

Chapter 12.

Aquaculture sector policy

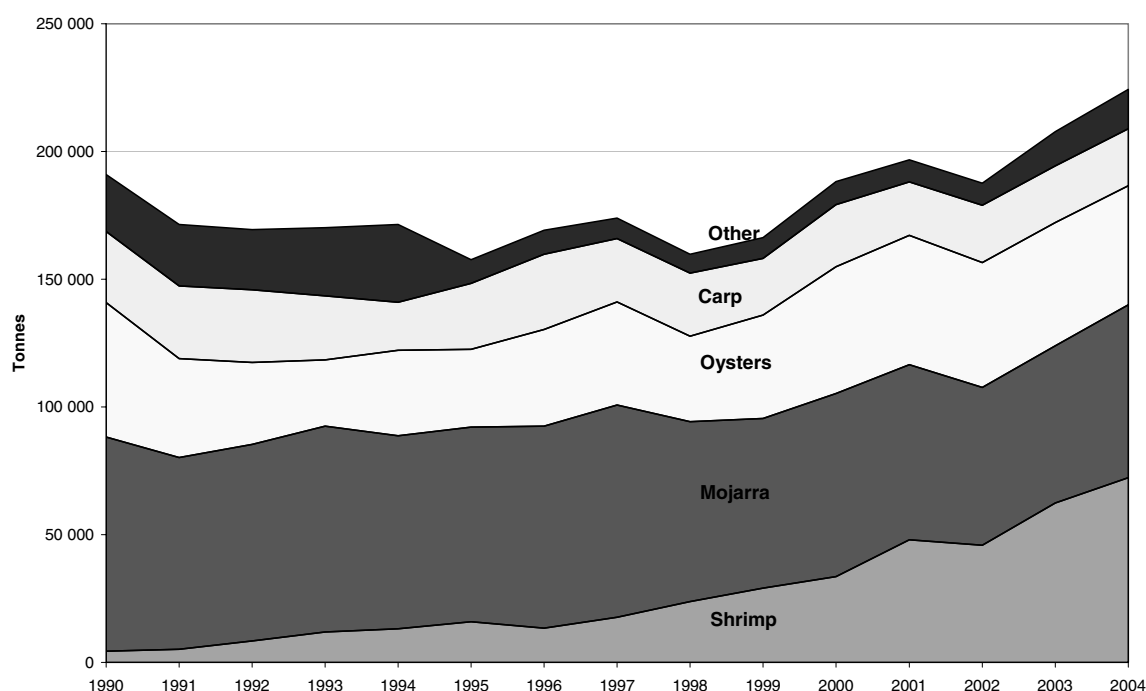
Aquaculture is a relatively recent industry in Mexico and is still considered to be at a development stage. However, there is a high degree of optimism about the prospects for growth in the sector, particularly for high value species such as shrimp. Mexico is well-endowed with coastal lagoons (156 710 km²), rivers and inland lakes, many of which are characterized by high productivity and are suitable for aquaculture. According to the National Fisheries Chart, a total of 64 species were cultured in Mexico in 2003 (Table 12.1). Most of these are freshwater fish, followed by freshwater and marine molluscs, although marine crustaceans (shrimp) is the main high value species.

Table 12.1. Number of aquaculture species produced in Mexico

Category	Total	Native	Exotic or introduced	Hybrids
Freshwater fish	26	9	14	3
Marine fish	5	5		
Freshwater and marine molluscs	14	12	2	
Freshwater crustaceans	6	4	2	
Marine crustaceans	7	7		
Amphibians	6	5	1	
Total	64	42	19	3

Source: CONAPESCA.

Aquaculture production grew at an average rate of 1.2% a year between 1990 and 2004, reaching a total production of 224 249 tonnes in 2004. Growth in more recent years has been much stronger, averaging 4% a year since 1995. Aquaculture accounted for around 12% of the total production volume for the fisheries sector in 2003. There has been strong growth in aquaculture shrimp production, averaging around 23% a year since 1990 (albeit from a low base), reaching 72 279 tonnes in 2004 (Figure 12.1). Unofficial data from different sources in the country report that total shrimp production in 2005 reached an historical record of more than 90 000 tonnes with the States of Sonora and Sinaloa achieving historical State production records. Production of most other major aquaculture species, such as carp, mojarra, oysters, has declined over the same period. This shift is due to the conversion of some aquaculture operations to the more highly valued shrimp, restrictions due to environmental regulations, and a shift to fishing operations by small scale producers in some parts of the country.

Figure 12.1. Aquaculture production in Mexico, 1990-2004^a

a. Carp and tilapia are indigenous species in lakes and rivers where they are caught.

Source: CONAPESCA.

If the aquaculture sector is to continue expanding in line with industry and government expectations, it is necessary that the policy framework governing the industry provide an appropriate enabling environment. Without such policy conditions, the industry will struggle to take full advantage of the favourable resource and environmental conditions it faces in Mexico. At the same time, the policy framework must balance industry development objectives with environmental and social policy objectives. Aquaculture can have adverse impacts on the environment without appropriate management, and it is important that this be fully factored into the policy framework. Similarly, aquaculture has the potential to play a role in poverty alleviation but such potential will only be realized through careful development of sectoral policies across a range of policy areas. This chapter examines a range of issues in aquaculture sector policies and identifies a number of measures that the Mexican government can usefully pursue to ensure that the aquaculture sector can continue to grow in a sustainable way.

Institutional arrangements

The development goals and the main policies for the aquaculture industry are set at the national level by SAGARPA and CONAPESCA. In addition, each of the Federal States selects and discusses its own development policies at the state level with the federal government, carries out its own promotion of aquaculture, and assists CONAPESCA in regulating and setting standards for the industry. The importance of aquaculture varies considerably at the state level. In only four States (Chiapas, Oaxaca, Campeche and Baja California Sur), aquaculture is administered at a Secretariat level

Table 12.2. Mexican official laws, regulations and standards related to aquaculture

