PART 1

Reviews and synthesis

Global review and synthesis of reviews of EIA and monitoring in aquaculture in four regions and for salmon aquaculture

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ABSTRACT

This section offers a summary and overview of the main findings of Phase One of the project "Environmental impact assessment and monitoring in aquaculture", a component of the FAO project "Towards sustainable aquaculture: selected issues and guidelines". It draws on the findings and recommendations from four regional reviews of EIA and monitoring in aquaculture (Africa, Asia-Pacific, Europe and North America, Latin America) and also a special study on EIA and monitoring in the salmon aquaculture industry. The reviews reveal a huge diversity in aquaculture systems, regulatory frameworks and the implementation of EIA and monitoring. Broadly speaking, EIA is only applied to a small proportion of aquaculture globally and, where it is applied, there is rather limited evidence of effectiveness. Monitoring is also limited, and the use of both EIA and monitoring to inform sector management as a whole is rare especially in developing countries. More effective and better targeted EIA and monitoring will depend on better sector management systems, comprising clear environmental objectives and standards (appropriate to both national and local needs), and mechanisms for the management of large numbers of small-scale developments within the capacity of the environment. Monitoring coupled with appropriate feedback mechanisms (to individual farms and the sector as a whole) should be key elements in such a system.

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Acronyms and abbreviations

To improve readability we have sought to minimize the use of acronyms apart from the following relatively widely-used and understood terms

ASEAN	Association of Southeast Asian Nations
BMP	Best Management Practice
CoC	Code of Conduct
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan (associated with an EIA)
FCA	Fisheries Cooperative Association (Japan)
GAP	Good Aquaculture Practice
ICZM	Integrated Coastal Zone Management
SEA	Strategic Environmental Assessment

Summary

This global review and synthesis attempts to summarize the key findings and recommendations associated with four ***Regional Reviews*** of EIA and monitoring in aquaculture, and also a special study on EIA and monitoring in the salmon aquaculture industry ***(Salmon Review).*** These ***Reviews*** have been undertaken in the context of the FAO project component on EIA and monitoring in aquaculture. The ***Reviews*** are detailed and comprehensive, and provide an invaluable resource for learning and inter-country comparison.

The body of this section is structured in line with the terms of reference given for the preparation of all the ***Reviews***, addressing requirements, practice, effectiveness, and improvements, of EIA and monitoring in aquaculture. This summary offers a more cross cutting approach, focussing on some of the key issues and processes associated with EIA and monitoring in aquaculture.

PLANNING AND MANAGEMENT FRAMEWORKS

The wider policy, planning and management framework is critical to the effective implementation of EIA and monitoring in aquaculture. It is impossible to summarize the diversity of these frameworks, but a few examples stand out. In South Australia and New Zealand local marine aquaculture development plans are required, which include aquaculture zones with corresponding objectives, indicators and management response thresholds. These provide a clear framework for licensing and setting conditions or permits for individual farms. They also streamline the environmental assessment process relating to individual farm proposals.

In Japan, Fishery Cooperative Associations are themselves responsible for the management of coastal aquaculture areas, with support from fishery research stations and oversight by prefectural government. They are embarking on a process of so-called Aquaculture Ground Improvement Plans (AGIP) to improve environmental conditions.

More usually the framework is complex, with permits and regulations associated with a range of government departments and agencies. These may relate to disease management, stock movement, water quality, biodiversity, landscape and tourism, product safety, etc. This complexity is a common theme in many of the ***Reviews***, and a source of much frustration to aquaculturists, especially in Europe and the United States of America.

Though there is provision for Strategic Environmental Assessment in many countries (often recommended as an approach to deal with the problem of cumulative impacts) there are few examples of its application. However, less formal versions of SEA are being used in various integrated coastal management initiatives.

A widespread recommendation was for more work on environmental capacity and carrying capacity so that strategic sustainable production plans can be set for particular waterbodies, and licenses/rights issued accordingly.

EIA

The ***Reviews*** make it clear that in many countries it is difficult to separate EIA from environmental regulation more generally. Indeed, the nature of EIA and the way it is applied depends on the wider environmental management framework – and this is as it should be. Unfortunately in some countries with weak environmental management, EIA is seen as a solution – when in reality it is but one tool, and will be ineffective in the absence of other key elements of a management system.

Nonetheless, specific EIA procedures are now very widely established, and EIA is applied to aquaculture in many countries. Clear thresholds or criteria (size, production, type, location) are applied in most cases, and in practice this means that EIA is usually only applied to marine finfish farming in Western countries, and to industrial scale shrimp farming projects throughout the world. It is rarely applied to shellfish farming or small-scale freshwater aquaculture. This means that the bulk of global aquaculture production is not subject to EIA, and alternative approaches to the environmental management of the sector must be applied.

This makes sense. It is clear that individual farm level EIA cannot effectively address many of the key environmental issues associated with large numbers of small-scale aquaculture developments, such as cumulative impacts on waterbody water and sediment quality; introduction of alien species; excessive use of chemicals and antibiotics. Nor does it deal well with inappropriate siting. Nonetheless, for larger scale developments it has played a major role in changing the culture and politics of development, with environmental concerns now high on the agenda when developing project proposals.

Several weaknesses are identified in the ***Reviews***, the most common being lack of consistency in assessment; lack of appropriate standards; lack of integration/ coordination between levels and divisions of government; inadequate or inappropriate public consultation; lack of assessment skill and capacity; and excessive bureaucracy and delays in permitting procedures.

A key element in the EIA process is the development of an environmental management plan, including appropriate mitigation measures and monitoring. The extent to which these plans are developed, their quality and degree of implementation appears to vary very widely across the globe, and depends to a great degree on other supporting regulatory measures, and the resources and capacity of regulatory authorities.

EIA has both strengths and weaknesses, and it is important that these are recognised in its application, so that it is not used to address issues which it cannot effectively deal with. Equally the typically large areas of overlap with other regulatory and management measures need to be recognized and rationalized. For example, sector level "good aquaculture practice" guidelines may substitute for large parts of any EIA generated environmental management plan.

Some developed countries with significant aquaculture industries, such as Japan and to a lesser degree the United States of America, do not apply EIA as such (i.e. as an identifiable separate legal procedure), but nonetheless have rigorous licensing and permitting regimes which require different forms of environmental assessment.

MONITORING

Monitoring data may be collected:

- as part of an EIA generated Environmental Management Plan (EMP);
- in compliance with some form of code of practice;
- for the information of the farmer in support of husbandry;
- by regulatory authorities as part of enforcement;
- by regulatory authorities as part of monitoring in wider environment.

Many weaknesses were identified in the ***Reviews***. The main one was lack of follow through of monitoring requirements as developed in the environmental management plans – in terms of analysis, reporting and feedback – into management of individual farms and the sector as a whole. With regard to monitoring in the wider environment (usually undertaken by government) the main problems relate to the ambition and scope of much monitoring and the lack of capacity to analyze, report and use this data to improve management of the sector as a whole. A common recommendation was to use risk analysis to identify priority issues for which monitoring was required, and to focus on the most important parameters.

DECISION-MAKING

Decision-making did not figure explicitly in most of the ***Reviews***, but was a common underlying theme reflecting issues such as: inconsistency; lack of transparency; subjectivity. This is an important issue worthy of more attention. While some of these problems can be addressed through drawing up of standards, criteria, thresholds and so on, there will remain a need to make trade-off decisions which will include highly subjective socio-cultural dimensions, including tradition, community, landscape and so on. There is huge variation in the way these issues are addressed (e.g. by politicians, committees, commissioners, facilitators, ad hoc panels, etc.) and much experience to draw on.

MANAGEMENT SYSTEMS

Amongst the various weaknesses highlighted in the ***Reviews*** three in particular stand out:

- The difficulty of addressing cumulative impacts of many small-scale developments through conventional EIA.
- The lack of environmental objectives and standards – especially those suited to the local context.
- The lack of analysis and feedback of monitoring data into sector management.

These are all indicative of a tendency for government and regulatory authorities to focus on particular techniques (such as EIA) and individual farms rather than on a management system for the sector. Equally the emphasis on monitoring at farm level needs to be balanced with emphasis on environmental management systems which can make use of this information.

The components and tools used in such management systems would vary according to development context and the nature of aquaculture development. The key elements are however simple:

1) understand the values of the natural resource system (which underpins aquaculture and other activities);
2) set objectives, indicators and response/management thresholds to maintain or enhance these values;
3) agree on mechanisms and means by which to meet the objectives (farm and sector level mitigation);
4) monitor performance in terms of achieving objectives;
5) make corrections to the mechanisms if necessary to meet objectives.

Some countries are beginning to recognize this, but much remains to be done. The emphasis on EIA and monitoring only may well have been a distraction. EIA and monitoring are *specific tools* for environmental management, which, in the absence of an overall and effective management system, simply become bureaucratic exercises.

This emphasis on understanding natural systems, and building corresponding management systems is in line with the principles for an "ecosystem approach to aquaculture" being developed through another component of this project (Soto, Aguilar-Manjarrez and Hishamunda, 2008).

Introduction and background

This section offers a summary and overview of the main findings of Phase One of the project "Environmental Impact Assessment and Monitoring in Aquaculture", a component of the FAO project "Towards sustainable aquaculture: selected issues and guidelines". Phase One of this project supported the preparation of four regional case studies which reviewed existing EIA and environmental monitoring procedures and practices in aquaculture in selected countries of the following four composite regions.

Africa:	Egypt, Madagascar, Nigeria, South Africa, Tanzania, Uganda;
Asia-Pacific:	Australia, China, India, Indonesia, Japan, Malaysia, Philippines, Thailand, Viet Nam;
Europe/North America:	Czech Republic, France, Greece, Hungary, Italy, Netherlands, Poland, Spain, Turkey, United Kingdom, as well as Canada and the United States of America;
Latin America:	Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico.

A fifth special case study focused on EIA and monitoring in marine cage aquaculture of salmon in Canada, Chile, Ireland, New Zealand, Norway, the United Kingdom and the United States of America. A case study on small-scale cage culture in Bolinao Bay in the Philippines was also prepared for the technical workshop (see Part 2 of this publication).

This section seeks to draw together the main findings of these comprehensive and detailed reviews. The great diversity of aquaculture systems, geography and economic context made this a daunting task, and this review cannot do justice to the breadth of information and experience assimilated by the various authors. This section therefore also seeks to signpost wherever possible specific examples, so that readers can explore particular issues in more detail by reference to the individual review documents.

Where a particular country is referred to, the source of information will be the corresponding regional review unless otherwise stated. Where the source is the salmon special case study, this is explicitly referred to in order to avoid confusion with the corresponding regional review.

Where the reviews are referred to in the text, the following abbreviations are used:

Africa Review. Review of EIA and monitoring in aquaculture in Africa

AP Review. Review of EIA and monitoring in aquaculture in the Asia-Pacific Region

ENA Review. Review of EIA and monitoring in aquaculture in Europe and North America

LA Review. Review of EIA and monitoring in aquaculture in Latin America

Salmon Review. Review of EIA and monitoring in salmon aquaculture

The Reviews. General reference to all the review papers

Country Reviews. This refers to the subsidiary country reviews which are presented within the regional reviews and salmon review

Bolinao Bay Case: EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay, Philippines: a case study

The main part of this synthesis is structured broadly in line with that used in the above ***Reviews***, addressing in turn requirements, practice and experience, effectiveness and suggested improvements EIA and monitoring in aquaculture. There is inevitably some duplication and overlap between the sections on requirements and practice. The executive summary has been structured somewhat differently in order to rationalize the overlap between these sections, and in order to draw out some key issues.

Legislation and requirements

INTRODUCTION

The environmental management of natural resources, and water resources in particular, has increased in importance throughout the world in recent years, and comprehensive frameworks now exist in many countries. Indeed, in several countries (Nigeria, Philippines, South Africa) environmental protection and sustainable natural resource management are enshrined in the constitution.

Much of the environmental legislation has been put in place since the 1970s (Japan, Philippines, United States of America), the 1980s (China, Hong Kong SAR, Indonesia, Republic of Korea, and Western Europe) and the 1990s (much of Africa, Latin America and Southeast Asia). Many countries make specific regulatory provision for aquaculture, usually with an environmental management dimension, although this may come under different ministries and/or umbrella legislation, including agriculture, fisheries, water resources management (including irrigation), land use, environmental protection. There is very wide variation in the degree and complexity of environmental regulation and management. In many countries the legal framework is complex, with a wide range of ministries, agencies, and different levels of government having a range of responsibilities relating to aquaculture.

In Egypt, for example, environmental management of aquaculture takes place primarily within the well established legal framework relating to irrigation. In Japan there are highly developed procedures for the management of fisheries and aquaculture in coastal waters through user organizations. In Spain, freshwater aquaculture is highly controlled under laws relating to water supply and use. South Africa has new and comprehensive legislation covering environmental management frameworks, strategic environmental assessment, EIA, and more specific requirements for particular activities.

In some countries where aquaculture has developed rapidly over the last two to three decades there has been a tendency to develop aquaculture-specific legislation, including provision for environmental management. Thus Mexico and Norway for example have both passed aquaculture specific legislation in recent years with the primary objective of promoting sustainable aquaculture development. While not necessarily reducing the complexity of environmental management procedures, this does at least ensure that the procedures are appropriate to aquaculture, or "fit for purpose".

The most complex and restrictive regulation and management tends to apply to intensive marine finfish farming, mainly because this is a relatively new and rapidly growing industry in many countries, and because the marine environment is often regarded as relatively pristine.

In just a few countries there is very little legislation for the environmental management of aquaculture. This applies for example in some of the Eastern European countries where extensive pond rearing of carp is a traditional activity which has been practiced for up to thousand years, and which has never been regarded as a threat to the environment (Hambrey, Edwards and Belton, 2008). Indeed it is widely regarded as an example of sustainable husbandry. In some Eastern European countries extensive pond culture is regarded as making a significant contribution to biodiversity, and some ponds have been designated as nature reserves. The situation may change if culture practices become more intensive. At the other extreme, some countries (e.g. Madagascar, Norway) have a specific aquaculture law.

BOX 1

Legislation typically serves as the framework for regulation relating to:

- Conversion or use of a site
- Destruction/modification of habitat
- Abstraction/use of water
- Use of drugs and chemicals
- Discharge of waste (food, fecal materials, dissolved nutrients, chemicals, drugs)
- Monitoring of water quality on the farm, and in the wider environment
- Import/rearing of alien species/GMO
- Movement of stock, and control of disease (biosecurity)
- Reporting and treatment of disease
- Food safety/quality (chemical residues and bacteria)

The complexity of most legal frameworks, and overlapping responsibility between different ministries, agencies, and levels of government, is raised in several of the *Reviews,* and in particular that relating to Europe and North America. In some countries this problem has been recognized, and some rationalization achieved through sector specific framework legislation (i.e. an aquaculture Act). These laws usually have the overall objective of promoting responsible and sustainable aquaculture development. However, the use of coastal or common access freshwater resources will always impinge on a wide range of rights and interests, and the legislation is bound to be fairly complex.

In most countries the legal framework is implemented through some form of licensing or permitting procedure, supplemented with powers to control or manage some or all the issues listed in Box 1. Some form of application and assessment process is typically required in order to gain a licence and any associated permits, and this may or may not include a requirement to undertake EIA. In several Latin American countries a specific *environmental licence* is required.

