.S., if a farm releases less than a certain volume of effluent, a discharge permit may not be required. Another way to encourage small farmers to engage in the process, while allowing for cost recovery, is to establish a sliding scale for permit fees.

## ZONING

Zoning involves the use of the permitting process to allocate space for specific activities or types of infrastructure, attempting to logically integrate and accommodate various land uses. Zoning can also be used as a tool to identify which sites are most appropriate for various activities from an environmental, biodiversity, operational, and social perspective. Both terrestrial and marine areas can be zoned, although relatively little marine zoning has been done to date. Geographic Information Systems (GIS) can be useful in zoning. GIS compiles data on multiple parameters and allows this information to be viewed on one grid. It can be used to evaluate the interaction of various parameters to determine the suitability of specific sites, or specific activities. Because of the complexity of scale, intensity, and species-specific issues associated with aquaculture, zoning is not always the best tool to determine siting. The ability to use zoning as a tool depends largely on a characterization of the space available to various economic activities and establishment of criteria for optimizing land use. Where these do not exist, it is better to use other approaches, including the allocation of environmental capacity or resources (e.g., water availability or limits on the number or size of operations). These limits can be modified as the sector gains more experience with the particular form of industry development. Keep in mind that each type of aquaculture varies greatly in its needs for space and natural resources use. Some combination of both zoning and other approaches to allocate the use of resources may be ideal for managing aquaculture.

Good practices for zoning aquaculture include:

- Establish ranges of scale and intensity that encourage efficient production, rather than focusing entirely on maximizing production volume
- Consider the limitations of natural resources such as water and land, and work to ensure ecosystem resilience and health
- Address competing needs for resources by other user groups
- Ensure the best use of particular land types or resources by competing user groups
- Consider issues of density or cumulative numbers that could have environmental impacts (total allowable limits for nitrogen levels from farm effluents for a particular body of water) or could impact other farms. (if one farm impairs the water quality of another further downstream)

Zoning procedures must also include the opportunity, at all stages in the zoning process, for public review and comment.

## SITING AND CONSTRUCTION CRITERIA

Siting aquaculture operations in an appropriate manner is one of the best ways to ensure efficient farm operations, minimize environmental impacts, and reduce threats to biodiversity. Some aspects of siting depend upon the social and economic context of the operation. Zoning and siting criteria go hand-in-hand. The criteria to select appropriate sites vary according to the type of aquaculture that will be implemented. It is advisable to thoroughly review the various types of aquaculture that may be proposed in an area and to work with groups of specialists, industry members, and natural resource managers to develop a set of siting criteria for each type of aquaculture.



Credit: University of Texas

Large, multiple earthen pond systems have the highest potential to result in large-scale alteration of habitat. Farm operations are also affected by site selection. For example, ponds such as the one above, that were built in mangrove areas before the industry became aware of the inadvisability of building in mangrove soils, are difficult to drain or to manage water quality. Development of good siting criteria for the specific type of aquaculture can help avoid these problems. Most shrimp ponds in Honduras (left) are located inland of the mangrove area, leaving the mangroves largely intact and making the ponds easier to operate and to control water quality.

Most mistakes made in developing aquaculture projects occur during siting or building earthen ponds. This activity generally requires large-scale alteration of the landscape and the ability to manage the pond as a “mini-ecosystem” during the production cycle. Many factors must be considered to ensure that the pond functions well, including soil type, grade and elevation, distance from water sources, type of water source, and other physical factors. The farmer must be able to drain the pond completely for harvesting and disinfecting. Thus knowledgeable engineers or surveyors must train those building the ponds and then continue to offer technical assistance.

Open water or reservoir (e.g., cage culture) aquaculture projects will be affected by water level, wind force, and wave energy. It is also necessary to consider the presence of wildlife, migratory waterfowl, nearby communities, and other user activities.

Siting considerations might include:

- What natural hazards should be considered—e.g., climatic events such as storm surges, waves or sea-level rise?
- Is the location secure from theft? Without security, fish may be stolen just before the planned harvest
- What type of habitat at the site? Is it wetland, and will construction obstruct wildlife migratory routes?
- What will be the effects of allocating public resources (e.g., land or water space) to private use?

Construction and operational practices must also be considered. At least some components of most operations—particularly those relying on earthen ponds—will involve the clearing and moving of earth. Measures must be taken to avoid erosion, stormwater run-off, and destruction of valuable habitats. Unwanted materials and fill must be properly disposed of. Precautions must be taken to guard against oil and fuel spills. Also, access to the construction site must be considered (i.e., should roads be constructed?).

In some cases, mitigation for damage or loss of habitat may be required. For example, it is now a common practice to prohibit the building of ponds in wetlands or mangroves. However, some minimum clearing may be allowed for canals or drainage areas required for the farm, but this should not present threats to local habitats. Aquaculture operators may have to restore mangroves or wetlands in adjacent or nearby areas. Decisions on these issues should be made in a case-by-case basis, as not all wetland areas are equivalent in their ecological value.

## **CODES OF CONDUCT AND BEST MANAGEMENT PRACTICES**

Just as in fisheries, codes of conduct and best management practices (BMPs) can play an important role in the sustainability of the aquaculture industry. BMPs provide detailed guidance on the siting, construction, operation, and processing of aquaculture operations. Codes of conduct tend to be general, while best (or good) management practices are more specific and are crafted to cover the specific needs of each type of aquaculture. Codes of conduct are expressions of policy or philosophical approaches to aquaculture. In some cases, codes may be used temporarily in place of national policies, or they may be converted into policy. When referring to management practices, some practitioners prefer the term “good” to “best” as this reflects the fact that technology and science offer continual improvements to the state-of-the-art.

The degree of specificity can vary considerably for BMPs. In general, BMPs offer guidance and an attempt to establish ranges or standards for certain parameters. It is important to maintain flexibility to allow for judgment calls and changing circumstances. For example, a BMP might recommend a range for acceptable values for nutrient loading in effluent. It would be unlikely however, to set this as a standard since water quality varies between sites and no one nutrient load will fit all situations.

Both codes of conduct and BMPs should be developed through dialogue between stakeholders. It is important that stakeholders come to a consensus, or producers may pay little attention to the resulting recommendations. BMPs should reflect the best scientific knowledge available, but be realistic in terms of what local farmers can implement. Some BMPs are relatively easy to adopt. For example, a recommendation to “limit the amount of feed to what the fish can eat within ten minutes” is straightforward and simple to follow. Further, it may also provide cost savings to producers. Some BMPs, however, will be difficult to implement because they are costly or because circumstances do not allow existing farms to make changes. For example, settling basins may be recommended for farms with the space to accommodate them. However, older farmers may not have the space, and smaller farmers may lack the financial resources needed to build the basins.

Once codes of conduct or BMPs have been developed and consensus has been reached, the codes of conduct or BMPs must be tested by farmers and revised if necessary. At some point, they can be legally adopted into law or approved at the national level.

Training people in the use of codes and BMPs is critically important. Without training, people may lack the skills for effective implementation, making the effort that went into developing them a waste of time. Training personnel at all levels of an operation—from managers to laborers—is important, as each has a direct effect on the way a farm is operated and hence its outcome.



Codes of conduct are generally adopted by associations of producers, although they may also be developed and approved by governments. For shrimp aquaculture, Honduras and Nicaragua have developed some good examples of codes of conduct. In Nicaragua, a group of farmers, scientists, and government representatives developed the “National Code of Conduct for Shrimp Farming.” After an extensive review process and formal adoption by the Association of Nicaraguan Aquaculturists, the Ministry of the Environment and Natural Resources approved the code.

## **RESEARCH AND EXTENSION SERVICES**

Continuing support in the form of research, extension services, and financial support often make the difference between a failed aquaculture project and a successful one. Research and extension are also critical in moving aquaculture towards environmental and social sustainability. A single operational practice can affect production, environmental impacts, and profitability. Hence, efforts to improve practices of all types through continuing engagement have multiple benefits. Small aquaculture producers may also require assistance with environmental sustainability, marketing, export, and sanitation.

Aquaculture research is needed to develop farming practices for new native species, improve production efficiency, assess and correct management practices, and reduce environmental impacts. Bringing a new species into culture and breeding the organism in captivity requires research into the species’ physiology, reproduction and growth cycle, and nutritional needs. Continuing research will also benefit the topics of feed formulation, product development, equipment design, soil science, hydrology, and water quality. Once a species is under cultivation on farms, research must continue to assess progress and make improvements. In most cases, the research role will fall to university and government scientists. For over 20 years, USAID has also played a key role in guiding and sponsoring aquaculture research through its Collaborative Research Support Program (CRSP), the World Fish Center, and other organizations. USAID support to aquaculture has included the development of partnerships between U.S. and foreign universities to deliver training programs, fund graduate students, and link extension and research.

Extension is the process of promoting the transfer of technology and providing support for its implementation and improvement. Extension is an institutionalized means of supporting aquaculture by providing new information and methods, and linking farmers with researchers. This work is usually performed by extension agents based at universities or government agencies. In the case of the U.S. Land Grant or Sea Grant agencies, individuals may play both a research and extension role. Extension agents may also assist with non-technical topics such as marketing or financing. Some countries have little or no extension capacity and have great difficulties in reaching large numbers of small-scale farmers. In order for the aquaculture sector to grow and prosper, extension capacity must be expanded. For increased sustainability, extension services should be tied to the private sector.

## **CERTIFICATION, ECO-LABELING & TRADE-BASED APPROACHES**

Increasing awareness of the environmental and economic consequences of overfishing and unsustainable aquaculture has led to a growing interest in certified seafood products, whether produced by aquaculture or capture fisheries. Certification of aquaculture products initially focused on farm-raised shrimp, although this is rapidly expanding to include a wide range of species. As with fisheries, certification in aquaculture encompasses a suite of steps including standard setting, accreditation, and compliance with established standards. The certification process is often tied closely to production and to post-harvest issues, but ideally will encompass the entire production chain, taking social, environmental, and economic issues into consideration. One reason why certification for aquaculture has not become more widespread is the somewhat greater cost of certified products over un-certified products. The primary motivation for producers to gain certification is the forecast that it will eventually be necessary in order to remain competitive with large-scale marketers such as WalMart, which has stated they will buy only from certified sources in the future. One challenge in the process of receiving accreditation is reaching

consensus among the stakeholders on which a neutral, technically qualified party will serve as the accrediting body. An additional consideration is whether certification standards should correspond to a given country's internal regulations, particularly in the case of worker rights and safety.

Many shrimp producers and processors have adopted Hazard Analysis and Critical Control Point (HACCP) or ISO 9000/14000 standards and feel this encompasses most of the certification needs for protecting human health and worker safety. Currently, the Aquaculture Certification Council (ACC) is the leading third-party certifier for shrimp aquaculture. The ACC uses criteria, covering basic environmental and labor standards) that were negotiated between industry representatives and NGOs. The ACC is considered controversial by some, as it is an industry-led initiative. Most certified operations are integrated shrimp farms and processing plants.

It is useful to note that the U.S. is the third largest seafood importer in the world, trailing only the European Union and Japan, each of which have very different standards and certifying procedures. Importing countries have been known to ban aquaculture imports from sources where contaminants have been found in products or where there are concerns over food safety. Thus, aquaculture practitioners in exporting nations must be familiar with the variety standards and requirements of different buyer countries around the world.

Developing countries often see importation measures as obstacles to trade. There are two trade-based practices at the foundation of this concern. The first is the U.S. Food and Drug Administration (FDA) approach to addressing food safety — regularly inspecting and testing imported seafood for the presence of human pathogens such as salmonella and E. coli, or the presence of toxic and cancer-causing chemicals used in processing. Shipments where salmonella is detected are returned to the shipper. Repeated failures to pass inspection may place the offending processor on the “blacklist,” which bans further imports. The second practice that concerns exporters is the US Department of Agriculture (USDA) requirement for country-of-origin labeling (COOL). This is intended to provide consumers with information on a variety of agricultural products including farmed and wild caught seafood. Consumers may use this information to choose whether to purchase from local or imported sources, or to distinguish between products from countries which may be associated with various environmental, legal, labor, or other such consumer concerns.

## **SOURCES FOR MORE INFORMATION**

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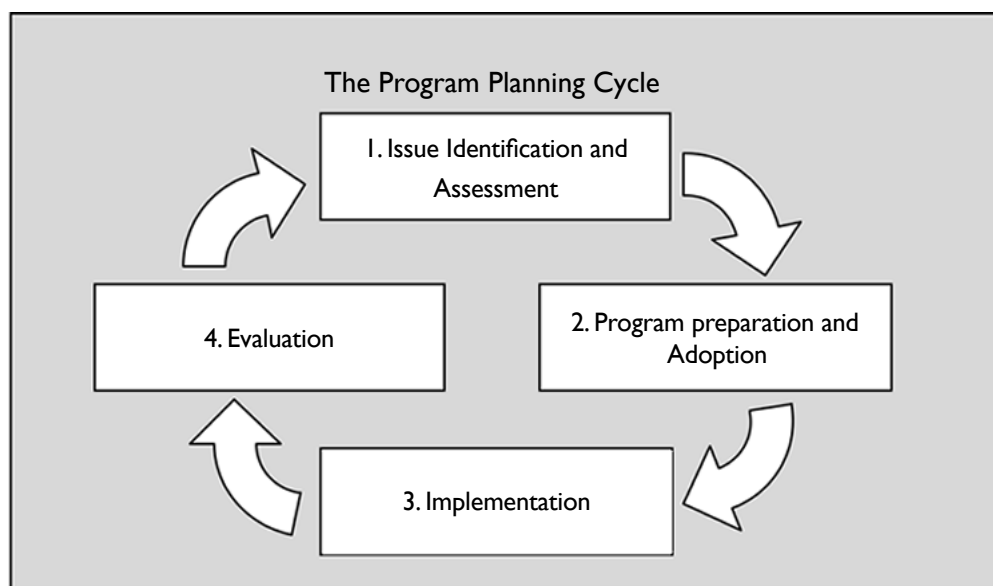
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# 11.0 AQUACULTURE PLANNING

As mentioned in Section 8.0 (Fisheries Planning) of this guide, the project planning and implementation cycle for fisheries and aquaculture is similar to that of other sectors, as shown in the figure below. This section illustrates the steps in the planning cycle as they apply to sustainable aquaculture development.



## ISSUE IDENTIFICATION AND ASSESSMENT

### Understanding the Local Context

In aquaculture development an understanding of the local context is essential and must be in place from the beginning of the program design process. Local context can be gathered through an assessment of the current status and trends in the aquaculture sector, including the governance structure, the management rules in place, and the types of aquaculture systems involved. The assessment must include an investigation of the status and trends in the ecosystem, its natural functions, its use by the community, and its ability to withstand potential threats. It must also review the social and cultural characteristics of a location, as well as the needs and constraints of the stakeholders involved. It is equally important to understand how readily stakeholders will accept the aquaculture methods. Societies that have traditionally practiced aquaculture or agriculture are more likely to accept aquaculture than are societies comprised largely of fishers or gatherers.

Key issues and the strategies to address them will differ across communities, regions, or countries. Hence, the program design must be tailored to these differing priorities and contexts. Some issues can be addressed quickly, while others may require a longer time frame to solve. In either case, it is necessary to consider the issues within the broader framework of overall aquaculture planning in order to minimize or avoid unexpected consequences resulting from program decisions.

An aquaculture system can be examined from many angles. These include culture, scale, importance to food and income, policy, legal and institutional framework, capacity, environment, and willingness to manage fisheries. Understanding the present situation from all these perspectives is necessary in order to plan for more sustainable aquaculture development activities in the future.

Aquaculture must also be considered in the broader development context. For instance, as the human population grows, there is increased competition for inputs such as water, fuel, and grain sources. The rising price of fuel is also a concern as the cost of fuel may comprise up to 30 percent of total production costs for most intensive and semi-intensive aquaculture operations. Fuel prices also affect the price of many other inputs, such as feeds. In the best of times, most aquaculture operations—even the largest and most successful—operate on slim profit margins. Thus, increasing fuel prices greatly affect aquaculture production, with small producers hurt the most.

Following are some general trends in aquaculture that should be considered in program decision-making.

**Water scarcity and water quality.** Aquaculture depends on water and is increasingly threatened by diminishing water supplies. As freshwater flow is reduced, the salinity in estuarine areas increases. This can, in turn, increase the risk of disease outbreaks. A current trend in aquaculture is to re-use water (recirculation), use water for secondary purposes (aquaponics, irrigation), or to completely avoid routine water changes (zero-exchange). Such practices help conserve water, reduce pumping costs, and may produce secondary products such as plant crops. Water quality is also important in maintaining good aquaculture production—aquaculture can be a victim of pollution from urban and industrial sources, or even neighboring aquaculture farms. Coastal aquaculture is particularly vulnerable, as it is located in the lower watershed, and thus may suffer from the accumulated impacts of pollution and sedimentation from up-stream sources. Likewise, aquaculture poses threats to other downstream water uses. Internalizing these outside impacts will reduce water pollution and other environmental impacts.

**New culture systems.** Although most aquaculture is still conducted in earthen ponds, new culture systems are becoming widespread. Intensive and/or recirculation systems are more common and in some cases are necessary to conserve water. These systems increase the efficiency of aquaculture and allow aquaculture to be conducted in areas where water and/or land are scarce. This will be increasingly important in the future.

**Opening of markets.** The tremendous growth in aquaculture is partially spurred by the combination of a growing world population and an increasing need for high-quality protein. As globalization opens new markets, new opportunities for international trade in all aquaculture products become available. North-South trade is likely to continue to expand as temperate areas show increasing demand for tropical aquaculture products. Globalization has also helped improve aquaculture technology in developing nations as a result of improved access to information, products, and support services. Growing international trade in aquaculture products has also spurred efforts to develop international or regional standards and certifications to help protect the environment and human health and welfare. However, the costs of complying with such standards and undergoing a certification process can be challenging, if not impossible, for small producers. Unless they are provided with both technical and financial support to enable them to meet standards and participate in the global marketplace, small producers may be driven out of business. Thus, as the global aquaculture trade continues to grow, it is critical to consider issues of equity, the use of local resources, and the need to retain economic value in the local economy. Special assistance may be needed if small-scale producers are to participate in the global trade in aquaculture products.