Legislation or NOM	Description and objective	Date
059-SEMANART-2001	Determine all flora and fauna terrestrial and aquatic species, subspecies that are endangered, treated, facing extinction, rare or under special protection and establishes specific rules for its protection.	Amended 6 March 2002
PROJECT 089-ECOL-1994	Establishes maximum allowed limits for pollutants contained in residual waters discharged from aquaculture activities into receptor water bodies.	20 September 1994
Federal Law for Fisheries	It is the legal framework for fisheries and aquaculture, oriented towards sector sustainable development.	Amended 25 June 1992
Federal Law Fisheries Regulation	Chapter III. Specifically related to aquaculture	Amended 29 September 1999
NOM-009-PESC-1993	Mexican Official Standard (NOM), to establish procedures to determine zones and duration of close fishing season and capture of aquatic species in federal waters of Mexico.	4 March 1994
NOM-010-PESC-1993	Establish sanitary requirements for the importation of aquatic organisms in any development stage to be used for aquaculture or ornamental culture in the country.	16 August 1994
NOM-011-PESC-1993	Regulate application of quarantine, to prevent introduction and dissemination of certifiable disease during importation of live aquatic organisms in any stage of development to be used for aquaculture or ornamental culture in the country.	16 August 1994
NOM-EM-001-PESC-1999	Modification and extend validation of the emergency official standard, to prevent and control the introduction and dissemination of pathogenic agents causing the disease named White Spot Viral Syndrome (WSSV) and Yellow Head Virus (YHD).	Amended 22 February 2000
NOM-EM-003-PESC-2000	Emergency norm to regulate requirements to determine presence of viral disease in live, dead crustaceans and their products or sub-products, in any presentation, and the artemia (<i>Artemia spp</i>) to introduce and move into the country.	Amended 25 April 2000
NOM-EM-001-PESC-1999	Requirements to prevent and control introduction and dissemination of viral diseases named white spot virus (WSBV) and yellow head virus (YHV).	17 March 1999

Legislation or NOM	Description and objective	Date
EM-05-PESC-2002	Establish requirements and measures to prevent and control dissemination of high impact disease and for the use of antibiotics in shrimp culture in the country.	19 July 2002
PROJECT 020-PESC-1994	Explain approved techniques for the identification of pathogens causing diseases in live cultured and wild aquatic organisms and the ornamental ones in the country.	7 December 1994
PROJECT 021-PESC-1994	Regulate artificial feeds, manufacture ingredients, feeding non-conventional products used in aquaculture and ornamental culture, imported and national for their commercialization and consumption in Mexico.	20 January 1995
PROJECT 022-PESC-1994	Establish regulations for hygiene and control and the application of Hazard Analyses of Control Critical Points (HACCP) procedures in farming and culture infrastructure.	26 January 1995
Notification	To acknowledge zones and duration for closed fishing season for aquatic fauna species and its complementary to NOM-009-PESC-1993.	4 March 1994
NOM-030-PESC-2000	Requirements to determine presence of viral diseases in aquatic crustaceans alive, dead, their products and sub-products in any form and <i>Artemia spp.</i> , for their introduction to national territory and movement within the country	15 January 2002
NOM-003-ECOL-1997	Establishes maximum allowed limits of contaminants for treated residual waters that are re-used in services to the people	21 September 1998
NOM-EM-006-PESC-2004	Emergency norm that establishes the sanitary aquaculture requirements for the production and movement of aquatic crustaceans, alive, dead, their products and sub-products, and for their introduction in national territory	20 January 2004

Source: Adapted and modified from Alvarez-Torres (2003); CONAPESCA (2005).

within the State's government. In all others, aquaculture is administered at the Department or Under-Secretariat level. As is the case for the wild capture fisheries sector, CONAPESCA also issues Mexican official standards (NOMs) for the aquaculture sector. A list of the NOMs for the aquaculture sector is shown in Table 12.2.

Within the Federal Fisheries Law, CONAPESCA's main objective is to administer the use of aquaculture resources in a sustainable manner, promoting the development of value chains that put together activities and players in the production, distribution and consumption of aquaculture products. The development and promotion of production chains is seen by CONAPESCA and SAGARPA as a key way for individual producers to increase competitiveness.

Support programmes

Prior to 2003, the essential role of CONAPESCA in relation to the aquaculture sector was primarily normative. While there was strong support for the sector in principle, government actions to promote an industrial and high-yield aquaculture sector had little success as there was never a strong federal budget to support initiatives. This changed in the second half of 2003 when a funded programme, *Alianza Contigo* (also known as *Alianza para el Campo*), was initiated at the national level to promote and support the development of fisheries and aquaculture projects. *Alianza Contigo* is the first programme of this kind in a decade in Mexico and through it, financial support is given to economically-feasible aquaculture projects that focus on the industry development goals set by the government: species diversification, systems intensification, and integration of chains. *Alianza* is a capitalization programme, which funds infrastructure and equipment but excludes support for operating costs. *Alianza* is based on an alliance among different parties to fund projects: the producer, the federal government and other complementary sources like state governments, other sectoral programmes, etc. The Federal government does not provide 100% of the cost of projects.

The stated goal in the *Alianza Contigo* operational rules developed in 2003 is:

“To promote and support the integral development of the fisheries and aquaculture sectors, through the rational and sustainable use of resources, in order to achieve higher standards of living for producers, their families, and the fisheries and aquaculture communities in the country.”

Specific objectives of the Programme were further elaborated as:

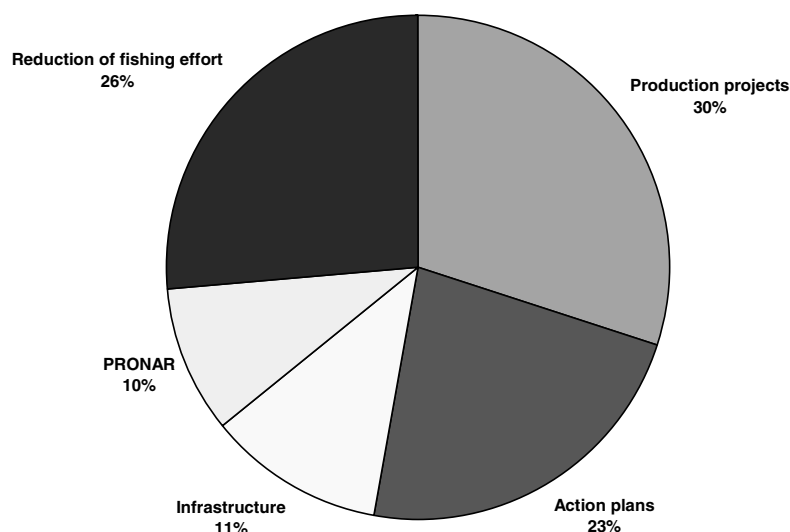
- To optimize and organise the administration and use of fisheries and aquaculture resources, based on the development of studies and projects which guarantee their sustainability.
- To encourage the integral development of aquaculture and fisheries through strengthening productive organization, capacity building and technical assistance, for individuals and groups of producers, in coordination with the Sub-Secretary of Rural Development of SAGARPA.
- To reactivate investment and capitalization of fishers and aquaculture producers, granting them support for the modernization of fisheries and aquaculture infrastructure, strengthen production chains, and increase competitiveness by means of production projects that help reduce pressure on several traditional fisheries stocks.

