

# International Principles for Responsible Shrimp Farming

2006



**International Principles for  
Responsible Shrimp Farming**

**2006**

**FAO, NACA, UNEP, WB, WWF**

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO), the Network of Aquaculture Centres in Asia-Pacific (NACA), United Nations Environment Programme (UNEP), the World Bank Group (WB), and the World Wildlife Fund (WWF) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

COPYRIGHT AND OTHER INTELLECTUAL PROPERTY RIGHTS, Food and Agriculture Organization of the United Nations (FAO), the Network of Aquaculture Centres in Asia-Pacific (NACA), United Nations Environment Programme (UNEP), the World Bank Group (WB), and the World Wildlife Fund (WWF) 2006.

All rights reserved. Reproduction and dissemination of material in this information product for educational or other non-commercial purposes are authorized without any prior written permission from the copyright holders provided the source is fully acknowledged. Reproduction of material in this information product for resale or other commercial purposes is prohibited without written permission of the copyright holders.

© 2006

## Abstract

Shrimp farming is one of the fastest growing aquaculture sectors in many parts of the world and also one of the most controversial. Rapid expansion of this sector generated income for many countries, but has been accompanied by rising concerns over environmental and social impacts. The *International Principles for Responsible Shrimp Farming* provide the basis upon which stakeholders can collaborate for a more sustainable development of shrimp farming. The *International Principles* have been developed by the Consortium on Shrimp farming and the Environment, which consists of the Food and Agriculture Organization of the United Nations (FAO), the Network of Aquaculture Centres in Asia-Pacific (NACA), the Coordination Office of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities of the United Nations Environment Programme (UNEP/GPA), the World Bank (WB) and the World Wildlife Fund (WWF).

FAO/NACA/UNEP/WB/WWF. 2006. *International Principles for Responsible Shrimp Farming*. Network of Aquaculture Centres in Asia-Pacific (NACA). Bangkok, Thailand. 20 pp.

# Table of Contents

<b>1. Background and Purpose.....</b>	<b>1</b>
Introduction .....	1
Shrimp Farming .....	1
Process .....	2
Purpose .....	3
<b>2. International Principles for Responsible Shrimp Farming .....</b>	<b>4</b>
Principle 1 – Farm Siting.....	4
Principle 2 – Farm Design.....	5
Principle 3 – Water Use .....	6
Principle 4 – Broodstock and Postlarvae .....	7
Principle 5 – Feed Management.....	8
Principle 6 – Health Management.....	9
Principle 7 – Food Safety.....	10
Principle 8 – Social Responsibility .....	11
<b>3. Implementation .....</b>	<b>12</b>
3.1 Public sector .....	12
<i>Aquaculture legislation .....</i>	<i>12</i>
<i>National aquaculture development strategies.....</i>	<i>12</i>
<i>Integrated coastal area management and land use plans.....</i>	<i>12</i>
<i>Environmental assessment .....</i>	<i>13</i>
<i>Aquaculture monitoring.....</i>	<i>13</i>
<i>Farm registration.....</i>	<i>14</i>
<i>Institutional strengthening.....</i>	<i>14</i>
3.2 Private sector .....	14
<i>Adaptation and adoption to local conditions .....</i>	<i>14</i>
<i>Investment .....</i>	<i>15</i>
<i>Knowledge transfer and communications.....</i>	<i>15</i>
<i>Farmer organizations and private institutions .....</i>	<i>15</i>
<i>Stakeholder cooperation.....</i>	<i>16</i>
3.3 Regional and International Cooperation .....	16
<b>4. Key references and information sources .....</b>	<b>17</b>
4.1 Key references .....	17
4.2 Case studies conducted by the Consortium Program.....	18

# 1. Background and Purpose

## Introduction

Aquaculture production and trade in aquaculture products continues to grow at a fast pace, responding to increased global demand for fish, shrimp, molluscs and other aquatic products. In 2004, aquaculture production reached 59 million tonnes, with a farm gate value of \$70 billion. Developing countries dominate aquaculture production and trade, contributing over 80% of production and 50% to the value of internationally traded aquatic products. Aquaculture is making an increasingly significant contribution to the global seafood trade, as well as to domestic consumption, and will continue to grow due to stagnating wild capture fisheries supplies.