**Growth of employment and political power.** As the aquaculture industry grows, so does the number of fish farmers. In 2004, an estimated one-fourth of fish workers were fish farmers vs. fishers. While this growing sector provides important economic benefits, greater attention must also be given to

other needs of aquaculture farmers and workers, including health, occupational safety, labor laws, etc. As the aquaculture sector grows in size and importance, its political power can also be expected to expand. The sector can promote its interests and build relationships by participating in regional development efforts.

**Uneven growth of aquaculture across regions.** The Food and Agriculture Organization (FAO) cites the disparity of aquaculture development between regions as a key issue. The highly food-insecure African nations are particularly underdeveloped with respect to aquaculture. Only 0.36 percent of world aquaculture production comes from sub-Saharan Africa and only 1.19 percent from Northern Africa and the Middle East. This is particularly ironic given that some of the world's most heavily utilized aquaculture species, the tilapias, have their origin in Africa. Latin America is also relatively underdeveloped in terms of aquaculture, with the exception of shrimp culture. Meanwhile, both continents have tremendous potential and an acute need for aquaculture. The wide range of species, habitats, and natural resources available in these areas to support aquaculture are under-utilized. Development of sustainable aquaculture of all types on these continents should be prioritized as a means to assist with food security, export earnings, and income generation.

**An increased number of new species being cultured.** As aquaculture science and technology develops, new species are continually being brought into production. Much of this progress is due to the improved ability to breed fish, particularly marine fish, in captivity and on a large enough scale to form the basis for significant industries. Advances are also being made in “domesticating” certain species, generally through selective breeding and improved culture methods. This is moving aquaculture away from the use of what are essentially wild animals to domesticated animals, similar to what humans did with other livestock thousands of years ago. The result is an aquaculture industry that is more efficient, profitable, and accessible to groups with less technical capability.

**Increased farming of non-food products.** Aquatic plants and animals are increasingly used to produce non-food products for the global marketplace. These include human and animal food additives, pharmaceuticals, nutraceuticals (foods that provide health or nutritional benefits), pearls, shells, and ornamental organisms. Aquatic plants, including macroalgae (seaweed) and microalgae (microscopic forms of algae), are particularly important as non-food substances to be used as food additives (e.g., carrageenan, a thickening agent). Thousands of poor coastal villagers in countries such as the Philippines, Indonesia, Kiribati, and Tanzania grow and sell seaweed used in food processing. Some microalgae can also be used in producing biofuels—e.g., a farm in Texas is growing microalgae in earthen ponds to produce 5,000-8,000 gallons of oil that can be used for fuel.

### Considering the Appropriate Scale of Operations

Traditionally, small-scale aquaculture farms have been regarded as one development option for addressing food insecurity. The USAID Collaborative Research and Support Program (CRSP) provide good examples of how small-scale aquaculture offers multiple benefits to the poor — an important goal in areas such as Sub-Saharan Africa. A key question to consider is “at what scale of operation is it most economically viable?” In some cases, medium-scale farms or even a few large-scale farms will achieve an economy of scale that benefits the entire sector and also allows for structural improvements such as processing plants, roads, etc. However, large-scale operations can pose greater environmental threats to ecosystem resilience and health. Strategically planned development can also allow small-scale producers to benefit from rather than be marginalized by improvements.

While USAID programs generally emphasize small-scale aquaculture, the precise dimensions of “small-scale” vary greatly in terms of space utilized, projected production, and intensity. Initial efforts should focus on pilot-scale operations. The main objective should be to consider options that both benefit the greatest number of people and are economically viable and environmentally sustainable. Expansion is

warranted only if and when these first operations prove successful. An equally important consideration is the number of farms that may be developed in a particular place — limited technical assistance and funding are reasons to justify initially limiting the size and number of farms. Other factors to consider when making decisions about the scale and number of farms are: 1) the carrying capacity of the habitats in which the farms are established, and 2) the relationship between the farms and other economic activities in the area. Other questions to ask include: “Does expansion from a small- to medium-scale aquaculture farm provide sufficient added income to its operation to be worthwhile to a family?” and “Does the development of national aquaculture industries take advantage of key opportunities?” Small-scale farmers will not find it easy to graduate to larger-scale farms without proper institutional and financial support.

## **Involving Stakeholders**

Aquaculture development should take into consideration the targeted stakeholder group(s) and their specific needs, abilities, and resources. The more specific the characterization, the better. This includes ensuring that men, women, and other disenfranchised groups with a stake in the project have a voice. Matching the needs and desires of the stakeholder with the most suitable form of aquaculture increases the chances of the program reaching the desired outcomes. There are a wide variety of tools available for stakeholder mapping and needs assessments. These processes must be transparent and have a high degree of stakeholder participation in order to obtain useful results that can guide planning efforts. Equally important is the need for public support and buy-in. It is also useful to review actual successful case studies of different forms of aquaculture. Lessons learned, failures, and successes from these case studies can aid development of new projects.

## **Conducting Environmental Assessments**

Initial Environmental Examinations (IEE) must be performed for all USAID activities. Environmental Assessments (EA) may be conducted at the level of individual operations or entire industries, although it is not really appropriate or practical for EAs to be carried out for large numbers of small-scale farms. In this case, it may be useful to consider options such as an EA for a large geographic area where a number of aquaculture developments are planned; a strategic EA that would incorporate environmental considerations into policies, plans and programs; or a sector EA that would assess environmental considerations for the entire aquaculture sector in a country or region. Aquaculture program designs are subject to the same environmental reviews as other USAID-supported development initiatives. This includes reviewing such environmental parameters as habitat alteration, water quality, and pollution, among others. The type and severity of impacts will vary by the type and scale of aquaculture development activities proposed. The siting and construction of an aquaculture facility are generally the primary focus in an environmental assessment, but a wide range of other parameters should also be considered, including the selection of species and the intended operational practices.

Sustainable aquaculture must use farming methods that minimize impacts on the environment, including:

- Does not negatively impact critical habitats
- Uses appropriate species
- Does not use unapproved chemicals and drugs
- Carefully manages use of approved chemicals and drugs, and reduces or eliminates their use
- Avoids destructive practices
- Limits and properly manages effluents and other pollutants
- Maintains or improves water quality
- Uses natural resources appropriately and efficiently
- Engages in waste reduction and management

- Optimizes production (vs. increasing production or expansion)
- Are compatible with other coastal activities

### **Preparing Feasibility Studies**

Feasibility studies may be executed for individual or multiple operations. Feasibility studies quantitatively assess the technical and economic aspects of an operation, generally in reference to the operation's ability to make a profit by producing a given product. The study assesses opportunity costs, i.e., are there more profitable options for investment of available resources? Many feasibility studies cover only the operational aspects of aquaculture operations and neglect other important factors of success such as financial, marketing, and socioeconomic factors. A good feasibility study also considers whether the physical resources and skills are available to ensure the farm has a reasonable probability of success. For example, is the water supply sufficient, regular, and of the correct salinity and temperature? Will unskilled and skilled labor be available to support all phases of the operation?

### **Analyzing the Policy and Legal Frameworks**

Few countries have adequate national policies for aquaculture. Thus, a recommended first step in creating an aquaculture program is to develop appropriate national and local-level policy frameworks. Such frameworks should consider the economic, social, technical, environmental, and inter-sectoral issues (trade, transportation, health, etc.) associated with aquaculture. Success depends on creating an enabling environment, appropriate policy framework, improved governance and regulations, and incentives to increase voluntary forms of compliance. Since aquaculture straddles the land-water interface in many cases, it is common to find there are overlaps or gaps in institutional jurisdictions.

### **Characterizing the Value Chain**

Value-chain analysis characterizes the added value (and associated costs) that accrues to a basic commodity at each step in a chain of production activities, including the supply and distribution networks. The analysis also assesses the roles of the various stakeholders and organizations involved in the activities. Information from the analysis is used to plan a production strategy that will derive maximum benefits while at the same time reducing costs. It also identifies how and when various stakeholders can engage to best benefit themselves and the nascent industry. For established aquaculture industries, value-chain analysis can help identify new opportunities—e.g., an aquaculture producer may increase his income by undertaking simple value-added activities such as smoking the fish or entering different markets. Value-adding processes take place after the product has been harvested. Since women play a key role in post-harvest processes, they are a prime target audience for training and capacity building.

## **PLANNING AND PROGRAM DESIGN**

To increase the chance of success in aquaculture programs, the following actions should be taken during program planning and design:

- Conduct a careful assessment to identify opportunities
- Consider catalyzing national or regional industries, including service and supply sectors, while acknowledging potential cumulative impacts from scaling-up
- Identify and undertake activities that can show quick benefits and results
- Focus on proven species with regional or global potential including, where possible, native species
- Emphasize low-input, low-technology requirements that utilize existing resources
- Pay attention to enabling conditions and policies that guide responsible aquaculture development



- Minimize environmental impacts through proper assessment and a thorough understanding of ecosystem functions
- Set benchmarks to monitor environmental impacts and identify triggers to adjust environmental practices as needed

### Setting Goals

When planning aquaculture activities, it is critical to establish clear goals, benchmarks, and schedules to guide the development process. In the case of new aquaculture activities, it is necessary to:

- Identify targeted beneficiaries
- Set production targets
- Settle on the scale and number of farms
- Identify the target markets
- Establish institutional support mechanisms
- Define clear action plans

With both new and already established aquaculture initiatives, the goal(s) should define the key issues to address, the precise reforms needed, and the mechanisms to address these. A proven approach to accomplish this is to partner with a multi-sectoral working group that includes industry and scientific representation.

In order for an aquaculture project to achieve its long-term goals, objectives for increased employment, food production, economic efficiency, poverty reduction, biodiversity conservation, and ecosystem resilience should be set. These objectives are not always fully compatible and a single form of aquaculture may not address all needs. As such, it is necessary to make explicit decisions about trade-offs and priorities. Clear objectives must be in place before selecting the form, scale, and intensity of the chosen form of aquaculture development.

### Integrating Aquaculture into Broader Planning Efforts

A lack of regional planning, or planning that fails to consider the needs of the aquaculture industry, creates impediments for the sector. Likewise, aquaculture planning must integrate other resource uses and the maintenance of ecosystem goods and services.



Pearls can provide high value-added returns, but require careful value chain analysis as niche marketing and branding based on location of production can be key value-added factors.

Credit: George Stephens



Goal setting should also include consideration of gender dimensions. In Tanzania, women are the main contract growers of seaweed and have benefited economically. However, as producers, they are poorly organized, lack capital to establish independent farms, and have little bargaining power over prices dictated by buyers.

Credit: URI Coastal Resources Center

Too often, planning and assessment efforts focus on single farm operations. This limits the extent to which aquaculture can provide benefits to the country as a whole, and may ultimately doom individual operations. Small-scale farms often struggle to survive when the infrastructure and services that might have been available to a larger industry do not exist. Opportunity costs for very small farms may also be high. For example, having a few small-scale tilapia farms may benefit individual families; however, where there are a larger number of farms, building processing plant might be justified. A processing plant might, in turn, lead to an increase in the number of small farms and their expansion into larger, commercial operations. This could prompt the formation of a regional industry, which could potentially change the economic landscape of a region.

Increasingly, aquaculture is considered within the context of integrated coastal management (ICM). The goal of ICM is to guide development of multiple sectors in an ecologically, economically, and socially sustainable manner. The ICM approach allows for vertical and horizontal integration. This is a necessity for aquaculture, which must consider both land and water uses, and address conflicts and compatibility with other economic activities — all within the larger socioeconomic context. Unfortunately, ICM programs are not common in the developing world, and aquaculture programs in these countries must seek out the expertise they need. In all cases, planning for aquaculture should be integrated with other planning efforts, while at the same time recognizing institutional constraints that may exist.

### **Strengthening Enabling Conditions**

Weak governance can impede aquaculture development. It can also lead to rampant, uncontrolled development of the least sustainable forms of aquaculture. Therefore, it is necessary to carefully assess, and where possible improve, the enabling conditions for sound aquaculture governance. This includes evaluating the policies, laws, regulations, and institutions that are necessary to ensure effective governance and sustainable management of the industry. It is equally important to improve the business environment, including those industries, services, and infrastructures that support aquaculture development.

**Policy.** Few nations possess aquaculture-specific policies. At best, aquaculture is mentioned within fisheries or agriculture policies that generally and broadly encourage the activity. Given that aquaculture does not fit neatly within one sectoral purview, it may be necessary to develop national and local policies that specifically target aquaculture and its associated activities. Ideally, policy should address the goals of aquaculture, specify its intended benefits, clarify institutional and sectoral responsibilities, and identify mechanisms for coordination. Policy may also be used to establish priorities for aquaculture development, such as favoring the culture of native species or providing financial incentives.

**Laws.** Laws regulating aquaculture are commonly inadequate, non-existent, or so burdensome they make aquaculture development impossible. In light of this reality, a first step is to conduct a good review of the laws that do exist, followed by efforts to fill the gaps, harmonize existing regulations, and establish new regulations. New regulations should focus on maintaining ecosystem health and resiliency. Generally, laws cover multiple sectors ranging from environment to trade. However, some specificity is needed in regulatory reform to cover the many types of aquaculture that may exist. It is often necessary to streamline and clarify the permitting and licensing regulations in order to encourage a well-planned and sustainably managed aquaculture industry.

**Civil society and industry associations.** Members of the aquaculture industry and the general public can play an important role in aquaculture development and management. User associations and other types of civil society organizations can help organize the technical, political, and social strengths of its members. They can also help in self-governance of the sector. Associations may also be useful in organizing financing, conducting joint marketing, or organizing purchasing in bulk at lower prices. Where possible, formation of associations should be encouraged and supported. The involvement of government,

donors, and nongovernmental organizations can also strengthen association activities.

User groups often play a leading role in developing and adopting forms of voluntary management such as codes of conduct or best management practices (BMPs), with government then following suit. Members of user groups may have extensive technical knowledge and experience that favors the use of BMPs. This is important because a regulatory approach to monitoring aquaculture practices is difficult at best. For example, a farm manager who is both an expert in determining optimum feeding rates and motivated by financial factors to reduce the feed used at his facility is more likely to efficiently utilize this input voluntarily. In contrast, regulatory attempts to control feeding rates would be both counter-productive and virtually impossible to enforce.

Associations often assume the roles of other members of civil society as well. This includes promoting conservation and poverty alleviation, building health clinics, and engaging in other philanthropic activities that may benefit the organization.

**Capacity building.** Strengthening governance requires building capacity at all levels — capacity in the technical know-how of aquaculture as well as the capacity to address the industry's governance/legal issues. USAID missions can play a key role in such capacity building.

## Selecting Appropriate Species and Culture Systems

Selecting appropriate species and culture systems is fundamental to successful aquaculture development. As a general principle, species that possess the following characteristics are preferred:

- Native species
- Species that require little or minimal feeding during all or part of their life cycles (e.g., seaweed, filter-feeding bi-valves, extensively farmed shrimp)
- Species that can utilize feeds with lower protein contents or feeds that use local components
- Species proven to be easily cultured in tested systems that are low-cost, low-technology and within the technical capacity of local stakeholders
- Species with potential to be scaled-up to mid- size family farms or national industries
- Species for which larvae and juveniles are available in the wild without damaging local fisheries
- Species that can be cheaply and easily produced in local hatcheries
- Species that have a demonstrated market, are locally accepted, and are in demand as a food source

Aquaculture is diverse in terms of the number of species, types of culture systems, levels of intensity, and use of technologies. The descriptions below provide a broad overview of key terms and concepts needed for a basic understanding of aquaculture. References at the end of the chapter provide additional information.

### THE ROLE OF INDUSTRY ASSOCIATIONS

Industry associations can play a lead role in reforming a sector. The National Aquaculture Association of Honduras (ANDAH) and the National Aquaculture Association of Nicaragua (ANDA) worked closely with university specialists, local government agencies, and international groups to develop national codes of practice, adopt best management practices, form environmental protection committees, and begin certification processes. Additionally, both associations have played key roles in civil society activities such as philanthropic support to community bakeries, mangrove replanting, protecting sea turtle nurseries, and promoting environmental education. Both were among the first responders to the national crises presented by Hurricane Mitch when it devastated Central America in 1998. Industry can play a beneficial role when brought into the dialogue and planning process.



## Major Aquaculture Species Groups

The species groups or species listed below comprised the bulk of world aquaculture production volume between 2004 and 2006. The list also includes other important but less productive species. The list is not inclusive, and the reader is referred to the FAO Aquaculture and Fisheries site (<http://www.fao.org/fishery/>), for more detailed descriptions of species groups and their importance and limitations in aquaculture.

### Fish

**Carp.** Chinese and Indian species of carp are the most common food fish species cultured globally. In the period 2004 to 2006, they accounted for over 40 percent of world aquaculture by volume. The main species of carp—silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idellus*), and common carp (*Cyprinus carpio*)—are widely cultured globally and feed some of the world's poorest populations. Carp lend themselves to polyculture with other carp species and other fish. Since they are generally herbivorous or omnivorous, they can take advantage of the natural food sources occurring in ponds. Despite their ideal biological and culture traits, carp culture may be limited by a lack of acceptance as a food fish in some parts of the world. In general, carp do not spawn naturally in ponds and thus require low-technology artificial production.

**Tilapias (Cichlid family).** Cichlids are perch-like tropical and semi-tropical fish widely distributed throughout the world. Due to evolutionary divergence, thousands of species have evolved, some with highly specialized and useful traits. Tilapias are freshwater cichlids that are native throughout Africa. Various tilapias are among the most successful aquaculture species. The most common species used for culture are *Oreochromis niloticus* (Nile tilapia), *O. aurea* (Blue tilapia), *O. mossambicus* (Mossambique tilapia) and *O. hornorum* (Redeyed tilapia). Hybrid forms also exist, being bred for traits such as improved color and growth. Tilapias usually require temperatures over 80° F (27° C) to thrive. They have good culture characteristics including rapid growth, good flesh quality, rapid reproduction, and the ability to consume plant materials and utilize natural pond production as a food source. Culture is usually in earthen ponds or tanks. Some species can survive in brackish water, so are increasingly being grown in coastal areas, sometimes in polyculture with shrimp. Tilapias are usually the top candidate for small-scale fish culture due to its low technology requirements and high-level acceptance as food fish. Extreme caution should be exercised with introducing tilapias to watersheds where it is not already present, as its habit of prolific breeding could allow it to become a nuisance species. Ironically, tilapia culture in Africa is behind that in other parts of the world due to structural and economic issues, which in general impede aquaculture development in Sub-Saharan Africa.