Under the *Alianza* Operation Rules and criteria for eligibility, an applicant has to submit among other documents, a full, detailed project (for the case of application for support for a production project in aquaculture, mariculture or fisheries) including a technical and financial feasibility analysis, and the authorized Environmental Impact Assessment (EIA) if necessary. Although not listed as a requirement, many aquaculture production projects also have to receive approval for the use of water with the *Comisión Nacional del Agua* (National Water Commission, CNA).

Financial support is given to economically-feasible aquaculture projects that focus on the following development goals: species diversification; systems intensification; integration of chains; and value added.

Reflecting the complexity and varied characteristics and needs of the aquaculture and fisheries industries of the country, *Alianza Contigo* also funds among other things the *Programa Nacional de Acuacultura Rural* (National Programme for Rural Aquaculture, PRONAR), studies, organisations and development plans developed by the States, and the construction of common-use infrastructure (piers, cold-storage rooms). Priority is also given to sanitary and disease issues: CONAPESCA, through *Alianza Contigo*, assigns funds for the operation of the State Committees of aquaculture sanitary issues, who carry out work focused to monitor and control safety and sanitary issues of farms and aquaculture products. In every state, aquaculture producers organise meetings and vote for the President and Secretary of these State Committees. Figure 12.2 depicts the shares of the different parts of the *Alianza Contigo* programme in 2005, from a total budget of around MXN 836 million in 2005.

Figure 12.2. Distribution of support to aquaculture and fisheries under *Alianza Contigo*, 2005



Source: CONAPESCA.

As well as the direct support provided by PRONAR, the aquaculture industry also receives support from the infrastructure and action plan (*Plan de Acciones para el Ordenamiento*) components of *Alianza Contigo*. Many of the projects under the infrastructure programme, such as dredging of lagoons and canals, will benefit the industry. Around 21% (MXN 40 million) of the expenditure under the action plans was directed towards the aquaculture sector in 2005, primarily directed towards the modernisation and improvement of a number of aquaculture centres and studies into intensive aquaculture and marine ranching.

Through *Alianza Contigo*, CONAPESCA also addresses issues of sustainable shrimp farming and “productive conversion”. The policy for sustainable development of the aquaculture shrimp industry focuses on system intensification for shrimp farming, which is only approved for locations and farms where it is technically feasible and does not increase the risk of introduction or spreading of diseases. Support for new shrimp farms was provided in the first two years of the programme, but later the policy was modified and now only supports the incorporation of innovative, environmental-responsible technologies to already-established farms, or the implementation of sanitary biosecurity measures, processes and technologies. During the three years of operations, *Alianza Contigo* has favoured shrimp, tilapia and marine fish projects, following CONAPESCA’s development priorities.

Productive conversion, although not one of the main development goals for aquaculture, is a joint fisheries-aquaculture policy objective of high priority within CONAPESCA’s policy at the national level. Productive conversion is regarded as a long term strategy to alleviate stock overfishing and the social pressures from coastal fishing communities, many of whose livelihoods have been declining in recent years.

For the successful achievement of the policy goals of productive conversion (fisheries) and species diversification (aquaculture), there is an urgent need to develop biotechnologies to rear new species, mainly of marine species. Some success has been achieved already. Conversion for these fishermen means to initiate experiences as aquaculture farmers, with a double challenge: first, to understand, learn and adopt the behaviour of a farmer, who has to take care of a farm every day; and second, to be efficient and with increased productivity.

CONAPESCA coordinates the National Programme of Aquaculture Sanitation, and the National Network for diagnostic and disease prevention of aquatic organisms (PRONALSA). The network incorporates 13 different laboratories in the country specialized in aquaculture pathology, including CIAD (Centro de Investigación en Alimentación y Desarrollo), CIBNOR (Centro de Investigaciones Biológicas del Noroeste), CICESE (Centro de Investigación Científica y de Investigación Superior de Ensenada), Centro de Ciencias de Sinaloa, CINVESTAV (Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional), and others. The network is coordinated by the Metropolitan Autonomous University (Universidad Autónoma Metropolitana, UAM), with headquarters in Mexico City. The final objective is to build up a System of Epidemiologic Surveillance. Currently the network evaluates diseases on shrimp, bivalves and fish.

Box 12.1. Achievements in aquaculture

Bullseye puffer (*Sphoeroides annulatus*), by Centro de Investigación en Alimentación y Desarrollo. About 20 000 fry produced and stocked into floating marine cages, in a Project with social groups. August 2006.

Octopus (*Octopus maya*), by Universidad Nacional Autónoma de México UNAM biological station in Sisal, Yucatán. Production of octopus fry to supply a social project (wives of fishermen), and others. June 2006.

Pink shrimp (*Farfantepenaeus duorarum*) by Instituto Tecnológico del Mar de Campeche, Campeche. Production of enough postlarvae to supply commercial ponds up to 20 hectares. June 2006.

Bullseye puffer (*Sphoeroides annulatus*) in Centro de Desarrollo Tecnológico de Especies Marinas in Jalisco. About 70 000 fry, 3.5 mm length, to be stocked in ponds and floating cages, projects with social and private farmers. September 2006.

Flatfish (*Paralichthys californicus*) by Centro de Investigación y Educación Superior de Ensenada, in Baja California. Production of about 30 000 fry in 2006, to stock in tanks with private farmers.

Totoaba (*Totoaba macdonaldi*) by Facultad de Ciencias Marinas, Universidad Autónoma de Baja California. Production of fry in 2006, to begin experiences at pilot level.

White shrimp (*Litopenaeus vannamei*) cultured in floating cages, many sites in Sinaloa. Yield average is twice the intensive pond production.

White fish (*Pescado blanco*, *Chirostoma estor*) by Centro Regional de Investigaciones Pesqueras in Pátzcuaro, Michoacán. About 30 000 fry are to be stocked in ponds, tanks and floating cages in 2006, by social groups and private catfish producers.

Native cichlidae (*mojarras*) by Universidad Juárez Autónoma de Tabasco. By 2007, five commercial social and private enterprises will be running, and UJAT Hill supply the fry.