In practice, in many countries the small-scale and/or traditional nature of aquaculture means that most aquaculture operates outside the relatively new legal frameworks.

Japan offers a very different model. Broadly speaking the emphasis in the regulatory framework is on *the protection of aquaculture from other threats*, such as sewage and industrial effluents, rather than managing the threats from aquaculture. Although there is legal provision for aquaculture EIA in Japan – usually for larger projects but depending on the Prefecture – the main mechanism for environmental management of aquaculture is delegated and assigned to Fisheries Cooperative Associations (FCAs). Fisheries rights – including those to practice aquaculture - are granted by the Prefecture governor to an FCA. FCAs then become responsible for management and evaluation, including environmental assessment, monitoring, and putting in place appropriate local regulations, which in turn are authorized by Prefectural government. These procedures were strengthened in 1999 with the Law to "ensure sustainable aquaculture production" which addresses in particular disease, and environmental conditions. This requires FCAs to implement "aquaculture ground improvement plans".

Many countries have fairly comprehensive requirements. South Africa for example has new regulations covering environmental management frameworks, Strategic Environmental Assessment (SEA), EIA, and more specific requirements for associated risk assessments and environmental management plans.

PERMITTING AND LICENSING PROCEDURES

Nearly all countries now have in place some form of licensing and permitting procedure for aquaculture. Licences are usually conditional – in relation to production rates and/

or practices – and may be dependent on obtaining a set of more specific permits relating to land use, water use, the farming of particular organisms (especially introduced species), health and disease, waste discharge, etc. Some countries (e.g. Brazil, Ecuador) require a specific "environmental licence" which may address several of these issues.

Most countries require a basic technical proposal detailing the nature of the farm, and in some cases a simple "environmental statement". Other countries require a more detailed environmental assessment (though these vary tremendously in scope and detail[1]), especially for larger scale developments, as part of the permitting and licensing procedure (see below). In a few cases the licence and associated permits are more closely tailored to the needs of a wider environmental management plan for the sector or for a particular area or zone.

Licensing procedures generally serve as the key to environmental management of the industry. There is significant variation in the strengths of these procedures, the extent to which licenses or permits are conditional, and the scope and complexity of the conditions that may be applied. It is clear that a "one-off" permit is of little value in terms of the management of the aquaculture sector. To have value there must be an ongoing framework to ensure that any conditions or mitigation measures are adhered to, and where there is uncertainty about possible impacts, provision for monitoring. In general, while the requirements for licences are usually clearly laid down in the legislation and associated regulation, requirements for enforcement, monitoring, reporting, and feedback into the management of the sector are often limited and weak.

The duration of the license is a key issue. In Scotland (United Kingdom) a permit for marine finfish farming used to last for 15 years, but has now been made indefinite. In China a lease or permit to undertake aquaculture is issued for a 15-year period. In India, following a groundbreaking Supreme Court judgment in 1996, a licence is required for semi-intensive or intensive shrimp farming from the Coastal Aquaculture Authority, which is valid for only five years. The duration of a permit has significant implications for investment and is discussed further below.

In some countries licensing is a staged process. In Brazil for example there is a 3-stage process with a requirement for a preliminary license (approved concept and location); an installation license (authorizing the preparation and installation); and an operation license. The latter two licences are subject to an agreed "environmental control plan" and "environmental monitoring plan". In Honduras a preliminary environmental license is issued for one year only – to ensure that all mitigation actions stipulated in the document of approval are complied with. After this period, if conditions are satisfied, the environmental licence is renewed indefinitely, but the project is subject to regular inspection.

REQUIREMENT FOR EIA

Most countries now have specific legislation relating to EIA. Most of this has been developed since its introduction to the United States of America back in the 1970s. Over the last decade or so it has been introduced to many developing countries, including widespread adoption in Africa, where 75 percent of countries have specific EIA legislation of which 50 percent has been introduced in the last 5 years. In many cases this is "mirror" legislation, introduced in part in response to pressure from more developed countries, international agencies and development banks, and often based on legislation from western countries.

In some countries aquaculture is specifically referred to in the EIA legislation (e.g. Cuba, the Philippines); in others aquaculture comes within a category where

[1] There is a spectrum of environmental assessments and corresponding terms ranging from simple environmental statements or declarations written by the applicant, through "initial EIA", "preliminary assessment", "basic assessment", specific requirements relating to the content of a "project brief", to full blown independent professional EIAs including public consultation.

EIA may or may not be required, according to its type and scale, the quality and status of the local environment, and the judgment of local officials. In most countries EIA is required for activities or projects "*likely to have a significant impact on the environment*". Countries may have indicative lists of projects or activities deemed to meet this criterion.

In less developed countries (for example, most African countries) or those where small-scale aquaculture is well established, EIA is typically applicable only to major projects, and the relatively few examples applied to aquaculture have been called for by investors or aid agencies. Most aquaculture is perceived as small-scale and low risk – and the priority is on development rather than environmental protection.

Many countries have procedures which may not be formally labelled as EIA, but which have many similar characteristics or serve related functions. In Sabah, Malaysia new aquaculture over 10 ha requires a "*mitigation measures report*". In Victoria, Australia a formal EIA is not generally required, but a proposer is required to provide specific information to all permitting organizations: water authority; catchment management authority; environmental protection agency; local authority. Taken together this information amounts to a form of EIA.

Of particular significance to this review, several of the worlds' major aquaculture producers, including China, Japan, Thailand and some states in the United States of America, do not have a specific requirement for EIA in relation to aquaculture development, irrespective of scale. These countries rely variously on planning, clear standards and associated regulation, codes of practice, and monitoring. Algeria specifically excludes aquaculture from EIA regulations, in favour of specific tailored regulations.

Screening

The decision as to whether EIA is required, and at what level of detail, is often formalized in a process referred to as *screening*. This is meant to ensure that EIA is only applied where necessary, and is usually based on some form of environmental risk assessment - though this may not be referred to as such, and is rarely rigorous.

In many countries, aquaculture development requires EIA if it meets certain thresholds in terms of area, production or water use. In Asia for example these thresholds typically vary between 10 and 50 ha, although there may be differing provision for pond and cage farms, and for freshwater or marine. In most cases the practical effect of this is to include most significant intensive marine *finfish* developments, and to exclude small-scale and extensive production, shellfish farming, and most farming in freshwaters. The EU guidance (European Commission, 2001) notes the need to apply screening with care so as not to undermine smaller and more routine projects.

Some countries have lists of activities for which differing approaches are required. Thus Egypt has three lists: black, white and grey. Aquaculture is in the grey list, meaning that EIA *may* be required. However, if it is to be sited in an environmentally sensitive area, it becomes a "black list" activity and automatically requires full EIA. In Nigeria EIA is required if close to coral reef, mangrove swamps or wetlands, or if it involves significant drainage and irrigation. Similar provisions apply in Latin American countries such as Mexico, where EIA is required, for example, in mangrove areas, or in fish recruitment and nursery areas – although the final decision rests on the judgment of a local official following a site visit. In Ecuador, EIA is specifically required for aquaculture that makes use of groundwater in the highlands.

There is often a requirement for different levels or kinds of EIA according to the nature and scale of the enterprise. Thus in India farms above 10 ha require a relatively simple environmental impact statement (EIS) and details of environmental management and monitoring. Above 40 ha, a full EIA and environmental monitoring and management plan is required. In Mexico projects of more than 500 ha require a "regional" as opposed to a "particular" EIA. In many countries proposals are vetted

by the authorities and categorized in terms of their potential impact or environmental risk (e.g. Brazil, Honduras). Criteria may include size, location (sensitive areas), other users, technology, etc. Different levels of environmental assessment and control are required for the different categories. These may range from a requirement to agree to abide by the standard regulations, a requirement to make an environmental statement or declaration, through to full blown EIA.

Specific issues may also be used to trigger EIA for aquaculture. Thus in Madagascar and United Republic of Tanzania any plans to introduce an alien species or genetically modified organism automatically triggers EIA.

Some countries require EIA not only when a farm is established, but also if it seeks to expand (e.g. United Kingdom). Depending on the country and the scale of proposed developments, this may or may not be a full blown EIA (e.g. Mexico).

Responsibilities

EIA is usually paid for by the developer, carried out by third parties, and appraised by government experts or expert/stakeholder panels. Final decisions relating to EIA are usually the responsibility of either the environment agency or the sectoral (e.g. fisheries) agency, although in some countries local government plays a major role.

There is a general tendency in Asia toward decentralization of responsibility, and this applies to procedures such as EIA. In the United States of America the situation is complex with many agencies and departments at federal and state level. In Scotland there has been a recent shift in responsibility for permitting of aquaculture to local government, although environmental management remains the responsibility of a national agency.

These issues are dealt with in more detail in the discussion of practice below.

EIA procedures

EIA legislation is usually supported with guidance documents setting out the types of issue to be addressed in EIA. In some countries and regions there are specific guidelines – often detailed – for EIA, and in some cases detailed guidance specifically in respect of EIA for aquaculture (e.g. South Africa, United Kingdom, see also the ***Regional Reviews*** and the ***Salmon Review***). Most countries however follow a fairly standard procedure:

1) **screening** (is EIA required/what level is required?);
2) **scoping** (what issues should be addressed and how - this serves as the basis for terms of reference for the assessment);
3) **assessment**;
4) identification of **mitigation** measures (usually in the form of an environmental management plan or EMP);
5) **reporting**;
6) **evaluation**/appraisal;
7) **decision-making** and conditional permitting.

Screening is usually fairly standard and based on criteria set down in legislation, although in some countries is left up to local officials (see above section on Screening).

Scoping allows for initial consultations with agencies, government – and in some cases other stakeholders – to inform or define the scope and detail of any environmental assessment. The ***ENA Review*** notes that this process can however allow for the focus of the assessment to be "high-jacked" in favour of a particular agenda, and that more generic guidance on scope would ensure greater consistency and neutrality.

Typically however EIA will address all the major environmental issues associated with aquaculture as listed in Box 1, including direct, indirect, local and wider effects on water and sediment quality, ecology, other resource user interests and human wellbeing more generally.

Inclusion of effects on landscapes is more variable, but tends to be more significant in developed countries and locations with a significant tourism sector, such as Spain, Scotland and Canada. Indeed, in Scotland landscape has become an increasingly important element in EIA, since many of the other issues (such as impacts on water quality) are effectively dealt with under standard environmental management regulations.

Socio-economic impacts tend to receive rather limited attention in the requirements for impact assessment. To some degree this is because it is assumed that such issues will be taken into account elsewhere in the decision-making processes, especially where these include significant public involvement. There are exceptions however – EIA in Egypt places strong emphasis on assessing impacts on other resource users.

Clearly the potential scope of an EIA is huge, and boundaries difficult to draw. The usual scoping may not help much, if a full range of stakeholder interests is included in the process. Increasingly there is recognition of the need to use a more formal "risk" based approach to both screening and scoping – concentrating on those issues deemed to present the greatest risk of serious impact.

Many modern guidelines emphasize the need to address ecosystem functions and services, but experience of this is limited.

Assessing the **significance** of any identified impacts lies at the heart of EIA, yet it is difficult to legislate specific requirements. The quality of the process depends crucially on the skill, knowledge and impartiality of the consultant. Some countries, such as Malaysia, require that EIA consultants are certified by government, but this is far from universal.

Significance of identified impacts can however be measured in two important ways: through comparison with international, national or local standards; and through stakeholder or wider public consultation. Many countries have specific requirements in relation to these.

Most countries have **water quality standards**, which may apply to:

- particular waterbodies;
- particular types of waterbody;
- particular uses;
- particular zones.

In some countries objectives and standards have been or are being developed for particular locations and use zones, taking full account of local ecology, local values, and local uses as part of local integrated coastal or river basin planning (e.g. South Australia; Tasmania; New Zealand, parts of Europe). This ensures that there is an objective reference framework of objectives, values and standards against which to assess significance and/or acceptability of any impacts. This is a key requirement for effective management irrespective of whether formal EIA is required.

Norway has recently developed a set of standards relating to aquaculture installations – the "Nytec" standards (***Salmon Review***). Depending on exposure and hydrodynamics certain minimum standards for e.g. cage strength and construction must be met. These standards are independently audited and installations certified accordingly. They are intended as part of a wider strategy to minimize escapes. This is a particular example of streamlining the permitting process by standardizing mitigation measures for all installations, which would otherwise have to be established through individual EIA and associated environmental management plans.

In Japan, the Fishery Resources Conservation Association establishes environmental quality standards specifically for aquaculture grounds, and associated guidance for the development of area wide environmental management plans. These relate mainly to acceptable levels of dissolved oxygen (DO), chemical oxygen demand (COD), and acid volatile sulphides (AVS). These are supplemented with further sets of standards relating to water quality under the basic environmental law. Some of these are linked to health hazards and shellfish standards.

Standard **modelling** of organic matter deposition and nutrient or chemical dispersal is a routine requirement in some countries such as Norway and Scotland, and is increasingly being explored as a tool in other countries such as China and Japan. This again is a way of standardizing and formalizing what would otherwise be a part of EIA and making it a standard regulatory requirement in order to gain the appropriate discharge permits.

Public participation is often a specific requirement in EIA legislation and almost universal in guidance materials. Under Malaysian federal law for example, public participation in the EIA process is required. Usually, this is to allow for rapid identification of key resource use issues so that they can be addressed and/or defused. It also allows the farmer to draw on existing local knowledge. The extent and nature of such consultation, and the manner in which views expressed should be reported and analysed is rarely specified. There are exceptions to this however, with relatively strong and specific requirements in some African and Latin American countries for example. In Zanzibar a mechanism is provided for out of court settlements of environmental disputes – special mediators, trained in dispute resolution and acceptable to all parties can be appointed.

Environmental Impact Statements (EIS) – the reports associated with an EIA process – are also usually required to be publicly available. However, it is notable that the review teams for this present project generally found it difficult or impossible to recover specific examples of Environmental Impact Statements in many countries, especially in Asia and Europe. There are exceptions however – in Malaysia most EIA reports are available on the Web site of the Department of Environment. In countries where aquaculture planning and zoning is required, such as Australia and New Zealand, public consultation is a specific requirement in the identification of aquaculture zones.

Much EIA legislation sets down a specific requirement that EIA result in both an EIS and an "**environmental management plan**" (EMP), in which the mitigation measures to be implemented, along with monitoring, reporting and management feedback mechanisms are described (e.g. South Africa). In some cases the EMP may be incorporated in the licensing or permitting conditions for the farm.

MONITORING AND REPORTING

In most countries there is rather limited requirement for monitoring the environment in the vicinity of aquaculture operations. Most EIA will however identify some monitoring needs. In many cases the legislation to enforce such monitoring and/or its reporting is weak. There is limited coupling between EIA monitoring recommendations and wider environmental monitoring schemes.

Some countries do however make clear and specific provision for monitoring. In Ecuador for example the law requires that projects that have been subject to EIA, or have been granted an environmental license, are to be selected at random for periodic inspection so that if needed corrective measures can be introduced in a timely manner.