With increasing volume of production, trade and consumption there is a concurrent and increasing demand for improved sustainability, social acceptability, and human health safety from the aquaculture sector. This is not only affecting the international trading environment and pressurizing producers to focus on production methods to address those issues, but also challenges producing countries to develop and implement adequate and appropriate policies and institutions that provide a conducive environment for responsible production and trade. To assist in achieving these objectives, the members of the Food and the Agriculture Organization of United Nations (FAO) in 1995 adopted the Code of Conduct for Responsible Fisheries, providing a framework for responsible development of aquaculture and fisheries.

## Shrimp Farming

Shrimp farming has been one of the fastest growing aquaculture sectors in Asia and Latin America, and recently Africa, but also one of the most controversial. Rapid expansion of shrimp farming has generated substantial income for many developing countries, as well as developed countries, but has been accompanied by rising concerns over environmental and social impacts of development. Major issues raised include the ecological consequences of conversion of natural ecosystems, particularly mangroves, for construction of shrimp ponds, the effects such as salination of groundwater and agricultural land, use of fish meal in shrimp diets, pollution of coastal waters due to pond effluents, biodiversity issues arising from collection of wild brood and seed, and social conflicts in some coastal areas. The sustainability of shrimp aquaculture has been questioned by some in view of self-pollution in shrimp growing areas, combined with the introduction of

pathogens, leading to major shrimp disease outbreaks, and significant economic losses in producing countries.

Due to the strong global interest in shrimp farming and the issues that have arisen from its development, a Consortium Program involving the World Bank, the Network of Aquaculture Centres in Asia-Pacific (NACA), the World Wildlife Fund (WWF), and the Food and Agriculture Organization of the United Nations (FAO) was initiated in 1999 to analyze and share experiences on the environmental and social impacts, and management of sustainable shrimp farming. The development of the work program for the Consortium benefited from recommendations of the FAO Bangkok Technical Consultation on Policies for Sustainable Shrimp Culture (FAO, 1998), a World Bank review on Shrimp Farming and the Environment (World Bank, 1998) and an April 1999 meeting on shrimp aquaculture management practices hosted by NACA and WWF in Bangkok, Thailand. The FAO Expert Consultation on Good Management Practices and Good Legal and Institutional Arrangements for Sustainable Shrimp Culture held in Brisbane, Australia in December 2000 provided further guidance to the Consortium process.

The FAO Committee on Fisheries Sub-Committee on Aquaculture in its second session held in Trondheim, Norway, in 2003 agreed that a set of “core” management principles should be developed to support sustainable development of aquaculture, with a priority to shrimp farming requiring improved management. The Consortium was requested to undertake this responsibility. During this meeting the Coordination Office of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities of the United Nations Environment Programme (UNEP/GPA) expressed its interest to join this initiative and subsequently the Consortium formalized the partnership through signing a collaborative agreement with UNEP/GPA. This recommendation and partnership provides the basis for development of an internationally accepted set of principles that can be widely adopted.

## Process

The *International Principles for Responsible Shrimp Farming* have been synthesized from the outcome of the studies and consultations conducted by the Consortium, involving a wide range of stakeholders, from government, private and non-government organizations.

## Purpose

The purpose of the *International Principles* as mandated by the members of FAO and NACA, is to provide principles for management of shrimp farming that provide guidance in implementation of the FAO Code of Conduct for Responsible Fisheries in the shrimp aquaculture sector. The *International Principles* consider technical, environmental, social and economic issues associated with shrimp farming and provide a basis for industry and government management to improve the overall sustainability of shrimp farming at national, regional and global levels. The principles and associated guidance on implementation may be used by public and private sectors for development of locally specific Codes of Practice (COP), better management practices (BMPs) or other management approaches for shrimp farming, suitable for adoption by farmers in particular social, economic and environmental contexts.