A male Tilapia (*Oreochromis niloticus*). Tilapias are the backbone of world fish culture, now grown on every continent, and their production feeds millions of people.

Credit: CRSP

**Other freshwater fishes.** A wide range of freshwater fishes, other from tilapias and carps, are grown throughout the world. These include catfishes, perch, pike, trout, barramundi, gouramis, sturgeon, paddlefish, and many others. Aside from food fish, culture of ornamental and baitfish is also an important

economic contributor in many areas. Freshwater fishes are perhaps among the most vulnerable to environmental changes that affect water quality, volume, or regularity of supply. A notable contribution of USAID to aquaculture has been the development of new species of freshwater fishes such as “Chame” in the Americas through long-term support to the Aquaculture and Fisheries Collaborative Research and Support Program. New freshwater species offer appropriate alternatives to the introduction of non-native species such as tilapias and carps.

“Chame” (*Dormitator latifrons*) is a hardy species and easy to breed. It is well liked in some areas. In other areas it is considered an emergency food for the poor. Under-utilized native species with desirable characteristics abound, and can be developed for aquaculture, thus eventually offering alternatives to introduction of non-native species.

**Salmonids (salmon and trout).** Salmon and trout have a long history of aquaculture production. Most salmon aquaculture takes place in hatcheries, which produce juveniles from wild-caught fish that are then returned to the water to grow out naturally in the wild. Many wild salmon fisheries and programs designed to preserve endangered or threatened salmon stocks depend on hatchery production for survival. Salmon is cultured through the adult stage in Norway, Scotland, Chile, British Columbia, and some parts of the U.S. Farmed salmon provided 65 percent of the world supply in 2004, up from two percent in 1980. Expansion of salmon farming has been driven largely by increased consumer demand and because farmed salmon is available year round as opposed to the wild, seasonal fishery. Salmon culture is generally conducted in floating net pens or cages in calm water areas. Possible impacts include water pollution and escape of cultured stock.

Trout have been cultured around the world in temperate areas for many years and provide income through farming and sports fisheries. Trout thrive in cold, rapidly flowing water and are only an appropriate choice for aquaculture when water sources of this type exist. Trout are carnivorous and should not be introduced into pristine areas where the possibility of establishing wild populations exists. Under appropriate conditions, they can be a valuable species to consider.

**Other marine fish.** There are dozens of species of marine finfish that are established culture species and many more are being developed. In part, this rapid development is driven by the decline in wild fisheries and recognition of the need to conserve wild stocks. The most common species groups under aquaculture production are groupers, snappers, and sea bass, with most culture taking place in Asia. Pelagic aquaculture species include cobia, and bluefin and yellowtail tuna—although these forms are newer and less well-developed. Rabbitfish, milkfish, mullet, eel, and dozens of other species are also widely cultured. Marine finfish culture is projected to grow rapidly in the near future. Most culture is done in cages, pens, and nets in nearshore or offshore settings.



USAID and the AquaFish CRSP have supported development of native species throughout the world, such as research on Chame in Ecuador, a native fish popular in Latin America.

Credit: Ulises Hernandez

Aquaculture of grouper species is a rapidly growing area of marine fish culture. This is particularly the case in Asia, although other regions are also rapidly adopting the practice. Grouper aquaculture is moving towards better practices now that fingerlings can be produced in hatcheries. New feeds are being developed and improved practices are being established. Despite the work being done, many practitioners still employ questionable practices, which exemplify the concerns about marine finfish culture in

general. These practices include the use of net pens at high density in calm bay areas, which can lead to sedimentation below the cages and possible eutrophication of the surrounding waters. Other questionable practices include the use of live or whole “trash” fish as feed, and the use of antibiotics and other drugs to combat diseases in part provoked by poor water quality and high fish densities. With some refinement in aquaculture practices, grouper culture could also become an acceptable aquaculture practice.

## **Mollusks**

**Gastropods (snails).** Gastropods are snails and are generally more difficult to culture than their cousins, the bivalves. The most commonly cultured gastropod is the abalone, for which there is a high-value global industry. The recent development of more reliable reproductive and feeding methods should lead to an expansion in the culture of abalones and other snails.

**Bivalves (oysters, clams, cockles, scallops).** Bivalves are mollusks with two shells that generally feed themselves by filtering water and extracting algae. As such, they do not require artificial feed and have the advantage of generally being sedentary, thus eliminating the need for cages. Bivalves also perform a valuable ecosystem function by helping maintain good water quality. While most bivalve culture is done in shallow, inter-tidal or nearshore areas, some species such as mussels and scallops are grown farther offshore. Seed for bivalve culture is obtained from hatcheries or by capturing wild spat. Few environmental impacts are associated with bivalve culture.

## **Crustaceans**

**Shrimp and prawns.** The term “shrimp” usually refers to marine species while “prawn” refers to certain larger marine species and freshwater species. Shrimp and prawn culture produce some of the highest value products in aquaculture. Currently, culture of the penaeid species, principally *Penaeus monodon* or the tiger shrimp, is the most rapidly growing. White shrimp (*Litopenaeus vannamei*) and brown shrimp (*Penaeus setiferus*) are the principal shrimp species cultured in the Americas. *L. vannamei* is now widely cultured in Asia as its resistance to disease makes its culture more profitable than the traditional *P. monodon*. Shrimp culture has been widely criticized for causing environmental impacts. This is not universally true, however, as many shrimp ponds have been built without cutting mangroves and have successfully operated with few, if any, impacts. Shrimp are also an ideal culture species for other reasons. They have good feed conversion ratios (sometimes less than 1:1), they derive some of their nutrition from natural pond productivity, they grow rapidly, and they have a high market price. Small farmers in many areas can practice shrimp farming profitably. A good source of current information on the global shrimp industry is the Shrimp News International website, found at <http://www.shrimpnews.com/>.

## **Other Invertebrates**

**Sea urchins and echinoderms (sea cucumbers).** This group of invertebrates has demonstrated a boom in aquaculture production, increasing nearly 900 percent between 2002 and 2004. This is due in part to the relatively high value of the species and development of culture methods that make production feasible. Sea cucumber is a widely traded commodity internationally, with Asia as its major market. The high level of demand for sea cucumber, combined with the ease with which it can be harvested — i.e., lying readily available for collection on reef flats — has resulted in its exploitation to the point of near collapse. This is true even in some of the world’s most remote areas, where wild populations of sea cucumber have been much reduced. Culturing of sea cucumbers, however, could relieve pressures on wild stocks, while at the same time meeting continued growing demand for the product.



## Marine Ornamental Species

Although USAID does not generally support the pet trade, marine ornamental culture is rapidly growing and occurs on most tropical coasts. Aquaculture of some species could offer an alternative to the generally uncontrolled wild harvest of these organisms. While there are hundreds of species of marine ornamental organisms that can now be cultured, most are invertebrates. Fish make up over 50 percent of the ornamental trade. However, corals, invertebrates and some plants are also important. Approximately one dozen species of marine fishes are feasible for culture. One of the most popular aquarium fishes, the clownfish, is now routinely cultured. The U.S. imports 50-60 percent of all marine ornamental fish produced by fisheries or aquaculture. The marine ornamental trade is one area in which aquaculture can play an important role in providing substitutions for wild caught organisms while at the same time providing income to poor communities. Although the relationship of the marine ornamental trade to environmental management is complex, substitution of aquaculture products is beginning to emerge as a feasible alternative. Issues of certification and traceability of these aquaculture products will be important for this strategy to succeed.



Credit: Simon Ellis

Culturing of coral fragments in Pohnpei, Federated States of Micronesia, is part of a project designed to offer alternative livelihoods to fishing communities that support nearby marine protected areas that limit fishing. Corals are propagated from bloodstock colonies created and maintained specifically for this purpose. Coral farmers report fishing 16 percent less since farming began.

## Selecting Appropriate Culture Systems and Locations

Culture systems vary widely in their construction, use, environmental impacts, and threat to natural ecosystems. Minimal environmental impacts can be achieved with the use of enclosed, recirculation tanks with adequate filtration and multiple safety systems to reduce the release of diseases and invasive species. The selection of the culture system and its location should take a precautionary approach to protect water resources, especially drinking water, and to conserve ecosystem function. Each situation must be carefully assessed according to the species that will be cultured, the project site, financial resources, and other factors.

A current trend in aquaculture is the rapid growth of recirculation systems. Generally, land-based recirculation tanks with proper filtration systems can minimize environmental impacts. Recirculation systems minimize water usage, and make biosecurity easier since the system can be isolated. Rack culture of filter-feeding animals may also have minimal impacts and may serve to improve water quality. Earthen ponds are considered to be reliable and tested systems. However, they also incur some costs and if poorly sited and constructed can potentially have environmental impacts. Other systems have their own complications and issues, such as inshore cage culture and open-ocean aquaculture that do not control wastes and pollutants. In open-ocean aquaculture, new engineering technologies and new species of marine finfish are under development, but there is considerable controversy surrounding this approach as it does not internalize the environmental impacts associated with production (pollutants, wastes, fish releases). These systems are often used to farm high-trophic level species destined for developed countries and result in a net loss of food production.

**Earthen ponds.** Earthen ponds are still the most common system of aquaculture. Although they are relatively simple to build, great care is needed in selecting the location and in constructing the pond. Poor site selection and construction have led to the failure of many aquaculture endeavors. For example, building a pond that cannot be fully drained can lead to problems with harvesting and disease and can create water quality management problems. When using earthen ponds, soil and water quality management become important. Good guidance for pond construction can be found at: <http://www.aces.edu/dept/fisheries/aquaculture/ponddesign.php>, <http://www.fao.org/docrep/x5744e/x5744e0b.htm#Top%20OfPage>, and in most basic aquaculture manuals.

**Cages.** Cage culture can be a damaging form of aquaculture for several reasons. Excess feed, wastes, and pollutants are released into the environment and can accumulate on the bottom substrate in areas with poor water circulation or if fallowing is not practiced. Cultured organisms can also more easily escape in this form of culture. Due to these factors, cage culture can place greater threats on natural fish stocks and ecosystems than other forms of aquaculture.

Despite these drawbacks, cage culture is commonly practiced in sustainable forms in many parts of the world, most often in reservoirs, lakes, estuaries, and bays. It is also becoming common to use very large cages in offshore, open-ocean sites. This form of aquaculture does not impact drinking water unless very toxic chemicals are used or the area has poor water circulation. Project planners should consider the construction costs and ongoing labor costs of cleaning and maintaining the cages. Cage aquaculture can be technologically complex, as the strength of the cage and its anchoring design require careful consideration. Cage aquaculture should not be sited near coral reefs.

**Reservoirs.** Reservoirs that are used as source water for agriculture may be acceptable sites for aquaculture. However, reservoirs used as source water for drinking water should be avoided, as wastes, antibiotics, and other chemicals used in fish farming will render water unfit for human consumption. Normally, fish fry are stocked in the reservoir and then harvested once grown. This often resembles a natural fishery and requires some of the same management considerations. Unfortunately, this form of aquaculture rarely allows the operator to manage the culture well, which may lead to losses and slower growth rates. For this reason, the use of cages or pens may be a more appropriate alternative.

**Recirculation systems.** Recirculation systems can minimize environmental impacts and water use while internalizing the production costs of aquaculture; their use in developed countries is increasing. Recirculation systems are generally tanks or raceways where water is recycled by a biofilter. Biofilters vary greatly in design but usually contain materials with a large surface area that hosts bacteria capable of removing nitrogenous compounds from the used water, therefore improving the water quality to a level where it can be re-used. In some cases, the biofilter may be artificial wetlands or tanks that contain plants and/or sediments that help remove potentially toxic waste products from the water.



Well-designed earthen ponds located in appropriate areas offer many benefits in addition to hosting aquaculture operations. For example, USDA is promoting pond construction (such as these watershed ponds fed by run-off) for watering livestock, harvesting water, providing feeding sites for migratory waterfowl, recreation, etc. As freshwater becomes increasingly scarce in many areas, ponds offer a means to harvest and store much-needed freshwater.

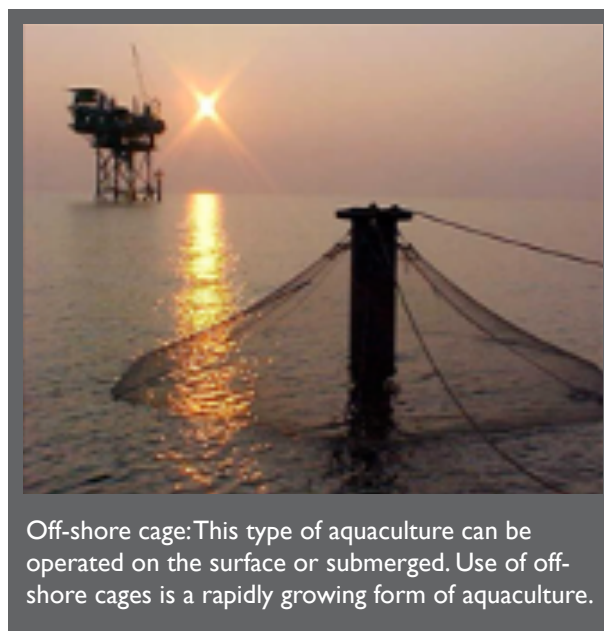
Credit: <http://www.aquanic.org>

Recirculation systems are usually more costly because at some stage water must be pumped, using energy. There are also costs related to building the system structures. However, in areas where water is scarce and/or costly, these systems may help save money and reduce water use and pollution discharge.

**Racks and rafts in the inter-tidal or nearshore zone.** The inter-tidal zone is the coastal area between the highest and lowest tide marks. Such areas are commonly used to grow species that require no additional feeds or inputs such as bivalves or seaweeds. The use of racks, rafts, and lines are commonly used in the inter-tidal zone. Inter-tidal aquaculture is usually practiced close to the operator's home, making it easy to monitor and secure the farm. Care should be taken to ensure that adjacent habitats, such as seagrass beds or coral reefs, are not displaced or damaged by aquaculture activities. Also, it is important to avoid conflicts with other resource users such as reef gleaners or fishers who gain access to the waterfront through these areas. As in all forms of aquaculture, species selection is important and should generally be limited only to native species. The use of non-native seaweed species, for example, has the potential for significant environmental impact. There have been several cases in which outbreaks of invasive aquaculture species have disrupted local ecosystems.

Aquaculture is practiced in shallow nearshore areas in a similar way to the inter-tidal zone, often using cages, racks, and tables that remain partially submerged at low tide. Precautions similar to those taken for inter-tidal areas should apply. Shallow nearshore areas allow aquaculture of many species including giant clams, pearl oysters, corals, shellfish, and seaweed. Some species, such as giant clams and corals, can be grown in coral reef areas if non-coral, sandy areas are used as the rack or line sites. For example, in Micronesia, community members who support MPAs grow giant clams and sponges in these protected areas as a form of alternative livelihood.

**Open-ocean cage culture.** Open-ocean farming generally takes place some distance offshore. Floating cages are used where the waters are sufficiently calm. Submerged, enclosed cages make it possible to conduct culture in deep waters — reducing or eliminating issues associated with strong waves, navigation, and theft. This type of aquaculture is a growing trend in almost all coastal areas and continued rapid growth is expected. However, as with other forms of cage culture, the environmental costs must be carefully assessed. Open-ocean cage culture can have the same types of environmental impact as other forms of aquaculture, including waste accumulation, organism escapes, etc. Rarely do countries have in place the needed policy or regulations to provide oversight over this relatively new form of aquaculture. Because of this, developing countries are sometimes targeted for investments in open-ocean cage culture as investors can take advantage of lax or non-existent environmental regulation.



Credit: <http://www.aquanic.org>

## Other Factors for Aquaculture Management and Development

### Culture Intensity

Culture intensity refers to the stocking density of the aquaculture organism. Culture intensity is also associated with the inputs and level of technology required to maintain this density. Densities will vary

greatly for different species. Stocking or grow-out density is an important consideration because the number and density of organisms will affect many aspects of management, including maintaining dissolved oxygen levels, keeping toxic compounds within tolerable ranges, managing effluent loads, and determining the amount of feed required. Because density can influence profitability, it is important to track profits against production costs to help determine the best level of intensity. However, higher density farms may have greater environmental impacts, including increased discharge of pollutants, increased tendency to use chemicals, and increased risks to ecosystem health. At the same time high density culture, if practiced appropriately, may produce less environmental impacts than extensive aquaculture. For example, there is more efficient use of space.

**Extensive Culture.** Extensive culture refers to culture systems with low organism density. Generally, extensive culture systems require less feed, no artificial aeration, and may produce minimal effluent loads. Often, feeding is not necessary or feeding requirements are lessened as the pond's natural productivity provides for most of the organisms' dietary needs. These systems tend to have the lowest environmental impact.

**Semi-intensive Culture.** Semi-intensive systems refer to facilities with moderate stocking rates. These systems require artificial feeds, attention to water quality parameters, and careful adjustment and control of feeding and fertilization. Effluent loading may be higher than in extensive culture, but measures can be used to control and monitor this in order to avoid impacts.

**Intensive Culture.** Intensive culture occurs when stocking densities are great enough to require high levels of feeding and fertilization. Aeration is usually required and water quality must be carefully controlled and monitored. Intensive forms of aquaculture are still relatively uncommon in developing countries due to their exacting technological requirements. Intensive culture is best avoided unless the practitioners are highly qualified and extreme care is taken with effluent loading.

In most cases, some level of semi-intensive culture will be the most profitable, utilize less space, and not require too high a level of technology. Extensive forms of aquaculture may be perceived as more attractive than intensive forms simply because the former require less technology, skill, and inputs. However, extensive forms may also be less efficient, less profitable, and require more space.

## Financing Aquaculture Development

Securing traditional sources of financing for aquaculture (e.g., banks) is and has always been difficult because aquaculture is perceived as a risky investment. Aquaculture is a new type of business venture to many financial institutions, has a history of failure, and many small operators lack collateral or land tenure. Several actions can help overcome barriers to financing to help small-scale aquaculture ventures.

