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Policy and governance in aquaculture

Lessons learned and way forward

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Preparation of this document

The COFI Sub-Committee on Aquaculture requested FAO to prepare Guidelines for Improving Governance in Aquaculture. As part of that process, two background papers were prepared that provide overviews of governance in aquaculture. One of them has a focus on the legal aspects of marine aquaculture governance; it is stand-alone publication as a FAO Fisheries and Aquaculture Technical Paper.

The second background paper is the current report. It summarizes some of the issues facing general aquaculture governance, current "best practices" and potential challenges for the future. The NEPAD-FAO Fish Programme (NFFP) funded the publication of this report.

Abstract

Effective governance of modern aquaculture must reconcile ecological and human well-being so that the industry is sustainable over time. Without effective governance, there will be misallocation of resources, and perhaps stagnation of the industry and irreversible environmental damage.

There is a consensus that modern aquaculture has a business orientation, similar to any small or medium-sized enterprise. For resources to be invested, there must be an enabling economic environment and secure property rights. However, there must also be controls or incentives to curb short-sighted business behaviour that damages the ecology or society. This requires that aquaculture be not only profitable but also environmentally neutral, technically feasible and socially acceptable.

Four governance principles – accountability, effectiveness and efficiency of governments, equity and predictability of the rule of law – are suggested as necessary for sustainable development of the industry. Accountability and predictability provide assurances to entrepreneurs that property rights and contracts will be honoured, while intergenerational equity suggests ecological conservation. The principle of effectiveness and efficiency implies that regulation of aquaculture will be sufficient without being too onerous, and also perhaps decentralization and public participation.

Based on these four principles, administrative and legislative frameworks can assist aquaculture to develop sustainably. In addition to governments, there are other participants in aquaculture governance such as communities, non-governmental organizations and producers. Particularly with market and participative forms of governance, these other actors can assist with monitoring and enforcement of regulations, and legitimize siting decisions. Their role in coastal zone management is critical because they provide the social licence that is so necessary for aquaculture to prosper.

A final section examines possible governance challenges in the future. The list is not exhaustive but is sufficient to suggest that aquaculture governance will have to adjust constantly to both endogenous and exogenous forces.

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Contents

Foreword

This report aims at assisting countries to improve governance of aquaculture activities within their jurisdiction. Many of the concepts and principles are common to other sectors but have not always been applied to aquaculture because the sector is relatively new. The result of poor governance has been stagnation in certain countries (even where supply and demand conditions are favourable to aquaculture), the spread of preventable diseases, irreversible environmental damage and opposition to aquaculture activities by local communities and groups. This publication argues that the goal of aquaculture governance is sustainability, which requires that ecological and human well-being be reconciled.

Four principles – accountability, effectiveness and efficiency of governments, equity and predictability of the rule of law – are suggested as necessary for effective aquaculture governance. These principles should guide the administration, legislative and regulatory framework of aquaculture. In addition to governments, other stakeholders such as communities, non-governmental organizations and producers should also be involved in the governance of the industry. These principles will also be part of aquaculture strategies.

Governance of aquaculture is likely to become more important, and more complex, in the future. There will be challenges intrinsic to the industry such as concentration in the production of certain species, the global expansion of marine aquaculture, and the pressure from consumers and the public for more accountability and transparency by industry and governments. In addition, there will be exogenous shocks such as severe weather disruptions. Retail chains will also demand higher quality standards, and traceability for farmed fish, as for other food products. All these challenges will create the need for legislative and regulatory adjustments, and perhaps oblige governments and producer associations to assist small-scale producers.

I would like to acknowledge the assiduous effort of Nathanael Hishamunda of the FAO Fishery and Aquaculture Resources Use and Conservation Division who led this project and guided it to fruition. The considerable contribution of Professor Neil Ridler and Elisabetta Martone is greatly acknowledged.

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Abbreviations and acronyms

CDD	community-driven development
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
Code	FAO Code of Conduct for Responsible Fisheries
EEZ	exclusive economic zone
EIA	environmental impact assessment
FEAP	Federation of European Aquaculture Producers
GMO	genetically modified organism
HACCP	hazard analysis and critical control point system
ICZM	integrated coastal zone management
IMTA	integrated multitrophic aquaculture
ISA	infectious salmon anaemia
ISO	International Organization for Standardization
NACA	Network of Aquaculture Centres in Asia-Pacific
NGO	non-governmental organization
PES	payment for environmental services
SME	small and medium-sized enterprise
SPS Agreement	Agreement on the Application of Sanitary and Phytosanitary Measures
TBT Agreement	Agreement on Technical Barriers to Trade

1. Introduction

ROLE OF AQUACULTURE GOVERNANCE

The reasons for promoting aquaculture are well known. Aquaculture contributes to the Millennium Development Goals by providing protein and increasing the availability of food. It generates employment income (often female employment in fish processing and marketing), so enhancing accessibility to food. Through multipliers, it increases economic growth, tax revenues and foreign-exchange earnings (Cai, Leung and Hishamunda, 2009). On the environment, aquaculture can have positive effects by reducing the pressure on overexploited fish stocks. However, there are potential costs. For example, potential hazards of cage culture include benthic enrichment, eutrophication of the water column, escapees and aesthetic loss. Aquaculture can also induce mangrove destruction. While some of these detrimental effects are reduced through the learning curve and technological advances, and through the self-interest of farmers themselves, many are intrinsic to the industry itself. For this reason, the industry is subjected to regulations or voluntary codes of conduct such as the FAO Code of Conduct for Responsible Fisheries (the Code), which are commonly referred to as "governance tools". Their aim is to harmonize human and ecological well-being by internalizing externalities that result from short-sighted behaviour.

The challenge of aquaculture governance is to ensure that the right measures are implemented to ensure environmental sustainability, without destroying entrepreneurial initiatives and social harmony. Risks to society must be reduced, but so also must risks and transaction costs to farmers. Without effective governance, there will be misallocation of resources or stagnation, and this affects all business, whether aquaculture or any other. As the driver of wealth creation, the private sector may enjoy cost-effective and transparent procedures or face obstacles in doing business. Regulatory procedures that can be conducive to investment may instead hinder all entrepreneurial initiatives in aquaculture. Without the rule of law, there will be little predictability and security. In such situations, farmers have no incentive to take risks or to invest. Rent-seeking rather than efficiency becomes rational behaviour in resource use, with resulting loss of productivity. This applies to agriculture or aquaculture with private property rights, but also to common-property sectors such as capture fisheries, forestry, land and potable water (Burns, 2007; De Young, Charles and Hjort, 2008; IIED, 2002; Salgado *et al.*, 2009; Antunes *et al.*, 2009). Efficient resource allocation hinges on governance, which, if improved in aquaculture, will have beneficial impacts on all sectors (FAO, 2008a).

SUSTAINABILITY

Sustainability is, therefore, the principal goal of aquaculture governance because it is enables aquaculture to prosper over a long period. Sustainability incorporates four aspects: economic viability, environmental integrity, social licence and technical feasibility. This is explicit in aquaculture policy in Norway: "a sustainable aquaculture industry is an industry that is competitive, market-oriented and environmentally and resource-friendly, and that supplies safe seafood of good quality" (Norwegian Ministry of Fisheries and Ocean Affairs, 2008). Economic viability requires that aquaculture operations be profitable over time, and be competitive. Profitability underlines market orientation of aquaculture ventures and implies an enabling business-friendly approach by governments. It also implies the rule of law to ensure security of property rights. Environmental integrity requires that negative impacts be mitigated, thereby enabling farmers to continue production at the same site over time. Environmental concerns

also influence consumer acceptance of farmed products. Social licence, which means the degree to which aquaculture is accepted by neighbouring communities and the wider society, is an integral part of governance and will become an increasingly critical sustainability factor, determining where aquaculture development occurs, if at all (Hishamunda, Poulain and Ridler, 2009; Lynch-Wood and Williamson, 2007). This is because perceptions of aquaculture not only affect demand for farmed products, but they can also affect supply especially when adjacent communities oppose aquaculture activities. These attitudes to aquaculture are in large part determined by perceived benefits. Thus, communications will become even more important in maintaining social licence (Barrington *et al.*, 2009; Whitmarsh and Palmieri, 2009). Technical feasibility requires that inputs such as seed and growing conditions are adapted to local conditions. Therefore, governance of aquaculture must aim at sustainability. Principles such as accountability, effectiveness and efficiency of government activities, equity, and predictability are means to achieving sustainability.

TYPES OF AQUACULTURE GOVERNANCE

Although sustainability is the common goal of aquaculture governance, the means to achieve this depend on traditions and values. As these traditions and values are not uniform across all jurisdictions, there are different types of aquaculture governance.

Hierarchical governance is somewhat similar to the traditional concept of "government" with elites and top-down decision-making. It is more common in societies where there has been a tradition of centralized authoritarian control. Market governance is common in Europe and in countries where one of the priorities of governments is foreign-exchange earnings. A third form of governance, participatory governance, is being increasingly applied in aquaculture. This form of governance is more widespread in countries where democratic values are widespread.

ORGANIZATION OF THE PAPER

The point of departure is a survey of why aquaculture governance matters and what the trends are. Governance matters because it largely determines the pace of development of modern aquaculture. This is confirmed by evidence from agriculture. The trend is towards more stakeholder (particularly producer) participation, often for practical reasons – codes of conduct and self-regulation reduce monitoring and enforcement costs. The second part of the paper organizes aquaculture governance issues such as institutional, legal and policy instruments into a pyramid adapted from forestry. At the foundation of the pyramid, there are four principles that should improve aquaculture governance, and therefore the sustainability of aquaculture. At the next tier, the role of governments in developing administrative and legal frameworks is summarized, as well as the role of other stakeholders such as communities, non-governmental organization (NGOs), and producers. Higher in the hierarchy of the pyramid, some aquaculture strategies and governance measures are examined.

Aquaculture governance in Norway is highlighted as an example. Since the rapid expansion in the mid-1970s, Norway has remained the largest producer by tonnage of farmed Atlantic salmon (*salmo salar*), the world's second-most-valuable farmed species. Its output of farmed Atlantic salmon exceeded 700 000 tonnes in 2007, having doubled over the previous decade, and earned Norway more than US$2.5 billion. The reason for selecting Norway is that this profitable and competitive expansion occurred without serious negative environmental and social impacts. Ecological and human well-being has been maintained, which suggests that aquaculture governance has been good. It is no coincidence that Norway is ranked among the very "best" in the World Bank's Ease of Doing Business and in its Governance Index, and also in the Corruption Perception Index of Transparency International. The third part suggests how some future challenges to aquaculture could affect its governance.

2. Importance and trends in aquaculture governance

THE IMPORTANCE OF GOVERNANCE

Governance has become a focus of study because of its importance. In its 2008 World Development Report, the World Bank (2008a) acknowledged that many of its recommendations on agriculture had failed because of weak governance. The absence of governance in a sector is easily recognizable with a number of key symptoms: a failure to distinguish between what is private and what is public; a failure to establish a predictable framework of laws, or arbitrariness in application of laws and rules; priorities inconsistent with development, leading to misallocation of resources; non-transparent decision-making; and the lack of sufficient regulations, or the existence of excessive regulations, which encourage "rent-seeking"(World Bank, 1991). Research suggests that these governance factors are more important than resource endowments or capital equipment in explaining differences in economic performance between countries (Lio and Liu, 2008; World Bank, 2008b).

The importance of governance is demonstrated by its role in determining living standards and poverty. For example, empirical growth theory has demonstrated that a primary explanation of the large differences in economic levels across countries is governance – the collection of laws, institutions, and government policies that make up the economic environment (Hall and Jones, 1997). Up to 75 percent of the differences in per capita income between countries can be attributed to governance factors (Keefer and Knack, 1997). A positive economic and legal infrastructure encourages production, whereas a perverse infrastructure discourages it in ways that are detrimental to economic performance. These studies confirm, as Adam Smith recognized, that a nation's economic growth is largely determined by the policies that governments follow (Johnson, 1997).

Factors, such as obedience to rules, extent of corruption, accountability and transparency influence risk and transaction costs. Total factor productivity and, therefore, per capita incomes are affected. Moreover, the gap widens over time. Those jurisdictions that have "good governance" provide an enabling environment for the accumulation of capital (both human and physical), which in turn enhances their rate of economic growth compared with those jurisdictions with weak governance. Hence, living standards increasingly diverge.

Not only is governance a significant explanatory variable in comparing overall living standards between countries, but it also explains differences in productivity in the same sector. A recent study compared agriculture sectors across 127 countries. Using World Bank governance indicators, it demonstrated that the primary explanation for differences in agricultural productivity was the quality of governance (Lio and Liu, 2008). Those countries that ranked higher in the governance indicators tended to have higher agricultural productivity. Political, institutional and legal environments were more statistically significant than other explanatory variables such as intercountry differences in precipitation or capital (the number of tractors). Not all World Bank indicators were equally important in explaining agricultural performance. The rule of law, control of corruption, effectiveness of government, and regulatory efficiency were more statistically significant than "voice" or participation. Moreover, divergences in agricultural productivity widened over time because of governance. Countries with good governance initially had greater agricultural output with a given input, but

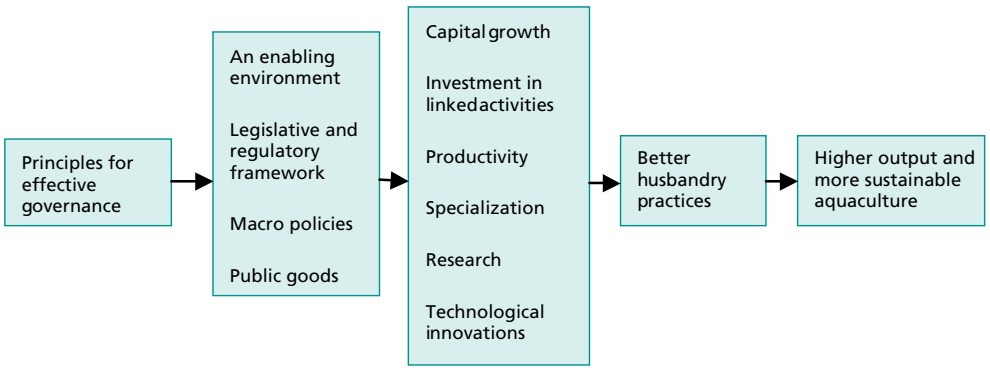
they also had higher investment and capital accumulation. Over time, therefore, with higher capital–labour ratios, the initial divergence in agricultural productivity between countries continued to widen.

Aquaculture is a form of agriculture with similar private property rights, and its productivity and long-term growth are equally dependent on governance. The focus of government intervention must be to provide an enabling environment for aquaculture to prosper, while also ensuring that negative externalities that arise from aquaculture activities are alleviated, if not avoided altogether. Business-friendly enabling policies, such as security of property rights, enforcement of contracts, and macroeconomic and political stability are important to stimulate entrepreneurship and investment because they reduce risk and costs. Similarly, without respect for the rule of law and enforcement of contracts, farmers, whether in agriculture or aquaculture, would have difficulty in marketing products and obtaining inputs from suppliers. Even the dissemination of new research and technology, and hence factor productivity, depends on administrative and institutional frameworks (Hirtle and Piesse, 2007).

Figure 1 illustrates the sequence by which governance determines the performance of a sector such as aquaculture. With the goal of sustainability, policies and institutions provide a predictable environment for the private sector. Moreover, the efficiency of the public sector is also improved by an effective administrative and regulatory framework (World Bank, 2008a). As a result, at the next step, productivity and capital accumulation, plus investment in backward- and forward-linked activities, is increased. Research is enhanced and, with it, technological innovation. At the farm level, secure property rights and long leases encourage adoption of better husbandry practices through best practices. Fish farmers have a self-interest in minimizing pollution particularly for species with a long gestation period and with high fixed costs because of direct impacts on profitability. In fact, there is evidence from salmon farming that, as the industry develops, there is a decrease in pollution, as illustrated in the environmental Kuznets curve (Asche, Roll and Tveteras, 2008). With better husbandry, there will be greater sustainability. Therefore, aquaculture governance should aim to replicate the "virtuous framework" shown in Figure 1.

Policy implications for the aquaculture sector are clear. Inputs such as seed and technical support are necessary for development of aquaculture but are not sufficient; governance issues must also be addressed. Institutions, the rule of law and the process of policy implementation matter perhaps more than resource endowments or technical inputs in influencing aquaculture output.

FIGURE 1
Governance impacts on aquaculture



Source: Adapted from Lio and Liu (2008).

TRENDS IN AQUACULTURE GOVERNANCE: GOVERNANCE MODELS

Aquaculture governance remains an issue in many countries as illustrated by conflicts over marine sites and by disease outbreaks that could have been prevented. Similarly, in certain countries, there is widespread public mistrust of aquaculture (particularly marine cage culture) – another indication of poor governance. Poor governance is also reflected in lack of development of aquaculture in certain jurisdictions in spite of favourable demand and supply conditions.

Poor governance of aquaculture is due to a number of reasons. In some jurisdictions, the sector is insignificant and of low priority. Even where intensive aquaculture is important, institutional and legislative frameworks have struggled to keep abreast of new challenges caused by the novelty of the industry and industry growth. An illustration comes from the United States of America, where offshore aquaculture has been handicapped by the absence of legislation and a federal lead agency (Pew Trust, 2007). There has also been a need to alleviate concerns of consumers and the general public. Although all food production entails damage to the environment, aquaculture has developed at a time of growing environmental awareness among the public, together with improved communications, and vociferous opposition groups. There has been particular scrutiny of marine aquaculture, particularly cage culture because it takes place in public space (unlike most agriculture). Well-funded NGOs generate media attention with scientific conclusions that may differ from those of industry or government. Most regions of the world perceive opposition to farmed seafood as a major challenge for aquaculture (Hishamunda, Poulain and Ridler, 2009). Governance measures to mitigate this consumer and public mistrust would be increased transparency and better communication.

A decade ago, FAO identified the principal issues of aquaculture governance as; "how to develop institutions and rules that recognize aquaculture as a distinct agricultural sector; integrate aquaculture concerns into resource use and development planning; improve food safety and quality to safeguard consumers and meet the standards of importers; and improve the management of aquaculture, particularly where it has the potential to be socially or environmentally unsustainable" (FAO, 1997). In the past decade, in spite of lacunae, considerable progress has been made in aquaculture governance. FAO has contributed to this progress through the Code and its guidelines for improving planning and policy development in aquaculture (FAO, 2008a). FAO has published guidelines for reducing administrative corruption, and provides Internet access to aquaculture legislation of more than 40 countries (FAO, 2007a, 2009). Improvements in husbandry management have been promoted by industry organizations such as the Federation of European Aquaculture Producers (FEAP) with its "best management practices", and agencies such as the Network of Aquaculture Centres in Asia-Pacific (NACA) with manuals on farming techniques.

Broader and softer than "government", governance covers not only what a government does but also the process by which collective action is taken. Thus, aquaculture governance includes how decisions are made and how conflicting interests are reconciled, in addition to the implementation of those decisions. Therefore, it is broader than the traditional concept of "government", which is centralized and has decision-making elites. Governance tends to be shared and inclusive, perhaps with a decentralized structure. This suggests consensus rather than consent (Gray, 2005). Thus, as values change, there must be continual institutional and legislative adaptation. For example, in addition to ongoing regulatory adjustments, governance reforms may incorporate stakeholder participation and decentralization if these processes increase effectiveness and efficiency.

Governance models can be classified into three main types, although in practice governance regimes are fluid and mixed with no clear-cut demarcation between them. Although there has been no historical evolutionary trend in fisheries governance, with

individual countries moving from one mode of governance to another depending in part on their social values and on prevailing ideologies, participatory governance is increasingly the norm in aquaculture (Gray, 2005).