The *International Principles* provide the basis upon which stakeholders can collaborate for a more sustainable development of shrimp farming. For governments, they provide a basis for policy, administration and legal frameworks, that can be renewed (or formulated where there are none), adjusted, funded and implemented to address the specific characteristics and needs of the sector in order to protect and enhance the industry, the environment, other resource users and consumers. Typically, existing legislation and guidelines have been modified from those suitable for other industries and are not always applicable to aquaculture. Strengthening of institutional arrangements, capacity and partnerships is also important to ensure the cooperation and coordination of all relevant institutions with jurisdiction over natural resources, animal and public health. The *International Principles* also provide the basis for development of standards and certification systems. Further details on implementation and compliance to the *International Principles* will be available through another publication which is currently being prepared by the Consortium.

## 2. International Principles for Responsible Shrimp Farming

### Principle 1 – Farm Siting:

Locate shrimp farms according to national planning and legal frameworks in environmentally suitable locations, making efficient use of land and water resources and in ways that conserve biodiversity, ecologically sensitive habitats and ecosystem functions, recognizing other land uses, and that other people and species depend upon these same ecosystems.

***Justification:** It is clear from substantial worldwide experience that inappropriate and unplanned siting of shrimp farms has resulted in production failures, environmental degradation, land use conflicts and social injustice. Thus, it is imperative that, during establishment of shrimp farms, due consideration is given to the environment, ecologically sensitive habitats, other land use in the vicinity, and the sustainability of the shrimp farming operations themselves.*

#### **Implementation guidance:**

- Build new shrimp farms above the inter-tidal zone.
- No net loss of mangroves or other sensitive wetland habitats.
- Do not locate shrimp farms on sandy soils or other areas where seepage or discharge of salt water may affect agricultural land or freshwater supplies.
- Do not locate new shrimp farms in areas that have already reached carrying capacity for aquaculture.
- Retain buffer zones and habitat corridors between farms and other users and habitats.
- Obey land use and other planning laws and coastal management plans.
- Improve existing farms in inter-tidal and mangrove areas through mangrove restoration, retiring unproductive ponds and increasing productivity of remaining farm areas above the inter-tidal zone.

## Principle 2 – Farm Design:

**Design and construct shrimp farms in ways that minimize environmental damage.**

***Justification:** With the increasing intensity and expansion of shrimp farming operations evident in recent years, suitable design and construction techniques should be used when establishing new shrimp farms. Advantage should be taken of improved techniques that take into account not only the requirements of the cultured shrimp and the management of the farm, but also integrate the farm into the local environment whilst causing the minimum possible disturbance to the surrounding ecosystems.*

### **Implementation guidance:**

- Incorporate buffer areas and techniques and engineering practices that minimize erosion and salination of surrounding areas during farm construction and operation.
- Minimize disturbance of acid-sulfate soils during construction and operation.
- Conserve biodiversity and encourage re-establishment of natural habitats in farm design.
- Minimize creation of degraded areas such as unused soil piles and borrow pits.
- Design dykes, canals and infrastructure in ways that do not adversely affect hydrology.
- Separate effluent discharge points from inlet canal to reduce self pollution and maintain biosecurity.

## Principle 3 – Water Use:

**Minimise the impact of water use for shrimp farming on water resources.**

***Justification:** Minimizing the use of new water is an essential part of modern, environmentally responsible shrimp farming. Reducing water exchange benefits the farmer by lowering pumping costs and reducing the chance of introducing toxic compounds, pathogens, disease vectors or other undesirable organisms into the farm. It also benefits the environment by reducing the discharge of nutrients and organic matter from the farms and by reducing the utilization of precious freshwater resources. Recent innovations have shown that proper management protocols can reduce water exchange requirements, even in highly intensive systems, with no loss in shrimp performance. This has benefits for all parties and should be encouraged at all levels.*

### **Implementation guidance:**

- No use of fresh groundwater for salinity control.
- Use water efficiently through minimizing water abstraction.
- Minimize discharge of farm effluents and sediment to the environment.
- Aim to return water with lower concentrations of nutrients, organic matter and solids to the ecosystem than that taken out.
- Incorporate settlement and sedimentation ponds into the water inlet and outlet designs.
- Manage water and soil quality to maintain suitable environmental conditions in shrimp ponds.
- Obey national laws and guidelines on water use and effluent discharge.

