The Ecosystems Approach to Aquaculture

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The Process

In 2006 the Fisheries and Aquaculture Department of Food and Agriculture Organization (FAO) of the United Nations recognized the need to develop an ecosystem based management approach to aquaculture similar to the Code of Conduct for Responsible Fisheries.

The Aquaculture Management and Conservation Service of the FAO Fisheries and Aquaculture Department organized an Expert Workshop in Palma de Mallorca, Spain, May 7 to 11, 2007 at the Universitat de les Illes Balears titled, Building an ecosystem approach to aquaculture that brought together 22 internationally recognized experts representing from different regions of the world that provided a wide range of expertise in the areas of the transdisciplinary environmental, social and economic issues in aquaculture.

- Contributed papers were presented:

Human dimensions of an ecosystem approach to aquaculture by Conner Bailey

According to Soto et al. (2008), Bailey (2008) analyzed the social implications of EAA and argued that social and biophysical dimensions of ecosystems are inextricably related such that a change in one dimension is highly likely to generate a change in the other, he also indicated that an ecosystem approach to aquaculture cannot follow a precise blueprint, which is why the concept of adaptive management is important. He identified seven issues that are directly related to resilience of social systems including i) entrepreneurial opportunity and employment generation; ii) gender relations; iii) economic diversification; iv) infrastructural development; v) food supply; vi) user conflicts; and vii) balances in wealth, income, and power. There are examples worldwide of aquaculture activities where some of these issues are considered properly but in general, greater efforts must be done particularly at the level of policy-making.

Economic implications of an ecosystem approach to aquaculture by Duncan Knowler

According to Soto et al. (2008), Knowler (2008) proposed the use of an agroecosystem framework. He introduced the concept of marginal opportunity cost, which measures what society must give up to obtain a little more of some particular good or service (e.g. farmed shrimp) recognizing the full set of costs incurred from production, regardless of where they occur or on whom they fall. Hence this captures the idea of an EAA from an economic perspective. The paper also recognized that it is difficult to "internalize externalities" without a better idea of the extent of the externalities at issue. The author concluded with a plea for more and better valuation estimates but also recognizes a need for evaluations of the effectiveness of such exercises.

Legal implications of an ecosystem approach to aquaculture by Jorge Bermúdez

According to Soto et al. (2008), Bermúdez (2008) called for a sound reflection about the implementation of EAA from a legal perspective, indicating the need for an integration of scientific, practical, economic and social aspects. EAA legislation will have to consider some specific "principles" such as: i) a holistic, multidisciplinary approach; ii) avoiding unnecessary complexity of measures which might paralyze aquaculture activity; iii) the consideration of "two-speed aquaculture", that is, the fast developing industrial aquaculture, and the slower, smaller, rural and family-type aquaculture. The diversity of aquaculture practices worldwide, with different production scales, represents a challenge in devising appropriate legal solutions. Effective law enforcement and the need to adapt to specific conditions may be another challenge to be faced by governments as well as by local management.

- and two global reviews:

An ecosystem approach to marine aquaculture: a global review by Barry A. Costa-Pierce

According to Soto et al. (2008), Costa-Pierce (2008) analyzed the global status of mariculture and finds that overall; there was a great deal of global, multidisciplinary research and development information and good progress towards an ecosystem approach at the farm level which can inform managers. At the commercial level, there has been a notable transition globally towards an EAA in the industrial/commercial sector for two, major commodities – mollusks and shrimp – over the past ten years. At the commercial scale for marine finfish, there was some progress but not enough towards an ecosystem approach globally. There are few technological or scientific issues remaining to implement an EAA. His review found that scarce participatory processes, poor understanding of social sustainability requirements, and poor governance hindered the widespread adoption of an ecosystem approach to aquaculture, which will require a much tighter coupling of science, policy, and management.