- Ensure that sound policies and regulations are in place for environmental sustainability and reducing impacts to ecosystems
- Conduct feasibility studies and financial analysis prior to starting the farm
- Gather the necessary information to apply for any financing that is available
- Educate farmers on how to access and manage financing
- Educate lenders on the topic of aquaculture
- Seek out government-sponsored, subsidized, or guaranteed finance programs
- Identify donor programs targeted towards small-scale aquaculture
- Resolve issues surrounding the requirement of collateral — e.g., if most farms are on leased land, promote the use of long-term leases as a form of allowable collateral



- It is important to note that in many if not most developing countries, it is at best difficult and often impossible for women to secure financing and provide the required collateral

## **IMPLEMENTATION**

### **Inter-Sectoral Working Groups**

Industries such as agriculture are generally overseen by a single government agency. In contrast, several government agencies usually share responsibilities for and jurisdiction over aquaculture. The involvement of multiple agencies often leads to overlaps and gaps in authorities, resulting in conflict. For example, it is often the government fisheries agency that holds primary responsibility for aquaculture program development. However, it may be the natural resources or environment ministry that is responsible for environmental compliance, while the trade or business development agency may oversee the commercial aspects of aquaculture. The assigned national body also may be “tunnel-blind.” For example, if a fisheries agency is assigned oversight for aquaculture, it may view the sector solely through the fisheries lens, with little consideration of the environmental or business aspects. The fact that aquaculture initiatives are sometimes catalyzed by NGOs or university researchers creates a further complication.

One way to address this situation is to develop mechanisms for inter-agency cooperation and communication, such as the use of formal working groups. In the planning phase, working groups of institutional stakeholders should develop clear mechanisms for involving a wide range of interested parties. The working group should also develop funding strategies, plan and oversee monitoring, and develop other legal tools and mechanisms to manage the industry.

### **Regulatory Oversight and Enforcement**

There are few areas of the world where the monitoring, surveillance, and enforcement capacity of government agencies is sufficient to ensure adequate regulatory oversight of aquaculture. Logistically, surveillance and enforcement is often complicated as farms may be located in remote and inaccessible areas. Monitoring aquaculture activities is, therefore, often divided between the private sector and the government. Universities and research institutions also play a role due to their technical capacity. In the U.S., for example, the government relies heavily on voluntary compliance, reporting by farmers, and on-farm monitoring in conjunction with strong liability laws (which rarely exist in developing countries). In all but the most egregious cases, a mix of government oversight and on-farm monitoring is sufficient to adhere to the basic requirements for good management of the farm and to prevent environmental impacts.

Monitoring can help achieve management objectives. In addition, the monitoring results can be used to improve management. Monitoring for monitoring sake — which tends to be common — is a poor use of resources. For monitoring to be useful and cost-effective, it is important to limit the number of parameters that are assessed to those that: 1) function as key indicators, and 2) can be effectively analyzed and interpreted.

Critical areas to monitor are water quality and sanitation at both the post-harvest and processing stages. Monitoring these bio-physical components requires data management and analysis, which in turn often requires equipment, laboratories, and specialists to perform the analyses. These resources and capacities may not be commonly available in developing countries.

Governments must also be willing to impose hefty fines or penalties when laws are broken, since a lack of enforcement can negatively impact aquaculture. This means plans for aquaculture development and associated budgets must include enforcement activities and the funds to support them.

## **Conflict Identification and Resolution**

Aquaculture development may expose conflicts between different resource users concerning development needs, values, and access to resources. Clearly these kinds of conflicts should be avoided whenever possible. Issues presented for public consultation should be handled with great sensitivity. One important rule is to establish broad public agreement on overall development objectives, strategy, and decision criteria before addressing specific aquaculture development cases or projects. This reinforces the need for comprehensive stakeholder participation in the initial planning phase. Such participation early in the process reduces the likelihood of conflict arising at the point when the aquaculture development plan is being formulated and implemented. When conflict does arise, there are a variety of approaches for resolution. These include litigation, arbitration, mediation, and negotiation. Mediation and negotiation are usually more desirable than litigation and arbitration. The latter two approaches both involve the imposition of a solution, and may not address or resolve the underlying causes of conflict, leading to these same conflicts re-surfacing at a later date. In contrast, mediation and negotiation seek to resolve differences through an emphasis on identifying common objectives.

## **Cost Recovery**

Mechanisms to recover government costs associated with development of the aquaculture industry may include fees for permits, utility charges, or extension services, and taxes on certain aquaculture products. Cost recovery may also include payments for ecosystem services—e.g., paying a user fee for freshwater taken from a stream. Ideally, funds from cost-recovery efforts are reinvested in the sector's activities or restoration of ecosystem services, rather than allocated to a general budget. The operator's ability to pay is an important consideration. A sliding-scale fee based on the size of the aquaculture farm can be instituted. In some cases, smaller operators may not be able to afford fees at all. In these cases, in-kind contributions may be acceptable. For example, farmers who receive subsidies or grants may be required to provide fingerlings to other farmers after the first harvest in lieu of paying fees.

## **EVALUATION AND ADAPTIVE MANAGEMENT**

Aquaculture is rapidly growing and evolving with new species, technologies, culture methods, and markets. In this atmosphere of change, it is critical for farm operators and policymakers to evaluate and learn from experience and be able to adapt quickly. Evaluation is the process of review and analysis of all relevant data and information. Evaluation is required to determine if the performance of aquaculture species and culture systems meets expectations. As time passes, the conditions at the start of an aquaculture development and management effort may have changed and new information will become available. In addition, the goals, objectives, and expectations to be achieved by aquaculture development and reform may have been altered by time and changing contexts.

Thus, as evaluation results become available to the government and aquaculture stakeholders, there will likely be changes in the culture methods, the species cultured, farm size, or permitting procedures. This process, effecting change based on evaluation, is referred to as “adaptive management.”

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# IV. POST-HARVEST ISSUES

## 12.0 Introduction

## 13.0 Fisheries and Aquaculture Product Quality and Sanitation

## 14.0 Marketing and Economic Issues



Credit: Tanyo Begun

Use of insulated containers and ice to keep harvested fish products cool for transportation to market maintains product quality and freshness. Unfortunately, ice is often unavailable at many small-scale fish landings around the world.

## 12.0 INTRODUCTION

Post-harvest procedures for both the fisheries and aquaculture sectors are similar, as these products often enter the same marketing and processing channels on their way to the consumer. Once fish products leave a fish pond or fishing boat and enter the market chain, they are seldom distinguished as being farm-raised or wild-caught. For this reason, this section of the guide applies to both sectors.

Post-harvest losses—physical or economic—are an unacceptable waste of the product. Physical loss results from poor handling, preservation, and discarding. Nutritional loss can also occur as a result of poor handling and processing of the product. Economic loss occurs when fish spoil and lose their value or when fish are re-processed, which raises the cost of the finished product. In some cases, the use of fish for animal rather than human consumption is also counted as a loss of a food product.

Post-harvest losses in small-scale fisheries are one of the highest in any food production system. An estimated 10–12 million tons of fish per year are lost to spoilage, much of it resulting from over-harvesting during times when processing, distribution, and marketing systems are inadequate to handle or preserve the excess amounts.

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# 13.0 FISHERIES AND AQUACULTURE PRODUCT QUALITY AND SANITATION

The high water content of fish makes it necessary for them to be either: 1) consumed soon after harvest, or 2) quickly preserved. If not, fish quickly decompose, losing their value and presenting health threats. This is a problem even for small-scale producers, since their goal is to obtain not only food, but also income. When ice or other preservation methods are not available, the small-scale producer still has food for the family, but has a limited market in which to sell the product and make income.

The first step in ensuring post-harvest value is to provide training in basic sanitation and preservation methods. The second step is to provide simple, low-cost preservation equipment and resources such as ice. The ability to maintain food quality for just a few additional days can make the difference between having to quickly sell the entire harvest at a low price to neighbors or being able to transport it to a larger market and sell it for a higher price. In remote locations, achieving this will be nearly impossible due to the high cost of implementing even the simplest procedures. In such instances, careful consideration must be given to whether non-perishable products, such as seaweed or pearls, are better alternatives to seafood production. Non-aquaculture alternatives for food and income should also be considered.

## ON-BOAT HANDLING

On-boat handling is extremely important. Between the time that fish are landed on deck and off-loaded, the fisher can take steps to improve its quality and reduce losses. Almost as soon as fish are landed, bacteria can start to deteriorate the flesh, decreasing the quality of the product. This deterioration cannot be stopped, but it can be slowed by temperature control and careful handling, and by preventing contamination. Simple steps include keeping the deck as wet and cool as possible, especially in hot weather. Another on-boat procedure that will help is to quickly sort the catch, concentrating on the smaller fish that heat up more quickly and the higher value species. Shorter tows or fewer nets per string can also speed up the sorting process. Reducing the use of gaffs and throwing when handling can also reduce physical damage to the fish. Gutting and gilling the fish while still on the boat and using clean gloves or hands and a sanitized knife help to eliminate bacterial contamination. Using water with a simple bleach solution to clean hands, gloves, and knives will also help.

Another process that will preserve quality is washing the fish in a freshwater or brine solution and then chilling them. If fish are stored in totes (with ice, if possible), they should be neatly packed, belly down on the bottom layer and belly up on all the upper layers. All totes should have drainage holes. Severely



Maintaining cleanliness and hygiene at processing centers is critical for ensuring a safe and sanitary supply of seafood product.

Credit: Universidad Centro Americana

damaged fish should be separated from other fish. Fish bent in rigor mortis should not be straightened out as this causes separation of the muscle bands in the flesh, which reduces the quality of the fillet.

## PROCESSING

Processing facilities are extremely important in the fisheries sector. Even fish that are fresh and clean when delivered to a processing facility can become contaminated if the facility fails to follow best practices. Fish processing expertise and proper facilities are necessary for anything more than the very smallest scale operation. Processing facilities offer benefits such as improved product quality and revenues, and employment opportunities. However, it is often difficult to develop and manage these facilities, particularly in remote locations. When the product is intended for local consumption only, processing inspection, enforcement, and compliance may be lax.

Processing facilities are usually financed by the private sector. Responsibility for exports and human health, however, falls to government agencies, which must ensure that processing meets national requirements. Products for export must meet international standards as well. While exporting companies are generally of sufficient size and capability to comply with importing countries' standards, there are notable exceptions. In some cases, the reputation of a country's entire aquaculture industry can suffer long-term damage if even one plant fails to meet standards. Therefore, the responsible government agencies have a stake in enforcing compliance and providing technical assistance.



Drying fish products is a common form of preservation when cold storage or ice is unavailable to maintain product freshness.

Credit: URI Coastal Resources Center

## ENVIRONMENTAL CONSIDERATIONS

Sanitation issues affecting a fishery or aquaculture product extend well beyond the scope of the immediate production facility. Fish and aquaculture product sanitation begins with environmental quality: Unhygienic environmental conditions can lead to product contamination. Some water pollutants, such as mercury and PCBs (polychlorinated biphenyls), can bio-accumulate in aquatic organisms, making them unsafe to eat. The processing environment may also become contaminated when solid waste is disposed of improperly, or where potable water is not available to wash one's hands before handling the fish. For these and other reasons, all aquaculture or fisheries development efforts must address inadequacies in sanitation, highlighting the need to approach aquaculture development and fisheries management from a broader integrated coastal zone management perspective.

Environmental and social conditions have a direct impact on the product safety of bivalves and shellfish. Whether addressing pre- or post-harvest sanitation issues, it is important to consider shellfish sanitation as part of the planning and management efforts for both cultured as well as for natural harvest areas. Filter-feeding mollusks such as clams and oysters have a pronounced tendency to bio-accumulate toxic substances in their tissues and to harbor pathogens in their digestive tracts. Bivalves, where only the adductor muscle is eaten (e.g., scallops in the U.S.), do not carry this risk. Gastropods also tend to escape this problem as their digestive tract is not consumed (e.g., snails). Nevertheless, there are health threats associated with bivalves—ranging from toxic compounds derived from harmful algal blooms to pathogens such as Hepatitis A, Salmonella, and Vibrio.



Bivalves are also highly susceptible to post-harvest contamination. Many countries deal with these pre- and post-harvest issues by developing shellfish sanitation plans that cover a wide range of topics. These plans often focus on monitoring water quality to confirm that pathogens or toxic algae are not present. This is especially important in areas where shellfish are often eaten raw. Another element of shellfish sanitation plans focuses on post-handling good practices. These best practices should inclusively describe proper handling procedures from when the shellfish are removed from the water until they are presented to the consumer.

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# 14.0 MARKETING AND ECONOMIC ISSUES

Before producers begin to harvest their products it is important to identify the opportunities for and costs of marketing. This involves both logistical and legal issues. First, producers must be able to get their products to market in good condition. Then they must negotiate the sales process. Producers often seek to market directly to the end consumer and reap the maximum profit. However, most small-scale producers simply cannot afford the costs associated with direct-to-consumer marketing. There may be ways for farmers to sell some, if not all, of their product direct to the consumer, or to increase the selling price and their profits by considering value-added strategies. For example, even simple steps such as salting fish or selling only the fillets can increase profits. Another strategy is to choose the time of harvests to occur around special events or holidays, when customers may be willing to pay higher prices for the product. Cooperative efforts in marketing are often effective, as access to larger markets often requires a specified minimum volume of product that is made available on a regular schedule. This is something a single producer likely could not promise, but which might be possible for a cooperative of producers. Marketing and its associated issues is an area in which government agencies can provide important support and assistance to producers.

## CERTIFICATION

Certification schemes are becoming increasingly popular in aquaculture and fisheries. These labels are used because a certified sustainable product may bring a price premium and because an increasing number of consumers prefer a “green” product. This is similar to other labeling schemes such as “certified organic” or “fair trade” labels. While the Marine Stewardship Council’s (MSC) sustainability label is apparent on certain types of wild caught seafood products sold in supermarkets in developed countries, particularly the U.S. and Europe, aquaculture certification labels are less evident at the consumer level. In part, this is because there are multiple certification schemes depending on the country of origin. Many countries (e.g., Bangladesh and Thailand) have national certification schemes, while others rely on international schemes such as the Aquaculture Certification Council (ACC).

In the case of aquaculture, certification is important as well since many large retail food stores are requiring sustainably sourced product from their suppliers. A possible downside to certification is that small producers are likely to be excluded unless they receive assistance in the certification procedure. In some cases, processing plants may use new certification standards as an excuse to impose lower pricing on small producers whose only option is to sell their products to the local processing plant.



Credit: Marine Stewardship Council

Country-of-origin labeling is also a means of informing the consumer about the source of an aquaculture or fisheries product. Although not necessarily explicit in this labeling, it may lead consumers to infer traits about food safety, and trade and environmental issues. Branding (i.e., using images or phrases to distinguish one product from another in the marketplace) is another way to convey information on quality, health, safety, environmental impact, and other information. Hazardous Analysis Critical Control Point labeling is common on most seafood products imported into the U.S. It is expected that efforts towards certification, labeling, and branding will intensify as consumer awareness grows and the effectiveness of these approaches are proven in the marketplace.



Product showing the Marine Stewardship Council certified label.

Credit: Marine Stewardship Council

## SOURCES FOR MORE INFORMATION

- Bureau of Oceans and International Environmental and Scientific Affairs; Certifications Pursuant to Section 609 of Public Law 101-162.

<http://www.epa.gov/EPA-GENERAL/2000/May/Day-03/gI1025.htm>

- Globe Fish Marketing reports.

<http://www.globefish.org/index.php?id=481&easysitestatid=1533326373>

- Seafood network information center.

<http://seafood.ucdavis.edu/>

- Fish and Seafood Market Research Reports.

<http://www.marketresearch.com/browse.asp?categoryid=490>

- Best aquaculture practices certification.

<http://www.aquaculturecertification.org/>

Aquaculture certification council.

<http://www.aquaculturecertification.org/>

- Seafood watch.

<http://www.montereybayaquarium.org/cr/seafoodwatch.aspx>

- Marine Stewardship Council.

<http://www.msc.org/>

# **Appendices**

## **USAID PROGRAM INFORMATION**

**Appendix A. INTERNATIONAL INSTRUMENTS AND INITIATIVES**

**Appendix B. U.S. LEGISLATION**

**Appendix C. USAID REGULATIONS, POLICIES, AND PROCEDURES**

# Appendix A. INTERNATIONAL INSTRUMENTS AND INITIATIVES

## CONSERVATION AND MANAGEMENT OF STRADDLING FISH STOCKS AND HIGHLY MIGRATORY FISH STOCKS

The United Nations Agreement for the Implementation of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks is commonly referred to as the UN Fish Stocks Agreement (UNFSA). It was adopted in 1995 under the United Nations Convention on the Law of the Sea and entered into force in 2001. The U.S. has ratified the UNFSA. The UNFSA establishes certain minimum obligations with respect to highly migratory and straddling fish stocks, and provides an internationally recognized framework within which countries can work together to ensure the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks through effective implementation of the Law of the Sea Convention. Straddling stocks are fish stocks that occur in more than one EEZ or that occur in both an EEZ of a country and also in the high seas (e.g., cod, flounder, and turbot). The term “highly migratory” fish refers to fish species that undertake lengthy ocean migrations and also have wide geographic distributions usually through the EEZs of two or more countries and/or into the high seas. Highly migratory usually denotes tuna and tuna-like species, shark, marlin, and swordfish. The UNFSA establishes detailed principles and minimum international standards for the conservation and management of these stocks to ensure that such measures are compatible and coherent. It seeks to ensure that there are effective mechanisms for compliance and enforcement of those measures on the high seas and recognizes the special requirements of developing States in conservation and management as well as the development and participation in fishing for highly migratory and straddling stocks.