## Principle 4 – Broodstock and Postlarvae:

Where possible, use domesticated selected stocks of disease free and/or resistant shrimp broodstock and post-larvae to enhance biosecurity, reduce disease incidence and increase production, whilst reducing the demand for wild stocks.

***Justification:** Recent trends in shrimp farming have seen a change towards the use of domesticated stocks of animals, following the current agricultural paradigm. Elimination of the need to source broodstock and/or post-larvae from the wild has allowed the industry to develop successful programmes for the enhancement of their shrimp stocks, in terms of both their reproductive and production characteristics. It has also led to the development of some disease free and/or disease resistant stocks. Concomitantly, these developments have led to reduced demands for wild stocks and hence reductions in unwanted by-catch and habitat losses involved with their collection. However, further work is required to achieve these advances for all currently cultured species. The problems with transboundary movements of non-indigenous species which brought new threats of disease transmission and reduced biodiversity must be addressed.*

### **Implementation guidance:**

- Avoid negative impacts on biodiversity from collection of wild caught broodstock or post-larvae.
- Give preference to local and indigenous shrimp species.
- Adopt on-farm quarantine and biosecurity measures to reduce risks of disease introductions.
- Use domesticated stocks wherever possible.
- Stock good quality postlarvae to improve chances of successful harvest.
- Comply with national, regional and international criteria controlling the movement and quarantine of animals.

## Principle 5 – Feed Management:

**Utilize feeds and feed management practices that make efficient use of available feed resources, promote efficient shrimp growth, minimize production and discharge of wastes.**

***Justification:** Control and rationalization of feeds and feeding in modern shrimp farming is of critical importance in maintaining a cost-effective and environmentally sound industry. This is due to many factors including: Feeds and feeding account for 50-60% of the operational costs of semi- and intensive shrimp farming. Wasted (uneaten and unmetabolized) feed in addition to affecting pond water quality and predisposing shrimp to disease is also a major contributor to the discharge of nutrients and organic matter from shrimp farms leading to eutrophication of the environment. Increasing concern is also being expressed regarding the wasteful use of increasingly scarce resources of fishmeal going into shrimp diets for a net loss of protein resources and allied losses due to by-catch from the fishmeal industry. Formulation of cost-efficient and high quality, low polluting diets, and proper management of the feeding regime are thus crucial in attempting to optimize the efficient use of feeds in shrimp farming.*

### **Implementation guidance:**

- Use good quality formulated feeds.
- Make efficient use of shrimp feed resources.
- Minimize shrimp feed wastage.

## Principle 6 – Health Management:

Health management plans should be adopted that aim to reduce stress, minimize the risks of disease affecting both the cultured and wild stocks, and increase food safety.

***Justification:** Maintenance of the health of shrimp stocks in farming situations should focus on maintenance of a healthy environment in the ponds at all phases of the culture cycle in order to prevent problems in the ponds before they occur and reduce the likelihood of disease transmission outside the farms. Attempting to limit the introduction of diseases through use of disease free stocks, thorough preparation of the ponds before stocking, maintenance of optimal environmental conditions through management of stocking densities, aeration, feeding, water exchange and phytoplankton bloom control etc., routine monitoring and recording of shrimp health to detect any developing problems, and maintenance of biosecurity in quarantining and treating any diseased ponds are all critical elements in any health management plan.*

### **Implementation guidance:**

- Implement health management practices that reduce shrimp stress and focus on disease prevention rather than treatment.
- Maintain biosecurity and minimize disease transmission between brood-stock, hatchery and growout systems.
- Implement management strategies that avoid spreading shrimp diseases within and between farms.
- Use veterinary drugs responsibly and minimize the use of antibiotics.

## Principle 7 – Food Safety:

**Ensure food safety and the quality of shrimp products, whilst reducing the risks to ecosystems and human health from chemical use.**

***Justification:** Increasing focus is being placed on the safety of foods being sold in the worlds' markets. These concerns include not only ensuring that foods for human consumption are free from excesses of harmful or undesirable chemicals, but also that the workers producing these foods and the environment surrounding the production facility have been protected from negative effects of the use of these chemicals. Increasing calls for total traceability of food products are also affecting the food production industry such that consumers can be assured that the product has been produced without the use of transgenic technologies, without addition of undesirable or harmful chemicals or additives, and that all of the environments and ecosystems affected by the production facilities has not been compromised in any way.*

### **Implementation guidance:**

- No use of banned veterinary drugs and chemicals.
- Be responsible in use of permitted veterinary drugs and chemicals.
- Apply quality control systems to produce safe and quality shrimp farm products.
- Implement measures for sanitary harvest, handling and transport of shrimp.