At one extreme is "hierarchical governance", which is somewhat similar to "government". Hierarchical governance is a top-down, command-and-control-type of governance with the assumption that elites are the sole repository of knowledge and can enforce unpopular measures. There is little, if any, consultation with stakeholders. Hierarchical governance is exemplified by the top-down European Fisheries policy (Gray, 2005). The philosophical base is Hobbesian; a principle that individual egoistical behaviour must be controlled by the "stick" (Gray, 2005).

In aquaculture, hierarchical governance exists where governments develop policy independently, leaving producers to manage their farms. An example of such hierarchical governance is China. China's success in aquaculture has been largely due to government policies, with the authorities facilitating and formulating policies and guidelines to speed up structural reform of the fishery sector, but farmers are left to make production decisions (Hishamunda and Subasinghe, 2003). In some countries, this type of governance has disappeared for practical reasons. This was the case of Thailand where command and control measures failed to produce sustainable shrimp aquaculture; laws became outdated, enforcement was inadequate and producers non-compliant (Stead, 2005). There has since been devolution to industry, with more self-regulation using voluntary codes of conduct (as discussed below).

A second type is "market governance". Market governance leaves aquaculture mainly to supply and demand forces. The danger is that market excesses result in unanticipated environmental damage and social upheaval. An example was the initial development of commercial milkfish and shrimp farming in Southeast Asia, which was largely laissez-faire (Hishamunda *et al*., 2009a). Attracted by aquaculture's potential to contribute to livelihoods and foreign-exchange earnings, governments failed to regulate external costs as farmers pursued myopic profit-maximization. The result was destruction of mangroves, and social unrest. Broader economic benefits of aquaculture (that include non-use as well as use values[1]) were lost, and may even have become negative. Since then, countries in the region have learned from that experience and have reverted to regulations, moratoria on some aquaculture development, and codes of conduct.

Similarly, other countries that have adopted market governance have accepted the need to mitigate market failures. In Europe, where this form of governance predominates (although participatory forms are increasing with coastal aquaculture), market excesses are mitigated by domestic regulations on environmental protection, health and safety (Stead, 2005). With its goals of enhancing industry profitability and competitiveness within the constraint of sustainability, Norway's Aquaculture Act of 2005 illustrates this form of governance.

The third type of governance is "participatory governance". In aquaculture, it extends from industry self-regulation using codes of practice, comanagement of the sector with industry representatives and government regulators, to community partnerships. Self-regulation and comanagement are the principal forms of participatory management, with aquaculture producers implementing a detailed code of conduct, under the overall supervision of the State. This may be at the local, national or international level.

At the local level, neighbouring (and competing) farmers work together to coordinate environmental and production measures. For example, in Scotland, the United Kingdom of Great Britain and Northern Ireland, local salmon farms cooperate in fallowing and medication (Howarth, 2006). The motivation may be altruistic, but also self-interest in maintaining a healthy husbandry environment. Compliance is

[1] Non-use values include bequest and existence values.

enforced by peer pressure. In New Brunswick, Canada, where the Bay of Fundy has specific zones for salmon farming, the salmon growers association fully participates in managing the ecosystem. In Norway, the industry is increasingly becoming self-managed although fish health and animal welfare aspects of aquaculture are comanaged (Norwegian Ministry of Fisheries and Coastal Affairs, 2008). The industry now undertakes most inspections, with government only checking periodically. Such local self-regulation is behind the "salmon neighbourhoods" that Chile is proposing as part of its strategy to control infectious salmon anaemia (ISA).

At the national level, many countries have codes of conduct as part of self-regulation. The incentive for farmers to meet these codes is certification of quality. However, industry organization must also have the ability to exclude those that do not comply. In Canada, for example, there is a national code of conduct for responsible aquaculture developed by the Canadian Aquaculture Industry Alliance. This code is based on the hazard analysis and critical control point (HACCP) system indicating standards for fish health, environmental quality and product traceability. Scotland, the United Kingdom of Great Britain and Northern Ireland, has its "Quality Assurance" scheme in which members must meet standards of quality and environmental management that are internationally recognized such as ISO 14001. Codes of best practice that cover disease control, welfare, health and safety, and separate environmental codes are also envisaged (Howarth, 2006). Thailand has its Good Aquaculture Practice guidelines for the responsible husbandry of shrimp. It also has a sophisticated code of conduct that demands international quality standards. This code incorporates standards for feed, drugs use and environmental protection.

At the regional level, an example of self-regulation is the European industry association FEAP. It has a code of conduct that has nine themes that cover environment issues, consumer issues, husbandry, socio-economic issues, and the public image of the industry. There are 75 indicators that include biodiversity and public perceptions.

The limit to self-regulation and comanagement of aquaculture is the narrow range of stakeholders. In addition to industry and government, other interested parties wish to be involved, particularly in coastal aquaculture. Coastal aquaculture rarely occurs in isolation; it usually occurs in locations where natural resources are claimed by other sectors such as the capture fisheries, agriculture, shipping and tourism. The growing emphasis on integrated coastal zone management (ICZM) has prompted more inclusive forms of participatory governance (Stead, 2005). Not only does it allow other stakeholders to participate but it also increases legitimacy by extending the array of stakeholder participation. It has the potential to reconcile conflicts over aquaculture sites.

3. The governance pyramid in aquaculture

To illustrate the multifaceted aspects of aquaculture governance, a pyramid with different levels (Figure 2) has been adapted from forestry (IIED, 2002). At the base and lower levels of the pyramid, governance covers all sectors not only aquaculture, but at higher levels the governance issues are sector-specific. Certain measures to improve governance, such as macroeconomic and political stability, are beyond the mandate of aquaculture planners, but will influence the efficacy of policy instruments, and planners should be cognizant of this (FAO, 2008a). However, at higher levels governance measures are within the purview of aquaculture policy-makers.

PILLARS AND PRINCIPLES OF AQUACULTURE GOVERNANCE

The values of society are the foundation of the governance pyramid. They are more basic than laws that prescribe how sectors and people can behave; values indicate how they should behave. Ideally, in aquaculture, values would guide behaviour that is principled, which would obviate the need for restrictive regulations, i.e. the "best" regulation is self-regulation. Strong corporate social responsibility of aquaculture farmers would act as social licence inducing "beyond compliance" behaviour (Lynch-Wood and Williamson, 2007). These values are not static; they constantly evolve. Nor are they universal; they are based on the cultural and political traditions of individual societies. However, there are some common values and principles, and these are the basis of the normative framework and guidelines of the Code.

More than 90 percent of aquaculture output occurs in Asia. The Asian Development Bank defines governance as "the manner in which power is exercised in the management of a country's economic and social resources for development". It identifies four governance pillars: accountability, participation, predictability and transparency (Asian Development Bank, 1995). These pillars have been fundamental drivers in governance reforms in the region.

FIGURE 2
Governance pyramid in aquaculture

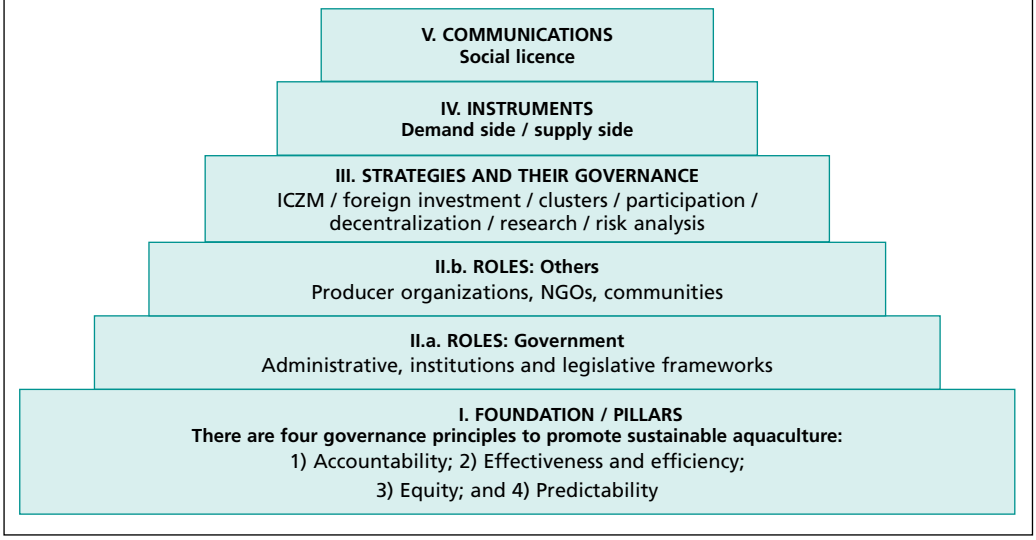


TABLE 1
Examples of demand-side and supply-side governance reforms

Issue category	Issue	Constraint	Examples of reforms required (objectives)	Time frame
Administrative / institutional	Poor enforcement	Personnel / funding	Rely more on codes of conduct and producer associations	Medium term
Regulations	Excessively regulated	Lack of review	Reduce redundant regulations. Pre-review of new decrees	Short term Medium term
Licences and permits	Too lengthy/ expensive	Duplication of procedures	Learn from "best practices" elsewhere	Short term
Human resources	Lack of skilled managers	Training too expensive	Encourage cooperative training programmes	Long term
Environmental	Pollution	Compliance of SMEs Cost of meeting standards	Establish aquaculture-specific zones. Use producer associations for peer pressure Use nucleus farms Cross-subsidization	Medium term

Source: Adapted from FAO-NACA (1997).

Supply-side governance reforms (Table 1) have reduced corruption by transferring supply of inputs from the public to the private sector (World Bank, 2008a). This could explain why aquaculture feed in Southeast Asia is now almost exclusively provided by the private sector (Hishamunda *et al*., 2009a). Demand-side governance reforms, such as increasing accountability and transparency, have resulted in aquaculture governance in Thailand becoming more participatory and less hierarchical. These governance reforms have led to more ecological and social sustainable aquaculture, without jeopardizing economic viability.

For the World Bank, governance includes selection of political leaders and is defined as "traditions and institutions by which authority in a country is exercised and the process by which governments are selected, monitored and replaced, the capacity of the government to effectively formulate and implement sound policies, and the respect of citizens and the state for the institutions that govern economic and social interactions among them" (World Bank, 2005).

There are three pillars and six indicators. The first pillar is "the respect for institutional framework", which has two dimensions, including the "rule of law" and "control of corruption". The rule of law reduces risk and transaction costs, thereby encouraging productive activities. With lower risk, farmers have greater access to credit and at a lower cost, and, generally, the sector becomes more attractive to entrepreneurs. The second pillar is "the quality of government actions", which consists first of "government effectiveness" and second of "regulatory quality". Regulatory quality indicates the tendency to under- or over-regulate. The third pillar, "the selection of authority", also has two dimensions: "voice and accountability" and "political stability". Voice and accountability reflect the ability of the population to participate in the selection of their leaders, and to monitor them through a free press.

For the aquaculture sector, four general governance principles are suggested. They are a combination of Asian Development Bank and World Bank indicators that can be applied at the sectoral level to achieve the goal of sustainable aquaculture (Table 2). Macroeconomic and political stability and lack of violence are all part of an enabling environment that permits aquaculture (or any other sector) to flourish. However, aquaculture can have little influence on these. Therefore, the four principles do not include macro principles over which the sector has no control. Instead, they focus on the meso (civil) and micro (industry and watershed) levels. They are criteria against which institutional roles and policies of the sector should be judged, although more detailed principles exist for environmental approaches and for husbandry practices. The four are: accountability, effectiveness and efficiency, equity, and predictability.

TABLE 2
Some governance principles

Asian Development Bank principles	World Bank principles	Possible aquaculture principles
Accountability	Accountability / voice	Accountability
Participation	Control of corruption	Effectiveness / efficiency
Predictability	Government effectiveness	Equity
Transparency	Political stability	Predictability
	Regulatory quality	
	Rule of law	

All four principles are implicit in the Code, which provides guidelines that satisfy many of the criteria for good governance in aquaculture. Article 9.1.1 requires States to establish, maintain and develop an appropriate legal and administrative framework to facilitate the development of responsible aquaculture and, Article 9.1.3 the regular updating of aquaculture plans to ensure that resources are being used ecologically and efficiently. There are other Articles on the import of exotic species, the maintenance of genetic diversity and ecosystem integrity and the need for environmental assessment of aquaculture. Social factors are included by requiring access to fishing grounds by local communities, and stakeholder and community participation in developing management practices (Article 9.4.2). In addition, there are articles on post-harvest practices and trade. These principles also exist in much aquaculture legislation, regulations and codes of practice.

Two other possible principles, participation and subsidiarity, are not included. Both were explicit in the guidelines for aquaculture policy and planning (FAO, 2008a). However, they are subsumed as a means of improving government effectiveness and efficiency. Another reason for their exclusion is that they may not be that important in aquaculture sustainability. For example, participation was less statistically significant than other World Bank indicators in explaining differences in agricultural productivity (Lio and Liu, 2008).

Accountability implies greater openness of administrations so that officials are answerable for their actions. For example, decisions on licences should be open to appeal and the granting criteria should be transparent. Accountability includes performance-based standards for officials, and mechanisms for reporting, auditing and enforcement. Accountability would also be reflected in timely decisions. It not only increases predictability for aquaculture producers and other stakeholders but tends to reduce levels of corruption (Alesina and Weder, 1999). As an independent variable, it was one of the most statistically significant in explaining agricultural productivity across countries (Lio and Liu, 2008).

Effectiveness and efficiency reflect the quality of administration and are highly correlated with indicators of competitiveness (Verheijen, 2009). They are also statistically very significant in comparing agricultural productivity across countries. For aquaculture, strategies, plans and regulations would need to be consistent with overall policy objectives, and that service should be cost-effective. Performance-based management systems are suggested as a means to increase the effective and efficient delivery of services by the public sector (Verheijen, 2009). Some enabling measures may also enhance effectiveness and efficiency: first, integration; second, participation; and third, subsidiarity.

Integration has three components. The horizontal component is the integration of decision-making in aquaculture with other departments representing different sectors, such as agriculture, fisheries and tourism at the same level as aquaculture. The vertical component is the integration of decision-making among different levels of government – federal, state, and municipal. The third component is ICZM, which requires integrating all human activities on the coast in order to maintain ecosystem

health and enhance human economic well-being. It is the preferred strategy of the European Commission for aquaculture development and has been successfully applied in certain jurisdictions.

A further possible concept of integration is that of fish with other food products. Integrated aquaculture, such as rice–fish farming, has the potential to mitigate environmental damage from other sectors (Subasinghe, Soto and Jia, 2009). It can also supplement cash crop income. Similarly integrated multitrophic aquaculture (IMTA), which is the farming of different species at the same site, can enhance ecosystem integrity – mussels sequestering carbon and seaweed reducing nutrient loadings. While transmission of disease may be an issue, IMTA should face no regulatory hurdles within certain countries of Europe (Glenn and White, 2006). Overall, its ecological and social impacts are positive, as are its potential to reduce financial risk through diversification. However, its overall economic viability is still unproven (Ridler *et al*., 2007).

Participation or "voice" incorporates stakeholders whether producers or local communities in decision-making. It will tend to become more important as ecosystem management and ICZM become widespread. There are several economic arguments for having stakeholders participate in aquaculture decision-making. First, participation should increase acceptance and compliance, thereby reducing transaction and enforcement costs. Second, by educating the public, it should enhance trust in aquaculture, increasing consumer acceptance of farmed seafood. Third, participation encourages the incorporation of local (indigenous) knowledge in decision-making, which could improve productivity. However, participation has its problems. It may be used as a tactic by government officials to avoid making decisions. Alternatively, it may be used to "rubber stamp" decisions already made. Moreover, obtaining consensus can be expensive as it requires human and financial resources. It should be remembered that among the World Bank indicators "voice" was less statistically significant than other variables in explaining intercountry differences in agriculture productivity (Lio and Liu, 2008).

The third strategy for enhancing effectiveness and efficiency, namely subsidiarity, is the principle that management should be decentralized unless there is a reason for higher-level intervention. For example, subsidiarity would imply that local communities are involved with site selection, even determining criteria. The advantage of decentralization is that local knowledge and interests can improve decision-making. It also increases legitimacy and public acceptance of decisions. It may even be a means of promoting aquaculture, because the evidence suggests that public support of aquaculture increases when benefits accrue to local communities, and the public are aware of these benefits (Katrandis, Nitsi and Vakrou, 2003).

Equity is critical for sustainability when it refers to intergenerational equity. Natural habitats should not suffer irreversible damage because their total economic value will be negatively affected. It suggests that aquaculture entrepreneurs should be obliged to evaluate ecological and environmental impacts of their operations, and investment decisions should be based on (low) social discount rates.

Intragenerational equity concerns income and regional distribution and gender fairness. Intragenerational equity can be included in procedures for licence applications. Norway limits the dominance one owner can have in a particular region and in the national aquaculture industry. It also gives preference to more isolated and impoverished regions with reduced fees and larger sites. Gender balance can be promoted by encouraging female applicants for licences, and moral suasion on financial institutions to provide females with equal access to credit.

Predictability refers to the fair and consistent application of laws and regulations. It also requires transparency with an open, clear decision-making process. It is linked to the World Bank's principle of the rule of law, which was statistically very significant in explaining difference in agricultural productivity between countries.

Lack of transparency, e.g. in licensing criteria, increases risks and transaction costs for entrepreneurs; whereas if conditions are clear, predictability increases.

Predictability would require, for example, that farmers can retain their produce and that the possessor of the property or lease has the right to exclude others from the property. Such security of tenure, whether freehold or usufruct, is an important target for government policy because it influences investment decisions directly, especially in operations that are land-intensive or water-intensive, such as commercial aquaculture. With predictability, property rights also become fungible, easing access to loans because they can be used as collateral. However, predictability also works in the reverse direction – property must not be subject to arbitrary confiscation and taxation. Grounds for expropriation of land or non-renewal of licences, and of taxation, must be transparent. This avoids arbitrary decisions subject to influence-peddling (FAO, 2007a).

Table 3 provides are some examples of poor governance and of governance reforms that act on both the demand and supply side of aquaculture. Demand-side governance reforms focus on improving accountability and transparency whereas supply-side reforms focus more on reducing the role of the State and, therefore, the opportunities for influence-peddling. This is done mainly through the cost-effectiveness and efficiency, as well as predictability, principles.

As mentioned above, the four principles of good aquaculture governance are means of meeting the fundamental goal of aquaculture governance, which is to enhance sustainability of the sector. Sustainability requires that the four conditions of economic viability, environmental neutrality, social acceptability and technical feasibility be met.

Economic viability is evident when farms have positive and stable profits and are competitive. It is the key prerequisite for sustainability, for without it the other three elements of sustainability become moot. Without economic viability, aquaculture can only continue if subsidized.

TABLE 3
Some indicators of poor governance in aquaculture

Key principles	Implications of poor governance	Examples of improvements
Accountability	· Officials are sole decision-makers without transparent guidelines · No opportunity to appeal decisions · Public mistrust of government policy · No credible source of scientific information	· Increase transparency of criteria · Communicate benefits and costs of aquaculture · Reduce secrecy by industry
Cost-effective and efficient oversight	· Over-regulation deterring investment and international competitiveness · Conflicting regulations · Multiple layers of approval for a licence · Long delay and heavy cost to obtain a licence · Criteria for obtaining a licence unclear and left to official discretion · Decisions made in ignorance of different contexts · Lack of capacity and resources to monitor and enforce regulations · Lack of support from communities and stakeholders	· Require cost–benefit analysis of regulations. · Establish a lead agency · Establish one-stop-shops · Encourage wider participation · Capacity building
Equity	· Short-term leases provide an incentive for myopic business behaviour · Inability of SMEs to compete against a dominant farm	· Make licences renewable subject to compliant behaviour. · Encourage banks to provide credit to women.
Predictability	· Property rights that are ambiguous or not secure with poaching and costly security · Short duration of farming licences, which makes farmers reluctant to invest in long-term improvements · Decisions on site selection subject to rent seeking by officials · Taxation is subject to influence-peddling	· Improve property rights regime · Lengthen leases · Increase transparency of criteria and procedures

Source: Adapted from Burns (2007).