### Specific Obligations of Parties to the Fish Stocks Agreement

- Use at least the minimum international standards for the conservation and management of straddling fish stocks and highly migratory fish stocks
- Use the precautionary approach, ecosystem approach, and best available scientific information when managing these fisheries
- Cooperate in ensuring conservation and promoting optimum utilization of fisheries resources either directly or through regional fisheries management organizations or arrangements
- Ensure compatibility between conservation measures taken in areas of national jurisdiction and in the adjacent high seas
- Agree to minimize pollution, waste, and discards of fish
- Use effective mechanisms for compliance and enforcement of measures
- Consider providing financial, technological and scientific assistance to developing States in order to manage and sustainably use straddling and highly migratory stocks and participate in regional fisheries management organizations
- Resolve disputes in a peaceful manner consistent with the LOS Convention

### Web Sites

UN Division for Ocean Affairs and Law of the Sea.

[http://www.un.org/Depts/los/convention\\_agreements/convention\\_overview\\_fish\\_stocks.htm](http://www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm)

## CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

The Convention on Biological Diversity (CBD) provides an internationally recognized framework where countries can work together to conserve and sustainably use biological diversity. It identifies common problems, sets overall goals and general obligations of Parties and outlines frameworks for technical and financial cooperation to achieve these goals. The responsibility of implementing these goals and objectives, however, rests largely with the countries themselves. As of June 2009, 191 countries were Parties to the CBD. The United States has signed, but not ratified the convention; thus it is not a Party to, and is not legally bound by the Convention. Most USAID mission countries are parties to the CBD.

The Convention has three primary objectives: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits from genetic resources, including as appropriate, access to genetic resources. These objectives are achieved through a comprehensive approach that includes consideration of biodiversity at the ecosystem, species, and genetic levels. The CBD promotes partnerships among nations through scientific and technical cooperation, access to financial resources, and the transfer of environmentally sound technology.

Marine and coastal biodiversity has been an early priority of the CBD with decisions on its conservation and sustainable use dating back to the very first Conference of Parties in 1994. A thematic program of work was developed during the Fourth Conference of Parties and several iterations have been approved by Parties to integrate emerging issues into the marine and coastal biodiversity work program, such as marine protected areas, mariculture, high seas biodiversity, coral reef conservation and integrated marine and coastal management.

### Specific Obligations of Parties to the CBD

- Develop national strategies, plans, or programs for the conservation and sustainable use of biological diversity
- Integrate the conservation and sustainable use of biological diversity into the relevant sectoral and cross-sectoral plans, programs, and policies
- Identify components of biological diversity important for conservation and sustainable use
- Identify processes and activities that have, or are likely to have, significant adverse impacts on the conservation and sustainable use of biodiversity
- Establish a system of protected areas to conserve biological diversity
- Establish mechanisms to respect, preserve, and maintain the knowledge, innovations, and practices of indigenous and local communities embodying traditional lifestyles relevant to the conservation and sustainable use of biodiversity

### Some Key Points about the CBD

- Although the United States is not a party to the CBD, almost every USAID-presence country is a party to the CBD.
- Countries that are party to the CBD should have a National Biodiversity Strategy and Action Plan (NBSAP). USAID staff in those countries can use the CBD and the guidance from its Conference of Parties (COP) to encourage conservation action and integrate the NBSAP into the mission's Foreign Assistance Act 118/119 analyses and mission strategies.
- The CBD cooperates with other international organizations such as the FAO and may provide links to other relevant conventions or agreements, such as the FAO Code of Conduct for Responsible Fisheries.

## Web Sites

CBD Web site. <http://www.cbd.int>

NOAA Fisheries, Office of International Affairs. <http://www.nmfs.noaa.gov/ia/intlagree/cbd.htm>

## CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES OF WILD ANIMALS (CMS)

The Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. The Convention entered into force on November 1, 1983 and currently has 110 parties. CMS is a framework treaty with numerous regional or global Agreements (legally binding) and Memorandums of Understanding (MOU) (non-legally binding) under it focused on the conservation and management of particular species. The United States is not a signatory to the CMS; however, non-parties can adhere to species-specific Agreements or MOUs concluded under the Convention.

As such, the United States is a signatory to the MOU on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA). A major focus of IOSEA is to address sea turtle bycatch in fishing operations, as detailed above. CMS is also considering developing a sea turtle instrument for the Pacific region to complement IOSEA. The United States is in the process of trying to ratify the Agreement on the Conservation of Albatrosses and Petrels (ACAP). The bycatch of seabirds during longline and trawl-fishing operations is considered one of the most significant threats to albatrosses globally. Further, CMS has held two meetings to develop an instrument aimed at improving international cooperation on migratory sharks. The United States, through Department of State and NOAA, are participating in these discussions.

Generally, migratory species threatened with extinction are listed in Appendix I of the Convention and migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. There are a number of marine species listed in Appendix I and/or Appendix II, including sea turtles, cetaceans, sharks and seabirds.

### Specific Obligations of Parties to CMS

- Promote, cooperate in, and support research relating to migratory species
- Endeavour to provide immediate protection for migratory species included in Appendix I through strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them
- Endeavour to conclude Agreements covering the conservation and management of migratory species included in Appendix II
- Recognize that conservation and management measures differ between each species-specific Agreement or MOU, each having its own set of obligations to its parties, particular to the species covered and taking into account the requirements of the region

### Some Key Points about CMS

- USAID staff should determine whether the host country has signed and ratified CMS and any of its sister instruments, and to what degree they are effectively implementing their obligations.
- USAID staff in CMS countries can use the Convention and the guidance from its Conference



of Parties (COP) to encourage conservation and management action for particular species either regionally or globally.

- The CMS can provide links to other Conventions or Agreements, such as CITES, RAMSAR, and the FAO Code of Conduct for Responsible Fisheries.
- NOAA and the CMS Secretariat signed a Letter of Cooperation in 2008, which expresses their intent to cooperate in order to promote and facilitate collaborative activities for the purpose of conserving and managing migratory marine species and their habitats throughout their ranges, consistent with the goals and objectives of CMS and NOAA.

## Web Site

Convention on the Conservation of Migratory Species. <http://www.cms.int/>

## CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF FAUNA AND FLORA (CITES)

The Convention on International Trade in Endangered Species (CITES) is an international agreement to ensure that international trade in specimens of wild animals and plants (including aquatic species) does not threaten their survival. CITES entered into force in 1975. As of June 2009, 175 countries are Parties, including the United States.

CITES works by enacting a series of controls on international trade of specimens of selected species. It requires governments to regulate the international trade of species listed under the appendices of the Convention on the basis of a system of permits for the import, export, re-export and introduction of specimens. These permits represent varying degrees of protection that depend on the biological status of the species. More than 33,000 species of animals and plants are listed on one of three appendices to CITES.

- Appendix I lists species threatened with extinction. Except in exceptional circumstances, CITES bans international commercial trade in these species. Trade is tightly controlled and generally limited to scientific purposes for species placed in Appendix I.
- Appendix II species are not necessarily threatened with extinction, but may become so unless trade is strictly regulated. These include species that are in international trade and are vulnerable to overexploitation. Regulated trade is allowed provided that the exporting country issues a permit that includes findings that the specimens were legally acquired, and the trade will not be detrimental to the survival of the species or its role in the ecosystem. In 2013 manta rays and 5 species of sharks: the oceanic whitetip (*Carcharhinus longimanus*), scalloped hammerhead (*Sphyrna lewini*), great hammerhead shark (*Sphyrna mokarran*), smooth hammerhead shark (*Sphyrna tigrina*) and the porbeagle shark (*Lamna nasus*), were added to Appendix II.
- Appendix III delineates how a country may unilaterally (without a vote) list in Appendix III any species that are subject to regulation within its jurisdiction for which the cooperation of other Parties is needed. Importing countries must check for export permits for the species issued by the country of origin for Appendix III species and certificates of origin from all other countries.

The CITES Appendices currently include close to 100 commercially exploited aquatic species of fish, mollusks, and echinoderms. They include, for example, the giant clam, the Caribbean queen conch, brown sea cucumber, seahorses, humphead wrasse, and the whale shark. CITES trade measures have also had significant impact on some non-fish species that are important either as targeted species in marine harvesting activities or taken as bycatch in fisheries. For example, a number of whale species and stocks are listed in Appendix I, as are all marine turtle species, stony corals, and black coral.

## Specific Obligations of Parties to CITES

- Designate management and scientific authorities to carry out functions specified in the treaty, including establishing scientifically-based quotas for species listed in Appendices II and III
- Prohibit trade in violation of the CITES
- Penalize trade in violation of the CITES
- Confiscate specimens illegally traded or possessed
- Ensure the legal and sustainable trade of species listed in Appendix II

## Some Key Points about CITES

- USAID may not implement any activity or program that violates CITES.
- USAID staff should determine whether the host country has signed and ratified CITES, and to what degree they are effectively implementing the CITES.
- The U.S. Fish and Wildlife Service has lead responsibility for CITES implementation and enforcement within the U.S. government, including interagency coordination on all CITES matters.

## Web Sites

CITES Web site. <http://www.cites.org/>

TRAFFIC - the wildlife trade monitoring network. <http://www.traffic.org/>

U.S. Fish and Wildlife Service: CITES in the United States. <http://www.fws.gov/international/cites/>

IUCN Red List of Endangered Species. <http://www.iucnredlist.org/>

## FAO CODE OF CONDUCT FOR RESPONSIBLE FISHERIES

The Code of Conduct for Responsible Fisheries (the Code) was adopted by the United Nations Food and Agriculture Organization (FAO) Conference in 1995 to promote long-term, sustainable fisheries and aquaculture. Capture fisheries face environmental and socioeconomic crises in many parts of the world. The purpose of the Code is to address those crises by encouraging the rational and long-term sustainable utilization of fisheries. Long-term sustainable usage of fish resources can help with resource conservation, ensuring food supplies and alleviating poverty in fishing communities. It prescribes principles and standards for the conservation and management of all fisheries and prescribes as well how fishing operations themselves should be conducted. It also addresses the capture, processing, and trade in fish and fishery products, fishing operations, aquaculture, fisheries research, and the integration of fisheries into coastal area management.

The Code is a voluntary instrument. It is the first international instrument of its type to have been concluded for the fisheries sector. The Code does not require formal acceptance by governments. However, FAO member countries have committed to implement the Code, and other governments and stakeholders have a responsibility to act consistent with the Code and to address urgent management issues.

## Specific Obligations in the Implementation of the Code of Conduct

- The FAO Secretariat is responsible for monitoring the implementation of the Code and to report to the FAO Committee on Fisheries (COFI) on progress and related developments concerning implementation.

- The binding Agreement to Promote Compliance with International Conservation and Management measures by Fishing Vessels on the High Seas (the Compliance Agreement) is an integral part of the Code.
- To facilitate the implementation of the Code, the FAO has prepared, and continues to prepare, guidelines that give practical and technical advice to fishers and managers on specific topics.
- The Code calls for the adoption of measures to address the needs of developing countries, especially in the areas of financial and technical assistance, technology transfer, training and scientific cooperation and in enhancing their ability to develop their own fisheries as well as to participate in high seas fisheries, including access to such fisheries.
- The Code also has detailed sections addressing key environmental considerations in fisheries management, including reducing trash and pollution, and minimizing waste and harmful impacts on habitats and non-target species.

### **Some Key Points about the Code of Conduct**

- Four voluntary international plans of action (IPOAs) have been concluded within the framework of the Code to elaborate specific measures to reduce the incidental capture of seabirds, to manage sharks and fishing capacity, and to prevent, deter and eliminate illegal, unreported and unregulated (IUU) fishing.
- For each IPOA, governments are called upon to develop and implement national plans of action in accordance with agreed international measures.
- Implementation of the Code has been uneven, often due to lack of resources or political will. Implementation in developing countries in particular would benefit from improved education and outreach, better coordinated legal, law enforcement, and scientific capacity building, and economic incentives that increase compliance and political will.

### **Web Sites**

FAO Code of Conduct for Responsible Fisheries. <http://www.fao.org/docrep/005/v9878e/v9878e00.htm>

FAO Fisheries and Aquaculture Department. <http://www.fao.org/fishery/ccrf/en>

FAO Brochure: What is the Code of Conduct for Responsible Fisheries?

<http://www.fao.org/docrep/003/x9066e/x9066e00.htm>

## **INTERNATIONAL CORAL REEF INITIATIVE (ICRI)**

The International Coral Reef Initiative (ICRI) is a partnership among governments, international organizations, and non-governmental organizations that strive to preserve coral reefs and related ecosystems, such as mangrove forests and seagrass meadows. Established in 1995, ICRI is a unique public-private partnership committed to reversing the global degradation of coral reefs and related ecosystems. Over one billion people depend on reef resources for their food security, well-being, and livelihoods. Over the last decade, ICRI has been the driving force behind scientific, governmental and civil society efforts to protect coral reefs. Through mobilizing governments and a wide range of other stakeholders, ICRI strives to improve management practices, increase capacity and political support, raise awareness and share information.

ICRI emerged out of the recognition that the world's coral reefs and related ecosystems are facing serious degradation, primarily due to anthropogenic stresses. It is estimated that nearly 20 percent of the world's coral reefs have been irreversibly damaged and effectively lost, with an additional 15 percent on track to be lost in the next 10 to 20 years. ICRI was launched as an effort to raise international awareness of the threats to coral reefs and to catalyze action to reverse their degradation.

Since its founding, ICRI has recognized a number of operational networks to assist in achieving the Framework for Action. The Global Coral Reef Monitoring Network (GCRMN) is a global network of people, governments, institutes, and NGOs monitoring coral reefs and their user communities in over 80 countries. The network functions as a coordination mechanism for publishing results on the status of coral reefs of the world for decision-makers and the public.

### **Specific Commitments in the Implementation of the ICRI Objectives**

ICRI calls for governments, regional organizations, and international organizations to:

- Strengthen commitment to and implementation of programs at the local, national, regional, and international levels to conserve, restore, and promote the sustainable use of coral reefs and associated environments
- Incorporate management provisions for the protection, restoration, and sustainable use of coral reefs into existing local, regional, and national development plans
- Strengthen capacity for development and implementation of policies, management, research, and monitoring of coral reefs and associated environments
- Establish and maintain research and monitoring programs to ensure efficient use of scarce resources and a flow of information relevant to the management of coral reefs and associated environments

### **Some Key Points about ICRI**

- ICRI is an informal and voluntary mechanism that allows representatives from countries with coral reefs (both developing and donor countries) to sit in equal partnership and to engage alongside development banks, international environmental and development agencies, scientific associations, the private sector, and nongovernmental organizations to share information and discuss the best strategies to conserve the world's coral reef resources.
- The U.S. Department of State, USAID, and NOAA all played important roles in establishing ICRI, and continue to provide technical assistance, financial support, and leadership.
- The Initiative is coordinated by a Secretariat that rotates among member governments. The first Secretariat was hosted by the US Department of State (1994 to 1996).

### **Web Sites**

International Coral Reef Initiative. <http://www.icriforum.org/>

Global Coral Reef Monitoring Network. <http://www.gcrmn.org/>

NOAA Coral Reef Conservation Program. <http://coralreef.noaa.gov/>

## **MARINE TURTLE AGREEMENTS**

There are two major agreements in the world to protect marine turtles—The Inter-American Convention for the Protection and Conservation of Marine Turtles (IAC) and the Indian Ocean-Southeast Asian Marine Turtle Memorandum of Understanding (IOSEA). The IAC is the only binding treaty in the world to protect sea turtles. Currently, there are 13 countries party to the treaty. These countries include the United States, Mexico, Guatemala, Honduras, Costa Rica, Panama, Venezuela, Peru, Ecuador, Uruguay and the Netherlands Antilles. The IAC protects green, hawksbill, leatherback, Kemp's ridley, olive ridley and loggerhead sea turtles.

The IAC objective is to promote the protection, conservation and recovery of sea turtle populations and of habitats on which they depend, based on the best available scientific evidence, taking into account

the environmental, socioeconomic and cultural characteristics of the parties. This Convention prohibits the intentional capture, retention or killing of turtles and their domestic trade of eggs or other parts. This Convention also calls for habitat restoration, scientific research and the reduction of incidental capture. The IAC can regulate vessels of the parties and thus take measures to address fisheries interactions.

The other major agreement is the Indian Ocean-Southeast Asian (IOSEA) Marine Turtle Memorandum of Understanding (MOU). It is a non-binding intergovernmental agreement that aims to protect, conserve, and recover marine turtles and their habitats in the Indian Ocean and Southeast Asia region. The agreement falls under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (see CMS below). The following marine turtles are protected under IOSEA:

- Green turtle (*Chelonia mydas*)
- Hawksbill turtle (*Eretmochelys imbricata*)
- Loggerhead turtle (*Caretta caretta*)
- Olive ridley turtle (*Lepidochelys olivacea*)
- Leatherback turtle (*Dermochelys coriacea*)
- Flatback turtle (*Natator depressus*)

As of June 2009, there were 30 signatories to this agreement. The IOSEA Marine Turtle MOU implements a framework through which regional States and other concerned States can share the responsibility of protecting, conserving, and recovering depleted marine turtle populations. The Agreement Area covers 44 range states that are divided into four sub-regions: Southeast Asia and Australia, Northern Indian Ocean, Northwest Indian Ocean and West Indian Ocean. The Conservation and Management Plan focuses on reducing threats, conserving critical habitat, exchanging scientific data, increasing public awareness and participation, promoting regional cooperation and seeking resources for implementation. Due to many other pressing development issues in the region, some countries lack the resources for successful implementation of the MOU. Therefore, through the MOU these countries are offered support and capacity-building assistance. Success of any MOU activity is based on the active participation by a wide range of actors including all levels of government, non-governmental organizations and civil society.

### **Specific Obligations**

- To date, the IAC has passed resolutions addressing hawksbill and leatherback turtles, as well as adopting the FAO sea turtle guidelines.
- The IOSEA is a non-binding MOU. However, the United States on several occasions has used resolutions from the IOSEA to encourage other organizations such as RFMOs to take action.

### **Some Key Points about the IAC and IOSEA**

- The United States is the current seat of the Secretary Pro Tempore of the IAC and the chair of the Conference of Parties until 2011.
- The United States is one of the principal funders for the IAC and IOSEA.
- The United States views the IAC and the IOSEA as important tools for sea turtle conservation. The U.S. Fish and Wildlife Service, the Department of State and NOAA's National Marine Fisheries Service collaborate on these agreements regularly.

## Web sites

Inter-American Convention for the Protection and Conservation of Sea Turtles.

<http://www.iacseaturtle.org/defaulteng.htm>

Indian Ocean-South-East Asian Marine Turtle Memorandum of Understanding.