## Principle 8 – Social Responsibility:

**Develop and operate farms in a socially responsible manner that benefits the farm, the local communities and the country, and that contributes effectively to rural development, and particularly poverty alleviation in coastal areas, without compromising the environment.**

***Justification:** There are increasing demands for products which are produced through environmentally sustainable shrimp farming practices, but that have been produced by employees who were treated fairly, and that the enterprise that produced the product is a respected and active component of the society. It should be the responsibility of a civilized society that the benefits derived from shrimp farming are shared equitably.*

### **Implementation guidance:**

- Minimize conflicts with local communities that may result from shrimp farm development and operation and ensure that aquaculture developments are mutually beneficial.
- Take measures to ensure shrimp farming benefits the communities in shrimp farm areas.
- Ensure shrimp farm worker welfare and fair working conditions.
- Minimize risks to smallholders engaged in shrimp farming through training, extension and appropriate technical and financial support.
- Provide training to farmers and workers in responsible shrimp farming practices.

### 3. Implementation

The *International Principles for Responsible Shrimp Farming* provide public and private sectors with the basis for planning and operational management of responsible shrimp farming. This section provides guidance on potential actions by stakeholders in support of implementation of the *International Principles*.

#### 3.1 Public sector

##### Aquaculture legislation

The *International Principles* should be used as a framework of key issues to be considered by public authorities in development of the legislative frameworks necessary to enable responsible development of national shrimp farming industries.

##### National aquaculture development strategies

The *International Principles* should be used for preparation and regular update of national development strategies and plans for shrimp farming, as the basis for promoting responsible management practices, equitable sharing of benefits and balanced use of natural resources in harmony with other coastal activities.

A participatory approach involving public and private sectors, and local communities, is recommended to ensure the intended provisions of the aquaculture strategies and plans are understood and to facilitate adoption by ensuring stakeholders have a role and responsibility in implementation.

##### Integrated coastal area management and land use plans

Integrated coastal area management plans should be prepared, and include shrimp, and other types of aquaculture, located within environmentally suitable locations. Suitable areas for shrimp farms, and other types of aquaculture, should be designated as zones within integrated coastal area management plans, and coastal land use plans. The *International Principles* should be consulted in preparing such plans, ensuring suitable sites are selected, and that aquaculture sites and activities are within the carrying capacity of the coastal environment, and that conflicts with other key coastal sectors are minimized.

Responsibilities for integrated coastal area management should be devolved to the lowest administrative level and capacity building provided to responsible local institutions to support successful integrated coastal area management. Land tenure and property rights should be clearly defined in coastal area management plans to encourage long-term investment, responsible design and construction of shrimp farms according to the *International Principles*.

Land use zoning should be directed towards maintenance of the ecological functions of coastal areas, whilst allowing multiple uses of land to accommodate competing demands and activities and limit cumulative impacts.

### **Environmental assessment**

Environmental impact assessments should be conducted for shrimp farm developments and the *International Principles* used as a framework for such assessments. Environmental assessments may be conducted at a strategic or project level. Strategic level environmental assessments are recommended for assessing the cumulative impacts of large numbers of small-scale shrimp farms, and development of environmental management strategies for such coastal areas. Project level environmental assessments should be considered for larger individual projects.

Environmental assessments enable the integration of environmental, social, technical and economic considerations during the planning and decision making processes for allocation of land, water and other natural resources for shrimp farming developments. Environmental assessment procedures should allow for participation and early discussions among the shrimp farm project proponents, regulatory agencies and other stakeholders. Early consultation among stakeholders should allow evaluation of alternative sites, designs and management measures before investment is committed.

Environmental assessments should also consider risks and management options should shrimp farms stop operations, including environmental rehabilitation of affected locations.