Environmental sustainability requires that aquaculture strategies and operations should have long-term horizons with low (social) discount rates. Because environmental concerns are of particular concern to consumers of farmed fish and to communities near production sites, guidelines are needed for aquaculture production. Among these would be adoption of the precautionary approach where there are many unknowns, a risk management framework, concern for carrying capacity, ecosystem-based management and extensive public participation (Pew Trust, 2007).

Social acceptability refers to social licence and the degree to which aquaculture activities are accepted by the local community, by various interest groups and by the wider society. It requires that there should be intragenerational fairness, which means support for small-scale farms perhaps by clustering and cooperatives, and enhanced property rights for women, who should have equal access to production inputs much as credit and training. Social licence requires that industry has an ethos of corporate social responsibility, involving local communities in site selection, and with transparency over environmental impacts. Such transparency need not penalize the industry if benefits from aquaculture are also communicated clearly.

Technical feasibility means that farmers must have the knowledge and all technical skills that are required for growing a given fish species. For example, aquaculture operations would be unsustainable if all seeds or cages had to be imported each time they were needed. For aquaculture to be sustainable, local technology should be able to produce cages and seed.

ROLE OF GOVERNMENTS IN AQUACULTURE GOVERNANCE

Above the foundation and pillars in the governance pyramid of aquaculture come the role and scope of different stakeholders in aquaculture. Among the stakeholders are governments with their panoply of legislative and regulatory controls. Other stakeholders include producers and their associations, NGOs and local communities.

The role of the State in administering aquaculture

One question that arises is the balance between the role of the State and that of the private sector in aquaculture. There is now a consensus that modern aquaculture depends on the private sector and the profit motive (Brummett, Lazard and Moehl, 2008; Hishamunda *et al.,* 2012). Such aquaculture need not be large scale but does entail a business orientation as with any small and medium-sized enterprise (SME). Therefore, the State must provide an enabling environment, such as macroeconomic and political stability, and also some "public" goods such as rural roads, and research and development, in order to reduce costs and risks to entrepreneurs. At the same time, the State must intervene to prevent the private sector from concentrating on short-term profits at the expense of the environment and society. Market failures, such as externalities, scale economies, asymmetry in information and non-excludability in research, require intervention through regulations, economic incentives, or a combination of these. Ideally, government intervention should be transparent in order to ease public concerns and improve consumer perceptions.

While some intervention is needed, there is less agreement about its extent. Many governments have responded to market failures by providing inputs and services themselves. In some countries, there has been considerable success as with Viet Nam's provision of fingerlings for marine species. Governments have also successfully promoted positive externalities, whether through the clustering of small farms or through the nucleus farm programme of Indonesia (Hishamunda *et al*., 2009a).

However, in other cases, results of government development-oriented policies have been poor. Public sector provision may be ill timed (as with a public seed hatchery in Indonesia that was made redundant by private hatcheries), or inefficient with perverse incentives (public tilapia hatcheries in the Philippines with subsidized seed

of questionable quality that undercut private hatcheries) (Hishamunda *et al*., 2009b). Public facilities are also vulnerable to fiscal constraints, as with public fish stations in Africa, and their privatization leaves scarce funding available to those services that are "pure" public goods (those that will not be provided by the private sector). Privatization may also provide incentives for more effective service. An example is the dramatic increase in the number of private veterinarians in sub-Saharan Africa (World Bank, 2008a). A further argument for reducing the role of the State is the impact on corruption: "the more the state is involved in supplying inputs such as fertilizer and credit… the greater is the potential for corruption" (World Bank, 2008a). Because of these shortcomings, supply-side governance reforms have attempted to curtail the role of the State.

Where state financing but not provision may be needed (as for extension), an alternative to privatization is contracting-out. There is concern that outsourcing or contracting-out of services, such as extension, may particularly hurt small-scale farms. However, cross-subsidization is one means of preventing that; large farms would be charged more than small farms. However, as with privatization, contracting-out is subject to state and administrative corruption, and needs guidelines to prevent abuse (FAO, 2007a).

How should the State administer aquaculture?

The competent authority for aquaculture may be the Ministry of Fisheries. This is often the case where the industry is new or small, so that it can be administered with regulations for the capture fisheries (Percy and Hishamunda, 2001). However, Canada, which has a sizeable aquaculture industry, and particularly Norway, ranking among the top ten producers in the world, administer aquaculture under the Ministry of Fisheries. An alternative to the Ministry of Fisheries is the Ministry of Agriculture. This is the case for some of the world's largest aquaculture producers. China's Bureau of Fisheries, India's Aquaculture Authority and Thailand's Department of Fisheries are the lead agencies for aquaculture, and all fall under their respective Ministries of Agriculture. Like agriculture, aquaculture is concerned with animal production with the main difference being that the chief growing medium is water rather than soil. Issues such as access to land and water and treatment of effluents are often similar. There may also be insurance schemes available to animals. Therefore, an agricultural framework would appear appropriate, particularly for pond aquaculture. Even where there are common property issues, as in inland waterways and marine aquaculture, the responsible agency could be agriculture. An example is the province of New Brunswick in Canada where responsibility for all aquaculture, including marine cage culture, has been transferred from the Ministry of Fisheries to a combined Ministry of Agriculture and Aquaculture. In other jurisdictions, the competent authority is neither Fisheries or Agriculture, but elsewhere, such as the Ministry of Economics (Chile), or the Ministry of the Environment and Tourism (Zimbabwe). In some countries, such as Angola, Mozambique and South Africa, inland and coastal aquaculture is the responsibility of different ministries.

Table 4 suggests the national competent authority is responsible not only for national but also regional and international agreements. Regional agreements, such as in the European Economic Area, impose obligations on veterinary inspection, aquatic animal health and food hygiene. Among the international agreements that affect regulations for aquaculture are the Codex Alimentarius (1963), the Convention on Biological Diversity (1992), the Biosafety Protocol and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Other agreements may deal with the import of exotic species, as in the Code, product safety and traceability. Control of diseases, aquaculture research, the introduction of exotic species, the mitigation of the effects of global warming, and food safety and quality are areas that

TABLE 4
Aquaculture responsibilities within possible institutional frameworks

Level	Institutional framework	Management tools
International	FAO Code of Conduct for Responsible Fisheries	Code of conduct
	Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP)	Risk management
	World Aquaculture Society; Global Aquaculture Alliance; Greenpeace	Environmental protection
Regional	Federation of European Aquaculture Producers (FEAP)	FEAP Code of Conduct
	Network of Aquaculture Centres in Asia-Pacific	Regional research centres
National	National authorities Producer associations	Participation in international agreements
		National legislation & policy instruments
		National aquaculture regulations
		National codes of conduct
Local	Provincial / municipal authorities	Land tenure and site selection
		Environmental impact assessment requirements
		Strategic planning
		Licence / permits /site selection
Watershed	Producer organizations	Comanagement
		Salmon neighbourhoods
Farm level	Producers, employees	Good management practices
		Certification process

Source: Adapted from Bermudez (2008).

are becoming international public concerns. Most of these agreements are non-binding, but with the intensification of aquaculture, they are likely to become more important in the future. The benefits of such international coordination are demonstrated by the near elimination of certain animal diseases in southern Africa (World Bank, 2008a).

Whatever Ministry is responsible, a lead agency for aquaculture is desirable. Its focus would be to coordinate, plan and establish regulatory requirements for the industry, integrating aquaculture policy horizontally and vertically. Where such a lead agency does not already exist, a new body can be established. It could be an agency for aquaculture comprising different working groups, or a task force that is interdepartmental and with participants from different tiers of government (FAO, 2008a). An example is INCOPESCA in Costa Rica, which was created as the lead agency for the development of aquaculture (and aquaculture research) in 1994. In Honduras, DIGEPESCA not only regulates the sector but also prepares the aquaculture plan. The recently established lead agency for aquaculture in Mozambique, INAQUA, plays the same role. It is responsible for research and the oversight of incentives, as well as policy development and authorization of licences (INFOSA, 2009).

The advantage of having a lead agency is improved integration of administrative and regulatory initiatives of all activities related to aquaculture. As a new sector, aquaculture must work with departments that already have a role in managing resources and with a complex array of legislation often nested within many institutions. A lead agency can lower the risk of administrative overlap and departmental competition that increase transaction costs. Having a lead agency also enhances administrative accountability. In addition to reducing administrative "turf wars", a lead agency can reconcile the many legislative regulations that impinge on aquaculture. It would be responsible for constant review of aquaculture legislation and regulations. Administrative and regulatory integration, both horizontally and vertically, can be encouraged by decree

as with the Planning and Building Act in Norway that obliges agencies to cooperate. A lead agency should also be pro-active, seizing opportunities for aquaculture resulting from changing markets and new technologies. These opportunities may arise from changes initiated by the private sector, or from external forces such as international trade agreements (FAO, 2008a). Without a lead agency, aquaculture development can be handicapped. In the United States of America, for example, it is argued that marine aquaculture has been hindered by the absence of such an agency at the federal level (Pew Trust, 2007).

The potential for administrative overlap is greater when there are different tiers of governments. In Canada, for example, there are 17 federal departments and agencies with responsibilities for aquaculture, in addition to departments of the 10 provinces. The federal government has responsibility for aquaculture in the marine environment and the provinces for freshwater aquaculture. In some other federal States, such as Germany, India, Nigeria and the United States of America, responsibility for most aquaculture is at the local level, but regulations over the environment or the transport of fish across boundaries are within federal jurisdiction. In Malaysia, marine aquaculture is primarily regulated by the federal government whereas riparian aquaculture (including shrimp culture) is primarily the responsibility of the states. In France and Spain, mariculture and freshwater aquaculture come under different legislation. However, multiplication of administrative agencies is not unique to federal States; Greece has a complex administrative structure that makes integration and coordination of aquaculture management difficult (Glenn and White, 2007).

Constitutional and political factors may determine the tier of government where jurisdiction is placed, but in aquaculture, as in some other sectors, decision-making is best served by a combination of high-level and local jurisdictions. In India, coastal and inland fisheries are the responsibility of the federal government, but in the interests of local decision-making, there is comanagement between central and state governments. A similar arrangement has been made in Canada, another decentralized country. Canadian federal and provincial ministers have agreed to joint management of aquaculture, with most provincial governments assuming responsibility for site selection through federal–provincial memoranda of understanding. The federal government has been willing to surrender some of its constitutional powers. Interjurisdictional cooperation is illustrated with the Canadian Action Plan for Aquaculture and the Canadian Council of Fisheries and Aquaculture Ministers that commits both levels of government to improve regulations and sustainability of aquaculture (Masser and Bridger, 2007).

Integration and administrative coordination is particularly critical in coastal aquaculture where there are competing interests. Effective ICZM requires a cooperative regulatory framework that has been agreed upon by all major regulators and resource managers (Black *et al.*, 2006). This includes the local (urban) authority, which can influence coastal management through zoning. In India, the Coastal Aquaculture Authority was established to regulate coastal aquaculture activities in the country, while the National Fisheries Development Board oversees both aquaculture and fisheries, providing a broad perspective for different sectors. This was done through the 2005 Act. In Norway, where aquaculture is exclusively mariculture, coastal management comes under the Ministry of the Environment, with other sector ministries also involved (Norwegian Ministry of Fisheries and Coastal Affairs, 2006).

Administrative coordination is important for licensing procedures, because streamlining licensing procedures facilitates investment. This way, each department does not completely reassess applications or require environmental assessment. Too many administrative steps are cumbersome for investors; they also increase transaction costs. Similarly, one-stop shops where all information is available in one place are advisable. They do not require full institutional integration, merely a common location of applications and information. Many countries now have one-stop shops for

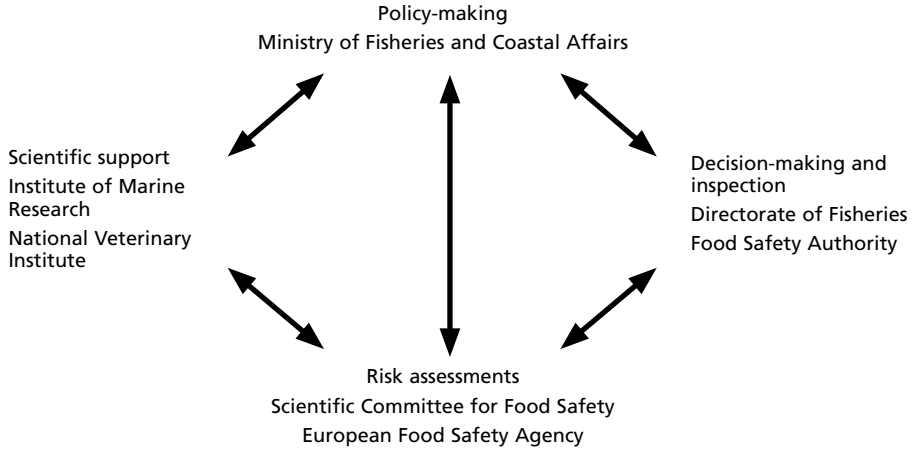
aquaculture licence applications. The lead agency responsible for guiding aquaculture in Norway, the Ministry of Fisheries and Ocean Affairs, provides a one-stop shop for licence applications giving timelines for decisions. A refinement is to have front-office/back-office separations where customers do not meet those who process the applications (FAO, 2007a). This reduces the opportunities for influence-peddling.

Administration of aquaculture in Norway

In Norway, while aquaculture is administered within a context of sustainability with regulations to ensure that practices are responsible, its governance is predominantly market-oriented. There, profits and competitive advantage are key objectives. Aquaculture's contribution to coastal value is also a priority. Environmental and social concerns are not ignored because the underlying framework is sustainability. This economic orientation is also reflected in its ambition to simplify administrative and regulatory procedures so as not to penalize producers and jeopardize comparative advantage.

As discussed above, the lead agency in charge of aquaculture in Norway is the Ministry of Fisheries and Coastal Affairs. Its Directorate of Fisheries has the responsibility for administering, coordinating and regulating the aquaculture industry; it also has the authority to enforce regulations and issue licenses. Under the Food Safety Act, the Food Safety Authority has the responsibility for regulations for aquatic animals in matters pertaining to animal health and food safety. Siting decisions are made by municipalities under the Building and Planning Act. The roles of institutions that govern aquaculture in Norway are illustrated in Figure 3.

FIGURE 3
Roles of institutions governing aquaculture in Norway



Source: Adapted from Torgersen (2008a).

THE LEGISLATIVE FRAMEWORK OF AQUACULTURE

Unless property rights are secure and enforceable, commercial aquaculture will not develop, because without them there would be no incentive to invest time and resources, and poaching would be a rational strategy (Lio and Liu, 2008). An illustration of the role of property rights is Myanmar (Hishamunda *et al.*, 2009a). Its Aquaculture Act guaranteed property rights of aquaculture farms that were already established, which encouraged the registration of illegal operations. Prior to this recognition of land rights, farms were often dismantled, deterring potential investors. The law also permitted aquaculture zoning in accordance with integrated coastal management, and although water rights for aquaculture are not absolute with agriculture given priority, the result of the act has been a dramatic expansion in shrimp farming in coastal areas.

As a new sector, aquaculture, unlike fisheries, rarely has dedicated laws, rules and norms, but is often regulated under provisions of an existing Fisheries Act, functioning within complex provisions, related to property law, environmental law, planning law and regulations for animal health and welfare, among others (Glenn and White, 2007). Having dedicated legislation in part depends on the importance of aquaculture. In many countries, it may be merely acknowledged through an enabling clause in fisheries legislation without criteria for licensing. However, leaving discretionary power to officials is susceptible to rent-seeking (Spreij, 2003). On the other hand, if the aquaculture sector is not likely to be an important industry, benefits from a complex legislative framework may not be worth the cost.

Aquaculture legislation in Norway is a good illustrative example of dedicated legislation. The 2005 Aquaculture Act is focused on wealth creation and administrative facilitation; its purpose is therefore economic. It explicitly aims to "promote the profitability and competitiveness of the aquaculture industry", while also including aquaculture's contribution to coastal value. This economic orientation is reflected in its ambition to simplify administrative and regulatory procedures so as not to penalize producers and jeopardize comparative advantage. Environmental and social concerns are not ignored because the underlying framework is sustainability. Linked to Norway's 2005 Aquaculture Act is its 2003 Food Act, which complements production codes by ensuring food quality and health standards, and therefore continued market access for the farmed fish. It requires that food is safe and of good quality throughout the production chain. The goals of the two acts are shown in Table 5.

The potential for legislative overlap, as with administrative overlap, is greater when there are different tiers of governments. However, the national government is responsible for international and regional agreements. Among the international agreements that affect regulations for aquaculture are those cited above. There are also regional agreements as between Canada and the United States of America, and within the European Economic Area. The latter imposes obligations on veterinary inspection, aquatic animal health and food hygiene.

TABLE 5
Norwegian aquaculture legislation

Act	Goal
2005 Aquaculture Act	"Promote the profitability and competitiveness of the industry"
	Simplifying administrative procedures
	Enhancing access to, and value of, coastal areas
2003 Food Safety Act	Safe food
	Viable food industry and maintain market access
	Ensure health, quality and consumer interests throughout the animal welfare production chain

Source: Adapted from Torgersen (2008a).

Regulatory frameworks in aquaculture

Regulations exist to provide an orderly and sustainable development of aquaculture. This is done by reducing negative externalities such as pollution or conflicts over land rights, and by encouraging positive externalities such as Indonesia's policy of promoting small-scale aquaculture operations around one large farm. The fundamental environmental goals are to protect genetic diversity and the integrity of the ecosystem (Howarth, 2006). A minimum list of regulations would include: avoidance of unacceptable impacts through the release of exotic species; protection from ecologically destructive use of resources; control of fish movement to limit transmission of diseases; and prevention of intrusions that conflict with the legitimate interests of others.

The danger is that regulations can be overly cumbersome, discouraging investment into the sector. Regulations directly affect the profitability of aquaculture. As Knapp

(2008) puts it: "to a significant extent the costs and economic viability of a fish farm depends on how it is regulated". Over-regulation destroys entrepreneurial initiative and motivation – the very ingredients necessary for successful commercial aquaculture. By restricting farm size and the use of technology, and adding further costs such as environmental monitoring, they can make an otherwise viable business economically unprofitable. Excessive regulations also provide opportunities for regulators to enrich themselves. Therefore, regulatory objectives should not only include environmental integrity and food safety, but also enhanced profitability and economic benefits.

For internationally traded products, over-regulation can destroy comparative advantage if competitors have a framework that is more amenable to industry. To avoid this competitive threat, regional (even international) regulations may be desirable. Thus, Norway must abide by certain health regulations of the European Economic Area, although concerned about over-regulation compared with non-European competitors; its preference would be for internationally recognized standards such as standards of the International Organization for Standardization (ISO) that would apply to all (Norwegian Ministry of Fisheries and Coastal Affairs, 2008). This internationalization of aquaculture legislation is occurring independently, driven by consumers and retailers.