Most countries have wider government funded and executed environmental monitoring schemes for coastal and freshwaters. China, Japan, Viet Nam all have such schemes specifically related to aquaculture, and these include monitoring of disease as well as environmental parameters. Countries for which shellfish farming is important also tend to have well developed environmental monitoring schemes, mainly designed to protect human health. In the European Union comprehensive monitoring of the aquatic environment (divided into "waterbodies") is required under the Water Framework Directive (European Commission, 2000). Monitoring specifically in relation to aquaculture will be required where aquaculture is identified as a possible threat to the quality status of the waterbody.

Responsibility for monitoring varies widely. In many developed countries with a significant aquaculture industry (e.g. Australia, Chile, Norway, Scotland) finfish farmers are required to undertake certain forms of monitoring and reporting related to sediment and local water quality, while government authorities undertake additional monitoring related to particular farms and/or the wider waterbody. In Australia, the discharge consent license requires farmers to undertake basic monitoring and reporting against environmental management objectives, and also to present an annual report to the Environmental Protection Agency (EPA), including mass balance in terms of nitrogen and phosphorus, analysis of data, etc.

In India requirements for monitoring are ***issues-based*** rather than prescriptive: impact on water sources; on ground water quality; on drinking water sources; on agricultural activity; on soil and salinization; effectiveness of water treatment; effect on green belt. No detailed guidelines are offered as yet.

ROUTINE REGULATION

Irrespective of licensing, EIA or sector planning initiatives, many countries have well established legislation and regulation to control and manage pollution and waste discharges from industrial activities. This has been extended to agriculture in recent decades, and many countries now apply controls to aquaculture – especially the more intensive production systems. In those cases where EIA is required, the EIA will address the extent to which the farm is expected to be compliant with these standard controls; in a few cases the EIA may inform the nature or level of license specific consents.

Regulation may apply to the following activities and issues:

- abstraction of water;
- land use activity;
- use of chemicals and drugs;
- use of/quality of other inputs (e.g. food);
- discharge of nutrients (typically N, P);
- discharge or organic matter (carbon or suspended solids);
- discharge of chemicals and drugs;
- import and movement of stock and eggs;
- introduction of alien species;
- disposal of mortalities;
- use of genetically modified organisms;
- product quality: chemical residues; bacteria.

Specific permits or certificates may be required for some or all of these, and typically some form of assessment is required in order to gain a permit or certificate for each. In practice therefore obtaining the various permits may correspond to – or substitute for – EIA. It is false therefore to assume that because a country (such as Japan, Thailand, parts of the United States of America) usually does not require EIA for aquaculture, its aquaculture management regime is less comprehensive or effective. Indeed, the contrary may be true: a well developed and implemented regulatory regime addressing all the key impacts of aquaculture may be more effective than "one-off" EIA.

Breach of a permit, or undertaking an activity without a permit, may be sanctioned through fines, restrictions, loss of license and closure. In India for example, the Coastal Aquaculture Authority can close down any farm which it considers to be causing pollution.

Regulation may be less specific and more tailored to local circumstances. In inland waters of Australia for example, farmers must ensure that their operations do not compromise "beneficial uses". These are defined for particular segments of waterways, and in practice usually relate to nutrients, pathogens, and aquatic pests. This represents a move towards an "ecosystem service" approach to management. The protection

of other stakeholders is often a key issue for regulation. In Cuba for example semi-intensive and intensive breeding of fish is not allowed in reservoirs used for human consumption. In China local fishery administrations have significant authority to generate regional regulations for aquaculture – tailored to local conditions and regional development plans – especially since disease and environmental degradation has become a more serious problem.

STRATEGIC ENVIRONMENTAL ASSESSMENT AND PLANNING

Even though provisions for SEA exist in many countries, there are few examples of its application. However, less formal versions of SEA are being pursued in various initiatives. The ***Reviews*** confirm that in recent years several countries have introduced requirements for SEA, including China, Hong Kong SAR, European Union countries, Republic of Korea and Viet Nam, and there is widespread interest in the development of area management plans for aquaculture.

In South Australia, Tasmania and New Zealand there is a statutory requirement for coastal plans and/or marine aquaculture planning, including the use of environmental assessment to identify areas suitable for aquaculture, and to develop local environmental objectives and standards. As part of these, environmental capacity must be addressed, and in this sense a form of SEA is being undertaken as an integral part of coastal planning. Similar exercises have been undertaken in Scotland, but only as pilot exercises to date. Aquaculture development zones are also being developed in South Africa and are seen as tool to minimize conflict and reduce risk and uncertainty associated with EIA outcomes. These are described as "ready to invest sites".

Under Mexico's recently introduced General Law for Sustainable Fisheries and Aquaculture, aquaculture management plans are to be developed for cohesive regions (species, systems, geography) which take account of regional economic development plans, ICZM and other relevant plans; which address carrying capacity of major waterbodies; which are developed on the basis of participation and inclusion; and which include infrastructure, environmental protection measures and sanitary issues. These plans are intended to set the framework and context for permitting procedures. This law does not appear to require SEA as the basis for the development of the plans, although any planning approach which addresses carrying capacity has much in common with SEA.

In China, individual states are responsible for drawing up plans for the use of water surface areas, and for defining areas suitable for aquaculture. Zoning is required under the Law on Coastal Areas. These plans must include specific provision to avoid/protect spawning, feeding, breeding and migrating areas. Aquaculture developers must apply for a license from the fisheries administration at or above county level in order to use these areas. The license may be withdrawn if a given area is not used within 12 months. Environmental assessment is now required for *special programmes* under a law introduced in 2002, and this applies to aquaculture programmes. This is supported by a new "planning environmental assessment" regulation.

In the European Union, SEA is required for development "plans or programmes" and this should include those related to aquaculture. For example, in Scotland an SEA was required for a government supported "farm relocation programme" (Scottish Executive, 2007). In India planning and management guidelines have been issued by the Coastal Aquaculture Authority. Planning is to be undertaken within the context of basin wide planning of state water resources. In Egypt aquaculture is rarely subject to EIA but is tightly controlled and managed under more traditional laws and plans relating to land and water use.

In Japan, aquaculture ground improvement plans (AGIP) must be drawn up by fishery cooperative associations, with approval from prefectural government required. These may include voluntary agreements on production, monitoring, sediments, etc.

The detailed procedures amount to a form of adaptive management, with monitoring feeding back into management initiatives.

Many other countries (e.g. Brazil) are in the process of introducing procedures for the development of regional or local area plans for aquaculture development, or intend to bring aquaculture within a broader coastal planning and management framework (e.g. many European countries).

CODES OF PRACTICE

Codes of conduct, codes of practice, best management practices, good aquaculture practice and a host of similar initiatives under a variety of names are becoming widespread across all regions, and seen as a means to reduce the regulatory burden on government and encourage self regulation within the sector (Tucker, Hargreaves and Boyd, 2008) . While not legally required in most countries, there may be links with regulation.

In Indonesia, Philippines and the United States of America, for example, adherence to Best Management Practice (BMP) may be a requirement for gaining a license or permit. The BMP serves a standard substitute for the "mitigation measures" or environmental management plan which might otherwise be identified in an EIA. In the United Kingdom the development of a widely-adopted Code of Conduct (CoC) for finfish farming was seen as a way to reduce the need for further regulation. In a sense however the CoC was only partly voluntary: without it more regulation would probably have been introduced.

STATE OF INDUSTRY REPORTING

Authorities in many countries compile data on the location and extent of aquaculture operations, although this is less readily done in those countries where aquaculture is small-scale and widespread, as in many parts of Asia. Authorities in some countries report in some detail on the status and performance of the industry. For example, under the recently introduced General Law for Sustainable Fisheries and Aquaculture, Mexico requires production of an annually revised comprehensive, technical and geographic "aquaculture chart" which includes information on species and culture systems, zoning and development potential, environmental regulation and sanitary/ food safety issues. In Norway and the United Kingdom annual state of industry reports are published on basic locational, production, employment and economic performance.

SUMMARY

The legislation and requirements relating to the environmental management of aquaculture are detailed and demanding in many countries, especially in relation to gaining a license or permit to farm fish above certain size or production thresholds. This is especially the case for marine finfish farming and large scale shrimp farming. EIA may or may not be part of the requirement for establishing a farm; but in practice most of the issues dealt with in EIA can be, and often are dealt with through a series of permitting procedures relating to specific environmental management issues. In some cases these procedures substitute for EIA, in others they overlap and duplicate to some degree. The complexity and scope of EIA is such that there is increasing recognition of the need for effective risk assessment as part of the screening and scoping processes.

The requirement for public consultation, and the required nature of such consultations in EIA remains very varied across the globe. The requirement to consider landscape is also rarely spelt out, though it is becoming more important in developed countries and those with major tourism industries.

Legislation relating to the environmental management of ongoing operations is typically weak in many countries, especially those that rely on EIA as the main tool

for environmental management. Requirements to audit and monitor implementation of EMPs arising from EIA for example, are often extremely limited. Environmental objectives and standards, and more comprehensive codes of conduct have become key tools in the environmental management of aquaculture and can strengthen or partially substitute for EIA. More comprehensive area natural resource management plans, marine, coastal or river basin plans or aquaculture plans are less widespread, but have become key tools in a few countries, including several with major aquaculture industries. These allow for the establishment of more locally appropriate procedures and standards.

While traditionally the requirement for better environmental management has come from government, there is increasing pressure from the market – especially the export market – for demonstrated environmental management credentials. Codes of conduct coupled with certification schemes are being adopted more widely, and in some countries this is seen as an opportunity to reduce the government imposed regulatory burden.

Practice and experience

There is significant legislation relating to the environmental management of aquaculture including EIA. For EIA itself there are relatively standard procedures, with much guidance and training, but rather limited application in many of the less developed countries.

In practice EIA as such is only applied to large scale aquaculture projects, irrespective of legislative requirements – typically large scale shrimp projects or medium-large scale marine finfish. The vast majority of aquaculture activity throughout the world is unaffected by EIA legislation, and this situation is unlikely to change. It is simply not feasible (and arguably pointless) to apply this procedure to the very large numbers of small-scale fish farms which dominate aquaculture production globally. Smaller farms are however increasingly subject to conditional licensing and good aquaculture practice (GAP) requirements, typically implemented through sectoral departments or agencies.

POLITICAL CONTEXT

There are substantial differences between countries in terms of the political priority afforded the environment, and this in turn influences the relative power of the various institutions involved – and especially the balance between environmental precaution and economic development. Broadly speaking greater weight is afforded environmental concerns in the developed western countries as compared with eastern and less developed countries. However there are significant regional variations. In Africa for example environment is well up the political agenda in Uganda and Ghana. In South Africa the "right to a healthy environment" and "sustainable development" are both enshrined in the new constitution. In Nigeria environmental protection is also enshrined in the constitution. In other countries it may be seen as bureaucratic and constraining.

INSTITUTIONS

One of the key issues in relation to any EIA system is where ultimate responsibility for EIA and any related permit/license/concession is vested. This is highly variable – indeed, no two countries are exactly alike. Many of the ***Country Reviews*** note the institutional complexity related to the management of aquaculture. Aquaculture tends to come between a range of sectoral ministries or agencies – agriculture, fisheries, water resources, rural development, etc. – and this makes the implementation of any management legislation complex and bureaucratic, especially when there are substantial subjective elements involved. The situation is further complicated by the need to take both national and local interests into account. In Brazil for example each state can propose their own criteria for environmental licensing – provided it is not more permissive that the federal regulations.

The environmental licensing or EIA process may be managed/coordinated by:

- a national environment or natural resources department or agency;
- "biosafety" agency;
- a national fisheries/aquaculture department;
- a national administration department;
- a state level governors office;
- a local government environment, natural resources or fisheries department;
- a local government planning department.

In many countries a range of other institutions and committees may be involved in advising, or in issuing appropriate permits – relating to siting, operation, discharges, medicines and so on. In Europe and North America in particular these procedures tend to be very complex and can result in long delays (often up to two years) in getting a farm established. This is usually more complex in respect of coastal and marine aquaculture.

The number and nature of institutions involved in a permitting process, and the way in which EIA is used as part of this process is therefore almost infinitely variable – both within and between countries. What is clear however is that in most cases the situation is complex, and often the cause of much frustration to aquaculturists. Even where there have been concerted attempts to simplify and rationalize procedures these have had limited impact: the issues are complex; the number of stakeholders and perspectives are large.

It is reported in several of the ***Reviews*** that links between the sectoral departments and environmental agencies/departments are often weak and lacking clarity. Some countries have made specific efforts to address this problem. Thus Ecuador has a "National Decentralized System of Environmental Management". This system constitutes a trans-sector coordination, integration and cooperation mechanism among the different institutions dealing with environmental and natural resource management. Honduras has a "National Environmental Impact Assessment and Evaluation System" which also seeks to coordinate and integrate the many different institutions and interests. In Uganda environmental officers and environmental liaison units have been established within the sectoral agencies or departments. China also offers an interesting example of significant integration between a strong national Environmental Protection Agency which is forced to integrate with local government at provincial and lower levels – since it often depends on it for funding.

There has been a recent tendency to give more responsibility to sectoral agencies for the environmental management of the sector. This applies for example in Norway, and a recent review of procedures in Viet Nam led to greater role for the sectoral agency in environmental management. However, responsibility for EIA itself is commonly assigned to a national environmental agency or its regional offices, although there are exceptions. In the United Kingdom for example, local government is now designated as the responsible authority for EIA, though using guidelines and templates developed by national government working with environmental agencies. Japan offers a simpler and substantially different model where producer organizations themselves are responsible for the management of coastal areas for fisheries and aquaculture – although they in turn are answerable to the prefectural government. Groups of operators can apply for a demarcated fishery right.

It is likely that where producer organizations or fisheries departments have a more powerful role, the situation will be more favorable for fish farm development. Broadly speaking sectoral departments or agencies (fisheries, agriculture, rural development, etc.) are more powerful than environment agencies in the less developed economies, while there is a more equal balance in more developed countries. In many cases however, the sectoral agencies are themselves required to take a major role in environmental management. This again has both strengths and weaknesses – it ensures a much closer integration of environmental and production interests, but it may weaken the rigor of environmental management.

A "one stop shop" – or single point of contact for the farmer – is often proposed as a mechanism to rationalize assessment and other regulatory procedures associated with aquaculture development. However, it is unclear that this will reduce complexity much, given the range of regulatory and stakeholder interests that must still be involved; although it might ensure more consistent advice to farmers. Farmers themselves have expressed doubts about the effectiveness of this (South Africa, United Kingdom) suggesting the emphasis should be simply on more efficient procedures.

In most countries private institutions or consultants usually undertake EIA on behalf of the aquaculturist. In several countries these must be government or agency approved. These consultants/institutions are usually EIA generalists – i.e. they are not aquaculture specialists, and this is flagged as a weakness in some of the ***Country Reviews***.

An ongoing problem in some countries is the poor relationship between farmers and one or more of the regulatory agencies. While this may be inevitable to some degree, there is no doubt that more positive relationships tend to generate more positive solutions. The example of Madagascar is instructive here – the shrimp farmers there have been especially pro-active in terms of improved environmental management (in order to avoid disease; and to access premium markets) and this inevitably makes for more positive relationships with the regulatory authorities.