### **Aquaculture monitoring**

Monitoring of shrimp farming operations should be conducted to assess environmental impacts and assist in farm management and improving the environmental performance of shrimp farming. Monitoring programs should be developed based on identified impacts and local environmental

conditions, but may include the water and sediment quality within farms and receiving waters, shrimp health and disease status and use of drugs and chemicals and residuals in harvested shrimp.

Involvement of all relevant stakeholders in environmental monitoring programs will also encourage and ensure shared responsibility for meeting the objectives of monitoring.

### **Farm registration**

Registration of shrimp farms is paramount to implementing the *International Principles*. It should be used to encourage the use of management practices in accordance with the *International Principles* and to ensure traceability and assist in maintaining quality controls over production.

### **Institutional strengthening**

Implementation of the *International Principles* should be supported through strengthening of institutions for transfer of knowledge, extension, monitoring, coastal area management, planning and implementation of legislation. Investment should be made in training and educational programs to improve the capacity of public and private institutions for management of shrimp farming. Mechanisms for transfer of knowledge, policies, legislation and better management of shrimp farming should be further developed, making optimal use of financial, human and information resources.

Cooperation between public and private sectors is strongly encouraged in training and educational programs to support knowledge transfer and improved management of the shrimp farming sector.

## **3.2 Private sector**

Private sector stakeholders should adopt these *International Principles* as a basis for self-regulation in the planning, design, construction and operational management of shrimp farming.

### **Adaptation and adoption to local conditions**

National or locally-specific management practices should be prepared based on the *International Principles* adapted to local social, economic and environmental conditions. The shrimp industry, supported by the public sector as appropriate, is encouraged to develop Codes of Practice, Better

Management Practices, Good Aquaculture Practice, and other management practices based on the *International Principles* to assist in their implementation.

### **Investment**

Investors in shrimp farm production and buyers of shrimp aquaculture products should use the *International Principles* as a basis for farm investment and shrimp purchasing decisions. The development of certification systems based around these principles could, for example, provide buyers with improved assurance of buying quality product produced in a sustainable manner. At the same time producers complying to the *International Principles* should be provided with market incentives and access that might enable better returns on their investments.

### **Knowledge transfer and communications**

Implementation of the *International Principles* in the private sector should be supported through effective communications, awareness raising and outreach to transfer knowledge on better management practices to all private shrimp farm stakeholders. National associations and private sector information networks play an important role in disseminating and sharing experiences, and innovations in implementation of these *International Principles* for better shrimp farm management.

### **Farmer organizations and private institutions**

Shrimp farmer associations and aquafarmer self-help groups should be encouraged by both private and public sectors to assist in improving local management of shrimp aquaculture, and as a mechanism for improving information flow and extension to communities involved in shrimp farming.

The strengthening of small-scale farmer organizations is particularly recommended to assist in disseminating knowledge on better shrimp farm management practices and sharing of experiences with small-scale shrimp farmers and encouraging members to adopt the *International Principles*.

## Stakeholder cooperation

Business and private sectors are encouraged to collaborate in multidisciplinary research, development and extension efforts that link research to the needs of the shrimp farming community and the improvement of environmental performance.

### 3.3 Regional and International Cooperation

Regional and international cooperation should continue to be promoted to support implementation of the *International Principles* and facilitate achievement of environmentally sustainable shrimp aquaculture development.

Regional and international organizations and partners, including public and private institutions, that promote aquaculture and those that deal with the protection of coastal and marine environments offer the opportunity to cooperate to improve the environmental performance of aquaculture. Such partnerships are recommended to give priority to transfer and adoption of technological innovations, capacity building, sharing of knowledge and experiences, generating standards and guidelines that support implementation of the *International Principles* and facilitate cooperation at regional and global level in responsible aquaculture.

Strengthening of mechanisms and partnerships for future review and development of the *International Principles*, compliance and implementation measures is also suggested.

## 4. Key references and information sources

This section includes key references on shrimp farming and links to case study material, practical implementation guidelines, educational tools and other materials designed to assist in responsible shrimp farming. The section includes relevant case study materials produced by the Consortium Program on Shrimp Farming and the Environment. Consortium documents are available at <http://www.enaca.org/shrimp>.