This would suggest that regulations should be kept to a minimum. Indeed, some aquaculture has no adverse effects. Even when adverse effects are possible, "self-regulation" may be the best policy except for severe and irreversible impacts (Howarth, 2006). Thus, in Norway, only the most serious diseases are prevented by government regulations; less serious diseases are the responsibility of the industry through codes of conduct and self-regulation.

In addition to relying on self-management and comanagement, there are other options to avoid over-regulation. Regulations are only as good as monitoring and enforcement and are time-consuming and expensive. If human and financial resources are unavailable, regulations will be largely ineffective. In fact, the lack of enforcement of existing regulations (because of resources) may be more important than weak legislation in explaining unsustainable practices in aquaculture (FAO, 1997). One means of curtailing unnecessary legislation is to have a mandatory regulatory appraisal process prior to enactment. This ensures that implementation is considered before and not after enactment. A sophisticated refinement of the pre-appraisal process could be a cost–benefit analysis. This is required for all federal regulations in the United States of America (with the estimates done by an outside agency, the United States Department of the Treasury). In addition to additional costs of monitoring and enforcement, the cost–benefit analysis could include any potentially damaging effect on incentives.

Periodic reviews of regulations to assess their relevance and effectiveness lessen the likelihood of overlapping laws, regulations and jurisdictions that contribute to inefficiency and bureaucratic rigidity. An illustration is a report on Mozambique that found that government procedures for evaluating new aquaculture projects were cumbersome and time-consuming (INFOSA, 2009). Canada has also undertaken a review of regulations governing aquaculture. Participation of stakeholders including farmers could also reduce the danger of over-regulation. Such participation allows all interests to be heard and legitimizes decisions, which should encourage compliance. Table 6 indicates some regulatory concerns and potential mitigating measures

In addition to regulations that control fish production, fish quality is attracting regulators' attention. This is because quality is important for domestic consumers and for gaining access to international markets. Standards of quality and hygiene, labour regulations and genetically modified organisms (GMOs) can sometimes be suspect as non-tariff barriers, but they must be met by exporting countries. This trend is likely to continue, for not only are importing countries under pressure from their consumers but domestic consumers will also increasingly demand assurances of fish quality.

TABLE 6
Examples of demand and supply regulatory reforms

Issue category	Issue	Constraint	Examples of reforms required (objectives)	Time frame
Administrative / institutional	Poor regulatory enforcement	Personnel / funding	Rely more on codes of conduct and producer associations	Medium term
Regulations	Excessively regulated	Lack of review	Reduce redundant regulations Cost-benefit of new decrees	Short term Medium term
Licences and permits	Too lengthy / expensive	Personnel	Learn from "best practices" elsewhere	Short term
Human resources	Lack of skilled managers	Training too expensive	Encourage cooperative training programmes	Medium term Long term
Environmental	Pollution	Compliance of small-scale farmers Cost of meeting standards	Establish aquaculture specific zones Rely more on producer associations Cross-subsidization	Medium term

Source: Adapted from FAO-NACA (1997).

Certain agencies must be specified as competent authorities with the right to issue quality certificates that are acceptable to importing countries. This will require that fish meet quality standards as specified by the HACCP system and chemical and drug quality control boards with traceability procedures.

In addition to quality, animal welfare will require attention from jurisdictions exporting to Europe. This may involve regulations and indicators to ensure that ethical standards are met in the husbandry, transport and slaughtering of fish.

Economic incentives

An alternative or complement to environmental regulations is the use of economic incentives. Rather than control regulations that explicitly detail pollution levels or methods, economic incentives aim to change behaviour through price or tax signals. They act as a signalling device to farmers to adopt best practices and through their self-interest to also meet policy goals. There are economic efficiency arguments for incentives rather than regulations, because they have the potential to achieve pollution standards at lowest cost to society. These payments for environmental services (PESs) are increasing because there is greater reliance on corporate self-regulation, and they are now used in farm carbon emission offsets in Mexico (FAO, 2007b).

In aquaculture, the main application of incentives would be conservation of biodiversity. However, the other main environmental service, carbon emission reduction, could also exist if it could be quantified for aquaculture operations. Costs of monitoring, and quantification of ecological benefits, are among the reasons why PESs have not been implemented in aquaculture. In spite of consumers expressing their preference for certified products and firms improving their corporate image, biodiversity-offset programmes have not been developed. Nevertheless, stronger international regulatory frameworks governing climate change and biodiversity conservation would increase the demand for offset services, and with them there would be greater use of PES (FAO, 2007b). In turn, carbon taxes or cap and trade would encourage the adoption of technologies such an IMTA, and the collective goal of biodiversity conservation of watersheds. Without PESs, such technologies, whatever their positive externalities, may not be attractive to farmers.

Regulations for planning an aquaculture operation

In order to organize aquaculture regulations, it is useful to do so by the life cycle of a farm. Classification here is by the planning stage, the management stage and the

marketing stage, although an alternative is to separate regulations into: control of development, control of production, and control of impacts.

Environmental impact assessment

Most countries that aim for sustainable aquaculture require some environmental assessment before a licence is given. This is the case countries such as Chile, Mexico, Mozambique, the Philippines and Venezuela (Bolivarian Republic of). In some cases, there may be no formal EIA required unless specifically requested, because EIAs are expensive. Instead, the authorities may demand an in-house environmental survey conducted by a competent third party, as in Norway for small farms, with obligatory EIAs being required only for farms over a certain size. The reason for exempting small farms from undertaking EIAs is so as not to jeopardize potential investment or undermine the industry's competitiveness. However, the danger is that cumulative environmental impacts of small farms in a cluster are ignored.

In Canada, environmental assessments are required where there are transboundary risks, which is the case for most aquaculture projects. However, most environmental assessments in aquaculture are limited to screening, rather than more expensive types of EIA, including comprehensive studies (VanderZwaag, 2006). To reduce expenses further, the federal authority permits class screening for projects that have well-understood environmental impacts. Assessments are self-directed with the responsible federal authority deciding the degree of stakeholder participation, if any. In the two principal aquaculture provinces, British Columbia and New Brunswick, there is no separate environmental assessment required, although British Columbia does require consultation with aboriginal communities.

Access to land and water

Prior to licensing, applicants must ensure that they have access to good-quality water, and also to land in the case of land-based aquaculture. Good-quality water is essential for aquaculture, and farmers must be able to protect that supply from the claims of others.

In land-based aquaculture systems where the water supply arises entirely on the farmer's property, the main issue becomes one of protecting the water source from pollution. When the source of the water is a lake or river, legislation must ensure that the farmer can obtain a secure right to water free of pollution. It must also ensure that the fish farmer can obtain scarce water at times of drought. If there is insufficient water in a river to satisfy all users in the dry season, disputes will inevitably arise over which users are entitled to take the available water and in sufficient quantities (Percy, and Hishamunda, 2001). In the absence of modern water legislation, this question is often resolved by some variation of the doctrine of riparian rights, which essentially shares water between owners of land adjoining the watercourse and prohibits large diversions entirely. Such systems rarely provide aquaculture operators with an assured right to a specific quantity of water; the use of water can often be challenged by riparian owners and other users during times of shortage.

In addition to adequate supply, fish farmers must be able to protect their source of water supply from pollution by competing activities. In practice, this requires that each country must have an adequate law for the control of water pollution that can be enforced at the instance of the fish farmer. Where aquaculture is carried on in cages or in coastal regions, the farmer must have the right to the area of water in which the operation will be located.

Regulations for planning an aquaculture operation: Norwegian practice

Regarding access to land and water in Norway, before a licence is granted, there must be permits for land and water access. The Directorate of Fisheries can only allow

site licences in areas approved by municipalities. Applicants may also be required to obtain approval for the use of groundwater. This is particularly relevant for land-based hatcheries. They may also need permits if operations disturb waterways.

As mentioned above, while environmental surveys are needed, an EIA is only required for large farms. However, the Norwegian regulations for planning and aquaculture operation indicate that all aquaculture is expected to be environmentally responsible; Chapter 3 of the Aquaculture Act is dedicated to environmental standards for aquaculture operations.

Regulations for managing an aquaculture operation

A number of issues require regulations to ensure responsible management of operations. For operating a farm, these would control wastewater emissions, fish movement, disease, drugs and feed. In addition, there should be regulations regarding food safety and animal welfare.

Water and wastewater control

Water and wastewater control have different implications for land-based and marine farms. Land-based farms must have access to a sufficient quantity and quality of water even in drought times, which may create conflicts with other users such as agriculture. Wastewater discharge may also have impacts on other users of the ecosystem through transmission of disease and pollution, but these impacts are easy to contain. For marine farms, monitoring and controlling discharge is harder than for land-based farms and may require some flexibility. In marine cage culture in Scotland, the United Kingdom of Great Britain and Northern Ireland, environmental standards depend on the receiving waters; biomass is limited according to the dispersive characteristics of the ecosystem so that assimilative capacity is not exceeded (Howarth, 2006).

Fish movement

Licensing of the movement of fish is necessary to protect native species against imported species. It also is a response to fish escapes that may endanger wild species or invade the habitat. Licensing of fish movement is also a means of disease control by preventing the spread of disease to other farmed fish or to wild fish. Therefore, regulations of fish movement are critical if a healthy aquaculture industry is to be maintained and the ecosystem is to be protected. Fish disease varies between species and between regions, so national legislation is needed. Enumeration and monitoring are valuable by-products of such regulations. In British Columbia in Canada, in Norway and in Scotland in the United Kingdom of Great Britain and Northern Ireland, salmon escapees must be reported. This enables record-keeping and allows for a review of containment systems. In Norway and Canada, except British Columbia, the government authorities are notified, whereas in British Columbia the manager is (Dow, 2004).

These environmental goals may conflict with economic interests particularly for the release of exotic species. The benefits in foreign exchange and in economic spin-offs of an exotic species can be significant. Chilean production of Atlantic salmon was worth almost US$3 billion in 2007, and employment generated in its salmon farming industry exceeded 50 000. Nile tilapia has become the main tilapia species cultivated in Southeast Asia, accounting for more than 80 percent of total farmed tilapia in the region, compared with only 20 percent in 1990. Also, in Southeast Asia, output of whiteleg shrimp exceeds 800 000 tonnes. However, there are also costs. Escapees can change the ecosystem with long-term implications. The introduction of inland species has been particularly damaging. As with freshwater species, introduction of marine species has led to damaging effects in some places. For example, the introduction of Pacific oyster to Australia displaced Sydney rock oyster, and the introduction of diseased shrimp into Taiwan Province of China damaged the marine shrimp industry.

Therefore, policy-makers should weigh benefits against costs, with a thorough risk assessment prior to introducing an exotic species. Risk management would suggest that the emphasis should be on precaution, alien species being introduced only as a last resort and under close supervision. This would suggest legislation to control exotic species. The same would apply to genetically modified fish.

Fish disease

Fish disease regulations are linked to fish movement and are designed to eradicate disease as effectively and as cost-efficiently as possible. Suspicion of disease or sudden increases in mortality should trigger an immediate health inspection, and if necessary steps to stop disease spread.

Drug use

Regulations on drug use may prohibit completely the use of some drugs with criminal penalties for a deterrent or authorize certain drugs with a licence. There will be a withdrawal period specified in which the fish cannot be marketed.

Regulations for managing an aquaculture operation: Norway

The Norwegian experience is used to illustrate these regulations for managing an aquaculture operation. In Norway, the Food Safety Act is the main act concerning the management of animal diseases. It stipulates the duties of producers and the powers that the State has to enforce these duties (Dow, 2004). There are articles dealing with treatment of dead fish, records and monitoring, fallowing, disinfecting equipment, and fish density. Producers are expected to provide plans over a two-year period and, as with escapees, have a contingency plan in case of disease.

To control water and wastewater, a permit is required for the emission of wastewater. However, no separate emissions application is needed because the Directorate of Fisheries forwards the application. To ensure animal welfare, there are prescribed guidelines for water quality and cage density. There are also required surveys of oxygen levels and water temperatures.

For regulating fish movement, foreign species require a special permit to be imported, and an aquaculture licence cannot be granted for alien species. For GMOs, a permit is required from the Ministry of the Environment, and the permit must show that there is no environmental or health threat. This requires a health impact assessment and an EIA. Norway has strict protocols on reporting escapees, managing them and for contingency planning because escapes are widely recognized as one of the greatest environmental problems for cage culture. Licence holders must report escapes to the Directorate of Fisheries immediately; whereas, as mentioned above, in British Columbia, Canada, the report is to the manager. Escaped fish must be recovered where possible and reports must be submitted to the Directorate of Fisheries among others. Regular monitoring is required, as is the exclusive use of certified technical equipment (cages, moorings, etc.), which must be inspected by accredited independent agencies. Risk analysis must be carried out to minimize future escapes, and contingency plans are required for detailing how future escapes will be limited and how recovery can be effective. The aim is to promote best management practices through regulations based on ISO 14001 standards of environmental management. Such measures appear to be effective; the number of escapees in 2007 fell by 33 percent from the peak in 2006, with a further 97 percent decline in 2008 (Torgersen, 2008b).

For disease control, the Food Safety Authority addresses aquatic animal health and can order all necessary measures to prevent disease spread. Viral infections such as ISA are harder to control than bacterial infections (which are susceptible to vaccines and antibiotic medication), and can only be controlled by preventive measures. Although the salmon industry suffered from a severe outbreak of ISA in the early 1990s, regulations

and zoning have reduced the incidence of this disease. However, pancreas disease costs the salmon industry about NOK500 million (about US$90 million) a year.

There are requirements for disease prevention measures and hygiene standards. The frequency of in-house and public veterinary inspections is mandated, and a veterinarian must be called if there is suspected disease. Daily enumeration of the fish in each cage, its biomass, losses and feed consumption is required and must be reported to the Directorate of Fisheries monthly. There is a ban on fish movement if there are disease or sea lice, with the Food Safety Authority as the competent authority.

The use of unauthorized drugs is forbidden, and records must be kept on the use of all veterinary drugs. Withdrawal periods are specified and must be adhered to.

Regulations stipulate the ingredients, additives and composition of feed, the use of genetically modified feed and additives, as well as the packaging and labelling of feed.

Licence policies

The purpose of licensing is to ensure an orderly development of the industry with due care taken to minimize negative externalities. Licence policies may also have regional strategic purposes as with Norway's different procedures in the northern county of Finnmark, or Viet Nam's preferential treatment of mountainous regions. The licensing body (the lead agency) will decide on the number, location, the criteria used and the selection of applicants. The process should be as transparent as possible. Most countries now require licences for aquaculture, although there are particular exceptions; Chile does not require authorization for aquaculture on private property even when fresh or marine water is used.

Costs. There is a cost to farms in obtaining a licence. The price charged for a licence must reflect the rent value of using common property resources if it is marine aquaculture. This would suggest high prices where demand is high even if it jeopardizes access to the industry by small-scale players. For example, in Norway, there is a difference between licences for salmonids (salmon and trout) and those for other species. In the first case, there is a charge for commercial salmonid licences, but there is no fee charged for non-commercial salmonid licences, which would include research or education. Farmers of other species are not charged a fee. In 2009, Norway planned to issue salmon 65 licences each worth NOK8 million (about US$1.4 million), although too high a cost in the past has resulted in unsold licences.

Discrepancies in application costs are illustrated with farmed salmon. To obtain new licences to farm salmon in three of the world's major producing countries in 2006 cost from about US$7 000 in Norway to at least US$400 000 in Canada (with Chile in-between at about US$50 000) (Marine Harvest, 2008). However, licence fees alone may not reflect costs such as application fees. In Norway, for example, the price of a new salmonid licence in 2009 was 8 million NOK. If the farm applies for one or more sites, or the extension of the allowable biomass at existing sites, it must pay US$7 000 for the handling of each application. The price of a licence therefore should be distinguished from application fees because licences alone may understate costs.

However, if unsuccessful, applicants are refunded their processing fee. For Norway, this licence fee and refund concerns only salmon and trout; no fee is required for other species. Annual fees can be based on biomass or tonnage (as in Norway and Scotland [the United Kingdom of Great Britain and Northern Ireland) or on area (as in Chile).

Length of lease. The duration of licences varies, but most are valid for several years. Permits that are for short periods are too brief to provide sufficient incentive for investment in the sector. The length of licences varies from five years in Japan, to eight years in Scotland (the United Kingdom of Great Britain and Northern Ireland) and indefinite in Norway. In Western Australia, they can extend up to twenty-one years, but annual renewal is necessary. The long licence period provides time for farmers to amortize their investment, while annual renewal enables regulators to control the

site. In Chile, licences are granted for an indefinite period, and can be leased to third parties (unlike Norway except in exceptional circumstances). Grounds for revocation of licences should be explicit; whether lack of respect for environmental safeguards or the period within which an operation must be established.

Procedures. The process of obtaining permits differs between jurisdictions. To grant aquaculture permits, most countries have in common the obligation to furnish documentation on administrative and economic aspects, geographical location and technical data such as the species to be cultivated. In Chile, a five-year business development plan is also required with the application. Other countries require information on nationality, with some restricting permits to citizens or members of the region. Most countries have a common permit for all species but some (France, New Zealand and the Philippines) require different permits for different species, or for certain aquaculture techniques.

There are a number of ways for administrators to decide between competing applicants. The usual method is to rank applicants according to whatever criteria have been predetermined. However, ranking involves considerable administrative time. It also tends to result in complaints and litigation. Because of these deficiencies, Norway is considering another technique. Instead of ranking, all applications that meet the criteria are considered acceptable. Selection is then by a draw, or by an open or closed auction from among these acceptable applications.

Rapidity. Not only the number of regulations but the time to process regulations can hinder development. One of the key principles suggested for land governance is "responsive" institutions (Burns, 2007). Regulatory processes must be rapid so as not to impose a heavy burden on competitiveness. Norway's Aquaculture Act specifies that different administrations and municipalities must expedite processing of applications efficiently and in a coordinated manner. One approach is to impose time limits. In Scotland (the United Kingdom of Great Britain and Northern Ireland), deadlines are explicit for the processing of applications. In Viet Nam, a decision has to be given within 90 days of the application; otherwise, the applicant has de facto a licence. In Norway, also, as Figure 4 shows, there are time limits at each application review. There have also been trials to determine which review process is most efficient; the Trondelag model, for example, delegating responsibility. This has resulted in time saved and in released administrative capacity. The time to obtain a salmon licence has fallen to less than six months compared with more than a year earlier (Ministry of Fisheries and Coastal Affairs, 2008). This compares with one to several years in Canada and five to seven years in Chile (Marine Harvest, 2008).

Registry. If aquaculture leases are tradable and can be mortgaged, a public registry is required. This provides necessary information to potential licence buyers and creditors about encumbrances. In Norway, the registry makes much of the information available on the Internet.

Size of lease. In all cases, not only the species is specified for the licence, but also the maximum size of the operation, whether measured in area or biomass, should be specified. The size limit prevents overloading of the ecosystem. In Norway, the standard salmon licence is for 780 tonnes maximum allowable biomass, but 900 tonnes is allowed in the more isolated regions of Troms and Finnmark.

Tradability. In some countries, permits are tradable. The ability to trade licences encourages efficiency and consolidation. This is because as the more efficient farms acquire permits the less successful farmers sell their licences and find alternative occupations. The danger is that profitability of the sector may cause speculative trading of licences, which in Chile prompted the Government to impose a moratorium on the issuing of new permits. Nevertheless, protection of the public interest may require that transfers be approved, as in Madagascar and New Zealand. Approval of transfers facilitates terminating the lease if regulations are not being implemented. It

also enables governments to prevent overconcentration of the industry. However, even without prior approval of licence transfers, overconcentration can be avoided. For example, Norway limits the right of any single owner to no more than 50 percent of the maximum allowable biomass in a region, and 25 percent of the national total, but does not requires government approval of licence trades.