An ecosystem approach to freshwater aquaculture: a global review by John Hambrey, Peter Edwards and Ben Belton

According to Soto et al. (2008), Hambrey et al. (2008) addressed the relevance of the ecosystem approach to freshwater aquaculture (mainly in Asia). Case studies included some examples where aquaculture has threatened sustained delivery of ecosystem services including biodiversity. Extensive and semi-intensive systems typically have a lesser effect over a greater area; while intensive systems usually have a more severe but more localized effect. As the authors pointed out, their case studies suggest that inland aquaculture generally improves human well-being and equity. Aquaculture generates employment for the poor, economic activity from the sale of low as well as high-value species in national and in some cases international markets, and low-cost fish for domestic consumption. Benefits generated through employment of the poor in the supply, processing and distribution chain can be substantial and significantly greater than those directly associated with small-scale farming. The authors recognized that to implement the ecosystem approach will require the development of institutions and associated integrated management systems which can deliver such an approach at realistic and practical scales, taking full account of the needs and impacts of other sectors, and this is a huge challenge. The key is to develop institutions capable of integration, especially in terms of shared agreed objectives and standards.

Hambrey et al. (2008) collected 18 case studies from various countries. Six case studies were integrated agriculture – aquaculture systems (one rice/fish and five pond culture; one was an

integrated peri-urban-aquaculture system; one was an integrated fisheries-aquaculture system; 3 were modern extensive to semi-intensive aquaculture systems; and 8 were modern intensive aquaculture systems.

Results

A synthesis from the FAO 2007 Workshop was then complied by all by 2008 and published as "Applying an ecosystem-based approach to aquaculture: principles, scales and some management measures" by Doris Soto, José Aguilar-Manjarrez, Jorge Bermúdez, Cécile Brugère, Dror Angel, Conner Bailey, Kenny Black, Peter Edwards, Barry Costa-Pierce, Thierry Chopin, Salud Deudero, Shirra Freeman, John Hambrey, Nathanael Hishamunda, Duncan Knowler, William Silvert, Nuria Marba, Syndhia Mathe, Ricardo Norambuena, François Simard, Paul Tett, Max Troell and Alexandre Wainberg.

FAO then worked to develop international guidelines for the "ecosystem approach to aquaculture" (FAO, 2010).

Definition

The ecosystem approach to aquaculture was defined as ***"a strategy for the integration of the activity within the wider ecosystem such that it promotes sustainable development, equity, and resilience of interlinked social-ecological systems."*** This definition is similar to that of ecosystem-based management as proposed by the Convention on Biological Diversity and also takes into account the article 9 of the Code of Conduct for Responsible Fisheries that refers referring to aquaculture (Soto et al., 2008).

Principles

FAO developed three principles and key issues at different scales of society:

Principle 1: Aquaculture should be developed in the context of ecosystem functions and services (including biodiversity) with no degradation of these beyond their resilience capacity.

The key issue is to estimate resilience capacity, or the limits to "acceptable environmental change". A range of terms has been used to estimate the limits to environmental change, including: a. environmental carrying capacity, b. environmental capacity, c. limits to ecosystem function, d. ecosystem health, e. ecosystem integrity, f. fully functioning ecosystems, all of which are subject to a specific social/cultural/political context (FAO, 2010; Soto et al., 2012). Conventional environmental impact assessments touch on just some of these issues. Application of the precautionary approach is important but inadequate in aquaculture; use of aquaculture risk assessment is becoming widespread (GESAMP, 2008).

Principle 2: Aquaculture should improve human-well-being and equity for all relevant stakeholders.

Aquaculture should provide equal opportunities for development which requires its benefits to be more widely shared especially locally so that it does not bring detriment to any sector of society, especially the poor. ***Aquaculture should promote both food security and safety as key components of human well-being.***

Principle 3: Aquaculture should be developed in the context of other sectors, policies and goals.

Interactions between aquaculture and its influences on the surrounding natural and social environment must be recognized. Aquaculture often has a smaller impact than other human activities, e.g. agriculture and industry, but it does not take place in isolation. There are many opportunities to couple aquaculture activities with other primary producing sectors in order to promote materials and energy recycling, and the better use of resources in general.

Implementation of an Ecosystems Approach to Aquaculture

Being a strategy, the ecosystem approach to aquaculture (EAA) is not ***what*** is done but rather ***how*** it is done. The participation of stakeholders is at the base of the strategy.

An ecosystem approach to aquaculture accounts for the complete range of stakeholders, spheres of influences, and other interlinked processes. Applying an ecosystem-based approach must plan for physical, ecological, social, and economic systems as a part of community development, taking into account stakeholders in the wider social, economic, and environmental contexts of aquaculture

Implementing the EAA will require strengthening institutions and associated management systems so that an integrated approach to aquaculture development can be implemented and account fully for the needs and impacts of other sectors. The key will be to develop institutions capable of integration, especially in terms of agreed upon objectives and standards.