### 4.1 Key references

**Briggs, M., Funge-Smith, S., Subasinghe, R.P., and Phillips, M. 2005.** Introductions and movement of two penaeid shrimp species in Asia and the Pacific. FAO Fisheries Technical Paper. No. 476. Rome, FAO. 2005. 78 pages.

**FAO. 1995.** Code of Conduct for Responsible Fisheries. Food and Agriculture Organization of the United Nations (FAO), Rome. Available on <http://www.fao.org>.

**FAO. 1997.** Aquaculture Development. FAO Technical Guidelines for Responsible Fisheries 5, Food and Agriculture Organization of the United Nations (FAO), Rome. Available on <http://www.fao.org>.

**FAO. 1998.** Report of the Bangkok FAO Technical Consultation on Policies for Sustainable Shrimp Culture. Bangkok, Thailand, 8-11 December 1997. FAO Fisheries Report No. 572. Rome. 31 pages.

**FAO/AFFA. 2001.** Report of the FAO/Government of Australia Expert Consultation on Good Management Practices and Good Legal and Institutional Arrangements for Sustainable Shrimp Culture. Brisbane, Australia, 4-7 December 2000. FAO Fisheries Report. No. 659. Rome, FAO. 2001. 70 pages.

**Subasinghe, R.P. and Arthur, J.R. 2005.** Regional Workshop on Preparedness and Response to Aquatic Animal Health Emergencies in Asia. 21-23 September 2004. FAO Fisheries Proceedings, No. 4. Rome, FAO. 2005. 178 pages.

**Subasinghe, R.P., M.G. Bondad-Reantaso and S.E. McGladdery. 2001.** Aquaculture development, health and wealth. In R.P. Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery & J.R. Arthur, eds. Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. NACA, Bangkok and FAO, Rome, pp. 167-191.

**World Bank. 1998.** Report on Shrimp Farming and the Environment – Can Shrimp Farming be Undertaken Sustainability? A Discussion Paper

designed to assist in the development of Sustainable Shrimp Aquaculture.

**World Bank, NACA, WWF and FAO 2001.** Thematic Review on Management Strategies for Major Diseases in Shrimp Aquaculture. Proceedings of a Workshop held in Cebu, Philippines on 28-30 November 1999. Edited by R. Subasinghe, R. Arthur, M. J. Phillips and M. Reantaso. The World Bank (WB), Network of Aquaculture Centres in Asia-Pacific (NACA), World Wildlife Fund (WWF) and Food and Agriculture Organization of the United Nations (FAO) Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 141 pages.

**World Bank, NACA, WWF and FAO. 2002.** Shrimp Farming and the Environment. A World Bank, NACA, WWF and FAO Consortium Program “To analyze and share experiences on the better management of shrimp aquaculture in coastal areas”. Synthesis report. Published by the Consortium. 126 pages.

## 4.2 Case studies conducted by the Consortium Program

**Begum A. and S.M. Nazmul. 2002.** Social Aspects of Shrimp Aquaculture in Bangladesh. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.

**Boyd C. 2002.** Chemical and Biological Amendments Used in Shrimp Farming. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 22 pages.

**Boyd, C. E. and B.W. Green. 2002.** Coastal Water Quality Monitoring in Shrimp Farming Areas, An Example from Honduras. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 29 pages.

**Boyd, C.E., J.A. Hargreaves and J.W. Clay 2002.** Codes of Practice and Conduct for Marine Shrimp Aquaculture. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 32 pages.

**Boyd, C. E. and J.W. Clay. 2002.** Evaluation of Belize Aquaculture, Ltd: A Superintensive Shrimp Aquaculture System. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 17 pages.

**De Walt, B., L. Noriega, J.R.R. Zavala and R.E. Gonzales. 2002.** Shrimp Aquaculture, People and the Environment in Coastal Mexico. Report prepared under the World Bank, NACA, WWF and FAO Consortium Pro-

gram on Shrimp Farming and the Environment. Published by the Consortium. 75 pages.

**Gautier, D. 2002a.** The Integration of Mangrove and Shrimp Farming: A Case Study on the Caribbean Coast of Colombia. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 26 pages.