Rainbow trout (*Oncorhynchus mykiss*) in Centro Acuicola El Zarco, in Estado de México. Beginning 2007, photoperiod techniques Hill allow commercial production eight months a year, of sanitary and genetic certified eyed eggs. CONAPESCA and Instituto Nacional de la Pesca.

Source: INP (Personal communication, September 2006).

Environmental aspects of aquaculture policy

The Secretariat of Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*, SEMARNAT) is in charge of formulating and implementing environmental policies in the country, and several of them apply to fisheries and aquaculture. Mexican environmental legislation has been established in the General Law of Ecology Equilibrium and Environmental Protection, which clearly states prevention as the main means to diminish ecological damage.

In June 2006, SEMARNAT published the *National Environmental Policy for the Sustainable Development of Oceans and Coasts in Mexico*. This New Environmental Policy is based on the following principles:

- Development in harmony with nature.
- Growth with human and environmental quality.
- Respect for legality and accountability.
- Alliances with social actors.

The six mainstays of the New Environmental Policy are (SEMARNAT 2006):

- *Integrity*: joint and coordinated management of natural resources.
- *Commitment with the sectors*: sustainable development is a task shared by several Federal Governmental Agencies.
- *The new environmental management*: to stop, reverse and restore the ecosystems deterioration including the three aspects of sustainable development.
- *Social and economic assessment of natural resources*: so they can be used in a rational manner.
- *Fight against environmental impunity*: without exceptions.
- *Social participation and explanation of accounts*: the civic society participates in preparing and executing the policies and programmes (NGO's, private sector, and academia).

While CONAPESCA promotes and supports production, establishes bans for fisheries and issues Mexican official norms related to aquaculture and fisheries, SEMARNAT develops policies seeking to protect marine resources. As is the case in many other countries in the world, both agencies disagree at times on an issue or decision related to aquaculture and fisheries in the country. When State Governments are involved, things become more complex and a multi-objective, multi-criteria problem arises. These days more than ever, and following the mainstays of integrity and commitment with the sectors of the National Environmental Policy for the Sustainable Development of Oceans and Coasts in Mexico, it is recognized that a greater coordination is required between CONAPESCA and SEMARNAT to identify and agree at the highest level of government, joint policies and procedures for the sustainable development of aquaculture and fisheries, which promote both industries but constrain their environmental impacts and externalities to society and the environment.

Stability of the policy regime

The policy regime for aquaculture has changed in recent years. Production and productivity improvements remain a priority. However, more attention is now being paid to production chains, added value, development of market channels, and sustainable development. Actions to promote aquaculture of an industrial and high-yield nature continue and actually could be further advanced through *Alianza Contigo*. Species diversification, productive conversion and systems intensification are objectives recently introduced in the framework to plan the sustainable development of the fisheries and aquaculture industries in Mexico. With regard to the marketing and processing activities, the goal is to restructure traditional forms of marketing, promoting added-value activities and systems, and increase compliance with safety, health and hygiene requirements.

Alianza Contigo was created in 2003 as a national Programme with funding decisions and project evaluations carried out by the central authority, CONAPESCA. This has changed in 2006 and, while it remains a federal programme, it is now one where the States will take the responsibility of the evaluation process and decision for allocating support, according to local priorities for aquaculture and fisheries development. How much funds from *Alianza Contigo* each State receives is based on, among other things, equity and the State's contribution to national production. CONAPESCA still sets the

development goals for the industry at a national level, but will resume a normative (regulatory) role in the *Alianza Contigo*.

Alianza Contigo has been sufficiently flexible so as to allow CONAPESCA to undertake adjustments to the support policy regime. For example, in 2003 and part of 2004, shrimp farming received the biggest share of support. More recently, CONAPESCA's policy for sustainable aquaculture development has shifted from this species, towards tilapia and others (diversification), reflected in the number of projects and share in total subsidies. The tilapia farming sector has been the fastest growing in the country in the last two years, responding to a strong, local market that is demanding larger quantities of tilapia every year.

It is foreseen that the policy regime in the near future will have to consider the development of marine aquaculture, as a promising new use of offshore waters in Mexico. The first ocean ranches are already established in the country, like the successful ones for tuna on-growth in Baja California (Panorama Acuicola, 2005). Ocean, marine aquaculture needs to be developed in an environmentally sustainable manner taking into account impacts that may result for ocean resources, environments and users. At present, there is no explicit policy framework at the federal level in Mexico for managing and providing guidance for the development of offshore marine aquaculture. It is therefore necessary for actions to be taken for the integration of marine aquaculture in State Coastal Zone Management.

Key policy issues

Sustainability and environmental issues

Under *Alianza Contigo*, aquaculture production projects have to comply with environmental requirements and rules as a condition for project evaluation and approval. Environmental impact assessments are the main tool for SEMARNAT to evaluate the environmental impact of production projects, and are a requirement for project evaluation. In addition, the National Water Commission evaluates and issues permits for water use in aquaculture projects; and there are indications that this has proved a difficult task to solve in several cases to date. Hence, it is likely that water use in aquaculture projects will be more strictly evaluated in the future, and the aquaculture industry has to be prepared for such a challenge. The promotion and development of recirculation systems and reduced-water exchange systems will be very important.

Questions of using resources in a sustainable fashion will become central with the years. Aquaculture for food security will increasingly be tested and demanded. There is still a lack of clarity with regard to the development of long-term framework conditions, including the integration of aquaculture in Coastal Zone Management.

Aquaculture development in Mexico has not come to a point yet, where it conflicts with other activities or industries for site availability (e.g. with tourism). Mangrove depletion was an important issue in the past, when the boom in the development of shrimp farms in the north-western region of the country took place. This problem has been addressed through a number of policy measures including a ban on mangrove clearing (except in a few limited cases where extensive reseedling is required to be undertaken for an area greater than the cleared area).

Sustainable development in aquaculture requires an effort to increase productivity and efficiency, while reducing environmental impacts. Worldwide, aquaculture production

performance is measured in terms of yields. In an effort to evaluate the aquaculture industry with more robust economic indicators like productivity and efficiency, CONAPESCA is conducting in 2006 for the first time a study to estimate productivity and efficiency indicators for the shrimp farming industry. These will be done at a regional level following methodology already reported and applied in aquaculture elsewhere (Martínez-Cordero and Leung, 2004, 2006). It is expected that after this initial study, the indicators will be reported on an annual basis and, at a later stage, complemented with the environmentally-adjusted indicators. Both sets of performance indicators will assist government decision makers in undertaking a better assessment of the industry as a basis for planning its sustainable development. It is expected that economic performance statistics based on efficiency and productivity for Mexico's aquaculture industry will be produced on an annual basis in the near future.