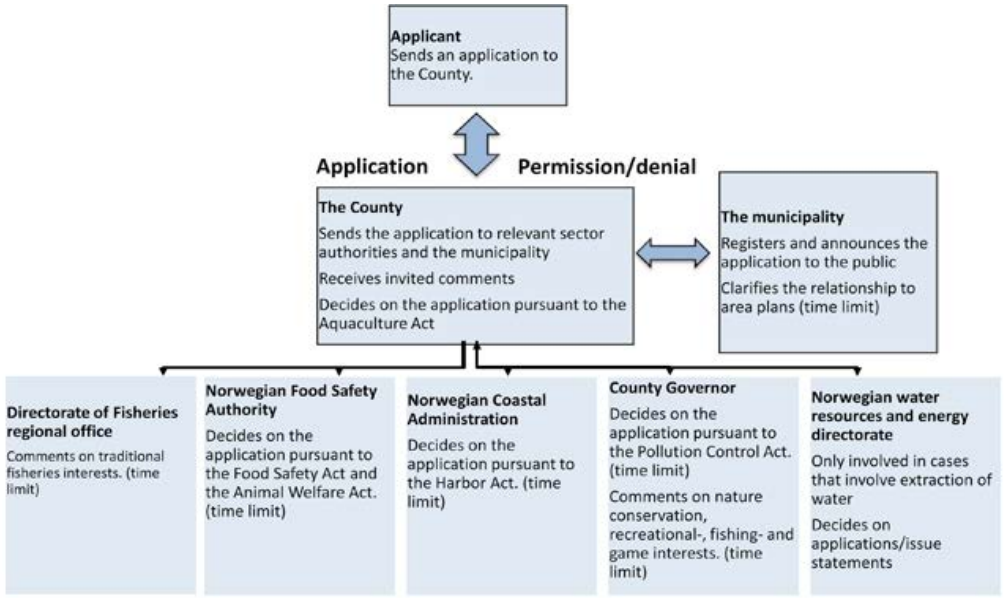
In Norway, not only are licences tradable (without government approval) but they can be mortgaged. There are a number of advantages. First, farmers have greater access to credit because the licence becomes a fungible asset. Second, there is the prospect that equity becomes more attractive and, where there is debt, long-term debt replaces short-term credit. Financial institutions face less risk because they are no longer forced to acquire all farm operations in the case of farm bankruptcy, but can acquire only a portion.

Transparency. In addition to cost and rapidity, transparency is important. Corruption is inversely related to transparency. Thus, making the criteria for obtaining a permit clear reduces the discretion of officials. It also reduces the transactions costs of entrepreneurs.

Transparency can be achieved without cost in a number of ways. When licences applications are sought, there should be a public announcement. This is done in Norway, where announcement is done together with the basic criteria for the allocation, the deadline for application, requirements as regards the application, the licence fee, and a call on women to apply. Those who submit applications should be obliged to inform the local population, and publish details, perhaps through newspapers as in Norway and Scotland (the United Kingdom of Great Britain and Northern Ireland). Public scrutiny and opinions from stakeholders are thereby encouraged. The criteria for licence assessment should be clear and explicit, as should the method of selection such as auctions, bids, or points. Restrictions should also be clear; whether applicants must possess certain assets – perhaps a minimum qualification in aquaculture management and/or a minimum amount of capital. The steps by which applications are processed could be stated (as in Scotland [the United Kingdom of Great Britain and Northern Ireland]), with a right of appeal if initial applications are unsuccessful.

Figure 4 illustrates the Norwegian licence application procedures, while Table 7 depicts the same country's licensing policy.

FIGURE 4
Norwegian licence application procedures



Source: www.fisheries.no

TABLE 7
Norwegian licensing policy and aquaculture governance principles

Principles	Licence policies
Accountability	· Public announcement about licence applications; with criteria, deadliness, requirements and licence fees. · All aquaculture operations are required to obtain a licence. · Economic viability enhanced by insistence on aquaculture experience of manager, a minimum financial base and the credit-worthiness of the licences (can be mortgaged). · An approved staff training programme is required and must be renewed every five years. · There must be knowledge on how to minimize escapees and how to handle escapees. Regulation of escapees in place with reporting to government. · Risk assessment of disease spread is part of application package. · Environmental surveys required for all operations and EIA for the largest. · Requires the cleaning up of sites after operations cease (within six months).
Effectiveness and efficiency	· Licensing procedure is required to be efficient and coordinated. · One-stop shop for licence and site applications in both freshwater and marine aquaculture. · Local office transfers all applications to other agencies, with streamlined applications for other permits. · Must conform to local municipal zoning. Municipalities decide where aquaculture can locate and have a veto on siting.
Equity	· Intergenerational equity within context of sustainability. · Differential regional licensing policy (Finnmark). · In present legislation (Aquaculture Act 2005), focus has shifted from regulation of ownership to regulation of management. Still, however, one measure to prevent concentration – no owner can control more than a specified share of regional and national biomass.
Predictability	· Licence provides right to exclude others. · Commercial licences are transferable and not time-limited. · Reasons for revocation of licences are explicit. · Information on licence applications must be disseminated to local population. · Monthly reports required per site and per cage on: number of animals, species, origin, stocking time, (live) weight, and density. Farms are obliged to post notices at sites where fish are being medicated until the end of the withdrawal period. · Licence registry is available to the public.

Regulations for marketing aquaculture products

Increasingly, domestic regulations concerning food safety and animal welfare are driven by importing countries. Food safety and animal welfare standards in importing countries may be perceived as non-tariff barriers, but countries wishing to access those markets must abide by them. This is leading to a globalization of standards because domestic regulations have to adapt to meet those standards.

Standards are responding to consumer demands transmitted through retail chains. These retail chains are "buyer-driven", setting quality and sometimes husbandry standards downstream to producers and processors. Some chains with large market share are "lead drivers", setting standards that other retailers must follow in order to remain competitive. For example, Carrefour sends inspectors on a regular basis to producers and processors to ensure that they satisfy its 85page manual (Phyne, Apostle and Horgaard, 2006).

The international agreement that is most relevant to aquaculture trade is the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). It is designed to protect human and animal health from food-borne risks. The SPS Agreement influences national regulations that address contamination of food, pesticide levels, food additives, HACCP requirements, packaging and labelling directly related to food safety (Dorman and Strom, 2006). It permits States to impose requirements higher than internationally accepted standards such as Codex Alimentarius, if justified by an assessment of risks. The Agreement on Technical Barriers to Trade (TBT Agreement) governs the use of labelling measures other than those related to food safety. Therefore, it applies to mandatory and voluntary ecolabelling schemes.

Consumers are not only requiring greater assurances about food safety, but also about the welfare of farmed fish. On the one hand, farmed fish benefit because they

are protected from predators and have an assured food supply. On the other hand, they are domesticated and subject to stress particularly if overcrowded. Therefore, animal welfare regulations are likely to become ever-more important for market access. In Norway, the objective is to embed ethical and welfare concerns in legislation on water quality, stocking density, handling and slaughtering, storage and transport of fish (Norwegian Ministry of Fisheries and Coastal Affairs, 2008). They are also assessing indicators of animal welfare. Regulations on animal welfare are needed but self-policing by producers may be sufficient. All diseases are related to animal welfare; so, it is in the interests of producers and the industry to ensure that regulations are enforced through managerial decisions on density, water quality and handling.

Regulations for managing an aquaculture operation: Norway

For food safety, there are hygiene measures related to trade, production and transport of fish. Regulations specify under what conditions fish should not be traded (physical appearance, level of veterinary drugs, and additives). In addition, the handling of fish, packing, labelling and transport is under the HACCP system. There must be an internal audit once a year, and employees must be informed. All operators are obliged to keep records of all movements of food one step upstream and one step downstream.

Comprehensive electronic tracing is needed, and an e-traceability project is under way. Traceability prevents health risks by removing suspect fish rapidly and increases market access (Norwegian Ministry of Fisheries and Coastal Affairs, 2008).

Since 1974, animal welfare has been protected by the 1974 Animal Welfare Act Relative to Prevention of Cruelty to Animals and more recently the 2010 Animal Welfare Act. The goal is to prevent unnecessary stress and suffering. The killing of animals must be done in a manner to limit suffering – procedures for killing fish (anaesthetized and then bleeding). Water quality and temperature must meet the demand of the species farmed. There must be sufficient space, feed and density (25 kg/m^3).

THE ROLE OF OTHER STAKEHOLDERS IN AQUACULTURE GOVERNANCE

Increasingly, corporate self-regulation and decentralization are extending the role of stakeholders, other than governments, in managing aquaculture. Costs of monitoring and enforcement have encouraged delegation of certain husbandry decisions to a collection of neighbouring farms, which are then subject to peer pressure. In addition, communities wish to be part of decision-making in allocating aquaculture sites.

Community groups and participation

Paragraph 6.13 in the Code says that the decision-making process should be timely and transparent, with active participation by stakeholders in fishery decision-making. This suggests that stakeholders should receive information ("informed consultation"), and also express their opinions. Particularly, marginal groups should be encouraged to participate. Involvement by all stakeholders provides legitimacy for aquaculture plans and policies and induces compliant behaviour in enforcing difficult decisions (FAO, 2008a). While participatory governance of aquaculture has come to the fore in many countries, there are questions about its effectiveness and cost-efficiency.

Participation allows all interests to be heard and contributes to resolving conflicts. A consensus-driven approach provides legitimacy and reconciliation of different perspectives. However, each jurisdiction has different procedures for the preparation of legislation and the degree of participation by stakeholders will vary. At one extreme is participatory governance, particularly community partnership and environmental stewardship, where the civil society participates fully in decision-making. At the other extreme, with hierarchical governance, policy-makers may not accept participation for cultural and political reasons, and "consultation" may be merely a means of informing stakeholders about decisions already taken.

There are also limits to participation owing to scarce resources. Participatory methods involve expenditure of money, time and skills. In particular, the absence of long-term funding for participation has handicapped the credibility and effectiveness of coastal planning in Europe (Stead, 2005). Time constraints will also determine the extent of participation. If policy formulation must be completed in a short period, widespread and intensive participation of stakeholders will be precluded. Cost-efficiency demands that additional costs of greater participation be weighed against additional benefits. Therefore, an optimal method will probably be some compromise between complete participation and a top-down approach.

The question of who should participate and whether all should have the same weight is controversial. However, where stakeholder participation has succeeded, there appear to be some principles (Black *et al*., 2006). In addition to all levels of government (national, provincial, indigenous and urban), there should be representatives of industry and also environmental groups. Residents in an area of resource use are an equal partner in the decision-making process. More remote urban interests should not dominate the decision-making process. All participants in resource allocation decisions must respect all users' interests and aspirations. Failure to participate in consensus formation and to follow the above social principles are valid grounds for exclusion from the decision-making process.

The methods for participatory governance have advantages and disadvantages. Thus, the method used will depend on factors such as the literacy of stakeholders, the willingness of potential participants to state their true preferences, and the hierarchical structure of society. Some methods save on the expense of face-to-face meetings, but all are time-consuming both for participants and for the facilitator (the lead agency). Therefore, prior to starting the process, it is imperative that those involved in policy formulation compare the different participatory methods for their applicability to the culture and the aquaculture issue. They must also compare the different methods for cost-effectiveness in terms of budgets and time (and perhaps skill requirements).

Surveys yield background data and indicate where there may be conflicts. These surveys may be basic questionnaires, or multicriteria decision-making procedures, including an analytic hierarchy process, which ranks preferences. In addition to surveys, there are groups such as focus or community groups. They provide depth and can be designed for particular interests, with media used as an educational tool from which to start discussions. They can be used to obtain opinions from a wide range of stakeholders. However, if they lack funds and legal authority, then support for them will suffer (Stead, 2005).

One method that ensures participation is the Delphi method. The Delphi method is an adaptive iterative survey method that offers adaptability, anonymity and an absence of peer pressure. It has been applied to analyse a number of aquaculture issues. It was used to develop criteria for aquaculture sustainability, and also to answer the question as to why horizontally integrated aquaculture, which can mitigate some harmful environmental effects of cage culture, has not been widely adopted (Caffey, 1998; Bunting, 2008). The Delphi method has also been used in policy formulation in one global study of aquaculture opportunities and constraints. Another application of this method is the development of aquaculture plans, as was the case in Chile. While time-consuming, the Delphi method involves little direct cost (organizing meetings), and may be a cost-effective method for certain purposes.

Non-governmental organizations

Non-governmental organizations have certain inherent deficiencies. They are not accountable, unlike politicians who are often democratically elected. They do not have to compromise but merely satisfy a narrow interest or place group, and single-issue partisans may not be representative of the broader society. Moreover, reliance on

donor funding can lead to sensationalism in order to attract media attention. The result may be rejection of aquaculture without considering economic and social benefits that accrue from aquaculture.

However, NGOs can have a constructive role in aquaculture governance. They can be a useful counterweight, particularly where there is market governance of aquaculture. If policy-making is de facto dominated by business with short-term horizons, NGOs serve as environmental and social lobby groups. They may be part of aquaculture advisory boards, as in Chile, and publish scientific studies that are not available elsewhere. The latter is particularly important where academic research is limited because of capacity. They can pressure business to increase transparency and improve working conditions. Their impact on government policy can be important even if indirect.

An example of the constructive role of an NGO is the Salmon Aquaculture Dialogue funded by the World Wildlife Fund. Industry and NGO representatives meet to discuss issues regarding the farming of salmon with the aim is to enhance sustainability of the industry. Traditionally, the Salmon Aquaculture Dialogue focused on environmental and ecological challenges but, recently, a technical committee composed of representatives from the major producing countries has been established to examine socio-economic issues. Other dialogues exist for other species.

Producer associations

Producer associations take many forms. They vary from local institutions, sometimes called "one-stop aqua shops", to sophisticated national organizations. In most countries, aquaculture does not have the economic weight of agriculture or even that of capture fisheries. Thus, its interests are often overlooked, and producer organizations can be useful just as a lobby group. In addition, they are frequently used as a means of exchanging information and diffusing technical knowledge. In Africa, producer associations have managed shared water supplies, and acted as financial intermediaries issuing credit (Hishamunda and Ridler, 2004). They can also be marketing agents and monitors for environmental self-policing, as with the Chilean Salmon and Trout Growers' Association. The association maintains HACCP and quality standards, thereby ensuring that all products exported are of a uniformly high quality. It has also played a major role in marketing farmed salmon, collaborating with other producing countries in generic advertising of salmon, and also in differentiating Chilean salmon by brand marketing. Research has also been an important priority for the Chilean association. This association established the Salmon Technology Institute to fund demand-driven research and to encourage the transfer of technology.

4. Strategies and their governance

As can be seen in the governance pyramid (Figure 2), an integral part of successful aquaculture is a strategy that contains specific instruments to meet development objectives outlined in the overall policy (FAO, 2008a). The value of a strategy lies in its focus. A strategy forces the lead agency to evaluate constraints and opportunities, with SWOT analyses, to set priorities and perhaps make hard choices. In doing so, it may also influence the appropriate form of governance. If the strategy aims to promote offshore aquaculture, for example, where there is little expertise outside government, hierarchical governance would be most efficient, whereas participatory governance is advisable for strategies such as coastal zoning.

Among possible strategies are ICZM, reliance on foreign investment, and nucleus farming. Measures that may be appropriate include stakeholder participation, subsidiarity and community-driven decentralization.

SOME POTENTIAL STRATEGIES

Integrated coastal zone management

Siting of marine zones is of critical importance to the environmental impact. Many of the adverse impacts of cage aquaculture can be attributed to siting (Pew Trust, 2007). While siting does not replace good management or regulations, it can make the difference between a sustainable operation and one that fails. At the very least, marine siting should consider: carrying capacity of the watershed, proximity of sensitive habitats, risks of disease spread, and interactions with wildlife (Pew Trust, 2007).

Siting must also take into account other users. In many countries, siting is the most contentious issue. Applications for a particular site usually face opposition, whether from cottagers, workers in other sectors, environmental groups and the wider public. In Canada, opposition to sites is perhaps the major impediment to development of the industry (McConnell, 2006). This is particularly the case when siting is ad hoc.

A strategy that appears to have been successfully implemented in Norway and elsewhere is ICZM. This is a tool for maximizing the value of coastal areas while recognizing (and if possible reconciling) different interests. Ecological and human activities that are compatible are incorporated within assigned zones. Cumulative effects of all human activities are assessed with trade-offs that are explicit and even quantified. Within an ecological framework, ICZM improves environmental integrity and has long been one of the general principles that should guide management of coastal aquaculture development (FAO, 1992). Among other benefits attributed to ICZM and zoning are the lower costs and greater predictability to farmers (and potential farmers) with streamlined application procedures. If there is community and stakeholder participation at the beginning of the planning process, compliance with hard choices appears more likely, which reduces opposition to siting decisions. In Norway, municipal participation in coastal management early in the ICZM process has avoided many siting conflicts prompted by ad hoc site applications (McConnell, 2006).

Zoning and ICZM have been the strategy adopted in many jurisdictions, and their use is likely to increase. In Australia, zoning has been proposed in Queensland (Queensland Government, 2008). In Chile, separate sea areas are zoned for salmon farming and the capture fisheries. Similarly, in Belize and the Philippines, zoning is an explicit tool for managing aquaculture. Off northwest Spain where shallow seas preclude extensive flushing, zoning has assigned salmon cages to more distant

locations. In Zambia, protected areas exist because of concerns for water conservation; in Ecuador, they exist for defence reasons. In other countries, such as Malawi, a distinction is made between private and public waters.

In Europe, ICZM is the favoured strategy of the European Commission to improve both the democratic deficit and the ecosystem deficit (Kaiser and Stead, 2002). In Scotland (the United Kingdom of Great Britain and Northern Ireland), decision-making on sites is increasingly a local matter with criteria based on ICZM within an ecosystem approach (Howarth, 2006). The 2003 "Location Guidelines for the Authorisation of Marine Fish Farms" excludes farms on the north and east coasts and then has three zones for the remaining coast. In the first zone, farms are only accepted in exceptional circumstances. In the second, areas are at the limit of their carrying capacity, which leaves the third zone as the most appropriate area for sites. There, farms are more likely to meet nutrient loading and benthic impact requirements. However, even in the third zone, applicants would need to demonstrate how they would manage sea lice and limit feed wastage.

However, in Europe, *ex post* analysis of demonstration projects indicates that funding has been a major constraint to adoption of ICZM, and has contributed to low stakeholder involvement (Stead, 2005). Participatory techniques such as consensus conferences or focus groups are expensive and long-term financing of local participation is generally not available. Two other problems were recognized as contributing to ICZM's failures: the lack of legal recognition of community groups, which enabled local authorities to ignore or over-rule recommendations, and concern that ecosystem management may not be compatible with ICZM. The challenges facing local participation suggest that the aquaculture industry will continue to self-regulate quality and welfare standards, while the wider coastal communities will decide on size and locations of farms; a combination of self-regulation and ICZM (Stead, 2005).

In Norway, the principal instrument for aquaculture siting is the 1985 Planning and Building Act, which falls under the Ministry of the Environment. All municipalities must have spatial plans that are approved by the Ministry of the Environment. Not only does the Planning and Building Act oblige horizontal and vertical integration, it encourages community participation and transparency at the very beginning of the planning process.

There were initial "turf wars" with the Ministry of Fisheries and Coastal Affairs with the latter requesting municipalities to allocate space for aquaculture. However, conflict with other coastal interests has been minimized by allocation of coastal space prior to any actual site application. Thus, holistic zoning at the beginning has been an effective tool in preventing conflict (McConnell, 2006).