<http://www.ioseaturtles.org/>

## RAMSAR CONVENTION ON WETLANDS OF INTERNATIONAL IMPORTANCE

The Ramsar Convention on Wetlands of International Importance (Ramsar Convention) was signed in Ramsar, Iran, in 1971. Its purpose is to address the loss of wetland ecosystems worldwide (both freshwater and marine), and provides the framework for national action and international cooperation on the conservation and wise use of wetlands. The Convention establishes criteria for designating rivers, marshes, coral reefs, mangrove forests, and other areas as a “wetland of international importance.” Parties are required to designate at least one Ramsar wetland site and commit to the wise use of wetlands resources and the establishment of reserves, as well as support international cooperation and fulfill reporting requirements. Wetlands are among the world’s most productive environments, and are critical to fishery production. As of June 2009, 159 countries are parties to the Ramsar Convention, including the United States which ratified the Convention in 1987.

### Specific Obligations of Parties to the Ramsar Convention

- Designate at least one national wetland for inclusion in the List of Wetlands of International Importance
- Accept the responsibility for conservation, management, and wise use of wetlands and their resources
- Promote the wise use of wetlands through land use planning and the establishment of natural reserves, cooperate in the exchange of information, and train personnel for wetlands management

More than 1,847 sites have been designated as Ramsar Wetlands of International Importance, covering nearly 450 million acres. Twenty-seven of these are in the United States, including the first U.S. Ramsar site with coral reefs, the Palmyra Atoll, 1,000 miles south of Hawaii. The Nature Conservancy and U.S. Fish and Wildlife Service are partners in protecting Palmyra Atoll’s resources.

### Some Key Points about the Ramsar Convention

- The Ramsar Convention provides a forum for information exchange among countries.
- The Ramsar Convention maintains a focus on conservation through sustainable use.
- Private and public lands can be designated Ramsar sites, providing a mechanism for public-private cooperation.
- The Ramsar Convention may provide links to other conventions, initiatives or USAID activities, such as the CBD, International Coral Reef Initiative (ICRI), Convention on Migratory Species, and Tropical Forestry Conservation Act.
- The U.S. Fish and Wildlife Service and the Department of State are the administrative authorities for Ramsar in the U.S.



## Web Sites

Ramsar Convention Web site. <http://www.ramsar.org>  
Convention on Migratory Species. <http://www.cms.int/>  
U.S. Fish and Wildlife International Wetlands Program.  
<http://www.fws.gov/international/DIC/global/wetlands.html>

## REGIONAL FISHERY MANAGEMENT ORGANIZATIONS (RFMO)

Multilateral Regional Fisheries Management Organizations (RFMOs) are critical vehicles for promoting long-term sustainable fisheries where international cooperation is required in conservation and management. Most coastal USAID mission countries are a party to one or more RFMOs. These organizations are responsible for the conservation and management of fisheries on the high seas, fish stocks that migrate through the waters of more than just one state, or straddling stocks whose populations occur on the high seas or are shared by multiple states. RFMOs may focus on certain species of fish (e.g., the Commission for the Conservation of Southern Bluefin Tuna/CCSBT) or living marine resources within a region (e.g., the Commission for the Conservation of Antarctic Marine Living Resources/CCAMLR).

RFMOs also have an interest in proper conservation of all species associated with or affected by their fisheries, as well as their broader ecosystems. This includes seabirds, turtles, dolphins, sharks, non-target fish, and certain marine habitats. These responsibilities have been outlined in international agreements governing the oceans, such as the FAO Code of Conduct for Responsible Fisheries and the United Nations Fish Stocks Agreement.

The following is a partial list of RFMOs around the world and web sites with information on each:

- Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR) [www.ccamlr.org](http://www.ccamlr.org)
- Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea (CCBSP) [www.afsc.noaa.gov/refm/cbs/convention\\_description.htm](http://www.afsc.noaa.gov/refm/cbs/convention_description.htm)
- Commission for the Conservation of Southern Bluefin Tuna (CCSBT) [www.ccsbt.org](http://www.ccsbt.org)
- General Fisheries Commission for the Mediterranean (GFCM) [www.gfcm.org](http://www.gfcm.org)
- Inter-American Tropical Tuna Commission (IATTC) [www.iattc.org](http://www.iattc.org)
- International Commission for the Conservation of Atlantic Tunas (ICCAT) [www.iccat.int/en](http://www.iccat.int/en)
- Indian Ocean Tuna Commission (IOTC) [www.iotc.org](http://www.iotc.org)
- International Pacific Halibut Commission (IPHC) [www.iphc.washington.edu](http://www.iphc.washington.edu)
- International Whaling Commission (IWC) [www.iwcoffice.org](http://www.iwcoffice.org)
- Lake Victoria Fisheries Organization (LVFO) [www.lvfo.org](http://www.lvfo.org)
- Northwest Atlantic Fisheries Organization (NAFO) [www.nafo.int](http://www.nafo.int)
- North Atlantic Salmon Conservation Organization (NASCO) [www.nasco.int](http://www.nasco.int)
- Northeast Atlantic Fisheries Commission (NEAFC) [en.wikipedia.org/wiki/North\\_Atlantic\\_Salmon\\_Conservation\\_Organization](http://en.wikipedia.org/wiki/North_Atlantic_Salmon_Conservation_Organization)
- North Pacific Anadromous Fish Commission (NPAFC) [www.npafc.org](http://www.npafc.org)
- Pacific Salmon Commission (PSC) [www.psc.org](http://www.psc.org)
- Regional Commission for Fisheries (RECOFI) [www.fao.org/fishery/rfb/recofi](http://www.fao.org/fishery/rfb/recofi)
- Southeast Atlantic Fisheries Organization (SEAFO) [www.seafo.org](http://www.seafo.org)

- Southern Indian Ocean Fisheries Agreement (SIOFA) <http://www.fao.org/fishery/rfb/siofa/en>
- Western and Central Pacific Fisheries Commission (WCPFC) [www.wcpfc.int](http://www.wcpfc.int)

### **Specific Obligations of Parties to RFMOs**

Conservation and management measures vary by RFMO. They may involve:

- Total Allowable Catches (TACs) and quotas
- By-catch, fishing gear, legal fish sizes requirements, and closed areas and seasons
- Monitoring, control and surveillance (MCS) measures to achieve management objectives, which could include: inspections at sea and in port, application of a vessel monitoring system (VMS), and independent observers on vessels
- International catch and trade documentation systems
- Annual reports on fishing operations, including amounts of captured and discarded fish

### **Some Key Points about RFMOs**

Strengthening RFMOs and their performance in order that fish stocks may be better conserved and managed remains a major challenge facing international fisheries governance. A lack of political commitment by the members of some RFMOs has thwarted efforts undertaken within those and other RFMOs to meet and address conservation and management challenges. Many RFMOs are taking steps to strengthen governance through the attempted implementation of explicit conservation measures directed towards species of commercial importance, by implementing the ecosystem approach to fisheries and by adopting a precautionary approach in interpreting science and policy options. They are also working to strengthen international cooperation; reduce illegal, unreported, and unregulated (IUU) fishing; promote transparency; and enhance monitoring, control, and surveillance (MCS) measures. Many RFMOs have also adopted measures designed to protect species that are caught in association with fishes of commercial interest. The strength of RFMOs depends upon the political will and strength of the national government member states operating within their own jurisdictions and in cooperation with other members.

### **Web Site**

FAO Fisheries and Aquaculture Department. <http://www.fao.org/fishery/rfb/search/en>

## **UNITED NATIONS CONVENTION ON THE LAW OF THE SEA**

The 1982 United Nations Convention on the Law of the Sea is the comprehensive and universally recognized regime governing uses of the oceans and their resources, including the framework for managing high seas fisheries. Most international agreements addressing living marine resources are based on the principles enunciated in the Convention

The Convention recognizes freedom of fishing on the high seas, but subjects that freedom to a number of conditions such as treaty obligations and the interests of coastal states in conserving and managing transboundary stocks, highly migratory species, marine mammals, anadromous species, and catadromous species. The Convention imposes a duty on states to collaborate on high seas living marine resource management, both directly and through regional fisheries bodies. Conservation measures to maintain or restore populations of harvested stocks are to be based on the best scientific evidence available and take account of interdependence between stocks. States are also to conserve and manage marine mammals in the high seas.

## **Specific Obligations of Parties to the Law of the Sea**

- A Coastal State exercises sovereignty over living resources in its territorial sea, which can extend as far as 12 nautical miles from shore.
- A Coastal State may proclaim an exclusive economic zone (EEZ) out to 200 nautical miles from shore, where it has sovereign rights with respect to the exploration, exploitation, conservation, and management of natural resources. These rights are subject to certain obligations, such as taking into account best available scientific information, sustainable management, and optimum utilization.

## **Some Key Points about the Law of the Sea**

- The United States is not yet party to the Convention, but views most of its provisions as reflective of customary international law. Many of the USAID presence countries are party to the Convention.
- The United States is party to the Agreement for the Implementation of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UNFSA), which builds upon some of the general obligations contained in the Convention.

## **Web Sites**

UN Convention on the Law of the Sea.

[http://www.un.org/Depts/los/convention\\_agreements/texts/unclos/closindx.htm](http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm)

UN Division for Ocean Affairs and Law of the Sea.

[http://www.un.org/Depts/los/convention\\_agreements/convention\\_overview\\_convention.htm](http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm)

# Appendix B. U.S. LEGISLATION

## ENDANGERED SPECIES ACT

The Endangered Species Act of 1973 (ESA) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. Congress passed this legislation after finding that various species had been rendered extinct as a “consequence of economic growth and development untempered by adequate concern and conservation” and other species had been “so depleted in numbers” that they were “in danger of or threatened with extinction.” The U.S. Fish and Wildlife Service (USFWS) administers ESA activities for terrestrial and freshwater species, while the National Marine Fisheries Service (NMFS) is responsible for marine and anadromous species.

A species is listed if it is threatened or endangered by:

- Present or threatened destruction, modification, or curtailment of its habitat or range
- Overutilization for commercial, recreational, scientific, or educational purposes
- Disease or predation
- Inadequacy of existing regulatory mechanisms
- Other natural or human-made factors affecting its continued existence

The decision to include a species on the list must be based on the best scientific and commercial data available, not on economic factors. When a species is listed, NMFS or USFWS is required to develop and implement a recovery plan for its conservation and survival.

“Critical habitats” for endangered or threatened species are areas that contain features that are “essential to the conservation of the species” and that may require “special management considerations or protection.” Areas can be excluded from critical habitat designation when the economic impacts of the designation outweigh the benefits of including the areas. The only exception is when failure to designate the critical habitat would result in extinction of the species.

Section 9 of the ESA prohibits any person subject to U.S. jurisdiction from “taking” any endangered species within the territorial sea or on the high seas and from importing or exporting such species. The term “take” means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect...or attempt to engage in any such conduct.” Prohibited takings include significant habitat modifications that kill or injure listed species by altering their essential behavior patterns. Any or all of these prohibitions can be extended to threatened species through rulemaking under Section 4(d).

The ESA contains a number of exceptions to the takings prohibition. NMFS or USFWS may issue permits for scientific purposes or to enhance the survival of an endangered or threatened species, including acts necessary for the establishment of experimental populations. The 1982 amendments allow NMFS or USFWS to permit a taking that is “incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.” Applicants for an incidental take permit must submit a conservation plan that specifies: 1) the impact of the taking; 2) a mitigation plan that includes measures to minimize the impacts and assures sufficient funding to implement these; and 3) the alternative actions that were considered and why they were not adopted.

Section 7 of the ESA requires all federal agencies to undertake programs for the conservation of endangered and threatened species and to consult with NMFS or USFWS before authorizing, funding, or carrying out an action that may affect a listed species or critical habitat under the ESA. The ESA

provides that “each federal agency shall, in consultation with and with the assistance of the Secretary, ensure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary to be critical.”

Broad prohibitions against taking of wildlife are applied to all domestic and international endangered animal species, and any or all of these prohibitions can be extended to threatened animal species. The ESA provides for acquiring land for animals and plants listed under the Convention on International Trade of Endangered Species (CITES).

### **Some Key Points about the Endangered Species Act**

Broad prohibitions against taking of wildlife are applied to all domestic and international endangered animal species.

### **Web Sites**

U.S. Fish & Wildlife Service. <http://endangered.fws.gov/>

USAID Environmental Compliance.

[http://transition.usaid.gov/our\\_work/environment/compliance/ane/eptm/annex\\_A.pdf](http://transition.usaid.gov/our_work/environment/compliance/ane/eptm/annex_A.pdf)

## **FOREIGN ASSISTANCE ACT**

In the U.S. Foreign Assistance Act (FAA), the President is authorized to furnish assistance for developing and strengthening the capacity of less developed countries to protect and manage their environment and natural resources. It further mandates that U.S. foreign aid shall not be used in ways that damage the environment, either globally or locally, or that deplete the natural resources base necessary for sustainable development. Of particular importance for USAID are Sections 117-119. In Section 117, the Congress finds that “if current trends in the degradation of natural resources in developing countries continue, they will severely undermine the best efforts to meet basic human needs, to achieve sustained economic growth, and to prevent international tension and conflict.” This means that the United States is required to take a leadership role in policies relating to natural resources and the environment, and to cooperate with developing countries to achieve environmentally sound development.

The FAA requires U.S. agencies with certain programs or projects in other countries to prepare environmental impact statements and assessments on the effect of any proposed project. It directs the United States to provide support to developing countries for training programs, educational efforts, research, and other activities designed to expand the knowledge base on environmental protection.

Section 117 indicates that “Special efforts shall be made to maintain, and where possible, restore the land, vegetation, water, wildlife, and other resources upon which depend economic growth and human well-being, especially of the poor.”

Although Section 118 focuses on tropical forests, it is also applicable to small-scale fisheries because of the ecological importance of mangroves for oceans and fisheries. Section 118 requires that every country development strategy or country plan prepared by USAID include an analysis of “the actions necessary in that country to achieve conservation and sustainable management of tropical forests, and the extent to which the actions proposed for support by the Agency meet the needs thus identified.” Country Development Cooperation Strategies and 118/119 Analyses need to examine the potential impacts from all sectors and programs on the natural resources of the respective country or region.

Section 119 dictates that every country strategic plan developed by USAID shall include “The actions necessary in that country to conserve biological diversity and the extent to which the actions proposed for support by the Agency meet the needs thus identified.”

FAA Sections 118 and 119 are subject to annual reporting requirements according to FAA Section 634(a). Both Sections 118 and 119 specify that USAID work with nongovernmental organizations (NGOs) whenever feasible. Section 119 also provides guidance regarding consultation with local people and organizations.

Section 119(g)(10) provides for the denial of direct or indirect assistance “for actions which significantly degrade national parks or similar protected areas or introduce exotic plants or animals into such areas.”

The FAA also provides USAID with the authority to supply funding for fisheries management and conservation. Congress authorized the use of FAA appropriations for assistance to countries for “protecting and maintaining wildlife habitats and developing sound wildlife management and plant conservation programs.” In providing such assistance, the legislation directs USAID to make special efforts to:

- Establish and maintain wildlife sanctuaries, reserves, and parks
- Enact and enforce anti-poaching measures
- Identify, study, and catalog animal and plant species, especially in tropical environments

### **Some Key Points about the Foreign Assistance Act**

- It is important to analyze Sections 118 and 119 at the very early stages of planning for a USAID Country Development Cooperation Strategy (CDCS). Environmental officers should plan and ensure that these reviews are started very early in the planning process. The intent of Sections 118/119 analyses is to inform and influence country and mission strategies.
- Full consideration must be given to identify actions that USAID may take to conserve and sustainably use tropical forests and biodiversity from all ecosystems. The CDCS needs to examine potential impacts from all sectors — such as economic growth, agriculture, infrastructure and engineering, education, health, democracy and governance, as well as environment — and the role that USAID could play in mitigating threats.

### **Web Sites**

Fish and Wildlife Service. <http://www.fws.gov/laws/lawsdigest/FOREIGN.HTML>

Committee on International Relations, Committee on Foreign Relations: Legislation on Foreign Relations Through 2002 <http://www.usaid.gov/policy/ads/faa.pdf>

USAID Statutory Checklist. <http://www.usaid.gov/policy/ads/200/202sae.pdf>

### **LACEY ACT**

The Lacey Act of 1900 prohibits trade in wildlife, fish, and plants that have been illegally taken, possessed, transported, or sold both domestically and internationally. The Lacey Act stands as one of the broadest and most comprehensive laws for the U.S. Federal Government to combat fish and wildlife crime. The Lacey Act is administered by the Department of the Interior (U.S. Fish and Wildlife Service), Department of Commerce (National Marine Fisheries Service), and Department of Agriculture (Animal and Plant Health Inspection Service).



The Act has been amended several times to broaden its application from the original focus on the preservation of game and wild birds and the introduction of non-native or exotic species of birds and animals into native ecosystems. The 1969 amendments expanded the Act to include amphibians, reptiles, mollusks, and crustaceans. In 1981, the proof standard of “knowingly” was adopted in response to an increased illegal trade in fish and wildlife, both domestically and abroad. In 1988, the amendments created a separate and distinct violation for the intended falsification of documents pertaining to the export, import, or transport of wildlife, fish, or plants. The Act prohibits: a) the failure to accurately mark/label shipments of fish and wildlife; and b) trade in wildlife, fish, or plants that have been illegally taken, possessed, transported or sold.

**Prohibited Acts.** It is unlawful for any person to import, export, transport, sell, receive, acquire, or purchase in interstate or foreign commerce any fish or wildlife taken, possessed, transported, or sold in violation of any law or regulation of any State or in violation of a foreign law. “Fish or wildlife” means any wild animal, whether alive or dead, including without limitation, any wild mammal, bird, reptile, amphibian, fish, mollusk, crustacean, arthropod, coelenterate, or other invertebrate, whether or not bred, hatched, or born in captivity, and includes any part, product, egg, or offspring thereof. This definition covers most fish and wildlife, with the exception of domesticated pets, farm animals, and feral (wild, but formerly domesticated) animals.