Trade and markets

While disaggregated trade statistics for aquaculture are not available, Mexico is clearly a net supplier of aquaculture products to the world. The main export markets are limited to the United States, with some product going into Europe and Canada. The main market for shrimp is the United States where the bulk of exports consist of frozen product. In the last four years, the volume and value of Mexican shrimp exports to the United States have increased by 16% and 21%, respectively. The bulk of the exports are frozen product.

The estimated per capita direct consumption of seafood was 9.6 kg year in 2003. The local market for seafood is growing, and aquaculture farmers sell a sizable proportion of their fresh product locally, not necessarily in big wholesale markets of larger cities. Farmers often prefer local markets since size is not as strict a requirement as in export markets and yet they can still achieve very good prices, similar –in the case of shrimp– to the ones for export during Easter and Christmas. Long chains of middlemen characterize the distribution of seafood in Mexico.

The Mexican shrimp is a product with a high reputation and quality in the world market, but which had not been sufficiently supported and advertised. As a consequence, at the end of 2003 the Mexican Shrimp Council (Consejo Mexicano del Camaron, CMC) was established by the main shrimp producers and marketers. The purpose of the CMC is to further position the Mexican shrimp in world markets, to obtain better prices and a faster distribution of the product. The CMC has developed its own seal for the Mexican shrimp, which guarantees a product of the highest quality to purchasers and consumers, complying at the same time with all required standards of the US market. Presently the Council's promotion takes place only in the United States, but there are plans for expanding the area of action to European and Asian markets, and also considering the domestic market.

An important decision that will affect the trade market for shrimp in the future is the sale of Ocean Garden Products, the federal government-owned main shrimp exporter to the United States. After several failed attempts, the government finally sold Ocean Garden Products to a consortium of Sonora shrimp producers. It is expected that this sale will unlock the growth potential of Ocean Garden Products and greatly improve its competitive position in the US and Mexican market, improving the export possibilities of Mexican farmers.

At this stage, no problems have been encountered regarding to technical barriers to trade or sanitary and phytosanitary (SPS) measures. Mexico has set its own SPS standards and regulations for the introduction and movement of aquatic organisms into the country and quarantine requirements which are reflected in several official norms (Table 12.1). These standards concur with international agreements, are not barriers to trade, but allow protection of the industry from sanitary and safety-related risks.

Rural development and poverty alleviation

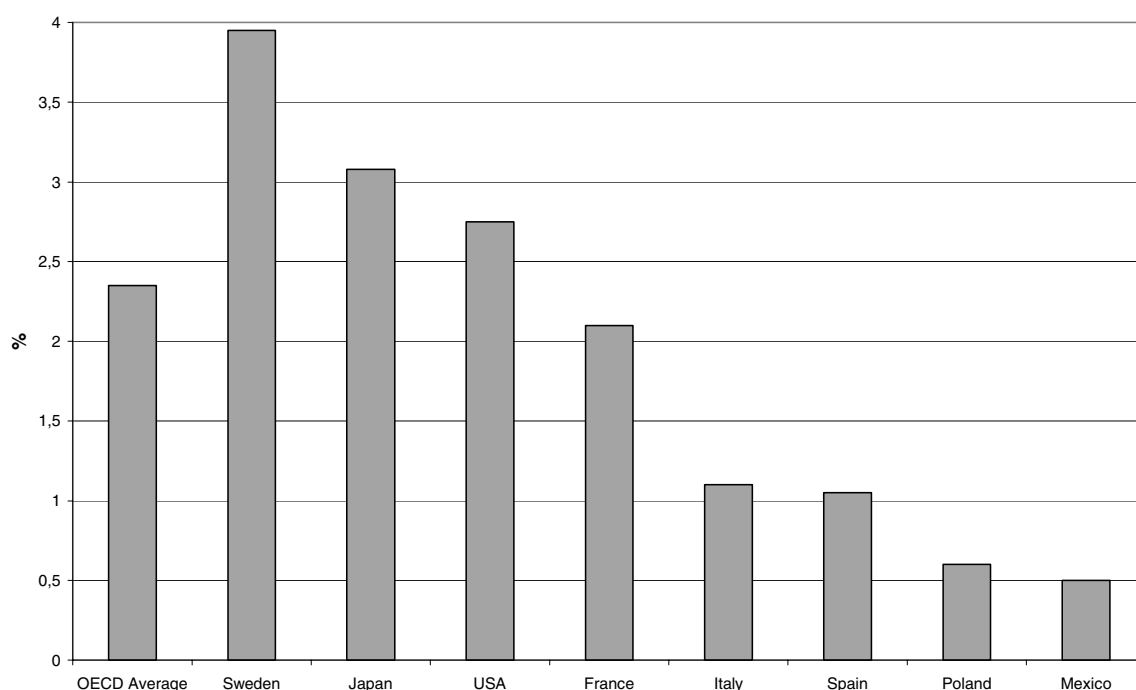
The social role of aquaculture in Mexico is becoming increasingly important. Aquaculture accounts for the creation of many new direct jobs all year around, and many other indirect jobs related to links to the processing and marketing activities. The Mexican aquaculture sector in year 2003 included a total of 1 451 enterprises. Official statistics of CONAPESCA show that in 2003 the total population employed in controlled aquaculture systems in the country was 23 028 persons, with another 250 159 persons engaged in aquaculture fisheries (inland fisheries). Aquaculture has been linked to the establishment of cooperatives and societies (organisations of producers, many of them rural). Official figures report that in 2003 there were 5 565 total cooperatives and societies for both fisheries and aquaculture, with 187 087 members in total.

CONAPESCA assists rural development through aquaculture by means of two programmes: *Alianza Contigo* and the National Programme for Rural Aquaculture (*Programa Nacional de Acuacultura Rural*, PRONAR). This latter has traditionally been the aquacultural program focused to support rural communities at federal level. In the last two years CONAPESCA has allocated similar amount of funds (around MXN 77 million to the States for rural aquaculture projects and actions (CONAPESCA, 2006).

One of the main characteristics of *Alianza Contigo* is its focus on communities of high and very high marginality in the country. The difference between this Programme and the old programmes with the same social goal is the fact that in this case there is no interest in promoting isolated actions of subsistence aquaculture, but rather the goal is to support new commercial producers at different levels of intensity and investment, seeking to generate development poles in rural (coastal and inland) communities. Recognizing the relevance of capacity building, the Programme seeks that supported projects are accompanied by training and extension services, both in technical and management aspects, while also reinforcing the capabilities of the social (public) organizations.