A key factor in ensuring that relationships between institutions are clear, and that particular agendas or power relationships do not dominate procedures, is to have clear frameworks, protocols and guidance. Equally these must be sensitive and flexible enough to respond to local circumstances, needs and values. Guidance is intimately bound up with particular procedures and is discussed below in relation to these procedures.

CAPACITY

Capacity to implement EIA, other permitting and regulatory procedures and effective monitoring varies widely. The ***Africa Review*** suggests that many countries in that region lack the capacity and skills to implement sophisticated – and in some cases potentially draconian – legislation, much of it based on Western models. Furthermore, this legislation has been developed more in response to international pressure than to local perceived need. The author notes a lack of capacity at all levels: policy; regulation; administration; technical advice/consultants; industry associations; and public consultation procedures. Lack of capacity generally, especially at regional and local level, is also highlighted in the ***Latin America Review***. The ***Asia Review*** also notes the requirements for EIA and monitoring are ambitious relative to the capacity to deliver. Capacity is weak in several dimensions: general skills (although separate country papers do not identify this as a key constraint); access to necessary assessment and monitoring techniques; financial and institutional support; and enforcement.

In several countries there are schemes to register and certify EIA consultant organizations (e.g. India, Malaysia, Uganda, South Africa). In Malaysia government registered and qualified EIA consultants are published on the web. Uganda now has a database of registered and certified environmental assessment practitioners, and there is a professional association – the Ugandan Association of Impact Assessment.

There is a general tendency to decentralization of responsibility for managing aquaculture (in Asia, Africa, and some European countries). This is creating some capacity problems at local government level. This is mentioned in particular in the China and Indonesia ***Reviews*** and in the Latin American review. Recent experience of decentralization of responsibility for EIA in Scotland shows that even in developed countries, local government may find it difficult to access the skills required.

There is also a widespread lack of capacity in terms of the competence and skills of farmers themselves to respond to the complex procedures. Although larger farms can employ qualified staff or pay for appropriate consultant advice this is not feasible for the vast majority of farmers across the globe.

Another dimension of capacity is *feasibility*. Many procedures are impractical and inappropriate for small-scale cumulative development which dominates aquaculture production on a global scale. Conventional project EIA is neither feasible nor useful as a tool for the environmental management of such development, and attempts to apply it to a significant part of the aquaculture sector are doomed to fail, however much institutional capacity and professional skills are improved.

This becomes more obvious in relation to wider environmental issues – there is increasing emphasis on addressing ecology and ecosystem functions and this is often mentioned in EIA legislation. However, these issues cannot practically be addressed through individual farm EIA, which has necessarily tended to focus on "farm gate" issues of sediment and local water quality. The connections between this and the quality of the wider environment are rarely addressed: hence the call for ecosystem-wide approaches (Soto, Aguilar-Manjarrez and Hishamunda, 2008).

PLANNING AND MANAGEMENT FRAMEWORKS

Rights and permits

In most countries the prime mechanism for the environmental management of the aquaculture sector is the issue of licenses and/or a series of permits relating to both siting and operation. The issue of such rights is usually dependent upon some form of assessment, ranging from issue specific (e.g. effluent quality) to comprehensive EIA. On the basis of such assessment a single conditional license and/or a series of specific permits is issued. Every country is different in terms of the range of permits and associated assessments required. There are no obvious standard models.

The requirement for some form of licence is however almost universal, though in many countries may not apply to existing long established small-scale farms. In practice effective environmental management will either require some form of licensing for all established farms, or else rely on voluntary codes of conduct and market driven mechanisms. Rights and permits are usually issued for a specified period and this varies substantially between activities and countries, varying for example between 5 years for the right to farm shrimp in India (semi-intensive/intensive) to perpetuity in the case of license to farm fish in Scottish waters (recently increased from 15 years).

These official rights may be complicated by, overlap with, or in some cases conflict with local traditional rights. This has been a particular issue in some countries in Africa, where the EIA process for aquaculture has sometimes revealed conflicts between traditional land use and fishery rights and "modern" legal rights. Although aquaculture is very similar to agriculture, the creation of ponds is usually seen as bigger change than crops.

Zones, protected areas and standard rules

Many countries do not have formal planning relating specifically to aquaculture, but do have land and water use zones which may restrict aquaculture activity. Zones may be either positive (i.e. aquaculture development zones or parks) or negative (i.e. aquaculture is excluded or highly restricted). Positive zoning is relatively unusual, though well established in some countries such as China, Japan, Republic of Korea, and some Latin American countries.

"Negative zoning" is almost universal. In Egypt no aquaculture is allowed in freshwater, or where agriculture is productive. This has led to the main area for aquaculture development being brackish-water. In Thailand no new shrimp farming is allowed in mangrove areas or freshwater. In most countries there are protected areas or zones from which aquaculture is excluded, or where it is unlikely to be permitted. In Chile for example there are substantial areas where aquaculture is not allowed for environmental reasons. In Scotland (United Kingdom) the situation is less clear. Aquaculture is not permitted in certain areas related mainly to the sensitivity or capacity of the environment. In addition there are large areas where permits may be harder to secure – for example in National Scenic Areas which cover large swathes of areas also suitable for aquaculture. In India shrimp farming is not allowed within a certain distance of the sea or lake shore.

Local aquaculture plans

Some countries now require the development of more comprehensive local marine development and management plans which set the objectives, standards and conditions for any aquaculture development. The procedures may or may not include SEA or EIA. These usually include some form of zoning, and in the case of some Latin American countries include the identification of suitable areas for "aquaculture parks".

Marine or aquaculture plans should lead to more predictable, streamlined and consistent decision-making and permitting procedures. The main problem with this approach is the cost – typically substantial and usually falling to local government with limited resources. It is arguable however that framework plans of this kind amount to investment in "soft infrastructure" required to underpin sustainable development of the industry.

Some states in Australia with significant aquaculture activity (Tasmania; S. Australia) now have statutory marine aquaculture planning. Regional aquaculture plans are developed, subject to Area Environmental Assessment (a form of SEA), which define suitable areas or zones for aquaculture. These are then translated in practice as "lease zones", a licence for which will encapsulate appropriate management requirements, limits, monitoring/response etc in line with the objectives of the overall plan. Tenders are then invited for the leases within the zones.

Many aquaculture "Master Plans" have been developed in Viet Nam which include some provisions for zoning. In Malaysia informal assessments have been undertaken for zoning initiatives, such as the Sabah Master Plan for aquaculture development. In the United Kingdom one local authority has developed local "framework plans". In the Philippines the new National Code of Practice serves as the basis for local framework plans (see below). Planning for aquaculture is relatively highly developed in China and Japan as already described above.

Many countries have developed guidance related to planning and management of aquaculture. India for example has developed a comprehensive raft of aquaculture specific guidance, emanating from several different institutions: the Coastal Aquaculture Authority; the Ministry of Agriculture; the Marine Products Export Development Authority – including guidelines for sustainable aquaculture, and highlighting the importance of issues of protection of livelihoods of local people, etc. This guidance is mostly directed at coastal aquaculture, but beginning to be developed also for freshwater – in respect of *Macrobrachium* for example.

Aquaculture parks

Aquaculture "parks" have been promoted in some Latin American and Asian countries. In Brazil, such a park is defined as a "*continuous physical space on aquatic environment, which encompasses a set of aquaculture areas and where other activities compatible with aquaculture can also be realized.*" Policy and regulation in Brazil also foresees the delimitation of preferential areas for small-scale aquaculture, defined as "*areas where allocation priority will be given to traditional communities attended by social inclusion programs*". In the case of Brazil these parks are very much part and parcel of the development of local plans for aquaculture development.

This represents a very positive approach to aquaculture development planning, but needs to be handled carefully. A concentration of activity of this sort, unless very well managed, may raise problems of waste disposal and biosecurity which may be less severe in more widely dispersed development.

Environmental capacity

A key issue for a more positive approach to aquaculture development – especially where zones or parks are being established - is the ability to predict carrying capacity for an area and so ensure sustainable production without breaching environmental

quality standards – either for aquaculture itself or for other users. Many countries are seeking to develop and refine methods to make these assessments. This may be technically simple or challenging dependent on the nature of aquaculture and the receiving environment. The ***Reviews*** provide examples from Brazil, China, Japan, Philippines, and Scotland amongst others. The case study on Bolinao Bay (see Part 1) also illustrates possible approaches. Further examples and insights can be found in McKinnon, (2007) and Tett (2008).

CODES OF PRACTICE AND VOLUNTARY MEASURES

In most cases there is not an effective planning and management framework for aquaculture, and the costs of this in relation to very large numbers of small and existing farms may be prohibitive. In any case, it may be difficult to use such frameworks to influence routine farm practices. Industry codes of conduct (CoC) or best management practice (BMP) therefore represent an attractive way forward, and have the added advantage of potential tie-in with certification schemes and market premium. They have become widespread in recent years and have been promoted by both industry and government. The development of many such codes was in many cases initially driven by hygiene, food safety and export concerns, but is increasingly extended to encompass broader environmental and in some cases social concerns.

Codes of practice have been initiated by government, private sector and NGOs. Often they have been collaborative efforts. Their application in practice ranges from use as an image building tool for industry, as an independently certified marketing tool, or as a government requirement. The private sector has been proactive in many countries, seeing BMPs as both a marketing tool and as a means to reduce government regulation and bureaucracy (Tucker, Hargreaves and Boyd, 2008).

The Brazilian Shrimp Growers Association has developed four codes for best management practices (BMP) concerning shrimp farming, shrimp feed production, shrimp hatchery operation and shrimp processing plants. These are comprehensive addressing issues ranging from mangrove conservation and site selection to chemical use protocols and biosecurity. Madagascar offers a strong example of industry driven codes of practice. The major shrimp farming companies have been very proactive, recognising early on the need to strengthen their environmental credentials, minimize disease, and ensure that the industry developed steadily and sustainably. Most farms have achieved *Label Rouge* and/or *Organic* status. Some are now working with WWF toward eco-certification under the guidance of the International Principles for Responsible Shrimp Farming (FAO/NACA/UNEP/WB/WWF, 2006).

In China best practice initiatives have been widely promoted and developed in recent years by both government and private sector to the point where the number of initiatives and associated labels has perhaps become confusing. Examples include the *Wholesome Agriculture Production Action Plan*, the *Safety Agri-food Certification* scheme and the "*Green Food Standard*" (all administered by the Ministry of Agriculture). The last of these includes requirements relating to maximum dosages for fertilisers, chemicals, medicines, etc. There are now 230 certified fisheries products and producers. China also has a dedicated Good Aquaculture Practice (GAP) initiative administered by the Certification and Accreditation Administration. This includes a base module for aquaculture, supplemented by species specific modules.

In the Philippines a national and legally binding Code of Practice for aquaculture has been developed. This goes beyond many other codes in so far as it also defines permitting and regulatory procedures, as well as farm operation requirements and standards. As such it amounts to a complete management framework. The code includes for example a requirement for local government and producers to identify suitable zones and sites; a requirement for an environmental impact statement for new construction; and specific provisions for the spacing of cages and the need to establish

carrying capacity. In addition to these planning related provisions, the code includes standard good practice provisions relating for example to organic waste, introductions, medicines etc.

Most countries now have some form of best management practice scheme (though subject to a wide variety of names), and although only occasionally explicitly defined as a legal requirement, adherence to best management practice is becoming the norm for any aquaculture product destined for export. Government in many countries has worked hard to facilitate introduction of these codes or related initiatives, including help to develop the codes and publishing associated guidance (see Mexico for example) or developing environmental strategies and associated action plans and inspection regimes at sector level (as in Cuba).

Increasingly these initiatives are also being extended to domestic product. India for example now has a National Centre for Sustainable Aquaculture which promotes best practice more broadly. One hundred societies of producers are now registered. Domestic market focused schemes are also increasingly common in China, as noted above. Over and above these national initiatives are international initiatives developed by agencies (such as FAO, the World Bank) and NGOs such as Naturland (organic certification) and WWF. The Marine Stewardship Council is also exploring certification of aquaculture.

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

Though widely recommended as a way to address the cumulative environmental effects of large numbers of small-scale aquaculture developments which characterize the bulk of aquaculture worldwide (e.g. GESAMP, 2001), the ***Regional*** and ***Salmon Reviews*** reveal that very few countries require or have implemented Strategic Environmental Assessment for aquaculture development. Strategic Environmental Assessment offers a comprehensive approach to identifying likely sectoral impacts, and establishing environmental objectives, standards, limits and so on for the industry – ideally as a of the basis for developing aquaculture development and management plans or integrated coastal zone management plans (ICZM). In practice any strategic planning process for aquaculture or natural resources more generally (e.g. integrated coastal zone management; river basin planning) which includes detailed consideration of sector level environmental impacts and management needs amounts to an SEA, and as such is already being implemented in several countries - for example in South Australia, New Zealand, Norway.

EIA

While all countries have some form of management and regulatory framework for aquaculture, complemented in some instances by voluntary measures, only a small proportion of aquaculture worldwide is, or has been, subject to EIA. To date EIA has only been applied consistently to some large scale shrimp farming projects in South East Asia, Africa and Latin America, and to marine finfish farming in Europe, Australia, North America and Latin America. This is unsurprising. As noted above, it is rarely feasible or useful to seek to apply it to large numbers of small-scale fish farm developments. Following, we offer only a brief overview on practices and experiences of the range of EIA procedures. The ***Regional Reviews*** offer a wealth of detail on specific practices which can be referred to as required. The key here is to report some of the key features of significance in terms of effectiveness.

Guidance

Most countries publish detailed guidance on EIA procedures. Three quarters of African countries have published EIA guidelines of which 50 percent refer to aquaculture. Some countries (e.g. Europe, Canada, South Africa) have developed detailed generic guidance

for EIA and associated permitting procedures. In countries with significant marine fish farming detailed sector specific guidance is available (e.g. Canada, Chile, Norway, Scotland/United Kingdom). There is also regional and international guidance relating to aquaculture EIA. Many of these are referred to and listed in the ***Reviews***, and some of the key reference documents are listed in the bibliography to this section.

It is notable however, and of considerable concern, that the ***Reviews*** reveal a general lack of clear objectives for EIA and its role in environmental management of the sector. In particular it seems to be regarded in many cases as a kind of comprehensive stand alone process, whereas it can only be effective if its application and scope is tailored to and complementary with the overall sector environmental management system. More specifically, there are many issues which are better dealt with through targeted regulations, codes of practice or standard planning restrictions. EIA should be used to "catch" the more local and site specific issues which are not addressed through these more general mechanisms.

Procedures

The basic procedure for EIA is described above under section on requirements and is applied in most countries. The main variations relate to the terminology, the institutions involved, the detail of information required or collected at each stage, the extent of publication and public involvement, and the rigor or otherwise in terms of requirements for implementation, monitoring and evaluation. Some of these variations are discussed in more detail in the following sections.

Screening

Screening requirements have been described in previous section on legislation and requirements and it appears that practice broadly follows requirements, and most small-scale aquaculture is excluded at this stage.

There are two basic approaches: screening based on standard criteria such as farm production (e.g. United Kingdom) or screening based on professional judgement or the deliberation of a committee (e.g. India). The latter may be informed by some form of basic assessment or environmental statement on the part of the proposer. In some cases (e.g. Philippines, South Africa, United Republic of Tanzania) screening comprises both approaches – i.e. a first round screening out of proposals which come below standard thresholds; and screening of those above the thresholds through some form of pre-assessment. The result of this process is that only some proposals are required to undertake full EIA.