**A violation must meet certain criteria.** The underlying foreign law must be resource-related. “Resource-related” means that the protection of wildlife is one of the purposes of the law. The catch must have been taken, possessed, transported, or sold in violation of a foreign law. The fish/wildlife must have been imported, exported, transported, received, acquired, or purchased in a manner prohibited by the Lacey Act. In this case, the U.S. Government has authority for civil administrative penalties (i.e., monetary fines), forfeiture of illegal product and vessels, and criminal sanctions. Rewards are authorized for information leading to arrests, criminal convictions, civil penalties, or the forfeitures of property, and for payment of costs of temporary care for fish, wildlife, or plants regarding a civil or criminal proceeding.

### Some Key Points about the Lacey Act

- Many USAID mission countries have endemic species that are threatened because of their value to international trade. This includes many marine species that may be caught using destructive fishing methods and sold throughout the world. The Lacey Act is a useful tool for addressing trade in these species due to its broad coverage and reliance on most domestic and foreign underlying resource laws.
- NOAA proceeds with a Lacey Act prosecution only when the nation whose underlying law has been violated supports the prosecution.
- NOAA may build upon the Lacey Act to target particular fisheries. For example, NOAA issued new guidelines that prohibit the import of spiny lobster tails below a minimum size as a way to prohibit the taking of juvenile lobsters from Central America and the Wider Caribbean.

### Web Sites

The Lacey Act. <http://www.fws.gov/le/pdf/Lacey.pdf>

U.S. Department of Agriculture: Plant Trade. [http://www.aphis.usda.gov/plant\\_health/lacey\\_act/](http://www.aphis.usda.gov/plant_health/lacey_act/)

Robert S. Anderson. 1995. The Lacey Act: America’s Premier Weapon in the Fight Against Unlawful Wildlife Trafficking. 16 Public Land Law Review. Public Land and Resources Law Review: 27.

<http://www.animallaw.info/articles/arus16publlr27.htm>

USAID Statutory Checklist. <http://transition.usaid.gov/policy/ads/200/202sae.pdf>

## **MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT**

Magnuson-Stevens Fishery Conservation and Management Act (MSA) is the primary law governing marine fisheries management in U.S. federal waters. Enacted in 1976, it aided in the development of the domestic fishing industry by phasing out foreign fishing in the U.S. exclusive economic zone (EEZ). The 1996 amendments focused on rebuilding overfished fisheries, protecting essential fish habitat, and reducing bycatch.

Prior to 1977, states were the primary managers of U.S. fisheries. MSA was a response to the slow progress made in the United Nations Convention on the Law of the Sea (UNCLOS) III negotiations. The MSA extended exclusive U.S. fishery jurisdiction to 200 miles offshore, which also became the outer limit of the U.S. EEZ.

The MSA established eight regional fishery management councils (RFMCs). These councils develop management plans that are implemented and enforced through regulations established by the NMFS. The MSA requires fishery managers to conserve the resource to produce a maximum sustainable yield (MSY).

The Magnuson-Stevens Reauthorization Act (MSRA) was passed in 2007 and made significant policy changes. MSRA mandates the use of annual catch limits and accountability measures to end overfishing. It also provides for widespread market-based fishery management through limited access programs, and calls for increased international cooperation. The Secretary of Commerce is required to work multilaterally through various forums — e.g., Regional Fishery Management Organizations (RFMOs) — to address illegal, unregulated, and unreported (IUU) fishing and bycatch of protected living marine resources.

Core elements of the MSA are:

- Foreign fishing vessels are prohibited from the U.S. EEZ (200 miles offshore)
- RFMCs must define and develop plans to prevent overfishing and restore stocks that are already over-fished in U.S. waters
- A ceiling on the optimum yield must be created in concert with the MSY.

Fishery management plans are required to identify essential fish habitat (EFH) for each fishery, minimize to the extent practicable the adverse impact of fishing activities on EFH, and identify other actions to conserve and enhance EFH.

### **Some Key Points about the Magnuson Stevens Reauthorization Act**

- NOAA submitted the first-ever report to Congress in January 2009 identifying six nations—France, Italy, Libya, Panama, the People’s Republic of China, and Tunisia—whose fishing vessels were engaged in IUU fishing in 2007 or 2008. This report opens the way for consultations between the U.S. government and officials of each of the six nations to encourage them to take corrective action to stop IUU fishing by their vessels.
- The MSA includes 10 national standards that provide overarching principles to guide the fishery management process. The 1990 amendments extended the Act’s jurisdiction to include all fish in the EEZ. It also committed the U.S. to cooperate with international organizations to manage highly migratory species throughout their range.

## **Additional information on IUU**

Under the international provisions of the MSRA, the United States is required to take action to combat illegal, unreported, or unregulated (IUU) fishing and reduce bycatch of protected living marine resources (PLMRs). Among the actions that must be taken, the Secretary of Commerce is required to produce a biennial report to Congress that identifies nations whose vessels are engaged in IUU fishing and/or bycatch of PLMRs.

### **For purposes of the MSRA, IUU fishing is defined as:**

- Fishing activities that violate conservation and management measures required under an international fishery management agreement to which the United States is a party, including catch limits or quotas, capacity restrictions, and bycatch reduction requirements;
- Overfishing of fish stocks shared by the United States, for which there are no applicable international conservation or management measures or in areas with no applicable international fishery management organization or agreement, that has adverse impacts on such stocks; and
- Fishing activity that has an adverse impact on seamounts, hydrothermal vents, and cold water corals located beyond national jurisdiction, for which there are no applicable conservation or management measures or in areas with no applicable international fishery management organization or agreement.

## **Web Sites**

Magnuson-Stevens Fishery Conservation and Management Act. <http://www.nmfs.noaa.gov/sfa/magact/>  
NOAA Magnuson Stevens Reauthorization Act. <http://www.nmfs.noaa.gov/msa2007/index.html>

## **MARINE MAMMAL PROTECTION ACT**

The U.S. Congress passed the Marine Mammal Protection Act (MMPA) in 1972 to establish a moratorium on the taking and importation of marine mammals and marine mammal products in U.S. waters, and by U.S. citizens on the high seas.

The MMPA authorizes the National Marine Fisheries Service (NMFS) to conserve and manage cetaceans and most pinnipeds, including whales, dolphins, porpoises, seals, sea lions, and fur seals. The U.S. Department of the Interior's Fish and Wildlife Service (USFWS) is responsible for polar bears, walruses, sea otters, marine otters, manatees, and dugongs.

The MMPA contains several exceptions to the moratorium, including:

- Permits may be issued “for purposes of scientific research, public display, photography for educational or commercial purposes, or enhancing the survival or recovery of a species or stock.”
- Unintentional taking of “small numbers of marine mammals” incidental to activities may be authorized.
- The Act allows the use of measures for the mammal’s welfare, or for the protection of the public health and welfare, to deter marine mammals from damaging property (including fishing gear and catch), or when necessary to protect human life.
- A general waiver provision under which the taking or importation of marine mammals and marine mammal products can be authorized.

The MMPA poses a moratorium on both the taking and importation of marine mammals and marine mammal products. The Act defines the term “take” to mean “to harass, hunt, capture, or kill . . . or to attempt to engage in any such conduct.”

The Act authorized the continued taking of marine mammals incidental to commercial fishing. However, it also set a goal to reduce mortality to less than each stock’s potential biological removal (PBR) level. The longer-term goal is to reduce mortality and serious injury to marine mammals in the course of such operations to “insignificant levels approaching zero mortality and serious injury rate.” The PBR is an alternative to setting numbers for acceptable takings.

### **Some Key Points about the Marine Mammal Protection Act**

Waivers allowing the importation of marine mammals or products require the Secretary of Commerce to determine that: the species or stock is at a healthy level and will not be disadvantaged by the taking; all animals to be imported were not pregnant or nursing or less than eight months old when taken; and the program for taking marine mammals in the country of origin is “consistent” with the MMPA. The Act established the Marine Mammal Commission and provides the authority under which the Commission operates.

### **Web Sites**

NOAA Fisheries. <http://www.nmfs.noaa.gov/pr/laws/mmpa/>

US Commission on Ocean Policy.

[http://govinfo.library.unt.edu/oceancommission/documents/full\\_color\\_rpt/append\\_6.pdf](http://govinfo.library.unt.edu/oceancommission/documents/full_color_rpt/append_6.pdf)

Marine Mammal Commission. <http://www.mmc.gov/>

Fish and Wildlife Service. [http://www.fws.gov/habitatconservation/marine\\_mammals.html](http://www.fws.gov/habitatconservation/marine_mammals.html)

## **OCEANS ACT OF 2000**

The purpose of the Oceans Act of 2000 is twofold: (1) to establish a national commission to make recommendations for a coordinated and comprehensive national ocean policy, both domestic and international; and (2) to require biennial reporting on ocean and coastal activities by all federal agencies.

Beginning September 2001, the Oceans Act requires the U.S. President to submit a biennial report to Congress of all federal programs related to coastal and ocean activities. For USAID to fulfill this reporting requirement, missions and operating units must describe all ocean, coastal, marine, coral reef and fisheries activities under “Key Issues” in the Performance Plan and Report (PPR).

The national commission established by Congress made recommendations for a coordinated and comprehensive national ocean policy to promote:

- Protection of life and property
- Stewardship of ocean and coastal resources
- Protection of the marine environment and prevention of marine pollution
- Enhancement of maritime commerce
- Expansion of human knowledge of the marine environment

- Investments in technologies to promote energy and food security
- Close cooperation among government agencies
- U.S. leadership in ocean and coastal activities

The Commission's report assessed and reviewed areas such as federal activities and laws, demand for ocean resources, opportunities for new investments, and effectiveness of the current governance framework.

In 2004, the U.S. Commission on Ocean Policy released their report citing the continuing degradation of coastal resources. It also cited the fragmentation of responsibility of programs designed to address coastal and marine issues of national concern. This was the first major national analysis of coastal management since the 1969 Stratton Commission. The following is a summary of the Commission's assessment of the U.S. governance system:

U.S. oceans and coasts are in trouble and major changes are urgently needed in the way they are managed. Emphasis is needed on ecosystem-based, watershed approaches that consider environmental, economic, and social concerns. A comprehensive and coordinated national ocean policy requires moving away from the current fragmented, single-issue way of doing business. Currently, the many entities that administer conservation and restoration activities operate largely independent of one another, with no framework for assessing overall benefits in an ecosystem-based context. The multitude of disjointed programs prohibits a comprehensive assessment of the progress of conservation and restoration efforts. This makes it difficult to ensure the most effective use of limited resources. Management approaches have not been updated to reflect the complexity of natural systems and responsibilities are dispersed among a confusing array of agencies at the federal, state, and local levels.

The Commission made more than 200 recommendations which included the following critical actions:

- Establish the U.S. as a global leader in ocean stewardship and resource conservation
- Adopt an ecosystem-based management framework
- Strengthen ocean education to better engage the general public
- Cultivate a broad stewardship ethic, and prepare a new generation of leaders to meet future ocean policy challenges
- Improve ocean governance
- Promote the use of sound science in decision-making

The Commission's vision saw the "United States as an exemplary leader and full partner globally, eagerly exchanging science, engineering, technology, and policy expertise with others, particularly those in developing countries, to facilitate the achievement of sustainable ocean management on an international level." The Commission recommended that U.S. leadership in coastal and ocean policy be affirmed and reinvigorated by acceding to the United Nations Convention on the Law of the Sea (UNCLOS). They also called on all ocean-related federal agencies to enhance their participation in international discussions and negotiations. These agencies should also take a leading role in building international capacity in ocean science and management, particularly in working in collaboration with developing countries.

## Web Sites

The Oceans Act of 2000. <http://govinfo.library.unt.edu/oceancommission/documents/oceanact.html>

# Appendix C. USAID DEVELOPMENT APPROACH, REGULATIONS, POLICIES, AND PROCEDURES

USAID's approach to sustainable and sound development can be summarized as follows:

Healthy and productive marine ecosystems are critical to U.S. diplomatic and development strategies to promote global food security, adapt to climate change, conserve biodiversity, improve economic security and competitiveness, enhance social stability, prevent conflict, improve human health, and mitigate disaster. U.S. assistance aims to empower communities and stakeholders to participate in decision-making affecting their interests, contributing to efforts to build the foundations of transparent, responsive and accountable governance.

Healthy, biodiverse ecosystems form the foundation for human well-being and economic and social development around the world. Healthy ecosystems are more resilient to climate change stresses, increasing the ability for adaptation and sustained economic development. USAID, the U.S. Congress, the U.S. Administration and the international community recognize that improving livelihoods, security, and human health depends on conserving biodiversity and sustainable resource use.

## Millennium Development Goals

The centrality of biodiversity conservation and environmental health in achieving global development goals is recognized in the articulation of the Millennium Development Goals (MDGs), established in August of 2002 at the World Summit on Sustainable Development (WSSD). MDG Goal 7 is "Ensure Environmental Sustainability" and identifies biodiversity conservation as the foundation for the other MDGs. "Reduce biodiversity loss" is a Target under MDG 7, with "Fish stocks require improved fisheries management to reduce depletion" as a sub-target:

*Major efforts to improve fisheries management are needed to improve the productive capacity of exploited stocks. Management action is also required to mitigate the impact of fisheries on aquatic ecosystems. These concerns can be addressed through the adoption of a holistic, participatory ecosystem approach to fisheries management.*

## THE FOREIGN ASSISTANCE ACT

The U.S. Foreign Assistance Act (FAA) fully recognizes the importance of environmental sustainability and conservation. The FAA requires that USAID address environmental and biodiversity concerns in all development actions. Section 117 on Environment and Natural Resources states:

*The Congress finds that if current trends in the degradation of natural resources in developing countries continue, they will severely undermine the best efforts to meet basic human needs, to achieve sustained economic growth, and to prevent international tension and conflict. The Congress also finds that the world faces enormous, urgent, and complex problems, with respect to natural resources, which require new forms of cooperation between the United States and developing countries to prevent such problems from becoming unmanageable. It is, therefore, in the economic and security interests of the United States to provide leadership both in thoroughly reassessing policies relating to natural resources and the environment, and in cooperating extensively with developing countries in order to achieve environmentally sound development.*



*(a) The President is authorized to furnish assistance under this part for developing and strengthening the capacity of less developed countries to protect and manage their environment and natural resources. Special efforts shall be made to maintain and where possible restore the land, vegetation, water, wildlife and other resources upon which depend economic growth and human well-being especially that of the poor.*

*(b) In carrying out programs under this chapter, the President shall take into consideration the environmental consequence of development actions. ([http://transition.usaid.gov/our\\_work/environment/compliance/faa\\_section\\_117.htm](http://transition.usaid.gov/our_work/environment/compliance/faa_section_117.htm))*

In Section 118, Congress has instructed USAID to address the loss of tropical forests, such as mangrove forests and tropical rain forests, which are among the most species-rich ecosystems on Earth ([http://transition.usaid.gov/our\\_work/environment/compliance/faa\\_section\\_118.htm](http://transition.usaid.gov/our_work/environment/compliance/faa_section_118.htm)). Section 119 of the FAA emphasizes the importance of biodiversity conservation and instructs USAID to give high priority to preventing biodiversity loss ([http://transition.usaid.gov/our\\_work/environment/compliance/faa\\_section\\_119.htm](http://transition.usaid.gov/our_work/environment/compliance/faa_section_119.htm)).

## **USAID ENVIRONMENTAL COMPLIANCE**

As a federal government agency, USAID is subject to applicable U.S. environmental laws, regulations, Executive Orders and procedures that ensure the wise use of the taxpayer's money. Effective implementation of these through state of the art environmental impact assessment ensures that the development activities USAID undertakes are not only economically sustainable but are protective of the world's environment on which we and future generations all depend.

Implementation and compliance within USAID is coordinated and enforced by a team of professional environmental staff led by the Agency Environmental Coordinator and a network of Bureau Environmental Officers, Regional Environmental Advisors, Mission Environmental Officers and the Biosafety Review Advisor.

## **REGULATION 216**

USAID environmental procedures are embodied in 22 CFR 216—commonly referred to as “Reg. 216” which has three basic goals:

- Ensure environmental factors and values are integrated into USAID decision-making processes;
- Assign responsibility within the Agency for assessing the environmental effects of USAID actions by the Agency since 1979; and
- Implement the requirements of the U.S. National Environmental Policy Act (NEPA) as they affect USAID programs

Today, Reg. 216 is regarded as USAID's principal directive for designing development activities that are environmentally sustainable. All USAID-funded or managed activities must be reviewed for their environmental impacts through an initial environmental examination (IEE) (see the ADS for rare exceptions). This provision includes all new activities and substantial amendments to ongoing activities, such as extensions in time, increases in funding, or modifications to activities.

Under 22 CFR 216, the Agency is required to conduct rigorous and comprehensive environmental reviews for all programs, projects, and activities, and substantive amendments to existing programs. In addition, Sections 118 and 119 of the FAA require USAID to conduct environmental reviews on tropical forests and biodiversity.

Guidance on applying 22 CFR 216 is found in USAID’S Automated Directives System, Chapter 204. This is available on the internet at: <http://transition.usaid.gov/policy/ads/200/204.pdf>. Additional guidance can be found at: [http://transition.usaid.gov/our\\_work/environment/compliance/22cfr216.htm](http://transition.usaid.gov/our_work/environment/compliance/22cfr216.htm).

The Code of Federal Regulations (CFR) also provides guidance to USAID on maintaining the natural resource base and ecosystem integrity. 22 CFR 216. 1(b)(4) instructs USAID to:

*(D)efine environmental limiting factors that constrain development and identify and carry out activities that assist in restoring the renewable resource base on which sustained development depends.*

### **Executive Order on Invasive Species and the U.S. Invasive Species Council**

The National Invasive Species Council (NISC) was established by Executive Order (EO) 13112 to ensure that federal programs and activities to prevent and control invasive species are coordinated, effective and efficient. (<http://www.invasivespecies.gov/>) NISC members are the Secretaries and Administrators of 13 federal departments and agencies who provide high-level coordination on invasive species. The Administrator of USAID is a member of the NISC. EO 13112 defines invasive species as “...an alien (or non-native) species whose introduction does, or is likely to cause economic or environmental harm or harm to human health.”