**Gautier, D. 2002b.** The Adoption of Good Management Practices by the Shrimp Industry on the Caribbean Coast of Colombia. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 62 pages.

**Kutty, M.N., P. Ravichandran, M. Krishnan, M. Kumaran and C.P. Balasubramanian. 2002.** The Role of Small Farmer Groups and Associations in Sustainable Shrimp Aquaculture Management. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.

**Macintosh, D.J., M.J. Phillips, R. Lewis III and B. Clough. 2002.** Thematic Review of Coastal Wetland Habitats and Shrimp Aquaculture. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 72 pages.

**Melana, D. M., E.E. Melana, C.E. Yao and E.L. Abuan. 2002.** Mangrove Management and Aquaculture in the Philippines. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.

**Nhuong T.V., R. van Anrooy and M.J. Phillips. 2002.** Coastal Shrimp Aquaculture: Searching for Better Management Practices - Some cases from the North and North-Central Vietnam. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.

**Nissapa, A. and S. Boromthaanarat. 2002.** Case Study on Institutional Aspects of Shrimp Aquaculture in Thailand. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.

**Preston, N.P., P.C. Rothlisberg, M.A. Burford and C.J. Jackson 2001.** The Environmental Management of Shrimp Farming in Australia. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 9 pages.

**Schwab, B., M. Weber and B. Lehmann. 2002.** Key management challenges for the Development and Growth of a Shrimp Farm in Northeast Brazil - A Case Study of Camanor Produtos Marinhos Ltd. Report prepared

- under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 33 pages.
- Siriwardena, P.P.G.S.N. 2002.** Report on a Code of Good Management Practices for Shrimp Aquaculture in Sri Lanka. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.
- Sonnenholzner S, L. Massaut, C. Saldias, J. Calderón and C. Boyd. 2002.** Case Studies of Ecuadorian Shrimp Farming. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 61 pages.
- Stanley, D., C. Alduvin and A. Cruz 2002.** Science and Society in the Gulf of Fonseca: The Changing History of Mariculture in Honduras. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 39 pages.
- Tacon, A.G.J. 2002.** Global Review of Feeds and Feed Management Practices in Shrimp Aquaculture. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.
- Tobey, J., H. Poespitasari and B. Wiryawan. 2002.** Good Practices for Community-based Planning and Management of Shrimp Aquaculture in Sumatra, Indonesia. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium. 18 pages.
- Tookwinas, S. 2002.** Assistance and Issues in the Implementation of the Code of Conduct for Shrimp Aquaculture. Report prepared under the World Bank, NACA, WWF and FAO Consortium Program on Shrimp Farming and the Environment. Published by the Consortium.



**Food and Agriculture Organization  
of the United Nations**

Viale delle Terme di Carracalla  
Rome 00100, Italy  
Web page: [www.fao.org](http://www.fao.org)  
Email: [FI-Inquiries@fao.org](mailto:FI-Inquiries@fao.org)



**Network of Aquaculture Centres  
in Asia-Pacific (NACA)**

Department of Fisheries  
Kasetsart University Campus  
Jatujak, Bangkok 10900, Thailand  
Web page: [www.enaca.org](http://www.enaca.org)  
Email: [shrimp@enaca.org](mailto:shrimp@enaca.org)



**United Nations Environment Programme (UNEP)  
GPA Coordination Office**

Kortenaerkade 1  
2518 AX The Hague  
The Netherlands  
Web page: [www.gpa.unep.org](http://www.gpa.unep.org)  
Email: [gpa@unep.nl](mailto:gpa@unep.nl)



**The World Bank - Netherlands  
Partnership Programme**

1818 H Street, NW  
Washington, D.C. 20433-1234, USA  
Web page: [www.worldbank.org](http://www.worldbank.org)  
Email: [rzweig@worldbank.org](mailto:rzweig@worldbank.org)



**World Wildlife Fund (WWF)**

1250 24th Street NW  
Washington D.C. 20037, USA  
Web page: [www.worldwildlife.org](http://www.worldwildlife.org)  
Email: [aquacultureinfo@wwfus.org](mailto:aquacultureinfo@wwfus.org)