Scope, issues addressed and level of detail

The environmental impacts of aquaculture have been extensively reported and researched over the last three decades, and there is much guidance available as to what should be considered in aquaculture EIA. The following is broadly representative of the various "check-lists" available:

- Water column quality
- Sediments
- Waterbody/environmental capacity
- Disease, lice, mortalities
- Chemicals/medicines
- Alien species
- Escapes
- Genetic interactions
- Biodiversity (endangered species etc)
- Ecosystem
- Resource use conflict (navigation; fisheries; farming)

BOX 2

Guidance from Coastal Aquaculture Authority of India on important issues to address:

- Farm location, and whether a whole or part of the farm land falls within mangroves, wetlands and other land types
- Nearby land uses, including environmentally sensitive habitats
- Water source
- Potential impacts on water logging of adjacent areas or pollution of drinking water sources
- Existence of wastewater treatment facilities
- Use of supplementary feeds, drugs and medicines
- Activities which may cause siltation, turbidity, with detrimental implications for local fauna and flora

- Cultural (landscape; job quality)
- Social/economic issues
- Input sourcing

A more specific example is given in Box 2.

In most countries, EIA is very "farm gate" focused, with particular emphasis on potential for localized pollution and water quality impacts. Despite exhortation to consider and manage ecosystem scale effects (e.g. the Convention on Biological Diversity; the Abuja Declaration and the African Convention on the Conservation of Nature and Natural Resources) these wider issues are rarely addressed in EIA – and indeed it is difficult to see how they can be at the individual farm level.

Socio-economic impacts also tend to be given little attention – which given the name EIA is unsurprising. However this is a hugely important issue which is addressed in more detail in the following section. Resource and access issues in particular are often of great significance.

The level of detail required in an EIA is highly variable and in any case depends upon screening and scoping procedures described above. In many countries (e.g. Philippines, United Republic of Tanzania,) a preliminary EIA (referred to variously as initial environmental examination or statement) is required, and a full EIA is then only required if some of the identified impacts are deemed "likely to be significant".

ASSESSMENT AND DECISION-MAKING

Irrespective of the use of EIA, the nature of decision-making will ultimately determine the environmental performance of the sector. There are several key points at which critical decisions are made:

- decision by farmer to develop or propose development in a particular location;
- decision by authorities to undertake an assessment;
- decision by authorities on the scope of any assessment;
- decision by authorities to permit development and associated farm activities;
- decisions and choices on the part of farmer in terms of detailed nature of development and operation.

An important issue at each of these stages is the extent of public consultation or participation.

Siting decisions

Siting is a crucial factor which determines the environmental impact of aquaculture, yet the ***Reviews*** were unable to offer much evidence about how site selection decisions are made.

In most cases siting decisions are made by the farmer based on availability, cost, and suitability. To some degree a consideration of suitability will encompass environmental considerations, since a good site must have appropriate (usually high) water quality and capacity to assimilate or disperse waste. However in most cases a small farmer will lack the expertise or opportunity to address these issues. In many cases there will be no "site selection": the farmer will simply respond to an opportunity in terms of land/water/rights availability. In some cases the authorities themselves facilitate a process to identify suitable zones for particular forms of aquaculture, which then serve to guide or constrain siting (e.g. Australia (Tasmania), Brazil, China, New Zealand, South Africa, Spain) in line with environmental and other interests.

Although alternative sites should be considered in best practice EIA, there is no evidence from the ***Reviews*** that this occurs, and indeed it appears to be rare. This is unsurprising: the additional costs of EIA relating to two or more sites would be substantial. In Scotland (United Kingdom) and Norway however, farmers are encouraged to engage in "pre-consultations" with regard to different possible sites, before making a full proposal.

Screening and scoping decisions

Screening decisions are usually based on standard criteria as discussed in previous section on legislation and requirements. In some cases however they may fall to a technical official or local government employee. Scoping decisions are usually made by technical agencies and government officials, although in some cases key stakeholders may also be involved in the form of an "ad hoc" committee.

Assessment and permitting decision procedures

These are the key decisions which ultimately determine the overall pattern of development of the aquaculture industry, irrespective of the use of formal EIA.

Assessment is often difficult and inconsistent. The key to consistency is the availability of national and/or local standards or baselines against which to make the assessment – and these are dealt with below. The ***Africa Review*** in particular notes a lack of baselines and standards against which to assess. Where these are available they are often derived from other countries and may be inappropriate to specific African contexts. This problem is common to many less developed countries across the globe.

However, standards are only part of the process. There will always be an element of subjectivity – and the need to make decisions appropriate to the local situation. The inclusiveness and transparency of the decision-making process, and the nature of the "final arbiter" is therefore a key issue. In practice there is enormous variation in this worldwide, reflecting political systems and governmental structures, the scale and nature of fish farming, public attitudes and perceptions and so on. Just a few examples are offered here to illustrate the variation.

In many countries (e.g. Malaysia) review of EIA reports is undertaken by the Department of Environment, with assistance from an ad hoc review panel, which may include both technical specialists and stakeholder representatives. In India (for shrimp farming) the ultimate permitting decision lies with the Coastal Aquaculture Authority. They are supported/advised by a district committee led by the head of local administration and assistant director of fisheries. This includes representatives of a variety of boards and departments (e.g. pollution control, planning, etc). At state level a similar committee is led by the secretary (fisheries) also with wide representation. The approval process may require site visits by committee members. In Indonesia, for larger farms, an EIA report plus environmental management plan, plus an environmental monitoring plan is submitted to a national, regional or municipal Commission of Appraisal. Consent itself is awarded by provincial governor or by head of local district. In the United Kingdom a local government planning committee will make the final

decision on planning permission, but this will also be contingent on more technical approvals and permits from the environment agency. In Japan new farms are screened by ad hoc committee – comprising local government, fishery cooperative associations, academics and others.

The extent of public participation in this process is usually limited except for very large developments. However, many countries have laws requiring publication of and access to proposals and associated documents, including EIA. In some countries there is a specific requirement for press and occasionally radio announcements. Access may however be restricted in parts by rights to confidentiality (e.g. Brazil, Mexico). In many European countries the planning process may specifically encourage letters of support or objection which will be taken into account in the final decision. This can create a good deal of uncertainty since most submissions will inevitably be negative. In several countries (e.g. Brazil, Norway) a public hearing may be required before final approval. In Colombia a public hearing may be requested on any EIA evaluated project, and such a hearing is specifically required before an environmental license can be issued in regions where black and indigenous populations exist.

Design and operational decisions

These are influenced by the EIA review outcomes, by the skills and knowledge of the proposer, by industry guidance and training, and by codes of practice and standards. In practice these can be strongly influenced by extension services where these are effective, and this is an area which probably has the greatest potential for influencing the environmental performance of large numbers of smaller farmers.

Overview of decision-making structures and procedures

Table 1 offers some examples of the various decision-making powers and institutions relating to different stages of the EIA process. In practice every country is different - there are no standard models – and it is difficult to draw out general conclusions about the effectiveness of alternative approaches, although these are discussed further below.

Decision tools and decision support

EIA and alternative or complementary environmental management procedures tend to generate large amounts of information on impacts, possible or potential impacts, and possible solutions. It is typically difficult for individuals or review panels to make

TABLE 1
Examples of decision-making powers and procedures

Siting	Screening/scoping	Assessment/permitting	Design/operation
Farmer decision (often few available options). In most countries there are specified no-go areas, excluding aquaculture In some countries (e.g. Australia) a strategic plan may include zonation which will limit or guide farmer siting decisions.	• Usually a technical government official in environment or fisheries agency. • May be advised by a technical or representative committee.	• Department of Environment (e.g. Malaysia) with assistance of review panel (technical specialists and sometimes stakeholder representatives). • Department of Fisheries (e.g. Viet Nam) or specialist Agency (e.g. Coastal Aquaculture Authority in India) – again advised by a technical and/or representative committee. • Commission of Appraisal/ representative committee (e.g. Indonesia, Japan) • Local Government (e.g. United Kingdom) advised by government agencies and planners	The farmer, but influenced by: • Skills, knowledge, extension; • Standard regulations; • EIA environmental management plan; • Code of practice; • Local plans.

objective decisions on the basis of all this information. A variety of factors can help inform and support decisions:

- national or local environmental objectives and standards;
- environmental capacity analysis and modelling;
- risk analysis;
- public consultation.

STANDARDS

The existence and use of standards as part of the environmental management of aquaculture, and to inform permitting procedures, enforcement, EIA and other procedures is highly variable. In many countries water quality standards are well developed, and in Europe these are now being applied in relation to particular waterbodies. In developing countries water quality standards have sometimes been copied from developed countries and may not reflect local conditions or needs. However ASEAN water quality standards for example are now being developed.

In many countries standards are applied in relation to the effluent quality itself. In India and Viet Nam for example there are now national standards for wastewater from aquaculture. These are of two types – for discharge to coastal marine waters, and for discharge to creeks/estuaries. While these serve as a starting point for limiting discharges, they do not take account of the capacity or characteristics of a particular waterbody. However some standards may be developed under the Indian State level Pollution Control Board which do take account of local circumstances. In some countries (including the whole of the European Union) water quality objectives and standards are being developed for individual waterbodies, according to their ecological nature, the types of use to which they are put, and local needs more generally. The following are just a few examples to illustrate the range and nature of such standards and how they relate to the management of aquaculture.

Marine waters in China have been divided up into 651 coastal environmental function areas, each of which has been assigned a classification:

Class I: Fishery waters; marine nature reserves
Class II: Mariculture areas
Class III: General industrial and coastal scenic spots
Class IV: Port and marine development areas.

For each class there is a set of appropriate water quality standards. Similarly there are five classes of freshwaterbodies. Class V – for agricultural use – also includes aquaculture. In Indonesia there are national standards, supplemented by local water quality standards (which may be related to use zones), with the standard applied appropriate for the most sensitive use. In Europe River Basin Plans are drawn up (under the Water Framework Directive) for major watersheds or groups of watersheds, with objectives and standards drawn up for smaller component waterbodies. These go beyond many previous standards in so far as some relate to "good ecological status" rather than solely to water quality. In all cases these standards serve as a key yardstick for EIA and other aquaculture permitting procedures.

CARRYING CAPACITY AND ENVIRONMENTAL CAPACITY

A key issue for environmental assessment and permitting procedures, including in particular permits to discharge nutrients or other wastes to a waterbody, is the extent to which the discharges may lead to a deterioration of water quality or ecological characteristics below the standards established for that waterbody. To address this requires an understanding and assessment of assimilative (environmental) capacity. In practice this can be difficult, which is why in most cases environmental management depends upon a combination of relatively arbitrary limits to waste discharge (in terms of quantity or concentration in wastewater) coupled with monitoring of the wider

waterbody to ensure standards are not compromised. The problem with this approach is that it is very difficult to reduce existing aquaculture or other activities once such standards are breached. If environmental capacity can be estimated, then strategic precautionary limits might be placed on aquaculture and other activities to ensure that standards are not breached.

Experts in many countries are now working hard to develop environmental capacity models for a range of waterbodies, including Brazil, China, Indonesia, Japan, Norway, the Philippines, Scotland, and Viet Nam. In Japan these assessments are used to inform "Aquaculture Ground Improvement Plans". In Scotland they inform "locational guidelines" and are being developed further for particular waterbodies. In Brazil they are being used to inform the development of aquaculture "parks".

There are interesting and substantial differences in the interpretation of the meaning of environmental capacity, reflecting the history of, and public attitudes to aquaculture. Experts in Japan, with its long established intensive marine farming industry, have studied environmental capacity issues for some time. Here the approach has been to define environmental capacity in terms of the *maximum rate of assimilation*. Benthic oxygen uptake is taken as an indicator of the rate of mineralization and benthic ecosystem activity. This peaks at a certain organic matter loading, beyond which function is clearly impaired. This is taken to correspond to environmental capacity – and the total organic matter loading from farms must not be allowed to exceed this amount. This is an example of managing the environment to maximize an environmental service (i.e. organic matter mineralization) – in this case a service to the aquaculture industry itself. This contrasts with the approach in many other countries, where environmental capacity is usually defined in terms of the organic matter or nutrient loading which can be accommodated without breaching the particular water quality standard agreed for that waterbody – usually through reference to historic water quality, national standards, or as agreed with other users. In other words the focus is not just on ensuring sustainable aquaculture, but on maintaining water quality for a variety of reasons. Japan has also developed indices of site suitability based on "embayment degree" and specific characteristics (water/sediment/fauna) which to some degree serve as indicators of environmental capacity. This is a similar approach to that used in Scotland (United Kingdom) to inform locational guidelines for fish farming through estimates of flushing rates.

COMPLEXITY, UNCERTAINTY AND IGNORANCE

While it may be difficult to estimate environmental capacity, or agree on acceptable levels of change to sediment and water quality, it may be even more difficult to make objective assessments of the significance and acceptability of other impacts. The effect of introductions is particularly difficult to assess, and complex trade-offs between ecological risks and economic benefits may be involved. The introduction of Nile perch into some countries in Africa illustrates some of the difficulties. There have been spectacular changes, and scientists still do not know how resulting effects and situations will continue to evolve. This in turn has resulted in a complex set of costs and benefits, and changes in the social distribution of these.

There are some innovative approaches to addressing the problems associated with uncertainty, risk and ignorance. In South Africa the following provision applies to any introduction of species:

> *"Should an alien species establish itself in nature as an invasive species because of the actions of a specific person, a competent authority may hold that person liable for any costs incurred in the control and eradication of that species".*

In other words, the dilemma of deciding on acceptable levels of precaution is shifted from government to developer, by making him/her responsible for the costs of any possible impacts.

RISK ANALYSIS

Increasingly risk analysis is being seen as a key tool to assist in screening, scoping and decision-making (GESAMP, 2008). In South Australia (fresh waters) for example there is now strong emphasis on a risk based approach to assessment. A risk profile of proposals is developed dependent upon the manner in which water is discharged (none, controlled, uncontrolled) and the amount of feed input (natural; minor manufactured; major manufactured). This risk profile is used to determine the scope of the assessment and need for mitigation, monitoring, etc. Risk based approaches are also being promoted in New Zealand. It should also be recognized that the risk analysis approach often has been used implicitly in screening and scoping procedures for many years.

Like any form of assessment however, standard risk analysis must be informed by thorough technical knowledge. Thus a fully recycled system should only be classed as of lower risk if there are effective procedures for disposing of waste that accumulates within the system. Equally while shellfish farming may be classed as low risk because it uses natural food, a high concentration of shellfish generate a very large quantity of faeces and pseudo-feces, and remove a great deal of natural food from the water column with a variety of ecological consequences.

PUBLIC CONSULTATION AND INFORMATION

In practice the quality of the environment is a matter of public (or political) choice, though informed by science as far as possible. Any effective planning and management regime and/or environmental assessment process should therefore include public consultation. Though specifically required in most environmental legislation, and in particular as part of SEA and EIA, the extent and nature of public consultation is highly variable throughout the world.