Federal agencies are required to report each year on their activities to reduce and prevent invasive species. For USAID to fulfill this reporting requirement, missions and operating units must describe all activities related to reducing or preventing impacts from invasive species under “Key Issues” in the Performance Plan and Reports (PPR).

### **Executive Order on the Protection of Coral Reefs and the U.S. Coral Reef Task Force**

The U.S. Coral Reef Task Force was established by Executive Order (EO) 13089 to ensure that federal programs and activities protect and conserve coral reef and related ecosystems, both domestically and internationally. USAID is an active participant on the U.S. Coral Reef Task Force, and co-chairs the International Working Group with the State Department. The international charge of the Executive Order is to: (1) assess the U.S. role in the international trade of coral reef species; (2) develop an appropriate, broad-based strategy for mitigating the negative impacts of trade; (3) develop and implement strategies and activities for the protection and sustainable use of coral reef resources worldwide; and (4) implement the International Coral Reef Initiative’s Framework for Action through expanded cooperation with ICRI partners.

Federal agencies report every two years on their activities that support the coral reef protection and conservation. For USAID to fulfill this reporting requirement, missions and operating units must describe all activities related to coral reef and related ecosystems, such as mangrove forests and seagrass meadows, under “Key Issues” in the PPRs.

In addition to compliance with relevant international treaties and with the FAA, USAID is legally required to comply with several key environmental statutes and regulations to ensure that its programs and projects are environmentally sound. This section does not provide the information necessary to address compliance with these regulations. Rather, it briefly describes some of the regulations of special importance to fisheries and aquaculture activities and programs.

For guidance on compliance with any of the regulations, refer directly to the ADS 200 series and consult with the USAID mission or bureau environmental officer. USAID has included specific language in the ADS 200 chapters, which identifies the objectives, authorities, and responsibilities of all Agency

personnel and describes all aspects of the planning and review process for environmental compliance. Chapter 204 maps out the policies, procedures, and staff roles and responsibilities. Chapters 201, 202, and 203 outline the ways environment is integrated into the planning, achieving, and evaluating dimensions of USAID programming.

# ACRONYMS

ACC	Aquaculture Certification Council
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
BMP	Best Management Practice
BOD	Biological Oxygen Demand
BRD	By-catch Reduction Device
CBD	Convention on Biological Diversity
CFR	Code of Federal Regulations
CITES	Convention on International Trade in Endangered Species
COFI	Committee on Fisheries
COOL	Country-of-Origin Labeling
COP	Conference of Parties
CPUE	Catch Per Unit of Effort
CRSP	Collaborative Research Support Program
EA	Environmental Assessment
EBM	Ecosystem-Based Management
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIA	Environmental Impact Assessment
ESA	Endangered Species Act
FAA	Foreign Assistance Act
FAD	Fish Aggregating Device
FAO	United Nations Food and Agriculture Organization
FDA	U.S. Food and Drug Administration
FED	Fish Excluder Device
FISH	USAID Fisheries Improved for Sustainable Harvest Project
GIS	Geographic Information System
GMO	Genetically Modified Organisms
ICM	Integrated Coastal Management
ICRI	International Coral Reef Initiative
IEE	Initial Environmental Examination
IPOPCORM	Integrated Population and Coastal Resource Management
IQC	Indefinite Quantity Contract
ITQ	Individual Transferable Quotas
IUU	Illegal, Unreported, and Unregulated Fishing
IWRM	Integrated Water Resources Management
LOS	Law of the Sea
MCA	Marine Conservation Agreement
MCS	Monitoring, Control, and Surveillance
MEY	Maximum Economic Yield
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSC	Marine Stewardship Council
MSRA	Magnuson-Stevens Reauthorization Act
MSY	Maximum Sustainable Yield
NEPA	U.S. National Environmental Policy Act
NGO	Non-Governmental Organization

NMFS	U.S. National Marine Fisheries Service
NOAA	U.S. National Oceanic and Atmospheric Administration
OIE	World Organization for Animal Health
PCB	Polychlorinated Biphenyls
PHE	Population-Health-Environment
RECOFI	Regional Commission for Fisheries
RFMC	Regional Fisheries Management Council
RFMO	Regional Fisheries Management Organization
SMART	Specific, Measurable, Achievable, Realistic and Timely
TAC	Total Allowable Catch
TED	Turtle Excluder Device
TRAFFIC	The Wildlife Trade Monitoring Network
TRP	Target Reference Point
TURFS	Territorial Use Rights in Fisheries
UNCLOS	United Nations Convention on the Law of the Sea
UNFSA	United Nations Fish Stocks Agreement
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USFWS	U.S. Department of the Interior's Fish and Wildlife Service

# GLOSSARY

**Access agreements** are entered into when distant water fleets (DWFs) fish outside their national waters and must enter into agreements with individual countries to fish inside of the Exclusive Economic Zone (EEZ). These agreements generally involve access to the fisheries resources in return for a financial contribution or in-kind benefits.

**Acquisition** involves buying or contracting for goods, services, or results.

**Active fishing gear** is gear used to pursue the fish — e.g., spears and harpoons, trawls (beam, bottom, mid-water) and dredges (hydraulic, scallop, clam), seine nets (purse, beach, and other).

**Adaptive management** emphasizes designing, implementing, and monitoring project activities in a way that helps people learn more about complex ecological and social systems, which in turn can help them make better choices and design more effective interventions.

**Aquaculture** is the culturing or farming of animals or plants in water.

**Area and time closures** are used in fisheries management to control fishing effort, protect certain essential fish habitat or protect species during critical life stages (e.g. spawning aggregations), regardless if they are permanent or seasonal closures.

**Artisanal or small-scale fisheries** are a more traditional, labor-intensive form of fishing performed by men, women, and children. The boats are sometimes mechanized; however, they usually involve fishing from small boats or from shore, gleaning, or use of traditional gear such as hand-lines, small nets, traps, spears, and hand collection methods.

**Best management practices (BMP)** rely mainly on voluntary adoption of practices that optimize production, minimize impacts, increase benefits, and reduce risks of all types.

**Biodiversity** is the variety and variability of life, including the diversity of genes within species, the diversity of species, the diversity of communities and ecosystems, and the diversity of ecological processes.

**Biofilters** generally contain materials with a large surface area which hosts bacteria that remove nitrogenous compounds from the used water, therefore improving the water quality to a level where it can be re-used.

**Biomass** is the measure of the quantity, usually by weight in pounds or metric tons (2,205 pounds=1 metric ton) of a stock at a given time.

**Biosafety** deals with the risk or hazard of using genetically modified organisms in research; field trials; or agricultural, medical, industrial, or other technologies.

**Biosecurity** is the ability to exclude pathogens listed by the OIE (World Organization for Animal Health) from farm operations. This is usually done through ensuring that new animals, workers, feed, and other items entering the farm are free of pathogens.



**Bivalves** (oysters, clams, cockles, scallops) are mollusks with two shells that generally feed themselves by filtering water and extracting algae.

**Boom phenomena** occurs when a particular type of aquaculture grows rapidly with little control or oversight in a context where technical capacity, governance, and policy may be absent or weak.

**Bycatch** is a byproduct of fishing. This includes the catch of non-target species, undersized fish, marine mammals, and endangered species.

**Bycatch reduction devices (BRDs)** are devices to help reduce catch levels and to increase selectivity. Gear modifications include large escape openings, biodegradable panels, large mesh and rope trawls, square mesh windows, and other bycatch reduction devices.

**Cage culture** is the farming of aquatic organisms in floating pens or other netted enclosures and is most often practiced in reservoirs or lakes, estuaries and bays, although it is now becoming common to use very large cages in off-shore, open-ocean sites.

**Capture fisheries** is the wild harvest of finfish, mollusks, shellfish, algae and aquatic plants, or other animals or live organisms from aquatic environments (lakes, rivers, estuaries and oceans)

**Catch per unit of effort (CPUE)** is the catch of fish, in numbers or in weight, taken by a defined unit of effort.

**Certification programs** set sustainability standards against which a particular fishery is audited. Certification encompasses three processes: 1) standard setting; 2) accreditation; and 3) certification—e.g., the Marine Stewardship Council (MSC).

**Co-management** is a partnership arrangement where fishers and government share responsibility and authority for managing the fishery.

**Codes of conduct** are broad guidelines or statements for conducting an activity in socioeconomically and environmentally compatible ways.

**Community-based management** is one form of co-management and is carried out at small-scales, usually by village communities.

**Consortium Agreement** is when three or more public and private entities jointly provide the services and share in all decision-making.

**Consumer-based management** approaches promote mass movements to buy only sustainably sourced seafood from retailers or patronize restaurants that serve only sustainable green or eco-labeled seafood.

**Contractual relationships** involve the contracting of a private entity by a public agency to provide goods or services to the public.

**Decentralization** refers to the shifting of responsibilities from central government to lower levels of government.

**Discard** is the fish that are caught but not landed because they are unmarketable, or prohibited.

**Eco-labeling** is a tag placed on a product that certifies it was produced in a sustainable, environmentally friendly way.

**Economic post-harvest losses** occur when fish spoil and lose their value or when fish are re-processed, which raises the cost of the finished product.

**Ecosystem-based management (EBM)** is an integrated approach that focuses on conserving the underlying health and resilience of the ecosystem, thus maintaining the system's goods and services and leading to increased productivity.

**Environmental assessment (EA)** is an analysis to determine whether a proposed action will have a harmful effect on the environment.

**Environmental impact assessment (EIA)** is an analysis to determine whether a proposed action will have a harmful impact on the environment, often comparing the impact of this proposed action with that of other alternatives and options.

**Eutrophication** is a process whereby water bodies receive excess nutrients that stimulate excessive plant growth. This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die.

**Exclusive Economic Zone (EEZ)** is the area of the ocean up to two hundred nautical miles from a country's shore.

**Extensive culture** refers to the lowest density of organisms kept in a culture system. Generally, extensive culture systems require less feed, no artificial aeration, and may produce minimal effluent loads.

**Feed conversion ratio (FCR)** is defined as the net amount of feed (dry weight) used to produce one pound or kilo of animal product (wet weight).

**Fish aggregating device (FAD)** is a man-made object used to attract ocean-going pelagic fish such as marlin, tuna and mahi-mahi (dolphin fish).

**Fish meal** is made from fish harvested but not used for human consumption, and used as the protein component of fish feed. It is easily digestible (as compared to vegetable sources such as soy), and supplies an amino acid (constituents of proteins) profile that fish require.

**Fisheries management** is the integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources, and formulation and implementation—with enforcement as necessary—of regulations or rules that govern fisheries activities in order to ensure the continued productivity of the resources and accomplishment of other fisheries objectives.

**Fisheries subsidy** is a government intervention (or lack of) that affects the fishing industry and has an economic value and typically reduces costs of operations to the private sector or individual fishing enterprise.

**Fishery stock** is defined as a portion of a fish population that may share biological characteristics and/or fishery characteristics.

**Fishing effort** is a predefined unit of total fishing gear in use for a specified period of time.

**Fishing mortality** is the deaths in a fish stock caused by fishing. It can include discard mortality and landings.

**Fishing power** is the catch that a certain gear or vessel takes from a given density of fish during a certain time interval. For example, larger vessels with more horsepower have a greater ability to catch fish, thus greater fishing power.

**Gastropods** (snails) are mollusks and are generally more difficult to culture than their cousins, the bivalves.

**Gear restrictions** can range from requiring minimum mesh sizes to avoid catching juvenile fish, to outright prohibitions on certain gear types (e.g., dynamite or blast fishing, the use of poisons such as sodium cyanide, or electro-fishing).

**Hard total allowable catch (TAC)** or harvest limit is a limit on total harvest and cannot be exceeded. This type of TAC restricts the harvest to a safe proportion of the exploitable stock of fish. A hard TAC is usually less than the actual maximum yield that can be extracted by the fishery based on biological considerations or effort levels. This figure needs annual updating.

**Highly migratory fish** refers to fish species that undertake ocean migrations and also have wide geographic distributions. It usually denotes tuna and tuna-like species, shark, marlin, and swordfish.

**Individual transferable quotas (ITQs)** allocate annual fishing quotas to individual fishers. These can be bought and sold among fishers or conservation groups.

**Input controls** are regulations directed at controlling the fishing power and total effort used to harvest fish. They can be in the form of limits to the number and size of fishing vessels; to the amount of time allowed to fish; and to the types, numbers, or characteristics of gear used.

**Intensive culture** occurs when stocking densities are high enough that higher levels of feeding and fertilization are required, aeration is usually required, and water quality must be carefully controlled and monitored.

**Intertidal zone** is the coastal area between the highest and lowest tide marks.

**Initial environmental examination (IEE)** is a brief statement of factual basis for a threshold decision as to whether an Environmental Assessment or an Environmental Impact Statement will be required.

**Invasive or nuisance species** is a species, often introduced inadvertently or deliberately by human activities from another continent or ecosystem, which can crowd out native species and take over habitats, thereby threatening native biodiversity.

**Large-scale industrial or commercial fisheries** use relatively capital-intensive fishing technologies, with harvesting and processing equipment owned by commercial entrepreneurs and operated by salaried crews.

**Limit reference points (LRP)** are stock assessment indicators that may correspond to a minimum condition (e.g., dangerously low spawning biomass) or a maximum condition (e.g., a high rate of decline in stock size or a high mortality rate).

**Marine ornamental species** are fish (mostly aquarium), corals, invertebrates, and plants.

**Marine protected area (MPA)** is an area of sea especially dedicated to the protection and maintenance of biodiversity and of natural and associated cultural resources, and managed through legal or other effective means. MPAs range from small, locally managed and enforced fisheries or ecological reserves (no-take reserves) to larger national marine parks that are zoned for multiple uses.

**Maximum economic yield (MEY)** is the point where the difference between total yield and total costs is the greatest. It occurs at lower total effort levels than maximum sustainable yield (MSY).

**Maximum sustainable yield (MSY)** is the largest average catch or yield that can continuously be taken from a stock under existing environmental conditions. This also is often referred to as the maximum biological yield.

**Mollusks** are bivalves (oysters, clams, cockles, scallops) and gastropods (snails).

**Natural mortality** is the deaths in a fish stock caused by predation, pollution, senility, etc. but not fishing.

**Nearshore environment** is the area that encompasses the estuaries, lagoons, bays, reefs, and sounds.

**No-take reserves or locally managed marine areas** are areas where extractive activities — including fishing — are permanently prohibited. Some no-take areas allow for non-extractive activities to occur, such as SCUBA diving or snorkeling.

**Non-extractive activities** are activities that include tourism, SCUBA diving and snorkeling.

**One-stop permitting process** is an application submitted to a single institution, which then facilitates review and approval by other institutions.

**Optimum yield** is the yield from the fishery that provides the greatest overall benefit to the nation with particular reference to food production and recreational opportunities.

**Output controls** are direct limits on the number or size of fish harvested regardless of the inputs used.

**Partnership Agreement** is when public and private entities jointly provide the service and share in all decision-making.

**Passive fishing gear** requires the fish to come voluntarily to the gear, e.g., gillnets, trammel nets, hook and line, hand-lining, trolling, long-lining, pots, and traps.

**Physical post-harvest losses** result from poor handling, preservation, and discarding.

**Protected area** can range from an area where there is no-take of all species, to areas where there are restrictions only on selected species, to restrictions on gear types, or seasonal closures such as during spawning season.

**Quota** is a portion of the total allowable catch allocated to an operating unit, such as an individual, vessel, or country.

**Recirculation systems** are generally tanks or raceways where water is recycled by pumping through some sort of biofilter.

**Regional Fisheries Management Organizations (RFMOs)** are affiliations of States that are responsible for the conservation and management of fisheries on the high seas and fish stocks that migrate through the waters of more than just one State.

**Rights-based management system** gives use rights to those individuals or groups entitled to access the fishery.

**Salmonids** are salmon and trout.

**SCALE** is a framework, a process, and a set of practical tools and techniques that catalyze system-wide change and result in enhanced livelihoods, improved governance, increased civil society participation, and the adoption of best practices.

**Secured access fishery** places a limit on the number of participants who have rights and responsibilities in harvesting and managing the resource.

**Semi-intensive culture** refers to moderate stocking rates where artificial feeds, attention to water quality parameters, and careful adjustment and control of feeding and fertilization to maintain water quality are required.

**Shrimp and prawns** are crustaceans. Shrimp usually refers to marine species while prawn refers to certain larger marine species and freshwater species.

**Small-scale or artisanal fisheries** are a more traditional, labor-intensive form of fishing performed by men, women, and children. The fishery is sometimes mechanized; however it usually involve fishing from small boats or from shore, gleaning, or use of traditional gear such as hand-lines, small nets, traps, spears, and hand collection methods.

**Soft total allowable catch (TAC) or harvest limit** is used as a reference point to assess how close actual landings are to desired levels. Soft TACS may be modified as necessary.

**Stakeholder** is any person, group, or organization with an interest in the use and management of some aspect of biodiversity in a given place, or which affects or is affected by a particular conservation action, ranging from local users, to government agencies, nongovernmental organizations, and the private sector. Stakeholders can include those at the local, national, and international levels.

**Stock** is a part of a fish population usually with particular life history patterns, migration patterns, spawning grounds, and subject to a distinct fishery.

**Straddling stocks** are fish stocks that migrate through, or occur in, more than one EEZ (e.g., cod, flounder, and turbot).

**Sustainable yield** is the number or weight of fish in a stock that can be taken by fishing without reducing the stock biomass from year to year, assuming that environmental conditions remain the same.

**Target reference points (TRP)** are stock assessment indicators of a desired stock status, such as biomass levels or fishing mortality rates.

**Trade-based management approach** uses importation measures as a way to assist in more sustainable resource management and illegal exports.

**Traditional management** is a form of community-based or co-management. It integrates local cultural or traditional practices, and often follows informal rules or community norms that fall outside of legal or conventional management regimes.

**Turtle and fish excluder devices (TED and FED)** help reduce catch levels and increase selectivity. Gear modifications include large escape openings, biodegradable panels, large mesh and rope trawls, or square mesh windows.

**Value chain analysis** is a method for analyzing the series of activities that add value to fish products.

**Voluntary and incentive-based management approaches** include codes of conduct or best management practices, and eco-labeling or certification schemes. These approaches encourage fishers to “do the right thing” through moral suasion, peer pressure, or for economic reasons.







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