Promotion of foreign investment

If there is limited domestic involvement in aquaculture, or in a linked activity such as feed, one strategy is to entice direct foreign investment. If there are few venture capital firms willing to invest in new projects of potentially high financial risk, foreign investment is one option. It absorbs some of the risks of establishing a new industry and the costs of acquiring technology and knowledge, as well as providing capital.

Chile has demonstrated that commercial aquaculture can develop by encouraging foreign investors. In the early 1990s, the ownership of Chilean salmon farms was primarily domestic, but the largest companies were predominantly foreign-owned. Foreign investors were permitted to repatriate profits at any time, and all capital after three years and there was a debt–equity agreement that gave foreign investors a premium in Chilean pesos for foreign debt. By enticing large international firms to invest in the industry, Chile obtained a demonstration effect for local producers, obviating the need to finance them. The success of this technological transfer is shown by the predominance of salmon production by domestic rather than foreign firms in

Chile; unlike Canada and the United Kingdom of Great Britain and Northern Ireland (Marine Harvest, 2008).

Costa Rica has also developed its commercial aquaculture through encouraging foreign investment. One foreign company dominates its tilapia industry. The demand for feed from this company alone was sufficiently large to stimulate feed production by domestic manufacturers. The company also prompted interest in tilapia production by domestic farmers, encouraging emulation and domestic investment in the sector. In Honduras, the Government initially focused on domestic small-scale farms, but it was only when government policies shifted to encourage foreign investment that the industry developed (Stanley, 2003). Similarly, in Africa, Madagascar has adopted policies to attract foreign investment in shrimp farming, and in Mozambique the two largest shrimp farms belong to foreign (French) investors. In Zimbabwe, the largest farm was initially established by foreign investment.

In Asia, China foreign investment projects are classified into four categories: encouraged, permitted, restricted and prohibited (FAO, 2009). Among encouraged foreign investment opportunities are the breeding of certain species as well as cage culture in deep waters. It also includes aquatic products processing, seashell products cleansing and processing, and development of function food made from seaweed. In addition, it includes the production of new varieties of chemicals and pesticides, as well as the production of antibiotic medicines.

In Southeast Asia, the overall extent of foreign ownership is uncertain, but it is generally small in relation to the size of the sector (Hishamunda *et al*., 2009a). In Indonesia, foreign ownership varies by species. Farming of groupers is primarily foreign-owned, while in ornamental fish operations and in seaweed farming, there is very low or zero foreign participation. The average proportion of all aquaculture operations owned by foreigners is 30 percent. In Malaysia, the only major foreign participation is ornamental fish cultivation. In Viet Nam, with its ambitious aquaculture plan, the need to increase domestic capacity in feed and avoid relying on imports prompted a strategy to encourage foreign direct investment in the feed sector with fiscal incentives such as tax holidays. The number of foreign companies involved in aquaculture doubled every year between 1998 and 2003, and Viet Nam can now meet most of its demand for aquaculture feed. In marine seed production, which Viet Nam has declared a priority, foreign companies are exempt from value added tax; they also enjoy reduced land taxes. Government funds are available to send students abroad to learn the technology of marine seed production. Feed production is still predominantly by foreign firms, but their share has been declining in favour of domestic producers (Hishamunda *et al*., 2009a).

However, foreign investment has an economic cost. Investors will require guarantees of profit and capital repatriation, and unrestricted currency conversion**.** They may also expect tax exemptions and other incentives**.** Such incentives could be debt–equity swaps and tax holidays. Honduras has encouraged its shrimp farming industry by offering tax holidays to foreign investors and, while the value of its output tripled from 1998 to almost US$130 million by 2007, the lost tax revenues have reduced multiplier effects for local communities (Stanley, 2003).

A further possible cost is non-economic; it is social. Foreign investments can generate resentment among the local population, particularly if the large farm is an enclave-type development, with managers hired from abroad, few backward linkages, little training provided, and research done elsewhere. To expedite the acquisition of technology and expertise, joint ventures that offer domestic investors the opportunity to participate and gain technological knowledge could be enforced.

Economic and social costs must be weighed against the benefits of acquiring technology, generating foreign exchange and developing a growth industry. Moreover, there are means of mitigating concern about foreign ownership of resources. In some

countries, aquaculture licences are restricted to nationals. The Philippines and Viet Nam have limits on the proportion of assets held by foreigners. In the Philippines, foreign participation is restricted in natural-resource operations (including aquaculture) to a maximum of 40 percent, but this may have been circumvented by using local people as "fronts". In Viet Nam the proportion is 70 percent. There is also the possibility of limiting foreign investment to joint ventures. They expedite the acquisition of technology by local people and offer domestic investors financial opportunities.

Promotion of large companies

In some countries, size is important to kick-start aquaculture or at least to accelerate its development. As with foreign investment, this involves both benefits and costs.

Among the benefits are the capital inflow and technological expertise that large, perhaps foreign, farms can bring. Infrastructure including sophisticated processing plants to meet HACCP standards may be needed and only feasible with a large company. Size may also be sufficient to achieve economies of scale in input production. This was the case of the Jamaican Broilers Group, which was encouraged by policy- makers to diversify from poultry to tilapia. Policy-makers' attempts to stimulate small-scale fish farming had failed, so, a large firm with an ability to produce feed was an alternative option. By itself, it could obtain economies of scale in feed production and was able to establish high standards in export markets, which benefited other producers. Far from damaging small-scale production, the Broilers Group encouraged "infant" farms by guaranteeing inputs and markets, and providing technical expertise. Indonesia adopted a similar policy in 2000 with the encouragement of business partnerships with nucleus farms for shrimp and tilapia.

However, there may be costs if the large farm dominates inputs or output markets. The extreme case would be a monopsony. Where a large aquaculture producer becomes the only source of employment, for example, working conditions are generally vulnerable. Such a "company town" is more likely in natural-resource sectors such as aquaculture. To ease resentment where there is a dominant aquaculture farm, an ownership stake can be offered to the local community by the employer.

Promotion of clusters and nucleus farms

Small-scale farms often lack technical expertise to meet quality standards and also obtain market access. One strategy to mitigate these handicaps is to encourage a large farm with links to small-scale farms. This is the strategy that has been successful in Costa Rica and Jamaica, has been encouraged in Indonesia, and has been suggested for Mozambique (INFOSA, 2009).

In some countries such as Costa Rica and Jamaica, a large farm already existed. With its market power and depth of resources, it was able to stimulate backward and forward linkages. Its success prompted small-scale farms to "piggy-back" using inputs provided by the large farm. This strategy is followed in Indonesia, where large farms must involve satellite farms.

In green belts, farms larger than 50 ha must develop along the nucleus-estate concept in which grow-out ponds are distributed to the landless for their eventual ownership under an approved financing plan. The large farm (nucleus) is expected to provide support to the farmers in terms of technology, inputs and marketing. The government's role has been to facilitate and to monitor these partnerships, suggesting improvements.

In Mozambique, there is recognition that reliance on small-scale subsistence farms has led to abandonment of ponds once donors departed (INFOSA, 2009). The new strategy relies on the profit incentive of SMEs linked to large farms as "drivers". The drivers provide juveniles, feed and sufficient technical assistance to maintain quality fish. In return, they purchase and market fish from the satellites. In addition, the drivers are eligible for tax holidays for 5 years and tax reductions on revenues for 20 years.

GOVERNANCE MEASURES

Data collection

Sustainable aquaculture is severely handicapped where there are insufficient data or where the data are unreliable. In fact, data are essential for informed decision-making in aquaculture, yet, this aspect is often overlooked. To develop a robust database requires planning similar to the requirements for aquaculture planning; that is, fitting it into administrative and legal frameworks, a budget, an analysis of human capacity and training needs, and a pilot trial (FAO, 2008a). The method of collection will depend in part on trust and on resource availability. There may also be a comparison of cost-effectiveness between methods, for example, between enumeration and sampling.

Southeast Asia provides an illustration of different collection processes (Hishamunda *et al*., 2009b). In Cambodia, those engaged in aquaculture activities are required to record the pen, pond or cage area and the quantity of species fed, and submit this monthly record to the provincial fisheries administration. The Department of Fisheries, in turn, estimates the total culture area. Other countries elsewhere in the world, such as Costa Rica, also require farmers to provide data on production and sales. However, while this individual reporting may be relatively inexpensive, concern by farmers over tax repercussions can reduce compliance. It can also result in deliberate inaccuracies.

To obviate individual tax concerns, a compromise is to have data collected at the local level. In Indonesia, data collection is at the village level. The sequence for gathering aquaculture data begins by determining the sample, and those villages sampled provide data for the local authorities. Annual data on production area and aquaculture households, and quarterly data on production, are then sent to the provincial government, to be compiled and published by the Directorate General of Aquaculture. Malaysia follows a similar procedure but data are collected by aquaculture extension officers, who send village data to the State Fisheries Office. There, the data are compiled and vetted before being forwarded to the Fisheries Department for further verification. In the Philippines, data are collected by survey. The Bureau of Agricultural Statistics surveys for freshwater, brackish-water and marine water environments, estimating quarterly data on harvest volume and value for each species. This information is generated at the regional, provincial and national level. In some countries, a complete census can be financed, but this may not be cost-effective in countries where aquaculture is a marginal sector.

Research

Research and dissemination of research results are an integral part of aquaculture governance. Modern mechanized aquaculture requires research as it becomes more intensified; its continued development hinges upon research. "Experience from salmon farming has shown that research is decisive for a profitable and sustainable development" (Norwegian Ministry of Fisheries and Coastal Affairs, 2008, p. 25). Not only does it increase production but issues that influence public perception of aquaculture, such as substitution of vegetable for fish oil, disease control, lice problems, carrying capacity of ecosystems and coastal conflicts, require research. Research contributes to public acceptance of aquaculture as an ethical and sustainable food source.

However, while research and training are critical in maintaining a dynamic sector, individual producers often lack the resources to undertake research themselves. Even when they can afford to, there is a disincentive if research results are not proprietary and will be available to everyone. For this reason, the aquaculture industry funds mostly applied research in Norway, leaving basic research predominantly to universities (Norwegian Ministry of Fisheries and Coastal Affairs, 2008). Such basic research can benefit the whole industry and society, which justifies government funding. Even such publicly funded research could be demand driven or determined by industry needs, rather than decided by government officials according to their skills or wishes.

One way to ensure that research is demand driven is to encourage private–public research partnerships. Companies make financial and in-kind contributions for the advancement of research. Their participation guarantees that the research is demand driven. Their contribution also leverages the public funding so the total research budget increases. Such private–public research partnerships have been successful in tilapia breeding in the Philippines (Hishamunda *et al.*, 2009a). They are also widely used in Canada for the development of new species or farming technologies.

Efficiency of research can also be enhanced by collaboration among national institutions. Collaboration diminishes duplication and encourages specialization, particularly if there is coordination of research efforts, perhaps by a lead agency. Research centres could be merged, as has been suggested for Norway (Norwegian Ministry of Fisheries and Coastal Affairs, 2008). This merging should help to achieve economies of scale and enhance the transfer of knowledge. It could also occur through regional and international cooperation with other research institutes.

Once the research results are known, it is important that they be widely disseminated. They enable government personnel to monitor and enforce husbandry practices, and producers to improve them. Extension workers should be informed, perhaps with workshops, and farmers through communication tools such as brochures and media broadcasts. Technical communications can be a two-way learning process. In India, the farmers' training centres not only disseminate technology to farmers, they also provide a communication channel to the researchers about field problems and indigenous technical knowledge.

Risk analysis

In Canada, risk analysis is used by the lead agency for aquaculture, the Department of Fisheries and Oceans, in managing coastal allocation. Its advantage is that there is a common language and understanding of ecosystem effects of certain activities and it can guide appropriate mitigation measures (Burgetz, 2008). There are four stages in risk management. The initial stage is assessment, which is the identification of risks. It is followed by the analysis of risks and its measurement. The third stage is risk response, which may require mitigation. The last step is risk communication.

While beneficial in assessing scientific hazards, risk analysis can be problematic at the policy level. In some cases, probabilities are unknown, and while the precautionary principle would suggest that activities should not be authorized if ecological effects are potentially irreversible, the danger is that there could be heavy economic and social impacts of disallowance. The opportunity costs of lost incomes or abandoned communities may not be considered in the scientific analysis. Risk analysis has a bias towards caution, which is not conducive to more risk-tolerant aquaculture investment. A final caveat is the communication of risk. Its scientific context may not be understood by the public for whom the concept of risk is very negative; poor communications can create mistrust for aquaculture activities and for farmed fish (Mazur and Curtis, 2008).

Subsidiarity

The principle of subsidiarity suggests that certain issues should be left to local authorities. Where there are neither externalities nor economies of scale, as with site selection, local communities are able to make their own decisions based on their own priorities. Empowering local communities and collaborative management increases the likelihood of habitat protection and environmental sustainability. It expands the knowledge base and can energize local initiative. On the other hand, where there are externalities, as with regulations over importing exotic species, higher-level decision-making is needed. The high level prevents "environmental dumping", by which one jurisdiction accepts standards unacceptable to others, a decision that will have negative repercussions on all.

This more local approach, community-driven development (CDD), appears to be the route that much aquaculture governance will follow. Linked to decentralization, CDD encourages industry, communities and the local government jurisdiction to decide priorities. Clustering of farms permits economies of scale in inputs and marketing with improved management of watersheds. Including NGOs and those with an interest in the community encourages public acceptance of the hard trade-offs necessary for strategic planning and integrated zone management. Increasingly, CDD is a focus of development strategies; the World Bank now allocates about 10 percent of its funding to CDD strategies (World Bank, 2008a).

An interesting case study of CDD was undertaken on Canada's west coast (Black *et al.*, 2006). The aim was to rationalize the cost of managing five clam species. The breadth of representation included organizations representing the indigenous population, local governments and regional governments, wild harvesters of shellfish, shellfish growers, and shellfish processors. The basis for development of the management board was that the board would operate by consensus, that all groups should be treated with mutual respect and that all groups were equally valid participants. Essentially, the board advised the two levels of government on the management of the local fisheries, and government agencies agreed to be advised by the board on managing the clam species. One concern of community management is that industry interests are not included. However, because the board was dominated by local residents there was always a balance in deliberations between the local need for industry development and the need for a sustainable harvest. This approach ensured that benefits from aquaculture were communicated fully. Involvement of so many local people also meant that there was strong local involvement in policing and that social pressure was often enough to curb harvesting outside of the approved harvest plan. A decade later, the board is still in operation.

However, in spite of its merits, decentralization requires not only local decision-making but also local fiscal capacity. This has been noted also for ICZM implementation. Local tax bases are often low and inelastic. Most developing countries have experimented with decentralization, but have faced resistance to the shift of personnel and the tax base from central to local jurisdictions (World Bank, 2008a).

5. Policy instruments

SUPPLY-SIDE INSTRUMENTS

Most policy instruments to promote aquaculture focus on supply because that is often where there is a constraint. There may be no feed industry or insufficient seed. There may also be diseases and limited funds to curb them, owing to a shortage of investment capital. The usual tool for stimulating supply is a fiscal incentive such as a tax holiday. This may be made available to both domestic and foreign investors. Fiscal policies are less costly to administer than monetary policies; custom exemptions and land tax exemptions can be administered by a few officials. They also do not require an immediate outlay from the public purse. However, there is an opportunity cost of fiscal incentives in lost tax revenues for governments. These lost revenues can severely limit the beneficial impact of aquaculture on society as a whole (Stanley, 2003).

The major operating cost for most species is feed, its availability and its cost. Other constraints to development of aquaculture include access to credit (and the interest rate charged) and the availability and quality of seed (Table 8). However, in most developing countries, access to credit can be more limiting than feed. Many policy options exist to alleviate these constraints. However, it is important to note that already governance reforms now strive to limit direct provision of inputs by governments because they incite rent-seeking by officials (World Bank, 2008a). Moreover, some are beyond the financial capacity of many developing countries, whereas others (such as government assistance with business plans) involve no outlay of public money.

Capital and credit constraints

Government monetary intervention in aquaculture has included direct subsidies to producers to kick-start the industry. The argument for this kind of support is that industries learn by doing, and so with maturity come economies of scale and international competitiveness. Once farms have these two attributes, government assistance should end. Another argument for early government support is that financial institutions are naturally prudent and new industries such as aquaculture entail greater, or at least unknown, risk. There may also be a lack of quality business planning and, at the small-scale, a lack of collateral perhaps because of uncertain property rights. Providers of start-up capital will therefore not give sufficient credit; or if they do, they will charge a risk premium (Hishamunda and Manning, 2002).

To assist with the shortage and/or the high cost of capital, policy instruments used in aquaculture have been cash grants, as in Canada, and credit subsidies, as in Indonesia. Policy instruments that do not involve direct budgetary expenditures have also been implemented. This is the case of government loan guarantees in Europe and state assistance with business plans in Madagascar, which improved access to bank credit. There may also be the potential for extending the same insurance available to agriculture, which would reduce the risk premium on bank loans and encourage banks to lend (Van Anrooy *et al.*, 2006).

However, monetary incentives to stimulate supply can be both inefficient and inequitable. Interest rate subsidies to aquaculture were abandoned in the Philippines, which recognized the disincentive impact of low interest loans (Hishamunda *et al.*, 2009a). The loans were viewed by borrowers as handouts, as was the case in Côte d'Ivoire with the government-supervised loans from the African Development Bank. In the Philippines, they also principally benefited the larger borrowers, who had more collateral and less risk. As a result, market, rather than subsidized, interest rates are

now charged, and non-financial government agencies, which had a poor record of financial management, have been replaced by banks as lending agencies. There is also the question whether interest rates *per se* are the most important capital constraint for aquaculture farmers including smallholders, in the Philippines. Many farmers and small entrepreneurs borrow from informal financiers, even at usurious rates, and are often able to repay such loans. More important than the rate of interest appears to be the ease and convenience of obtaining a loan approved with minimal paper work and documentary requirements (Hishamunda *et al.*, 2009a).

Feed and seed constraints

In some countries, the quantity and quality of feed and seed constrain the aquaculture sector. Feed is the principal cost in the cultivation of most species, and this cost has tended to increase with the rising price of fishmeal. The quality of feed can also be an issue. Similarly, quality and shortages of seed can be a constraint.

Policy instruments to encourage more and better feed production include explicit incentives for foreign investment, as with Viet Nam. Other policies include encouraging livestock companies to diversify into aquaculture and feed production (as Jamaica did), lowering tariffs on imported feed (as in the Philippines), promoting large integrated operations (as in Zimbabwe), and undertaking research to substitute imported fish meal with local ingredients (as in Malaysia).

Seed availability can be increased by offering hatcheries tax holidays, as is the case in Malaysia. Another example is Viet Nam with its plan to increase marine seed production. Viet Nam also used soft loans, exemptions from value added tax, and reduced land taxes. Government funds are also available to send students abroad to learn the technology of marine seed production. To improve the quality of seed, research has been promoted in many countries in public fish stations. However, research can also be undertaken by private companies on site, or in the case of the GIFT tilapia strain in the Philippines, in collaboration with a university.

TABLE 8
Examples of policy instruments to overcome specified supply-side constraints

Category	Issue	Cause	Examples of action required	Time frame
Technical	Shortage of quality feed	No feed factories	Lower tariffs on feed ingredients	Short term
			Research feed	Long term
Socio-economic	Lack of credit	Banks risk-averse about aquaculture	Loan guarantees	Medium term
		Lack of collateral of farmers	Encourage land entitlement	Long term
Physical	Shortage of suitable sites	Limited land and water	Increase productivity of existing sites	Medium term
			Encourage offshore mariculture	Medium term
Human capital	Lack of research	No qualified staff	Acquire knowledge developed elsewhere	Short term
			Educate staff	Medium term

Source: Adapted from FAO-NACA (1997).