Generally, there are four main dimensions to public consultation:

1. Sourcing of information to inform siting and management issues;
2. Provision of information to ensure that stakeholders are well informed of potential plans or developments;
3. Understanding of other user and stakeholder interests and perspectives;
4. Participation in decision-making.

In most countries the third of these appears to have been the focus of most consultations. The problem with the fourth is that it introduces a considerable element of uncertainty into the decision-making process.

The regional ***Reviews*** offer some interesting and innovative examples of public consultation. The United Republic of Tanzania for example has strong regulatory guidance on public participation – in terms of the need to seek views, publicise, and hold facilitated meetings. In Zanzibar a mechanism is provided for out of court settlements of environmental disputes. Special "environmental mediators", acceptable to all parties, and trained in dispute resolution can be appointed. Some larger companies may approach public consultation from a more self interested economic perspective – offering to employ local staff, training, supporting outgrower schemes, and providing community funds.

Many of the ***Reviews*** highlight significant weaknesses in information provision and transparency. In most countries it is difficult to access EIA documents or ascertain the basis of assessment decisions. However, things may be changing. China for example has just (May 2008) introduced new measures requiring disclosure of environmental information. The responsible authority in Mexico publishes a weekly list of aquaculture licenses granted, and any citizen has the right of access to information relating to EIA

and environmental licensing. In Australia and New Zealand public consultation is a key component in identifying and defining aquaculture zones. This is seen as much less confrontational than that typically associated with project EIA, where the developer already has "sunk investment" in site identification and proposal development/ feasibility studies, and by which time it is difficult to consider alternatives. Identifying zones on the other hand should allow for *give and take* and negotiated solutions taking account of all interests.

As noted above public *representation* may be a feature of assessment committees and review boards. Thus in Indonesia the "Commission of Appraisal" may include representatives of user groups, technical specialists, NGOs, etc. In Mexico "Regional Sustainable Development Councils" representative of a broad cross sector of society, have been established and may be consulted by officials involved in aquaculture permitting procedures. In Brazil and Colombia there is a "National Council for the Environment", again representative of a wide range of interests and stakeholders but at national level. The involvement of these higher level representative bodies allows for a more strategic representation of the many interests and the development/negotiation of compromise, and may be used to overcome to some extent, the confrontation that frequently occurs where public involvement is solicited on a case by case basis. Some caution is required in the interpretation of differences in apparent levels of public consultation. In Cuba for example the legal emphasis is on consultation with the various relevant state institutions rather than the wider public, but Cuba has relatively strong community representation within these institutions.

One of the most difficult issues associated with public consultation is the introduction of significant levels of uncertainty about the outcome of any assessment. Thus a developer can take all feasible measures to estimate and mitigate impacts, and ensure the enterprise stays within acceptable national or regional standards, yet opposition to development from particular sectors of society may result in refusal to permit the development. This may even threaten the viability of a business. The example of a local fishing company proposal for development of shrimp farming in the Rufiji Delta may be seen as a case in point (***Africa Review***). Though comprehensive project planning and environmental assessment was undertaken at great cost, local opposition was such that it was eventually turned down, and the company went into liquidation. On a smaller scale and usually with less dramatic consequences, similar problems are encountered by aquaculturists in Scotland. Such uncertainty may be reduced by very early engagement with local interests which is encouraged in many countries, but the dynamics of public opposition are often complex and unpredictable.

Overall however, the ***Reviews*** suggest that public consultation is often weak, and information not readily available. Again, these issues may be avoided to a large degree through more strategic planning as noted above.

MONITORING AND REPORTING

Given the uncertainties associated with environmental impacts, monitoring is essential, whether in relation to EIA and specific enterprises or to the regulation and management of the sector as a whole.

Environmental monitoring is a significant activity in most countries, typically undertaken by government authorities. Where fish farming is larger scale, companies usually undertake their own monitoring – either as required by government (sometimes directly arising from EIA and associated EMP), or for their own management information. Most countries also have national water quality monitoring systems which are not specifically related to aquaculture but serve to alert public authorities of any problems which may arise.

In some countries third parties may be involved – or partnerships of interest (e.g. Philippines) to ensure neutrality and representation of stakeholder interests. In Japan,

fishery cooperative associations are required to undertake monitoring and reporting for the farms in their area, assisted in some cases by prefectural fishery stations. In the Philippines there is provision for *Programmatic Environmental Performance Report and Management Plan* – but this has not yet been implemented in coastal and lake based aquaculture. In Ecuador a random periodic environmental audit is required for farms that have been subject to EIA, undertaken by qualified consultants registered and authorized by the national authority. In New Zealand and Australia monitoring programmes may relate directly to marine plans or aquaculture development plans, and be tailored to particular issues and zones as required. In China there is now a major sector related monitoring programme – the Fishery Environmental Monitoring network – covering 21 million hectares, with a major centre in Beijing. This covers inland and nearshore coastal waters with both disease and environmental components. A similar system is being developed in Viet Nam.

Monitoring typically relates to sediment quality and water quality, with different countries using different suites of indicators (sometimes complex), although there is much commonality. Most countries also monitor shellfish waters for pathogens and toxic algae to ensure safe shellfish products. Sediment quality is usually monitored using redox or sulphide measurements. Water quality may be determined by reference to suspended solids, dissolved oxygen, ammonia, nitrogen and phosphorus concentrations. Monitoring of benthic fauna is relatively frequent in many countries. In some countries requirements now include video survey, supplemented by periodic sediment checks. Video transect survey has the advantage of relatively low cost and the capacity to address both sediment and biodiversity issues.

Monitoring can represent a significant cost – up to US$20 000 per year for larger farms in developed countries (see for example ***Salmon Review; ENA Review***; Poseidon, 2008). A few countries (for example Honduras) may require a *bond*, or "economic collateral deposit", in the case of high environmental risk projects before a license can be issued. This serves on the one hand to discourage high environmental risk taking, and on the other to provide for remediation and restoration should environmental damage occur.

As discussed below, although monitoring is widespread, feedback into management systems appears to be weak in many countries.

OVERVIEW OF DISTINCTIVE OR INNOVATIVE FEATURES

Most countries have complex procedures relating to the environmental management of aquaculture, which are well described in the ***Reviews***. It is impossible to summarize and compare all the different elements and features of the environmental management and EIA procedures in the countries covered, and it is difficult to pick out and analyse specific subsidiary procedures, since these are often mutually dependent and cannot be fully understood in isolation.

Nonetheless there are important differences between countries, and some interesting or innovative features which may have relevance for other countries, particularly in terms of setting a more effective context and framework for EIA and monitoring. The features highlighted below have been selected as of interest in terms of exemplifying a particular approach or technique. Where this is of specific interest to the reader, he/she should refer to the more detailed descriptions and context presented in the ***Reviews***.

This summary overview is necessarily selective and subjective, and should in no way be seen as a summary of key procedures.

TABLE 2

Overview of selected notable or innovative features

a) Africa

Country	Selected notable or innovative features
Egypt	• Very long tradition of regulation and management of scarce water resources, closely allied with irrigation management rather than EIA legislation. • Particularly strong with respect to the allocation of *rights to competing users*, and social impact issues more generally.
Madagascar	• Legal framework explicitly recognizes the need for a *balance* between investment and environmental quality. • Specific law on responsible and sustainable aquaculture development. • *Shrimp industry has been very pro-active* in establishing environmental standards, and has been successful in maintaining low levels of disease, high quality product and associated price premium.
Nigeria	Quality of the environment enshrined in the federal *constitution*.
South Africa	• Right to a healthy environment and sustainable development are both *enshrined in the constitution*. • *Hierarchy of requirements* for SEA, EIA, ERA, EMPs. • Problem of alien species is addressed through provision for *liability* in the Biodiversity Act: • *"Should an alien species establish itself in nature as an invasive species because of the actions of a specific person, a competent authority may hold that person liable for any costs incurred in the control and eradication of that species"*.
Uganda	• Area environmental officers and *environmental liaison units* have been established *within* sectoral departments/agencies to promote *integration*. • *Standards* for sourcing and certification of aquaculture inputs, import of live fish and GMO.
United Republic of Tanzania	• High level of *environmental awareness*. • Introduction of Nile perch offers an excellent case study on the issue of *alien species*. • An innovative mechanism is provided for *out of court settlements of environmental disputes*, through specially trained environmental mediators. • Strong regulatory guidance on *public participation*.

b) Asia-Pacific

Country	Innovative or notable features
Australia	• Tasmania and South Australia have *statutory marine aquaculture planning*. Regional aquaculture plans are developed subject to area environmental assessment + zoning, including suitable areas for aquaculture. This translates in practice as lease zones for which tenders are invited, and conditional licenses which specify management and monitoring requirements. • In fresh waters in South Australia, the emphasis is on *risk based approach* to assessment, with the objective of sustaining "beneficial uses" of rivers/watersheds.
China	• Many aquaculture product *certification* initiatives. The overview body: China certification and accreditation administration has developed specific aquaculture modules. • Strong national environmental protection agency with subsidiary bureaux within - and partly dependent on - each level of government, thus facilitating *integration*. • EIA reports must be produced by *government certified agencies* (e.g. Universities, research stations). • *Fishery environmental monitoring network* – covering 21 million ha – addresses both disease and environmental parameters. • Waterbody *zoning* with specific environmental quality standards (EQS) for mariculture areas is being developed. • New legal measures for *public disclosure* of environmental information.
India	• A *sector level environmental assessment* undertaken of shrimp farming for the Supreme Court in 1996 raised awareness and served as basis for much legislation, regulation and guidance. • Aquaculture operating license *valid* for only 5 years.
Indonesia	• EIA etc submitted to a *"Commission of Appraisal".* • *Environmental capacity* models used for freshwaterbodies, and being developed for marine areas.
Japan	• 1999 Law to ensure sustainable aquaculture production. Focus is on monitoring, management and evaluation of capacity. Very little application of EIA to aquaculture. Emphasis is on *protection of aquaculture from other pollution threats*. • *Environmental management delegated* to area based fishery cooperative associations (FCAs) with some regulation/support from prefecture. FCAs are required to develop and implement adaptive "aquaculture ground improvement plans". • *Environmental capacity estimates* are normally based on sustaining ecosystem service to farmers (e.g. organic matter assimilation) rather than conserving a pristine environment. • Acid volatile sulphide (AVS) is considered to be the most *cost effective indicator.*
Malaysia	• List of independent but government *approved environmental assessment consultants published on the web.* • *Public participation* is required under federal EIA procedures. • Malaysia aquafarm *certification scheme* – voluntary, but managed by department of fisheries.

b) Asia-Pacific (continued)

Philippines	• *Constitutional guidance* on natural resource management. The Law requires "a rational balance between socio-economic development and environmental protection". • *National code of practice for aquaculture* encompasses best practice in planning and assessment by local government as well as operational recommendations. • Provision for *programme level EIS* including environmental capacity, risk analysis, and provision for environmental guarantee funds. • Detailed provisions for *monitoring* delivered through a range of mechanisms including national agencies, farmers, third parties. May include *multi-partite monitoring team* to encourage stakeholder participation. • Farms wishing to expand must submit *historic data* on environmental performance and impact. • *Environmental capacity* being explored under Philippines/EU Philminaq project.
Thailand	• *National aquaculture production and management plan*: 5 percent target growth rate - in balance with sustainability objectives. Local strategic aquaculture and natural resource plans in line with national plan. • *Farm registration* (covers 95% of farms) dependent on environmental evaluation by provincial fishery office in collaboration with local administration. • National government promoted and audited *good aquaculture practice (GAP) programme including code of conduct (CoC)* for shrimp farming – now shifting to independent management and audit. Bank loan to a farmer in Thailand is conditional on GAP/CoC adherence. • *Ban* on shrimp farming in freshwater areas and designated mangrove areas. • *Large companies have played a major role* in helping develop environmental management systems. • Rejection of contaminated product has had a significant effect on the use of chemicals.
Viet Nam	• *Sectoral plans and strategies well developed* and increasingly subject to SEA (under 2005 law). • A "*Commitment of environmental protection*" is required for small household business before granting land-use license. Appraised by district peoples committees. • Many *standards/codes* currently in preparation. • National *environmental/disease monitoring and early warning programme* for aquaculture.

c) Europe

Country	Innovative or notable features
France	• Inland aquaculture not permitted where *threat to native fish* populations. • *Strong public consultation* element with an "investigating commissioner" a) billposting; b) holding public consultation, c) interviewing the applicant and d) providing the "investigative commissioners report" to prefect. • Comprehensive *monitoring networks for shellfish* waters – water quality, microbiology, toxic plankton.
Hungary	• Carp pond *aquaculture synergistic with nature conservation* and biological water treatment. Many farms enrolled in "agricultural environmental protection programmes" and some are important nature reserves and recreational facilities.
Italy	• *National fisheries and aquaculture policy* with three year rolling plans revised annually. • Use a *trophic index to classify waters*
Norway	• Well developed *coastal management* procedures. • Total production controlled through periodic *public issue of production rights* through licenses. • "Nytek" *national standards* have been developed for *equipment* and siting. • Site based *modelling-on-growing-monitoring system (MoM)*. The rigour of monitoring requirements depends on degree of exploitation and impact.
Poland	• Carp ponds deemed to have *insignificant impact* on the environment. • New *national strategy* for the development of fisheries.
Spain	• Inland aquaculture very *low priority* in terms of allocation of scarce water resources.
Turkey	• Since 2006 *marine cages are excluded* from environmentally sensitive areas, enclosed bays and near shore areas. Many appeals are now in process. • *A eutrophication index* is used as a key decision criterion/monitoring tool. • Site/production licenses are *reviewed every two years*. • *ICZM* is being implemented including site allocation plans
United Kingdom	• An *allowable zone of effect* is prescribed, beyond which there should be no discernible impact. • EIA must focus "on only those impacts liable to have a significant effect on the environment" • Heavy emphasis on pre-consultation to inform site choice and make planning and consenting process more predictable. • Significant *monitoring* undertaken by operators according to a prescribed formula. • In freshwaterbodies farms are not normally allowed to *change trophic status*.

d) Americas

Country	Innovative or notable features
Brazil	• Ministry of fisheries and agriculture is investing in *local plans* for marine aquaculture development. • three *environmental licenses* required: preliminary, installation, and operational. • Representative *national environmental councils* may play a role in decision-making relating to environmental licenses. • Aquaculture parks have been established to promote development and rationalise assessment and establishment procedures.
Ecuador	Five farms comply with "Naturland" *organic* label.
Mexico	• *Aquaculture management plans* are developed for regions with similar environmental and aquaculture technology characteristics. • An aquaculture "*chart*" is published annually, detailing status, impacts, technology and management. • Recently enacted laws of *transparency* and access to information allow any citizen to get access to and consult all information regarding EIA and environmental licensing. • In difficult cases, *regional sustainable development councils* (including stakeholders and representatives) may play a role in decision-making relating to environmental licences.
United States of America	• Formal *EIA* is not a federal requirement, though some states currently (or will shortly) require it. • A rigorous permitting procedure is supported by *standards* (for effluents and receiving waters) coupled with *codes* of conduct and wider *monitoring*, delivering comprehensive environmental management.