Research and development extension

The federal government assigns funds for aquaculture research and technology development (R&D) to PROs through the National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología, CONACYT). The share of Mexico's gross national product that goes to PROs for research and development is the lowest among OECD member countries (OECD, 2006) (Figure 12.3). In Mexico, funds assigned to the development of research still fall short of the needs of the industry. In aquaculture, most of the applied research projects that receive support are in areas such as pathology, nutrition, and development of new production systems.

Figure 12.3. Expenditure on total R&D as a percentage of country GDP

Source: OECD (2006)

Funds to aquaculture research and development are allocated in two ways: sectoral and mixed funds. Under the sectoral funds, the total money allocated to the fund is shared between CONACYT and a Federal Secretariat, like SAGARPA. In SAGARPA's sectoral fund, CONAPESCA, CONACYT and the INP determine lines of support for fisheries and aquaculture R&D at the federal level, according to development policies and priorities. The sectoral funds of SEMARNAT and SEP (Secretariat of Education) have also occasionally approved support for research projects in aquaculture. The Secretariat of Economy has also set a sectoral fund with CONACYT to promote the generation of applied research and mainly, technology development, at the industry level. In this case, a research institution or a company is the responsible of the research. Very few aquaculture enterprises have applied to this fund.

SAGARPA's funds allocated to research reached MXN 1 936 million in 2004. However, this is an aggregated figure for research in agriculture, livestock, rural development, fisheries and food. It was not possible to trace back the specific funding to fisheries and aquaculture.

Under mixed funds, the support is allocated to a specific State, with complementary contributions from the State government. In this case the State Government and CONACYT set together the priorities for aquaculture and fisheries research and technology development. Mixed funds with support to aquaculture projects typically correspond to States where this production activity is important for the State government.

Several States have established State Councils of Science and Technology, who intervene in the process of priorities selection and proposals evaluation of CONACYT's mixed funds. These State Councils also have their own budgets to support research at

State level, issuing their independent call for research proposals in aquaculture and fisheries (e.g. the State Council of Science and Technology in the State of Sinaloa).

On the other hand, CONAPESCA, through *Alianza Contigo*, has also in recent years directly funded technology development and specific scientific studies of their interest. In 2005 MXN 7.3 million was allocated to support the development of ordering plans, studies, and to support technology development required by the aquaculture and fisheries industries in Mexico.

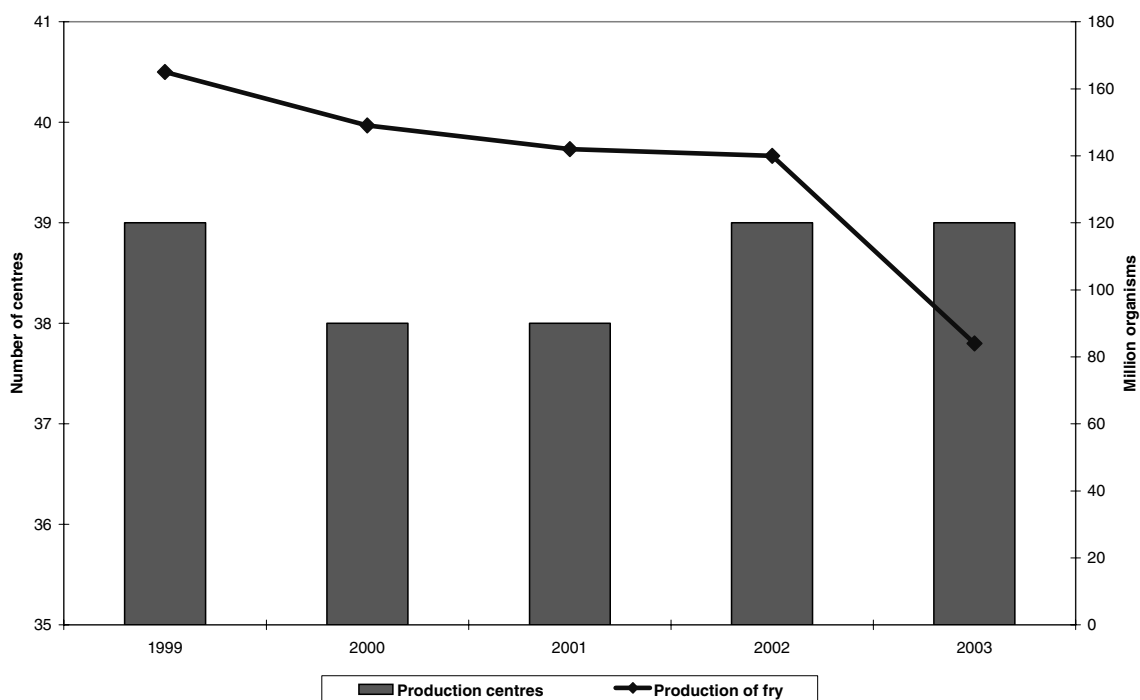
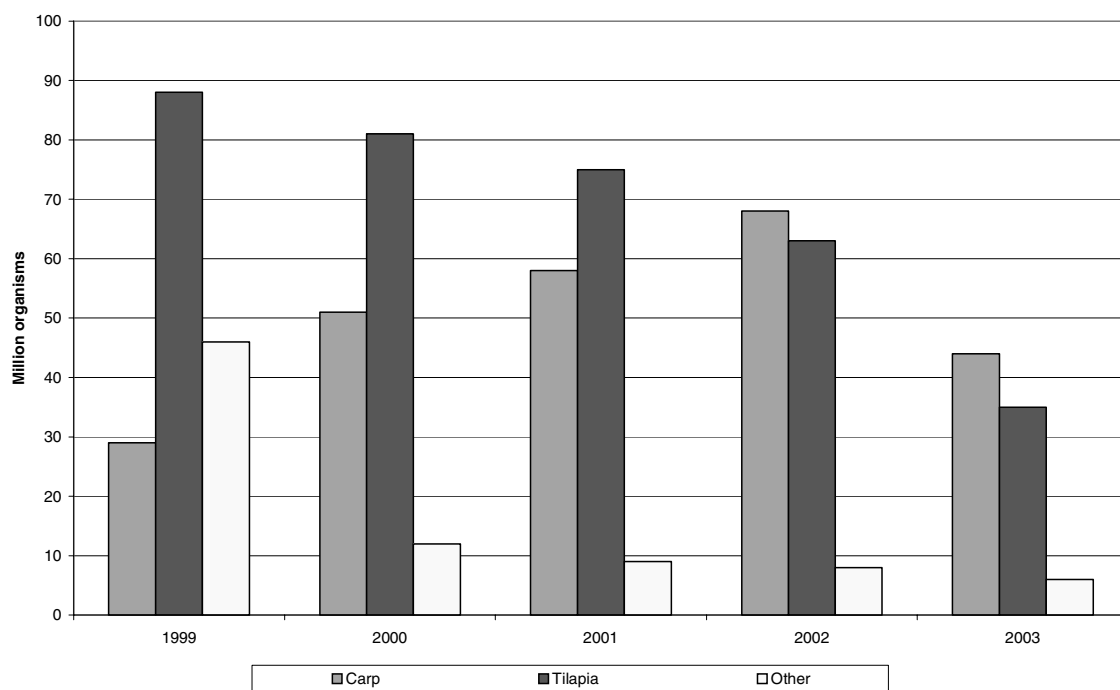
The role of the commercial aquaculture industry as a supporter of R&D is very small. It is very uncommon to find private entrepreneurs funding R&D at PROs. Currently, the biggest commercial shrimp hatcheries are conducting their own research programmes, mostly for genetics.