Demand-side policy instruments

In addition to providing supply-side incentives, governments and producer associations can promote aquaculture through marketing. In Jamaica, the Government, through the Inland Fisheries Unit encouraged producers to switch from *O. mossambica*, unpopular with consumers, to *O. niloticus.* It also appointed a marketing officer to create a market for the farmed fish. Taste tests were tried at government functions, recipe booklets were produced and cooking demonstrations were held on radio and television (Ridler and Hishamunda, 2001).

Governments can also ensure fish quality and safety through the hygienic handling and selling of fish. In China, the Government played an active role in investing in trading markets. In Thailand, fish could only be sold through fish agents registered with the Department of Fisheries. Similarly, Indonesia assisted with market infrastructure (Hishamunda *et al*., 2009a).

In Chile, marketing was also a tool for promoting the industry, but through producer associations. Generic marketing of farmed salmon was promoted by collaboration with producer associations of rival salmon-producing countries. In addition, the Chilean Producers Association engages in brand marketing, as do associations in other countries. The aim is to move away from commodity pricing towards monopolistic competition and price setting.

Table 9 provides some examples of the demand-side policy instruments used in aquaculture governance.

TABLE 9
Examples of policy instruments to overcome specified demand-side constraints

Category	Issue	Cause	Examples of action required	Time frame
Maintenance of quality standards	HACCP and fish quality standards	Restrictions from importing countries	Set internationally accepted standards, and control by a competent authority	Short term
Trade	Promote export oriented aquaculture	High transport costs	Improve logistics at airports	Short term
		Lack of market information	Obtain trade shows	
			Ascertain import details	Short term
Communication	Poor research dissemination	Low technology	Media broadcasts	Short term
			Improve extension	Medium term
Marketing	Smallholders unable to sell	Roads and absence of refrigeration	Encourage producer cooperatives	Short term
			Provide trading markets (to be privatized later)	Medium term

Source: Adapted from FAO-NACA (1997).

6. Communications

At the peak of the governance pyramid in Figure 2 is communications, which plays an important role in aquaculture governance. Too often, communications have been ignored or downplayed by the aquaculture industry and by governments, leaving NGOs alone to dominate the media. This can have deleterious consequences. For example, demand for farmed fish products appears to be generally strong. However, when there are reports on fish safety that are negative and widely reported in the media, consumers generally respond by buying less fish because they demand high standards of fish quality. Consumers may also be concerned about fish being produced in ways that are environmentally friendly. With retailers responding to these concerns, producers will need to maintain confidence in their product and reinforce environmental credentials. Thus, it is in the interest of producers and governments to increase transparency, enhance traceability, and communicate credibly.

Both of these concerns (fish quality standards and the manner in which fish is produced) reflect a matter of trust. In some instances, public mistrust of aquaculture is demonstrated by legal challenges to site allocation, by pressure put on politicians to declare moratoria on aquaculture expansion, or even by vandalism. A study of Canadian attitudes towards aquaculture, particularly salmon cages, illustrates how opinion can vary, and how it can affect decision-makers (Department of Fisheries and Oceans Canada, 2005). On the west (Pacific) coast, perceptions of focus groups were almost uniformly hostile to aquaculture; the opposite was evident from groups on the east (Atlantic) coast. The difference may reflect economic and demographic factors because the groups on the "poorer" east coast emphasized the employment benefits of aquaculture whereas the wealthy west coast respondents focused on adverse environmental impacts of aquaculture. The different attitudes have resulted in continual pressure on the west coast to stop the expansion of aquaculture; this has not happened on the east coast.

A global Delphi study on constraints facing aquaculture found that respondents in all regions except Africa and Eastern Europe expect opposition to aquaculture to be a threat to the future development of the industry (Hishamunda, Poulain and Ridler, 2009). In some regions, the cause of the opposition was considered to be misinformation; in others, it was a consequence of particular attributes of aquaculture. In Asia, public mistrust was seen as having a large negative effect in the next 15 years, and such mistrust had a high chance of happening. The mistrust was attributed to a "sensationalist" media. In the Americas and Western Europe, respondents also expected opposition to aquaculture to have a large or very large negative impact, and it was believed likely to happen. The negative perception was attributed to NGOs.

To counter public opposition produced by conflicts over limited coastal resources (a major concern in Asia, North America and Western Europe), the experts in the Delphi study suggested mariculture parks, zoning, and integrated coastal management. As mentioned above, these governance instruments have been successful in Norway and elsewhere.

Good governance also requires more transparency and less secrecy on issues such as fish health and pollution. Information on escapees, on diseases and on any health risk must be provided to governments, which could then disseminate it to the public. There should also be pro-active media communication strategies. These could: inform the public with campaigns about all aspects of aquaculture, including its contribution

to preserving fish stocks and generating incomes; ensure that sound information is available from credible sources; and use the Internet for two-way information sessions. The aim is to correct misinformation and to create trust (Mazur and Curtis, 2008; Whitmarsh and Wattage, 2006).

7. Future governance challenges

Aquaculture governance is likely to become even more important in the future if the sector is to remain sustainable. This is because all four factors of sustainability – economic, environmental, social and technical – will face challenges. The emergence of oligopolies in the production of certain species, the dominance of individual monopsonists in local communities, reconciling competing claims to water and land, the need to manage aquaculture within a deteriorating ecosystem also used by other interested parties, vocal opposition from well-funded NGOs, and funding of local research are among the likely challenges that are intrinsic to the industry as it grows.

Some future economic challenges will occur because aquaculture has become more capital-intensive and is likely to remain so as producers strive to remain competitive and the industry seeks to meet the ever-growing demand for fish. This will lead to increased industry concentration internationally and locally. Environmentally, aquaculture activities will face deteriorating ecosystems also used by other sectors. A major environmental challenge especially for marine aquaculture will be water pollution. Non-point pesticide runoff from agriculture, and industrial and urban waste, is likely to threaten the pristine water needed for marine finfish and shellfish. Freshwater aquaculture will be jeopardized by a growing scarcity of freshwater and land.

Aquaculture is also an industry competing for sites in coastal areas where other activities have preceded it, or enjoy more public support. Thus, recreation and tourism with high income elasticity of demand offer strong growth prospects, and communities may prefer these activities to aquaculture. Aquaculture is only one sector (and often a minor one) competing for priority and resources against more politically powerful lobbies.

SOME ENDOGENOUS FACTORS

Certification

As with international quality standards, the demand for ecolabelled produce is being driven by consumers. The gatekeeper for checking quality is a certifying body, perhaps a supermarket chain, rather than a competent authority with international trade. However, the effect is similar because it obliges producers to ensure traceability and meet consumer demands for environmentally responsible production (Ababouch, 2008).

The absolute quantity of organic aquaculture output remains small. It is in the beginning stage of the life cycle with marketing trials, but there are forecasts that by 2030 total output could reach 1.2 million tonnes, compared with 5 000 tonnes in 2000 (Franz, 2005).

Some of the reasons for the low output of organic aquaculture include the absence of common certification of what constitutes organic aquaculture, the issue of feed for carnivorous farmed fish, and high costs to meet standards.

These higher costs are illustrated with farmed salmon, which is the species with the largest organic output. Feed must comprise organic cereals. Organic cereals are about 30 percent more expensive than regular cereals, labour requirements are also about 20 times higher than in conventional farms; and stocking density in cages is only 5–10 kg/m^3 compared with 20–30 kg/m^3 for conventional farms (Franz, 2005). These higher costs must be reflected in prices, which limit demand.

Given its price premium, almost all organic output is sold in the United States of America, Europe and, increasingly, in Japan. Producers in developing countries

may have a comparative advantage producing organic fish because of their lower labour costs. They may also partially meet requirements with integrated production techniques. However, they will need considerable information about standards. They should also be cognizant of the economic risks of being in a niche market, as the price premium of organic products will decline as supply increases, and the time to adapt to organic culture can be lengthy, with consequent implications for cash flow. In addition, reliance on exports exposes producers to exchange rate volatility.

There is a further danger that private certification schemes could duplicate government standards, adding compliance costs to farmers, particularly small-scale farmers. Changing, and more demanding, standards are driven by consumer concerns about human and animal health, safety and environmental sustainability, and compounded by NGOs. They have already obliged retailers in some importing countries to demand standards through the supply chain. Certification raises concerns about protectionism, and whether private certification complies with the SPS Agreement.

Industrial concentration

With species such as Atlantic salmon that require heavy fixed costs and are global commodities, industrial concentration has occurred in order to benefit from economies of scale and of scope. Mergers have reduced the number of farms producing most (80 percent or more) farmed salmon output in the three largest producers (Norway, Chile and Scotland [the United Kingdom of Great Britain and Northern Ireland]) from 117 in 1997 to 44 in 2006 (Marine Harvest, 2008). In Scotland (the United Kingdom of Great Britain and Northern Ireland), at least 80 percent of output is produced by only five farms, and in the fourth largest producer (Canada) by only three. The concentration ratio (the proportion of the four largest farms in total national production of farmed Atlantic salmon) in Canada in 2006 was 92.3 percent; three farms alone produced 90 percent of output. This concentration ratio is higher even than in the United Kingdom of Great Britain and Northern Ireland (88.6 percent) and appreciably higher than in Chile (58.4 percent) and Norway (47.4 percent).

The increase in oligopoly power has not only occurred within those countries, but also globally. Two companies, Marine Harvest and Mainstream, were major producers in each of the four principal countries (Norway, Chile, the United Kingdom of Great Britain and Northern Ireland, and Canada). Together they produced more than 400 000 tonnes in 2006 (more than one-third of world output). The largest firm, Marine Harvest of Norway, alone accounted for about than one-quarter of the global output, being the largest single producer in each of the four major producing countries; with a share of national output ranging from one-third in Canada to more than half in the United Kingdom of Great Britain and Northern Ireland Its 52 sites in British Columbia, Canada, account for about 60 percent of the province's output.

The range of foreign ownership in Atlantic salmon farming among the principal producing countries ranges from zero in Norway to 90 percent in the United Kingdom of Great Britain and Northern Ireland (Marine Harvest, 2008). Chile and Canada are in the middle with 36 percent and 58 percent, respectively, of output produced by foreign firms. However, it should be noted that there is a significant difference between the two coasts of Canada. In British Columbia, the two largest producers, Marine Harvest and Mainstream, which are Norwegian, account for more than three-quarters of total output of farmed salmon, whereas all farms on the Atlantic coast are Canadian-owned.

For global firms, geographical diversification is a rational strategy because it reduces risks related to disease or exchange rate volatility. However, such market power can undermine smaller producers, and suggests that governments may have a role in supporting small-scale producers.

Concentration poses particular risks for jurisdictions where the farming occurs, threatening local employment and environmental standards. Because of economies of scale, aquaculture companies may enjoy monopsony power over the labour force as the dominant employer in isolated rural coastal communities. There are economic risks linked to the dependence on a single employer, or species. Disease outbreaks, price or currency fluctuations, food safety and food quality concerns among consumers can threaten the industry and its employment. Such negative demand shocks may tempt the dominant company to demand concessions. To remain attractive, communities may be prepared to sacrifice regulations regarding employment or environmental conditions.

This may be a particular danger when the firm is foreign. A foreign company may have little commitment to the community if demands for concessions are unsatisfied. How responsible the company feels to its employees (stakeholders) as well as to its owners (shareholders) depends on its commitment to social responsibility and corporate governance, but the danger of regulatory abandonment exists.

As concentration in aquaculture continues (and even accelerates), this issue will also be one for global aquaculture governance. To avoid environmental or social dumping, when transnational enterprises can threaten to move operations to other countries, regional or global rules are needed. This could be through international commitment to the Code or ISO standardized regulations.

Another policy option would be to limit the extent of foreign ownership in aquaculture, as in some countries in Southeast Asia. However, this could preclude obtaining the advantages of foreign investment that were elucidated above.

Offshore aquaculture

Currently, most aquaculture operations occurs in areas under the sovereignty or national jurisdiction of the coastal State (internal waters, archipelagic waters, territorial sea, contiguous zone, exclusive economic zone [EEZ] and the continental shelf). Although they might be weak, and their enforcement imperfect, legislative and regulatory frameworks that govern aquaculture in these waters exist in most aquaculture-producing countries (Macfadyen, Haylor and Brugère, 2006).

With the growing scarcity of land available for fish farming in most countries around the world and the escalating shortage of freshwater, the majority of aquaculture expansion in the coming decades is likely to occur in seas and oceans. With improved technology, sophisticated cage culture systems will induce a movement away from inshore to deeper waters. These waters could be within the EEZ of countries, or even further, beyond the 200mile belt of national jurisdiction. In 2009, Marine Harvest announced plans for four new offshore sites in the United Kingdom of Great Britain and Northern Ireland, each farm producing 20 000 tonnes of salmon. The sites will be residential.

As aquaculture expands offshore, the problem of farming in an environmentally and socially responsible manner will become more challenging. Governance will be of critical importance in ensuring that any expansion of the industry is founded on socially responsible principles. For example, when sites are located some hours from shore, workers may be paid only when they arrive on site rather than from the time they depart. This issue has arisen in Chile. Administrative and regulatory frameworks will have to be developed, even for aquaculture within the EEZ, by the lead agency for aquaculture in order that offshore aquaculture can be sustainable (United States Department of Commerce, 2008).

In international waters, all States are, in theory, on the same footing. Under Article 87 of the 1982 Convention on the Law of the Sea, both coastal and land-locked States have the freedom of the high seas, which includes, *inter alia*, the freedom of navigation, the freedom of fishing and the freedom to construct artificial islands and other installations (Macfadyen, Haylor and Brugère, 2006). However, these freedoms are to be exercised

by all States with due regard to the interests of other States in their exercise of the freedom of the high seas and to activities in the area. When exercising their high seas freedoms, States are therefore required to take account of conflicting uses of these areas.

Aquaculture will compete with other activities, particularly those related to the utilization of living and mineral resources, and to navigation and communication. Thus, one of the main challenges facing policy-makers is to establish international policy, institutional, legal and regulatory regimes that could be used to govern aquaculture operations conducted in waters under international jurisdiction. The challenge will also be to have these regimes address the shortcomings commonly found in national schemes.

Social licence

Social acceptability, also known as social licence, is an integral part of sustainability, but it has usually become an issue for aquaculture planners only after sections of the population have demonstrated discontent through conflicts or litigation. While aquaculture can contribute to economic growth, it can also create social disruption and inequities. Jealousy, concern over resources and resentment over hiring practices may trigger social conflict, as with shrimp farming in parts of South Asia. This can be particularly acute if small elites, domestic or foreign, dominate the industry.

Policy-makers must be aware of perceptions towards aquaculture that are often negative. The repercussions for aquaculture development can be severe, as demonstrated by opposition to site licences for salmon farming along the west coast of Canada. This kind of attitude towards aquaculture is likely to continue or even become more severe. Respondents to a global Delphi survey expected public opposition to aquaculture to be "very detrimental" to aquaculture development in North America up until 2020 (Hishamunda, Poulain and Ridler, 2009). In the same survey, respondents from Asia and Western Europe were also concerned about "social opposition to aquaculture due to sensationalist media".

To counter negative perceptions, industry can play a role by ensuring that the benefits of aquaculture accrue locally. As mentioned above, communications will become more important in elucidating benefits as well as environmental impacts. This should involve government policy-makers as well as producers. There should be transparency over escapees, disease outbreaks and other ecological effects so that there is a credible source of information to counter misinformation. Encouraging communities to participate in decision-making is important because it educates the public on all aspects of aquaculture.

A further step to reassuring the public about the contribution of aquaculture to society will be through fees and charges. As with agriculture that needs irrigation, water charges for land-based aquaculture are likely to rise to reflect scarcity value. Similarly, there will be demands that brackish-water and marine aquaculture reimburse resource rents through higher fees.

SOME EXOGENOUS FACTORS

In addition to factors that are inherent and are endogenous to aquaculture, there will also be exogenous shocks. Aquaculture is a sector that, because of environmental repercussions and trade, is vulnerable to wider global and regional shocks. Hence, aquaculture governance cannot be divorced from international and inter-regional influences. Among these are climate change and the spread of animal diseases, the growing role of the retail sector in dictating standards, the public's increasing interest in food safety and the environment, and financial imbalances as a result of the global recession. The latter could threaten public funding of aquaculture research, and the ability of producers to access credit from financial institutions.

Climate change

A future global shock to aquaculture governance could come from climate change and weather uncertainty (FAO, 2008b). Some effects may be beneficial. Global warming could allow the spatial expansion of cold-water aquaculture to areas that are currently too cold. Growing periods could shorten, with improved growth rates and feed conversion ratios. However, many effects will be negative, particularly as most aquaculture is in tropical and subtropical Asia. There could be increased virulence of pathogens and animal diseases, reduced ecosystem productivity in warmer waters, and adverse impacts on livelihoods (Soto and Brugere, 2008). Sea-level rise would damage onshore facilities and cause saltwater intrusion, while extreme weather conditions could cause destruction of cages, with escapees, possibly leading to loss of biodiversity.

At the regional level, climate change and extreme weather could reinforce regional institutions and structures (FAO, 2008b). Increased supply volatility, and the need to reduce carbon footprints, could oblige individual producers to review supply chains and distribution outlets, encouraging more local trade. There may also be regional cooperation in such areas as the gathering of common data and the sharing of best practices, as well as fish disease and the introduction of exotic species. Therefore, climate change could reinforce regional governance of certain issues in aquaculture. Aquaculture may also need to combine with other resource sectors in order to influence policies, because as a relatively small sector, it lacks a "voice" in international discussions on climate change policy, in spite of its vulnerability, and its contribution to food security.

International trade

Domestic and international trade are globalizing hygiene and traceability standards, obliging governance of aquaculture to adapt. Globalization of food chains, expansion of supermarkets standards and the World Trade Organization require increased traceability, ecological sustainability, and health and safety certification. Domestic consumers are also more demanding. There is growing legal pressure on companies to demonstrate due diligence in food risks, and a certain sense of corporate social responsibility. The result has a growing uniformity of food health and safety legislation to maintain access to markets. However, these requirements may be perceived and resented as protectionist. Compliance for developing countries can be very difficult, jeopardizing their export opportunities. An example is that of Uganda's aquaculture output (Bagumire *et al.*, 2009).

However, trade can generate large direct and indirect benefits. Therefore, marketing and trade policy for aquaculture must be enabling. Legitimate areas of concern for policy-making could be where there are communications and marketing constraints (Macfadyen, Haylor and Brugère, 2006). Governments must design health and safety procedures and good aquaculture management practices in order to meet consumer demands. Further government intervention could be in: export promotion and the development of marketing strategies; branding/certification of products; traceability; regulatory frameworks for trade (e.g. tariff rates); the availability and timeliness of market information available to producers/exporters; processing, preservation and transport technologies; and institutional development of marketing organizations. While they involve a short-term cost, there are long-run benefits if the industry becomes more sustainable.

However, trade also brings "losers" as well as "winners". Therefore, government must also intervene to ensure vulnerable interest groups share in the benefits of trade. Small-scale producers will need assistance to improve quality control and product handling issues (e.g. adoption of HACCP). The concentration of buyer-driven food chains combined with more demanding standards jeopardizes small-scale producers (Phyne, Apostle and Horgaard, 2006). Market access is becoming difficult except for

the very largest producers. One option is for national organizations to act as "chain upgraders", providing technical assistance for small-scale producers so that they meet international standards. Another option is to encourage nucleus farms that would provide similar support to their satellites, as in Indonesia.