Effectiveness

LEGAL FRAMEWORKS

The regional ***Reviews and Salmon Review*** offer limited insight into the strengths and weaknesses of alternative legal frameworks. This is perhaps unsurprising: the legal framework is intimately related to the history and development of each country, and that of the aquaculture sector, and the "ideal framework" can only be considered on a country by country basis. Nonetheless it appears that in many cases the legal framework is over-ambitious. There has been a tendency for developing countries to use developed country legislation as a model, taking little account of the more limited technical and administrative capacity to implement, and the diversity of aquaculture development.

EXTENT OF APPLICATION OF EIA TO AQUACULTURE

In global terms EIA procedures have only been applied to a very small proportion of aquaculture – mainly to large scale marine finfish farming in Europe, North and South America, Australia and New Zealand, and to major industrial scale shrimp farming projects in Africa and Latin America. The bulk of fish farming in Asia – which dominates global aquaculture production – is in effect untouched by EIA procedures. This is unsurprising. It is estimated that there are fourteen million aquaculture farmers in Asia (Corsin, Funge-Smith and Clausen, 2007), many of whom have been established for a long time and in some cases centuries. EIA cannot be used as an effective tool for the environmental management of aquaculture in these circumstances. Alternative approaches, such as environmental monitoring and regulatory response, extension, voluntary "good aquaculture practice (GAP)" and market led initiatives are required, and are already widespread.

EFFECTIVENESS OF EIA

The ***Reviews*** offer very little evidence of the effectiveness, and particularly cost effectiveness of EIA for aquaculture. In most cases there is little evidence that EIA procedures have led to improved environmental management; and at the same time frustration on the part of producers and developers at the delay and bureaucracy with which it is often associated. Several weaknesses are identified in most countries (see Box 3). In general these weaknesses are more significant with respect to small-scale producers.

Lack of standards and consistency

Consistent and transparent assessment can only take place if there is consistent guidance, baselines, and standards against which to measure the significance of impacts and which might serve as the basis of targets for mitigation. Many countries do have standards, and these are being further developed in most countries to meet modern expectations. However, these remain inadequate in many countries, especially in terms of reflecting local needs and conditions. Local marine, river basin or aquaculture sector plans are an important way to establish such standards and the ***Reviews*** reveal several useful examples of this approach.

However, the existence of standards for the aquatic systems within which aquaculture operates does not translate easily into standards for effluents from fish farms, without an understanding of *environmental capacity*. Although models are being developed in

BOX 3
Some of the weaknesses of EIA identified in the Regional Reviews

- Cannot address large numbers of small farms and cumulative impacts.
- Inadequate baseline data.
- Lack of objective and/or locally appropriate objectives and standards by which to assess.
- Complex, subjective and speculative, especially with respect to effects on landscape, local community and society.
- Lack of technical and decision-making capacity.
- Lack of capacity to undertake monitoring.
- Lack of effective monitoring, and feedback into management of individual farms and the sector more generally.
- Lack of enforcement of EMPs.
- Lack of sharing of EIA generated information.
- Ineffective public consultation procedures.
- Complex, delaying and bureaucratic; often perceived as bureaucratic process rather than management tool.
- Lack of clarity of institutional responsibilities.
- Difficulty of dealing with land ownership/use/rights issues.

many parts of the world, these are often difficult to apply in practice, especially in areas dominated by pond aquaculture (Hambrey *et al.*, 2004). In many situations therefore monitoring will be an essential part of assessment, and EIA without monitoring rather limited in utility. Several countries have national standards for aquaculture effluents, but these are of limited value without an understanding of local assimilation.

Lack of assessing and decision-making capacity

The utility of EIA depends critically on the way it is used in the permitting procedure, and the skills and judgment of those making decisions. Several of the ***Reviews*** noted a lack of technical capacity to make informed assessments and decisions, especially at local level.

Complexity and subjectivity of ecological impacts

While water quality issues may be addressed through a combination of national standards, modeling and monitoring, ecological impacts – other than direct conversion of habitat – are usually difficult to predict, and the significance of any change difficult to assess. While this is becoming an important area for EIA in developed countries the issues addressed are often subjective. Acceptable ecological change is not easy to define, although ICZM and river basin planning initiatives are beginning to address these issues. Western countries increasingly define acceptable ecological change beyond the immediate boundaries of the aquaculture enterprise as being zero. This is implicit in the "acceptable zone of effect" used in the management of finfish farming in Scotland (United Kingdom), and "good ecological status" used as a benchmark under the Water Framework Directive in Europe. In developing countries on the other hand significant change is likely to be acceptable except in designated protected areas, or with respect to particular habitats such as e.g. coral reef and mangrove.

Lack of suitability to address siting issues

A significant weakness of EIA as applied to aquaculture is its weakness in addressing siting issues – a major dimension of environmental management. In most cases a farmer chooses a site because of its availability, accessibility and cost. In some cases – and

especially for vast numbers of small-scale farmers in Asia, it is simply a question of digging ponds on existing farms. Best practice EIA should consider alternative sites – but typically, by the time the EIA is undertaken a site has been chosen and the EIA refers primarily to this site. In any case the cost of undertaking EIA in relation to several sites may be prohibitive except for very large developments.

Lack of suitability to address cumulative impacts and effects on the wider environment

All the regional ***Reviews***, and many previous studies, have noted the inadequacy of EIA to address the cumulative impacts of large numbers of small-scale development, typical of much aquaculture production worldwide. Some form of strategic environmental assessment, or environmental assessment applied to clusters of farms (see ***Bolinao Bay Case***), coupled with analysis of environmental capacity issues, preferably as part of a comprehensive natural resource planning and management system, is the only way to tackle these issues (GESAMP, 2001). Cumulative impacts are also associated with disease, and again this requires a sector wide approach to management.

Lack of suitability to address introduction of alien species or GMO

It is similarly difficult – or unnecessary – to tackle issues of introduction of alien species through EIA, and the ***Regional Reviews*** suggest that EIA has indeed been largely ineffective in this regard. There are local, national and regional risks associated with introductions, as a well as a highly uncertain set of costs, benefits and distributional issues. It is clear that this should be a question of national policy, possibly with regional variations, but the issues typically go well beyond what an individual farm EIA can deliver – except again in relation to very large scale developments involving detailed analysis and national level appraisal.

Sometimes negative and confrontational nature

Although EIA is often promoted as a possible mechanism to pre-empt conflict, it can equally serve as a stimulus to conflict. Public participation, though widely regarded as a key element in best practice EIA, must be undertaken with great care. For example it can highlight conflicts between traditional and modern access rights, as exemplified in the Rufiji Delta example from Africa. It can serve as a focus for debate between conservation orientated interests and development interest – and one in which compromise is extremely difficult.

If on the other hand social and economic issues are not addressed, and the emphasis is on developing practical mitigation measures and an environmental management plan, then although there may be little conflict, the rationale for EIA comes into question: there may be simpler standardized approaches to achieving these outcomes, through the implementation of standard regulations, or codes of conduct.

Inadequate public consultation

Several of the ***Reviews*** highlight weak or insufficient public consultation. However, as noted above, individual EIA may not be the best focus for debate over fish farm development and management, and may lead to rapid polarization of opinion. Public consultation as part of more strategic approaches to planning and management of fish farm development is likely to be much more effective and constructive.

Scope and lack of focus

Some of the ***Reviews*** note the breadth and lack of depth of many EIAs. There is a tendency to tabulate and discuss all possible activities and associated impacts, only a few of which are significant. This problem is well known and should be addressed through correct scoping procedures including risk analysis, before resources are

concentrated on exploring and defining mitigation measures for a few critical impacts. This may be done as a separate scoping exercise by the authorities, or as part of the EIA process itself.

It is also important to recognize that many environmental issues can be effectively addressed through other mechanisms (specific regulations, codes of practice, planning restrictions). EIA should focus on the more local and site specific issues which are not addressed through these more general mechanisms.

Delaying and bureaucratic procedures

In those countries where EIA is applied more consistently to aquaculture development, it is often regarded as a bureaucratic and delaying process, with limited benefit in terms of environmental management. This was especially noted for example in Europe and North America. In many cases EIA and associated permitting procedures can take 2-3 years for new farms or for significant expansion. This serves as a significant barrier to entry and disincentive to invest, especially in those countries where a permit has a relatively short life. Several of the ***Reviews*** note that the delays and inconsistencies are often attributable to lack of integration or agreement between different levels of government or between different departments and agencies.

Effect on the development of the sector

The ***Reviews*** offer very little information relating to the actual effect of these procedures on the development of the aquaculture industry. That which is presented is disturbing. From January 2004 until July 2008, the National System for the Authorization of Aquaculture in Union Waters in Brazil analyzed 1 357 applications with 652 for marine aquaculture and 704 for inland aquaculture projects ***(LA Review)***. By July 2008, only 2 individual proposals (0.01percent) were approved by all authorities involved in the analysis process. This low approval rate demonstrates the enormous difficulty in access to natural resources by small-scale farmers. It also demonstrates that any approval system which is as comprehensive as those commonly associated with EIA is bound to raise concerns from some parties. If the criterion for overall approval is universal approval, very few farms will be approved. Decision-making procedures must be developed that can make acceptable trade-off decisions between legitimate social and environmental concerns, and the need to nurture an important economic activity. In the case of Brazil this is being approached through the development of aquaculture parks, with six such parks already approved.

Lack of capacity to monitor implementation of mitigation and EMP

Several of the ***Reviews*** note a significant lack of capacity and procedures to monitor the implementation of EIA/assessment recommendations in terms of mitigation and management. It is too often seen as a one-off exercise rather than part of a management system. There are exceptions however. Some countries, such as Norway, prescribe an independently audited management system, including environmental management. The Federal Environmental Protection Agency in Mexico undertakes random audits of farms which have been licensed to operate conditional on specified mitigation measures. While we have no data on the success of these approaches, they clearly offer a way of reducing the burden of comprehensive government monitoring and enforcement.

Duplication with standard management procedures

One of the weaknesses of aquaculture EIA is that it often seeks to be comprehensive in terms of coverage of environmental issues. In practice most of the environmental impacts associated with aquaculture are well known, and there are specific regulations or management initiatives in place to deal with these in many countries. On the other hand EIA represents a critical "catch all" which ensures that no serious problems are missed.

Lack of effective feedback into sector management

Several of the ***Reviews*** note the difficulty of gaining access to EIA documents, and there was little evidence of EIA findings being assimilated to inform the development and management of the industry more widely, or indeed to inform other related EIAs. Evidence that the monitoring programmes arising from EIA are used to inform management of the industry was also limited in most countries, though this does appear to take place with respect to the salmon farming industry. In this case however most monitoring is relatively routine, and based on standard models and procedures.

SUMMARY OF THE STRENGTHS AND WEAKNESSES OF EIA

EIA seeks to address a very broad range of issues which have very different characteristics. Some of these are relatively technical and objective: the EIA makes predictions of impact, compares these with established standards, and if necessary identifies mitigation measures to ensure compliance with these standards. Others are much more subjective (social-cultural impacts; landscape etc) and related to local values and conditions. It is worth therefore briefly reviewing the types of issue addressed, and the strengths and weaknesses of EIA in addressing them.

Table 3 summarizes the key environmental issues associated with aquaculture, major characteristics from a management perspective, and the strengths or weaknesses of EIA as a method by which to address them. It also lists possible alternative or complementary methods or approaches which might be more effective, or which might be required to complement EIA. The table is "colour coded" to highlight the areas where EIA is most effective (green) or inadequate (amber/red) with yellow indicating some potential, but usually dependent on other circumstances.

It is clear from Table 3 that while some of the issues of concern can be usefully addressed by EIA – especially if there is a broader management framework - many cannot. It is therefore important that complementary or alternative approaches are in place for these issues, and that time is not repeatedly wasted on individual EIAs. EIA needs to be honed and designed to meet the specific needs of particular countries (and preferably zones) bearing in mind the other tools available, especially in respect of the amber and red rows highlighted above. *Its purpose needs to be clearly stated according to local circumstances.*

EIA in developing countries, and in respect of small-scale developments would be much better used as a simpler positive tool (perhaps used by extension workers) to assist in development of EMPs and mitigation measures – in other words, site specific best practice. It is much less suited as a regulatory assessment tool. It is of particular concern that some countries actually use some of the issues to which EIA is least suited as a trigger for the requirement for EIA. Thus in some countries the possible introduction of alien species may be a trigger for EIA (e.g. United Republic of Tanzania). This will simply reinforce a piecemeal and ill informed response to some major issues which require national level decisions leading to appropriate protocols.

EFFECTIVENESS OF MONITORING

We have already noted that assessment and mitigation is of little value without monitoring. Equally, monitoring is of little value unless it is part of an effective management system. Monitoring data would be much better referred to as *environmental management information*.

> ***"EIA as a single compliance event is of limited use unless it is combined with sustained monitoring. This is generally a weakness in developing countries" (Africa Review)***

The ***Reviews*** reveal both technical and management weaknesses in monitoring, irrespective as to whether it is related to specific EIAs, or is part of a wider environmental management system for the industry. This applies to all regions, but especially Asia,

TABLE 3

Strengths and weaknesses of EIA and alternative approaches in relation to different environmental impacts

The following table is colour coded:
Green: EIA an effective mechanism to address these issues
Yellow: EIA may be effective but depends on contributing factors
Orange: EIA not well placed to address these issues but may complement other mechanisms
Red: EIA ineffective

Issue	Key characteristics	Strengths of EIA	Weakness of EIA	Alternative or complementary measures
Impacts on biodiversity	Site related.	EIA well placed to make useful assessments and mitigation proposals.	Depends on knowledge and awareness of biodiversity values	Local biodiversity policy and/or national biodiversity priorities.
Impacts on landscape	Site related. Subjective, with local, national and technical dimensions	EIA well placed to make useful assessments and mitigation proposals.	Outcome may be unpredictable given the difficulty of generating nationally and locally agreed "standards" for landscapes	Local and national strategic development policy. Decision-making mechanism to balance landscape versus development interests. Design rules for different landscape types or zones. Fish farm free landscape zones.
Social and economic impacts	Site/project related.	EIA well placed to address these issues. Public consultation key requirement.	EIA practitioners rarely trained adequately to address these issues.	Sector studies; local development plans; development proposal/feasibility study.
Waste organic matter	Partly site related. National or local issues and in some cases standards.	EIA well placed to make useful assessments and mitigation proposals so long as standards defined for the waterbody	Effectiveness depends on: understanding assimilative processes in wider waterbody; existence of waterbody standards; and effective monitoring	Ideally nested standards related to different waterbodies and use zones. Environmental capacity estimates for waterbody. Codes of Practice (CoP)
Dissolved nutrients	Partly site related. National or local issues and in some cases standards.	EIA well placed to make useful assessments and mitigation proposals so long as standards defined for the waterbody	Effectiveness depends on: understanding assimilative processes in wider waterbody; existence of waterbody standards; and effective monitoring	Ideally nested standards related to different waterbodies and use zones. Environmental capacity estimates for waterbody. CoP
Chemicals	Site related but with wider implications.	EIA can make useful assessments and mitigation proposals	Effectiveness depends on: understanding assimilative processes in wider waterbody; knowledge of ecotoxicology; and effective monitoring	National standards and protocols for chemical use. Codes of Practice (CoP)
Escapes	Technical issue with local and national dimensions	EIA can make useful assessments and mitigation proposals.	Not cost effective to address this on a case by case basis	Containment standards. National/zonation strategy to minimize conflicts/ contacts with wild stocks
Knowledge, awareness, understanding		Potentially very effective as a tool to raise awareness of opportunities for mitigation.	Usually implemented on a site by site basis and seen as restrictive rather than promotional	
Siting	Technical issue (site suitability criteria). Strategic planning issue. Individual land-use change issue	Detailed practical focus on suitability of a particular site	Although best practice EIA requires consideration of alternative sites, this is rarely feasible. Repetitive process, especially with small-scale developments	Identification of suitable zones or sites for aquaculture as part of more strategic planning. Codes of Practice (CoP).
Sustainable sourcing	National issue – not site related.		EIA inappropriate to address these issues.	National policies or standards. Codes of Practice (CoP). Certification.
Disease	Site specific dimensions but regional, national, international issues.		Not a site specific issue. EIA not well placed to address.	National regulations (reporting; stock movement etc) Monitoring. Codes of Practice (CoP).
Introductions	Local, regional, national and international dimensions		Not a site specific issue. EIA not well placed to address.	National and international agreements and protocols.
General			EIA unsuited to small developments which are likely to grow. Need procedures for allocation of environmental capacity	

Africa and Latin America. While many countries in Europe and North America, as well as Australia and New Zealand may have advanced monitoring regimes, feedback into management and regulation is not always effective. These problems relate to skills and capacity, budgetary limits and lack of effective management frameworks.