The industry must establish closer and stronger links with research centres and universities to assure its growth and sustainable development. If the share of Mexico's gross national product that goes into research and development (R&D) is low, the amount of money invested by the aquaculture industry in R&D at research centres and universities is much reduced. However, research by itself won't solve all problems, and it is expected that all the actors (the federal and State governments, the industry and PORs) agree on how to coordinate investment in research with the strategies for business and trade development. It is also important that research from different fields is connected and ensure synergies.

Availability of feed and larvae

Production of seed and fry in CONAPESCA's hatcheries and laboratories is shown in Figure 12.4 for the period 1999-2003. Total production of 39 production centres has been declining as a result of old infrastructure and lack of operating funds. Production in 2003 was only half of the amount it was five years before.

For the same production centres, Figure 12.5 shows that carp fry production was the only one increasing in the period 1999-2002, before declining in 2003. The development of the commercial aquaculture industry of high valued species is based on fry produced in private hatcheries or laboratories. Government owned hatcheries and laboratories are run by CONAPESCA and provide fry for carp, trout, catfish and tilapia production in inland waters, or stock enhancement activities in natural and artificial reservoirs as part of a drive to sustain small scale aquaculturalists. They also undertake research and development on new species and quality improvement techniques as well as develop brood stock for sale to the private hatcheries. Several of these laboratories or hatcheries have been ceded to private investors for a certain period of years. These production facilities have been modernized and maintained with funds from *Alianza Contigo* although further work and funding is required to continue modernisation. There is scope for rationalising the number of hatcheries in Mexico to improve efficiency.

Figure 12.4. Aquaculture seed and fry production units and total production**Figure 12.5. Aquaculture seed and fry production (million organisms) in CONAPESCA's hatcheries and laboratories, by species**

Source for above figures: CONAPESCA (2005).

On the high-valued species side, commercial shrimp hatcheries supply 100% of the postlarvae required by the on-growing farms in the country. Data from the National Association of Shrimp Larvae Producers (ANPLAC) indicate that by August 2005, 8.48 billion post-larval fry were stocked in shrimp ponds for the 2005 season in Sonora, Sinaloa, Nayarit and Baja California Sur. This represents a 10% increase from 2004 figures for Sonora, Sinaloa and Nayarit. ANPLAC groups 19 commercial shrimp hatcheries in Mexico, which produce 90% of the total larvae of the country. It is important to keep in mind that in this northwestern region of Mexico, where more than 90% of the total shrimp produced by aquaculture takes place, the shrimp growing season is limited to 8-9 months per year; a farm's typical on-growing cycle is six months long. Accordingly, production from shrimp hatcheries is supplied only for three to four months during the year.

CONAPESCA's Master Aquaculture Plan is in the process of being developed. The plan identifies priority cultures and species to develop, according to three criteria:

- By value and volume: tilapia, trout, carp, catfish, tuna, ornamental fish, oyster, Pacific white shrimp.
- By potential for expansion: tuna, abalone, clams, pearls, mussels, redclaw.
- By development potential: many marine fishes including the following: *Lutjanus peru*, *Mycteroperca rosacea*, *Paralichthys californicus*, *Totoaba macdonaldi* and *Lutjanus argentiventris* in the Pacific coast; *Lutjanus campechanus*, *Trachinotus carolinus*, *Scienops ocellatus* and *Centropomus undecimali* in the Atlantic coast.

Sources of finance

FIRA-FOPESCA and BANCOMEXT development funds have been the main source of finance for the aquaculture sector for some years (Chapter 10). Table 12.3 shows amounts allocated by both sources to the fisheries and/or aquaculture sectors in the period 1994-2003, obtained from official information. FIRA-FOPESCA's support had been increasing steadily until 2003, assigning most of the money to projects of shrimp, oyster, bullfrog, mussel or prawn culture. Only in the period 2000-2003 total support to aquaculture grew almost 25%. On the other hand, funding from BANCOMEXT source also increased every year, and almost doubled from 2002 to 2003. Information after 2003 is not available, but, as explained earlier in this chapter, *Alianza Contigo* began in 2003 and since then represents the main source of financing for the aquaculture sector.

Alternate sources of financing to aquaculture activities are FOCIR (Capitalization Fund for Rural Investment) and SAGARPA-FIRCO (Trust for shared risk). FOCIR's Programmes in 2005 included support to productive conversion and to establish production chains. Funds from these sources operate in several cases as complementary support for a single aquaculture project.

Table 12.3. Aquaculture sector funding from FIRA-FOPESCA and BANCOMEXT

Year	FIRA-FOPESCA			BANCOMEXT ^a Short and long term loans
	Total aquaculture	Tilapia, carp and trout culture	Shrimp, oyster, bullfrog, mussel, prawn culture	
	MXN million	MXN million	MXN million	USD million
1994	105.04	3.57	101.46	
1995	97.94	1.94	95.99	44.9
1996	100.17	1.69	99.02	53.2
1997	97.52	3.55	93.97	42.8
1998	150.42	0.33	150.94	68.3
1999	271.58	3.17	268.41	82.2
2000	498.58	15.07	483.51	93.6
2001	589.53	17.1	572.42	67.9
2002	618.26	18.96	599.3	107.3
2003	619.87	5.23	614.63	193

a. Includes fisheries and aquaculture.