8. Conclusion

One of the major determinants of successful aquaculture is governance, which includes not only the means of managing the industry but also the process by which decisions are made. Therefore, governance covers how policies and regulations are generated and implemented, in addition to the content of those policies and regulations. Processes vary with traditions and values, which preclude a universal template. Moreover, no definitive model is possible for an industry that is evolving so rapidly. However, although identical governance measures cannot be uniformly applied because of cultural differences and the diversity of aquaculture, this paper has presented broad governance guidelines based on jurisdictions where the sector has developed responsibly.

One feature is the common goal of aquaculture governance – its sustainability. Sustainability requires profitability consistent with all risks associated with aquaculture, environmental neutrality so that ecological impacts are mitigated, and social acceptability of the industry. To achieve this goal of sustainability, three governance principles are proposed: accountability, effectiveness and efficiency of government activities, and predictability.

Another common feature of successful aquaculture governance is an enabling environment. This requires the rule of law and the secure right of property. Contracts must be enforceable, theft and corruption must be punished, and farmers must be convinced that all output resulting from their effort and expenditures will accrue to them rather than be siphoned off. An enabling environment also needs economic and social stability. Uncertainty is anathema to investors; hence, governments must reduce risks and transaction costs where possible. Exchange rate stability, low inflation, a minimum of regulation, and lack of violence are fundamental.

Strategies to increase predictability, such as zoning and ICZM, also reduce risks and transaction costs. Participation appears to be effective, particularly if the stakeholders are producers. Compliance is encouraged and costs of enforcement reduced. Self-regulation by the industry empowers producers to pressure those that are reluctant to comply. Wider participation by the public is also useful for zoning and ICZM strategies because interests are then explicit early in the spatial planning process. This obviates conflicts during siting decisions.

Governance will become increasingly important as aquaculture expands in an environment of deteriorating ecosystems, vocal and well-funded NGOs, climate change, consumer concerns over food safety and the environment, and internationalization of regulations due to import requirements. The industry will become more concentrated for those species that are global commodities with oligopolistic, even monopolistic structures. This may create resentment, particularly if the dominant firms are foreign-owned. Trust in the industry will be critical to maintaining social licence, which will oblige governments and the aquaculture industry to increase transparency and to improve communications.

References

Ababouch, L. 2008. Certification in aquaculture: additional value or cost? *FAO Aquaculture Newsletter*, 40: 36–37.

Alesina, A. & Weder, B. 1999. *Do corrupt governments receive less foreign aid?* National Bureau of Economic Research Working Paper 7108. Cambridge, USA.

Asche, F., Roll, K. & Tveteras, S. 2008. Future trends in aquaculture: productivity growth and increased production. *In* M. Holmer, K. Black, C. Duarte, N. Marbà & N.I. Karakassis, eds. *Aquaculture in the ecosystem*, Chapter 9. The Netherlands, Springer. 326 pp.

Antunes, P., Kallis, G., Videira, N. & Santos, R. 2009. Participation and evaluation for sustainable river basin governance *Ecological Economics*, 68(4): 931–939.

Asian Development Bank, 1995. *Governance: sound development management*. Manila.

Bagumire, A., Ewen, C., Muyanja, C. & Nasinyama, W. 2009. National food safety control systems in sub-Saharan Africa: does Uganda's aquaculture control system meet international requirements? *Food Policy*, 34(5): 458–467.

Barrington, K., Ridler, N., Chopin, T., Robinson, S & Robinson, B. 2009. Social attitudes towards integrated multi-trophic aquaculture. *International Aquaculture.*

Bermudez, J. 2008. Legal implications of an ecosystem approach to aquaculture. *In* D. Soto, J. Aguilar-Manjarrez & N. Hishamunda, eds. *Building an ecosystem approach to aquaculture*, *FAO/Universitat de les Illes Balears Expert Workshop, 7–11 May 2007, Palma de Mallorca, Spain,* pp. 67–78. FAO Fisheries and Aquaculture Proceedings No. 14. Rome, FAO. 221 pp.

Black, E., Chopin, T., Grant, J., Page, F., Ridler, N. & Smith, J. 2006. Canada. *In* J.P. McVey, C.S. Lee & P.J. O'Bryen, eds. *Aquaculture and ecosystems: an integrated coastal and ocean management approach*, pp. 7–52. Baton Rouge, USA, World Aquaculture Society.

Brummett, R. E., Lazard, J. & Moehl, J. 2008. African aquaculture: realizing the potential. *Food Policy* 33:371-385.

Bunting, S. 2008. Horizontally integrated aquaculture development: exploring consensus on constraints and opportunities with a stakeholder Delphi, *Aquaculture International*, 16(2): 153–169.

Burgetz, I. 2008. *Ecosystem based approaches to environmental interactions of marine aquaculture* [online]. [Cited 21 November 2012]. www.pices.int/publications/presentations/PICES_17/Ann2008_S5/9_s5_Burgets.pdf

Burns, T. 2007. *World Bank Land Governance Study Land Equity International 2007* [online]. [Cited 21 November 2012]. http://siteresources.worldbank.org/INTARD/Resources/Governance.ppt

Caffey, R. 1998. *Quantifying sustainability in aquaculture production*. Louisiana State University, USA. (PhD thesis)

Cai, J., Leung, P. & Hishamunda, N. 2009. *Commercial aquaculture and economic growth, poverty alleviation and food security. Assessment framework*. FAO Fisheries and Aquaculture Technical Paper No. 512. Rome, FAO. 58 pp.

De Young, C., Charles, A. & Hjort, A. 2008. *Human dimensions of the ecosystem approach to fisheries: an overview of context, concepts, tools and methods*. FAO Fisheries Technical Paper No. 489. Rome. 152 pp.

Department of Fisheries and Oceans Canada. 2005. *Qualitative research exploring Canadians' perceptions, attitudes and concerns toward aquaculture.* Ottawa. 188 pp.

Dorman, T. & Strom, T. 2006. Aquaculture and the multi-lateral trade regime. *In* D. VanderZwaag & G. Chao, eds. *Aquaculture, law and policy*, pp. 355–384. London, Routledge. 552 pp.

Dow, A. 2004. *Norway vs. British Columbia; a comparison of aquaculture regulatory regimes* [online]. Environmental Law Centre, University of Victoria, Canada. [Cited 21 November 2012]. www.elc.uvic.ca/projects/2004-02/AquacultureReport.pdf

FAO. 1992. *Guidelines for the Promotion of Environmental Management of Coastal Aquaculture Development*. Fisheries Technical Paper No. 328. Rome. 122 pp.

FAO. 1997. Development of regulatory frameworks, by C. Cullinan & A. Van Houtte. *In* FAO. *Review of the State of World Aquaculture*. FAO Fisheries Circular No. 886 Rev. 1. Rome. (also available at www.fao.org/docrep/003/w7499e/w7499e26.htm).

FAO. 2007a. *Good governance in land tenure and administration*. Land Tenure Studies No. 9. Rome. 57 pp.

FAO. 2007b. *The State of Food and Agriculture: Paying Farmers for Environmental Services*. Rome. 240 pp.

FAO. 2008a. *Report of the Expert Consultation on Improving Planning and Policy Development in Aquaculture*. FAO Fisheries Report No. 858. Rome. 27 pp.

FAO. 2008b. *Expert Workshop on Climate Change Implications for Fisheries and Aquaculture*. FAO Fisheries Report No. 870. Rome. 32 pp.

FAO. 2009. National Aquaculture Legislation Overview. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. [Cited 21 November 2012]. www.fao.org/fishery/nalo/search/en

FAO-NACA. 1997. *Survey and analysis of aquaculture development research priorities and capacity in Asia*. FAO Fisheries Circular No. 930. Rome. 112 pp.

Franz, N. 2005. Overview of organic aquaculture: an opportunity for aquaculture products. *FAO Globefish*, 77. Rome, FAO. 99 pp.

Glenn, G. & White, H. 2006. Environmental impact mitigation and bi-culture: a comparative legal analysis of flexibility within European legal regimes-bio filter deployment. *Aquaculture International*, 14: 297–317.

Glenn, G. & White, H. 2007. Legal traditions, environmental awareness, and a modern industry: comparative legal analysis and marine aquaculture. Ocean Development and International Law, 38: 71–99.

Gray, T. 2005. Theorizing about participatory fisheries governance. *In* T. Gray, ed. *Participation in fisheries governance*, pp. 1–18. The Netherlands, Springer. 159 pp.

Hall, R. & Jones, C. 1997. Levels of economic activity across countries. *American Economic Review*, 87: 173–177.

Hirtle, C. & Piesse, J. 2007. Governance, agricultural productivity and poverty reduction in Africa, Asia and Latin America. *Irrigation and Drainage*, 56: 165–177.

Hishamunda, N. & Manning, P. 2002. *Promotion of sustainable commercial aquaculture in sub-Saharan Africa. Volume 2. Investment and economic feasibility*. FAO Fisheries Technical Paper No. 408/2. Rome, FAO. 54 pp.

Hishamunda, N. Poulain, F. & Ridler, N. 2009. *Prospective analysis of aquaculture: the Delphi method*. FAO Fisheries and Aquaculture Technical Paper No. 521. Rome, FAO. 93 pp.

Hishamunda, N. & Ridler, N. 2004. Farm level policies for the promotion of commercial aquaculture in sub-Saharan Africa. *Aquaculture Economics and Management*, 8(1): 85–98.

Hishamunda, N. & Subasinghe, R. 2003. *Aquaculture development in China: the role of public sector policies*. FAO Fisheries Technical Paper No. 427. Rome, FAO. 64 pp.

Hishamunda, N., Bueno, P., Ridler, N. & Yap, W. 2009a. *Analysis of aquaculture development in Southeast Asia: a policy perspective*. FAO Fisheries and Aquaculture Technical Paper No. 509. Rome, FAO. 69 pp.

Hishamunda, N., Ridler, N., Bueno, P. & Yap, W. 2009b. Commercial aquaculture in Southeast Asia: some policy lessons. *Food Policy*, 34: 102–107.

Hishamunda, N., Ridler, N., Bueno, P., Satia, B., Kuemlangan, B., Percy, D., Gooley, G., Brugere, C. & Sen, S. 2012. Improving aquaculture governance: what is the status and options? In R.P. Subasinghe, J.R. Arthur, D.M. Bartley, S.S. De Silva, M. Halwart, N. Hishamunda, C.V. Mohan & P. Sorgeloos, eds. *Farming the Waters for People and Food. Proceedings of the Global Conference on Aquaculture 2010, Phuket, Thailand. 22–25 September 2010.* FAO, Rome and NACA, Bangkok. pp. 233–264.

Howarth, W. 2006. Global challenges in the regulation of aquaculture. *In* D. VanderZwaag & G. Chao, eds. *Aquaculture, law and policy*, pp. 13–36. London, Routledge. 552 pp.

International Institute for Environment and Development (IIED). 2002. *The Pyramid: a diagnostic and planning tool for good forest governance.* World Bank WWF Alliance for Forest Conservation & Sustainable Use. (also available at http://assets.panda.org/downloads/diagnosticandplanningtoolforgoodforestgovernance2002.pdf).

INFOSA. 2009. *Small-scale Aquaculture Development Plan for Mozambique*. Windhoek, Namibia.

Johnson, D. 1997. Agriculture and the wealth of nations. *American Economic Review*, 87(2): 1–12.

Kaiser, M. & Stead M. 2002. Uncertainties and values in European aquaculture; communication management and policy issues in times of "changing public perceptions" *Aquaculture International*, 10: 469–490.

Katrandis, S., Nitsi, E. & Vakrou, A. 2003. Social acceptability of aquaculture development in coastal areas; the case of two Greek islands. *Coastal Management*, 31: 37–53.

Keefer, P. & Knack, S. 1997. Why don't poor countries catch up? A cross-national test of an institutional explanation. *Economic Inquiry*, 35: 590–602.

Knapp, P. 2008. Economic potential for the US offshore aquaculture: an analytical approach. *In*: *Offshore aquaculture in the US: economic considerations, implications and opportunities*, pp. 15–50. Silver Springs, USA, US Department of Commerce, NOAA. 272 pp. (also available at http://aquaculture.noaa.gov/pdf/econ/Econ_rpt_all.pdf).

Lio, M & Liu, M-C. 2008. Governance and agricultural productivity: a cross-national Analysis. *Food Policy*, 33: 504–512.

Lynch-Wood, G. & Williamson, D. 2007. The social licence as a form of regulation for small and medium enterprises. *Journal of Law and Society*, 34(3): 321–341.

Marine Harvest. 2008. *Salmon farming industry handbook*. Norway. 80 pp.

Masser, M., & Bridger, C. 2007. A review of cage aquaculture; North America. *In* M. Halwart, D. Soto & J. Arthur, eds. *Cage aquaculture –regional reviews and global overview*, pp. 117–136. FAO Technical Paper No. 498. Rome, FAO. 241 pp.

Mazur, N. & Curtis, A. 2008. Understanding community perceptions of aquaculture: lessons from Australia. *Aquaculture International*, 16: 601–621.

McConnell, M. 2006. Conflict prevention and management: designing effective dispute resolution strategies for aquaculture siting and operations. *In* D. VanderZwaag & G. Chao, eds. *Aquaculture, law and policy*, pp. 171–206. London, Routledge. 552 pp.

Macfadyen G., Haylor, G. & Brugère, C. 2006. *Guidelines for policy development and implementation through consensus and participation: examples from the fisheries/aquaculture sector*. FAO/Government of Pakistan. 48 pp.. 48 pp.

Norwegian Ministry of Fisheries and Coastal Affairs. 2005. *The Aquaculture Act*. Oslo. (also available at www.regjeringen.no/upload/kilde/fkd/reg/2005/0001/ddd/pdfv/255327-l-0525_akvakulturloveneng.pdf).

Norwegian Ministry of Fisheries and Coastal Affairs. 2008. S*trategy for a competitive Norwegian aquaculture industry*. Oslo. (also available at www.regjeringen.no/upload/FKD/Vedlegg/Diverse/2007/Konkurransestrategien%20for%20havbruksnæringen%20på%20eng.pdf).

Percy, R.D. & Hishamunda, N. 2001. *Promotion of sustainable commercial aquaculture in sub-Saharan Africa. Volume 3. Legal, regulatory and institutional framework*. FAO Fisheries Technical Paper No. 408/3. Rome, FAO. 29 pp.

Pew Trust. 2007. *Sustainable marine aquaculture: fulfilling the promise; managing the risk*. Report of the Aquaculture Task Force. 142 pp. (also available at www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Protecting_ocean_life/Sustainable_Marine_Aquaculture_final_1_07.pdf).

Phyne, J., Apostle, R. & Horgaard, G. 2006. Food safety and farmed salmon. *In* D. VanderZwaag & G. Chao, eds. *Aquaculture, law and policy*, pp. 385–420. London, Routledge. 552 pp.

Queensland Government. 2008. *Great Sandy Regional Marine Aquaculture Plan*. Draft. Department of Primary Industries and Fisheries.

Ridler, N. & Hishamunda, N. 2001. *Promotion of sustainable commercial aquaculture in sub-Saharan Africa. Volume 1. Policy framework*. FAO Fisheries Technical Paper No. 408/1. Rome, FAO. 67 pp.

Ridler, N., Wowchuk, M., Robinson, B., Barrington, K., Chopin, T., Robinson, S., Page, F., Reid, G., Szemerda, S., Sewuster, J., & Boyne-Travis, S. 2007. Integrated multi-trophic aquaculture (IMTA); a potential strategic choice for farmers. *Aquaculture Economics and Management*, 11(1): 99–110.

Salgado, P., Quitana, S., Pereira, A., Ituart, M. & Mateos, B. 2009. Participative multi-criteria analysis for the evaluation of water governance alternatives. *Ecological Economics*, 68(4): 990–1005.

Soto, D. & Brugere, C. 2008. The challenges of climate change for aquaculture. *FAO Aquaculture Newsletter*, 40: 30–32. Rome, FAO.

Spriej, M. 2003. Trends in national aquaculture legislation (part I). *FAO Aquaculture Newsletter*, 30: 10–13. Rome, FAO.

Stanley, D. 2003. The economic impact of mariculture on a small regional economy. *World Development*, 31(1): 191–210.

Stead, S. 2005. A comparative analysis of two forms of stakeholder participation in European aquaculture governance; self-regulation and Integrated Coastal Zone Management. *In* T. Gray, ed. *Participation in fisheries governance*, pp. 179–190. Dordrecht, Springer.

Subasinghe, R., Soto, D. & Jia, J. 2009. Global aquaculture and its role in sustainable aquaculture. *Reviews in Aquaculture*, 1: 2–9.

Torgersen, Y. 2008a. Governance of cold-water sea cage aquaculture. Experiences from Norway. SOFIA Presentation. Puerto Varas, Chile.

Torgersen, Y. 2008b. Farmed Norwegian seafood; is it sustainable? SOFIA Presentation Puerto Varas, Chile.

United States Department of Commerce. 2008. Offshore aquaculture in the US: economic considerations, implications and opportunities. Silver Springs, USA, US Department of Commerce, NOAA. 272 pp. (also available at www.nmfs.noaa.gov/aquaculture/docs/economics%20report/econ_report_all.pdf).

VanderZwaag, D. 2006. Introduction: aquaculture law and policy struggling in the wake of the blue revolution *In* D. VanderZwaag & G. Chao, eds. *Aquaculture, law and policy*, pp. 1–11. London, Routledge. 552 pp.

Van Anrooy, R., Secretan, P., Lou, Y., Roberts, R. & Upare, M. 2006. *Review of the current state of world aquaculture insurance*. FAO Fisheries Technical Paper No. 493. Rome, FAO. 92 pp.

Verheijen, T. 2009. The what, when and how of governance in Europe and the CSI; a reform agenda. *Development and Transition*, 12: 3–5.

Whitmarsh, D. & Palmieri, M. 2009. Social acceptability and marine aquaculture: the use of survey-based methods for eliciting public and stakeholder response. *Marine Policy*, 33: 452–457.

Whitmarsh, D. & Wattage, P. 2006. Public attitudes towards the environmental impacts of salmon aquaculture in Scotland. *European Environment*, 16: 108–121.

World Bank. 1991. *Managing development: the governance dimension*. Washington, DC, World Bank. 76 pp. (also available at www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2006/03/07/000090341_20060307104630/Rendered/PDF/34899.pdf).

World Bank. 2005. *Governance Indicators IV: Governance Indicators for 1996 to 2004*, by D. Kaufmann, A. Kraay & M. Mastruzzi. Working Paper 3630. Washington, DC, International Bank for Reconstruction and Development. (also available at http://info.worldbank.org/governance/wgi/pdf/govmatters4.pdf).

World Bank. 2008a. *World Development Report: Agriculture for Development*. Washington, DC. International Bank for Reconstruction and Development. (also available at http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf).

World Bank. 2008b. Governance Matters 2008; Worldwide Governance Indicators 1996-2007. In: *The World Bank Group* [online]. Washington, DC. http://info.worldbank.org/governance/wgi/index.asp accessed 22 February 2009

Effective governance of modern aquaculture must reconcile ecological and human well-being so that the industry is sustainable over time. Without effective governance, there will be misallocation of resources, and perhaps stagnation of the industry and irreversible environmental damage. Four principles – accountability, effectiveness and efficiency of governments, equity and predictability of the rule of law – are suggested as necessary for effective aquaculture governance. These principles should guide the administration, legislative and regulatory framework of aquaculture. In addition to governments, other stakeholders such as communities, non-governmental organizations and producers should also be involved in the governance of the industry.