Purpose and use

Monitoring does not always have a clear purpose. There is a tendency to require or undertake water quality monitoring as a matter of routine; sometimes this becomes an end in itself rather than a means to improved management – especially of the wider waterbody.

Monitoring as prescribed in EIA and EMPs should be designed to test predictions and the effectiveness of mitigation. It will also typically be required to ensure that the farm is meeting national or EIA determined standards. Again there was little evidence of this from the ***Reviews***. There is even less evidence that such information is fed to the regulatory authorities to supplement their own wider monitoring programmes.

Similarly monitoring of the wider environment by users or regulatory authorities must feedback into management of the whole sector, and other activities which may be contributing to reduced environmental quality. There must be thresholds and response mechanisms. The Viet Nam case offers an example of where a comprehensive monitoring system for the wider "aquaculture" environment can be set up, but where feedback mechanisms to management remain weak. Other ***Reviews*** suggest that government monitoring data relating to the wider environment is effectively used and fed back into management – for example in the case of salmon farming, Europe, Japan, and North America.. In some cases associations with universities are developed encouraging a broader raft of analyses. In Japan some of these relationships – between prefectural stations and universities – have been going for more than 20 years.

Cost and capacity

There is little point in prescribing monitoring regimes if these are beyond the capacity of farmers or others to implement – in terms of cost or skills. In China it was found to be tough or impossible for small farmers to comply with the monitoring required for many certification programmes. In Japan, some of the fisheries cooperative associations find it difficult to meet monitoring requirements, but may be assisted by prefectural services.

Quality

Several of the ***Reviews*** note simple technical inadequacies with monitoring. For example, the Australia review notes that spot sampling of inlet and outlet water may have limited value given daily and seasonal variations. It may also serve as a poor indicator of improved farm performance. Mass balance auditing coupled with periodic local sediment and water quality surveillance may generate better information for performance assessment and management purposes.

Complexity – too many indicators?

Many countries collect data on a large range of indicators, some of which are "auto correlated". There may be potential for reducing the scope of monitoring until very simple indicators suggest there may be cause for concern. At such time more rigorous analysis may be required. In Japan and Norway for example simpler sediment and water quality monitoring regimes are used than in Scotland (United Kingdom). In Japan for example acid volatile sulphide (AVS) is used as the key indicator, whereas in Scotland a much broader suite including video transect survey is used. It is not clear that this generates more useful management information.

ENVIRONMENTAL MANAGEMENT SYSTEMS

Overall, the ***Reviews*** offer rather little evidence on the overall effectiveness of environmental management systems in place in different parts of the world, and in particular the effectiveness of EIA and monitoring. In many cases it is difficult to introduce effective environmental management measures before there are significant environment related problems. Thus in Japan the fisheries cooperative associations tend to be stronger and better organized, and more enthusiastic about environmental management in those areas where environmental and disease problems have already been significant. In areas where eutrophication and red tides have previously occurred, improvements have been made.

Aquaculture-specific legislation allowing for pro-active planning for the industry has "gone a long way to addressing public concerns and improving environmental performance"

Improvements

SUMMARY OF SUGGESTED IMPROVEMENTS

There was substantial consistency between countries, and between review papers in terms of the needs and opportunities for improvements to EIA and monitoring procedures for aquaculture, although there were also some differences. The following is a synthesis and summary of the many findings and recommendations arising from the review papers and the country reports encompassed within them. It should be emphasized that this is not a *consensus* list. Although many of the following recommendations were repeated across countries and regions, some were specific to particular countries (e.g. Box 4) and not all are perfectly compatible.

Policy and legislation

Legislation is highly developed in many countries, though only in countries with a major aquaculture industry is the legislation usually aquaculture specific.

- Simplify, clarify and streamline the legislation and regulatory framework.
- Strengthen environmental policy implementation at the local level, especially where economic priorities often override environmental concerns.
- Undertake periodic review of regulatory framework to take account of changes in aquaculture, the environment, international commitments and opportunities.
- Strengthen decentralization and participation.
- Strengthen requirements and protocols for effective monitoring, and mechanisms for feedback into management.

BOX 4

Recommendations for a best practice regulatory framework for aquaculture in Australia (PIMC, 2005)

- Integration of policy and clear legislative objectives – the overall objective and responsibility for aquaculture in each jurisdiction needs to be clarified as does the role of relevant agencies and the interrelationship between aquaculture and other planning and environmental instruments;
- Regional planning in line with appropriate planning and land-use principles plan for aquaculture in a pro-active and integrated manner to provide confidence and clarity to industry, government and the community;
- Zoning for aquaculture - areas considered appropriate for aquaculture development should be zoned using planning instruments.
- Transparent and equitable allocation of marine and freshwater resources for aquaculture.
- Leasing – investors need security of tenure.
- Risk assessment and management strategies commensurate with the level of risk (see technical/ scientific aspects below).
- Development consent processes – need to be aligned with other development processes.
- Licensing – should be more adaptive in nature, need for National approach.
- Compliance – licence conditions must be clear and enforceable.
- Environmental management systems (EMS) and eco-efficiency – important for enhancing "clean and green" image of Australia.

- Consider promotion of aquaculture sector specific development strategies and supportive legislation which would facilitate sector specific environmental management systems.

Institutions and capacity

Institutional strengthening was identified as a key issue in nearly all the reviews, and including both developed and developing countries.

- Increase political and industry awareness of the benefits to be derived from better environmental management.
- Clarify institutional responsibilities and procedures.
- Better integrate departments/agencies/levels of government and increase information exchange.
- Assign a greater role for sectoral departments?
- Develop a "one stop shop" for the farmer to deal with regulatory issues.
- Provide better support and advice for poor farmers – with the emphasis on positive, not negative advice.
- Facilitate organization of small farmers.
- Strengthen planning, monitoring, inspection and enforcement capabilities at local levels.
- Develop regional capacity of regulators and planners.
- Levy aquaculture export revenue to fund support and management systems for aquaculture.
- Ensure budget sufficient to underpin effective implementation of the management framework.
- Promote accreditation of laboratories to ISO 17025.

Planning and management frameworks, standards and limits

The need for better guidelines and standards to streamline EIA and monitoring, and to increase consistency and predictability was raised in nearly all the ***Reviews***. More effective use of risk assessment was also raised in several of the ***Reviews***. Specific recommendations included:

- Develop national and regional aquaculture development councils to bring all parties together to resolve issues and develop agreed strategy.
- Develop regional and sub-regional aquaculture plans.
- Develop spatial planning and zoning, with zone specific objectives and standards.
- Develop locally appropriate and agreed standards and corresponding plans.
- Develop regionally appropriate norms/environmentally precautionary reference points (water quality; exotic species; chemical use; feeds; biosecurity).
- Develop "nested" water quality standards: international, regional (e.g. European, ASEAN); local.
- Develop improved models and procedures for estimation of environmental capacity.
- Reduce uncertainty (for developer/farmer) in the EIA/decision-making process.
- Undertake sector based risk assessment and focus environmental management interventions accordingly.
- Develop more effective monitoring of the wider environment with feedback to sector management.
- Pay attention to threats *to* aquaculture as well as *from* aquaculture.
- Develop guidance, standards and regulation such that EIA is *not* required except in exceptional circumstances.
- Promote greater involvement of stakeholders and farmers in drawing up standards and procedures.

Management tools

Make greater use of economic instruments to encourage sustainable development and compliance with standards.

Permits and licenses

Licensing is widely regarded as the first essential step required to bring aquaculture within an environmental management framework, and is closely associated with environmental assessment and monitoring.

- Introduce licensing for all existing and new aquaculture.
- Streamline licence award procedures.
- Ensure realistic security of tenure to promote investment and sustainable operation.

EIA procedures

- Develop a synthesis document specific to aquaculture based on a review of all EIA guidelines.
- Reserve EIA for high risk projects.
- Use EIA only for largest farms or farms in highly sensitive areas.
- Apply EA in some form to clusters of small farms.
- Develop better/more consistent screening criteria and scoping guidelines.
- Streamline EIA procedures.
- Make sure small producers are not disadvantaged or excluded; minimize barriers to entry of small producers into aquaculture.
- Make EIA fit for purpose – i.e. do not attempt to use it for issues which project level EIA cannot address (e.g. alien species, wider ecosystem effects).
- Undertake better analysis of socio-economic issues.
- Introduce third party assessment/quality control of EIA.
- Certify/train EIA practitioners for aquaculture.

Consultation, information and transparency

Public involvement and better use of information is a recurring issue in all the ***Reviews***. This is far from simple however, and needs to be well managed if it is to do more good than harm.

- Improve awareness of need to consult and involve stakeholders in environmental management, planning and decision-making.
- More efficient and effective public (and *local*) consultation.
- Optimize the timing of public consultation: sufficient information available on which to base consultation; but before the proposal is too well developed to be easily changed.
- Make more use of representative councils to address strategic environmental issues.
- Increase Web-based disclosure and publication of EIA documentation and associated analysis.
- Publish EIA related permitting decisions - clarify the trade-offs made.
- Establish decision processes to address subjective issues: landscape, socio–cultural, access conflicts, etc.

Monitoring

Monitoring is seen as the key to better environmental management in most of the ***Reviews***, though there is always the danger of over-ambition in terms of coverage and parameters. Monitoring without analysis and feedback is largely worthless.

- Introduce effective monitoring of wider environment related to both identified risks and potential management responses.

- Give more attention to effects of other activities *on* aquaculture.
- Pursue an appropriate balance between farm level monitoring, and monitoring of the wider environment.
- Ensure value of information: fewer, more focused parameters?
- Ensure efficient analysis and reporting of monitoring data, and feedback into individual farm or sector management.
- Define and monitor sustainability indicators.
- Establish sampling standards and protocols.
- Make monitoring more locally relevant.
- Create national and regional information systems for aquaculture, drawing on monitoring information.

Analytical tools

A wide range of tools can help with assessment, communication, monitoring and analysis. Several of the ***Reviews*** highlighted opportunities for a greater role for risk analysis to enhance focus in both assessment and monitoring.

- Use risk analysis for screening and scoping in EIA.
- Use risk analysis as part of SEA and sector planning and management initiatives.
- Use risk analysis to inform and focus monitoring programmes.
- Develop environmental capacity models suitable for local and practical application.
- Make more use of simple nutrient budgets.

Awareness and good aquaculture practice

Without heightened awareness of the need for better environmental management and some basic tools to promote it, any government intervention in management of the sector may be resisted and mistrusted.

- Raise awareness, use extension.
- Promote voluntary and market led good aquaculture practice and certification.
- Explore/develop certification programme for aquaculture.
- Promote corporate social responsibility with larger companies.
- Use periodic independent or environment agency audits of management initiatives developed by industry and sectoral agencies.

Technology

Technology can and has had significant success in terms of improving resource use efficiency and reducing pollution, and advances will continue to be made. It is important however not to be over-prescriptive with regard to particular technologies, but rather let farmers adapt in their own way to incentives/pressure from government, regulators and buyers to improve environmental performance.

- Promote ecological/integrated aquaculture where economically viable.
- Promote/develop better waste management and treatment for aquaculture more generally.
- Explore better siting (e.g. offshore aquaculture) to reduce environmental impacts.

MANAGEMENT SYSTEMS

Among the various weaknesses highlighted in the ***Reviews*** three in particular stand out:

- the difficulty of addressing cumulative impacts of many small-scale developments through conventional EIA;
- the lack of environmental objectives and standards – especially suited to the local context;
- the lack of analysis and feedback of monitoring data into sector management.

These are all indicative of a tendency for governments and regulatory authorities to focus on particular techniques (such as EIA, monitoring) rather than on an adaptive management system for the sector. Thus monitoring at farm level is largely pointless in the absence of mechanisms and procedures to analyse the data and use it to further inform the management of the sector.

An effective management system would vary according to national and local conditions but would typically comprise some key elements:

1. understand the values of the system (for aquaculture and for other activities);
2. set objectives, indicators and response/management thresholds to maintain or enhance these values;
3. agree on mechanisms by which to meet the objectives (farm and sector level mitigation);
4. monitor performance in terms of achieving objectives;
5. make corrections to the mechanisms if necessary to meet objectives.

There are examples of such management systems being developed (for example Australia and New Zealand and in some of the salmon producing countries) but they are far from universal.

In conclusion, the specific emphasis on EIA and monitoring only may well have been a distraction. EIA and monitoring are *specific tools* for environmental management, which, in the absence of an overall and effective *management system*, simply become bureaucratic exercises.

EFFECTIVE AND ACCOUNTABLE DECISION-MAKING

Rather little is said in the ***Reviews*** about actual decision-making, beyond the oft repeated issue of lack of standards. However, standards in relation to many of the more subjective environmental issues are very difficult to agree, and in any case have a significant local dimension. We need effective, transparent and accountable decision-making procedures to address the difficult trade-offs which may have to be made in facilitating sustainable aquaculture (and other forms of) development.

This is an area which deserves much more research – mainly on a country by country basis. The ***Reviews*** prepared for this study illustrate the significant variety and complexity of decision-making processes in different countries, and it is very difficult to draw out generic lessons - so much depends on the details of context, history and informal relationships. The key is to build and improve institutions and decision -making procedures so that they:

- are rapid, efficient and cost effective;
- draw on the best available technical knowledge;
- take account of the interests and values of all stakeholders;
- take account of cumulative impacts;
- are consistent – yet responsive to local needs and concerns.

This is a tall order, but should be strived toward nonetheless.

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Most of the material for this global review and synthesis was derived from the *four regional reviews and the salmon review* prepared as part of this project. These in turn are well-supported with references. There are just a few additional key references cited in this synthesis document. The following are referred to directly in the text and/or are considered to be of particular value as guidance for developing effective environmental assessment, monitoring and management systems for aquaculture.

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