Source: CONAPESCA

Sanitary and quality assurance issues

Countries have different aquatic (marine, coastal or freshwater) environments and introductions of exotic species, both intentional and unintentional, can become a major threat. The exotic species do not have natural competitors or predators and so can cause significant economic damage to aquaculture, fisheries and the ecosystems. Impacts of introduced pests and pathogens can be dramatic and are usually irreversible and has caused fisheries to collapse, destroyed aquaculture stock, increased production costs, threatened human health and altered biodiversity. States, therefore, have a shared commitment to address threats to their aquaculture, fisheries, biodiversity, economy and human health.

Sanitary and safety issues in aquaculture and food have become a priority to the Federal Government in general and CONAPESCA in particular. In 2003, SAGARPA created the General Directorate of Aquaculture, Fisheries and Agrifood Safety (DGIAAP). As part of the National Service of Sanitary, Safety and Food Quality (*Servicio Nacional de Sanidad, Inocuidad y Calidad Alimentaria*, SENASICA), DGIAAP promotes the constitution of State Committees of Aquaculture Sanitary issues (SCASs), which are auxiliary organisms of producers. Responsibility for sanitary issues in aquaculture is shared between CONAPESCA and SENASICA, and most of the sanitary norms are in accordance with recommendations of the International Aquatic Animal Health Code. SCASs are responsible, with SAGARPA, CONAPESCA and State Governments, for the implementation and follow up of sanitary and safety actions and programmes for the aquaculture industry. Their main function is to detect, prevent and control the dispersion of diseases of high impact in aquaculture, reducing by this way the risk of investment. SCASs also encourage the application of Good Management Practices (GMPs). Table 12.4 shows a list of current SCASs operating in Mexico.

Table 12.4. State Committees of Aquaculture Sanitary issues (SCAS) operating in Mexico

Shrimp	Trout	Tilapia and carp	Bivalve molluscs
Sonora, Sinaloa, Nayarit, Colima, Tamaulipas, Baja California Sur	Edo. Mexico, Puebla, Chihuahua, Michoacán	Tlaxcala, Jalisco, Veracruz, Tabasco	Baja California Sur, Sonora, Baja California, Nayarit

Source: SENASICA, 2006.

SENASICA has established the Safety Programme of Aquaculture and Fisheries, whose objective is to encourage and endorse application of systems of contamination risk reduction like the Good Practices of Aquaculture Production (*Buenas Prácticas de Producción Acuícola*, BPPA) and Good Practices of manufacturing in the primary processing of aquaculture products (*Buenas prácticas de manufactura en el procesamiento primario de productos acuícolas*, BPMPPPA), in aquaculture farms and processing plants in the country (SENASICA, 2006). The BPPA Programme is currently executed for shrimp, trout and bivalves, on farmers' voluntary or self-involved scheme. SENASICA schedules every year extension and training courses in different States on issues related to aquaculture safety and sanitary.

CONAPESCA coordinates the National Programme of Aquaculture Sanitation and the National Network for diagnostic and disease prevention of aquatic organisms (PRONALSA). The network incorporates 13 different laboratories in the country specialized in aquaculture pathology, including CIAD (*Centro de Investigación en Alimentación y Desarrollo*), CIBNOR (*Centro de Investigaciones Biológicas del Noroeste*), CICESE (*Centro de Investigación Científica y de Investigación Superior de Ensenada*), *Centro de Ciencias de Sinaloa*, CINVESTAV (*Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional*), and others. The network is coordinated by the Metropolitan Autonomous University (*Universidad Autónoma Metropolitana*, UAM), with headquarters in Mexico City. The final objective is to build up a System of Epidemiologic Surveillance. Currently the network evaluates diseases on shrimp, bivalves and fish.

Alianza Contigo has also a Programme of Safety and Sanitary issues (PSS). Under PSS, a specific subprogramme of Aquaculture Sanitary (SAS) issues has been created. Through SAS, *Alianza Contigo* assigns funds to SENASICA for sanitary, safety and quality programmes and actions. SAS started operations in 2003 when the first SACs were established. It doesn't have disease-oriented campaigns, but rather focus campaigns to a species and the whole spectrum of diseases that the organism may have under culture. Currently three campaigns are launched: integral campaign for diseases control in shrimp, in fish and in molluscs. The campaigns correctly are based on biosecurity measures and good practices in production.

SENASICA also funds education, training and extension services. Up to date, three manuals of food safety of aquaculture organisms (bivalves, trout and shrimp) have been published (Calvario and Montoya, 2003; Chávez and Higuera, 2003; García and Calvario, 2003, respectively) and one for safety manufacturing practices of aquaculture products (Cárdenas and Noriega, 2003). They are used by SENASICA for training and extension courses to farmers and processors in the country.

Conclusion

The prospects for the aquaculture sector are very positive, and both industry and government are enthusiastic about future development potential. Mexico has made some good investments in recent years in developing an enabling environment for the sector. This is particularly evident in the establishment of the aquaculture centres, commitment to sanitary and quality assurance issues, extension services, the reduction in the destruction of mangroves, and training for aquaculture operators. Mexico's aquaculture sector operates in such a way that it can promote itself as being able to provide national and international markets with "clean and green" products.

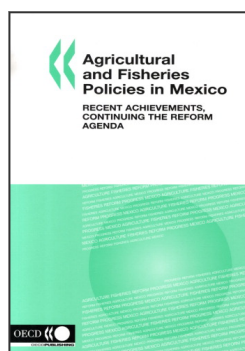
However, there are issues of coordination between government agencies with overlapping regulatory responsibilities for key aspects of aquaculture operations, particularly environmental management, land use approval and health and sanitation policy. Action is clearly needed to reduce red-tape and improve policy coherence in order to facilitate the further development of this emerging sector. In particular, action is required to develop a coherent, transparent, risk-based set of environmental parameters for aquaculture operations in order to reduce the costs and uncertainty associated with environmental compliance. Concerns also remain about the effect of public works such as canal construction and lagoon dredging on the shrimp larvae and juveniles, and on sedimentation in the waterways.

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From:

Agricultural and Fisheries Policies in Mexico

Recent Achievements, Continuing the Reform Agenda

Access the complete publication at:

<https://doi.org/10.1787/9789264030251-en>

Please cite this chapter as:

OECD (2008), "Aquaculture sector policy", in *Agricultural and Fisheries Policies in Mexico: Recent Achievements, Continuing the Reform Agenda*, OECD Publishing, Paris.

DOI: <https://doi.org/10.1787/9789264030251-14-en>

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