The widespread adoption of an EAA will require a much tighter coupling of science, policy and management. It will also require ***that governments include the EAA in their aquaculture development policies, strategies and development plans.***

Applying an ecological aquaculture approach at different scales of society

There are three physical scales important in the planning for and assessment progress towards an ecosystem approach to aquaculture: ***farm scale, watershed/aquaculture zone, and global***. Each of these has important planning and assessment needs.

Farm scale

Planning for aquaculture farms is easily defined physically and could be few meters beyond the boundaries of farming structures; however, the increasing size and intensity of some farms (e.g. large scale shrimp farming or salmon farming) could affect an entire water body or watershed.

Assessment of an EAA at the farm scale entails an evaluation of planning and implementation of "triple bottom line" programs - ecological, economic and social programs - that in a comprehensive manner account for impacts to the wider ecosystem and social impacts of farm-level aquaculture developments, including use of better (or "best") management practices, and use of restoration, remediation, and mitigation methods (National Research Council, 2010; Costa-Pierce and Page, 2012).

Proper site selection, levels of production intensity, use of species (exotic vs. native), use of appropriate farming systems technologies, and knowledge of economic and social impacts at the farm level should be considered.

Watershed/aquaculture zone scale

Planning for an EAA at watersheds/aquaculture scale is relevant to common ecosystem and social issues such as diseases, trade in seed and feeds, climatic and landscape conditions, urban/rural development, etc.

Assessment of an EAA at this scale is a two phase process and will include at PHASE I assessments of:

(1) inclusion of aquaculture as a part of regional governance frameworks, e.g. the overall framework of integrated coastal zone management or integrated watershed, land-water resource management planning and implementation. Assessments take into account existing scenarios, user competition and conflicts for land and water uses, and comparisons of alternatives for human development,

(2) impacts of aquaculture on regional issues such as escapees, disease transmission, and sources of contamination to/from aquaculture, and,

(3) social considerations such as comprehensive planning for all of the possible beneficial multiplier effects of aquaculture on jobs and the regional economy, and considerations of aquaculture's impacts on indigenous communities.

In PHASE II, progress towards a full implementation of an EAA at watersheds/aquaculture zone scale can be assessed by measuring the:

(1) abilities of governments to implement new methods of coastal and water governance to include ecological aquaculture,

(2) development of ecological aquaculture approaches that allow agencies responsible for permitting aquaculture to consider and manage activities impacting aquaculture and aquatic ecosystems (e.g. capture fisheries, coastal zone development, watershed management organizations, agriculture, forestry, and industrial developments) more holistically, such as new mechanisms to communicate, cooperate, and collaborate across sectors,

(3) design of ecological aquaculture management zones and parks that encourage aquaculture education, research and development innovations and partnerships, and also emphasize streamlined permitting of integrated aquaculture, polyculture, or innovative, integrated aquaculture–fisheries businesses and initiatives.

Global scale

Planning for an EAA at a global scale considers aspects of transnational and multinational issues for global commodities (e.g. salmon and shrimp). Assessment of progress towards an EAA at the global level entails evaluation of issues such as: availabilities of fisheries and agriculture

feedstocks for formulating aquaculture feeds and impacts on distant marine **and** social ecosystems, the economic and social impacts of aquaculture on fisheries and agriculture resources, impacts of aquaculture on markets, and impacts of globalization on social sustainability (social capital, goods and social opportunities). Applications of tools such as lifecycle assessments of aquaculture commodities and the use of innovative social enterprise management guidelines and tools are useful to determine impacts at the global scale.

Aquaculture practices which policy-makers could use when promoting EAA. These include: integrated aquaculture in general and integrated multi-trophic aquaculture (IMTA) as a subset of that; ecosystem-based approaches for mitigating negative impacts of aquaculture; inter-sectoral integration when appropriate; broadening stakeholders participation; use of appropriate incentives; use of local and other relevant knowledge; and promotion of EAA-specific research (e.g. estimate carrying capacity at farm level, at the level of the aquaculture zone, the region, etc.).

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