Aquaculture Magazine Nov/Dec 1999
Volume 25, Number 6

RESOURCE CONFLICTS IN AQUACULTURE: international experiences

By Paula Holland and Debbie Brown

Aquaculture production is undergoing rapid expansion in Australia. Between 1987 and 1996, world production of aquaculture products (including seaweed and other aquatic plants) increased from 13.5 million tons to around 34.1 million tons (FAO 1998). The expansion in aquaculture production has resulted in increasing demand for and exploitation of many natural resources, such as clean water and sites. As these resources are not limitless in supply, there may be conflict with other sectors.

The Australian Bureau of Agricultural and Resource Economics (ABARE) has recently released a major report identifying some of the approaches used overseas to resolve resource use issues for aquaculture (Holland and Brown, 1999). Some of the key findings in the report are summarized below.

Policy Needs For Aquaculture

The potential for aquaculture and other sectors to come into conflict over natural resources exists because the rights to use some of these resources are not well defined or enforced. The problem lies in the fact that society has conventionally relied on markets to determine resource use, whereas many of the natural resources used in aquaculture do not lend themselves to conventional markets. This can lead to problems between aquaculture operators and other resource users.

An example might be where normal markets are used to allocate fresh water between a fish farmer and a residential developer. If the farmer bought the rights to use upstream water and the developer bought the rights to the downstream water, residential buyers might suffer if waste from the farm entered their water. In this case, a conventional market for water would not ensure that developers had the clean water they had expected to buy: a conventional market may therefore not generate a clean and efficient outcome for resource allocation, and conflicts between users may arise.

Types Of Conflicts

In the absence of efficient markets, the resource conflicts that may develop in aquaculture can take two forms: they can involve spill over effects ('externalities'), where conflicts may rise because the actions of aquaculture operators affect others; or they can involve poor resource allocation systems, resulting in an inefficient allocation of resources.

Approaches to resolve aquaculture resource conflicts work by better defining the rights over how resources may be used. There are two key sets of instruments.

Regulatory instruments refer to approaches where controls are implemented, compliance is monitored, and non-compliance is penalized (ABARE, 1993). Such instruments can reduce resource conflicts by explicitly forcing operators to change their production methods to reduce externalities, or to allocate resources across competing users. For instance, governments might impose specific limits to the emissions that operators pump into water courses. Common examples of regulatory instruments include emissions standards and siting guidelines.

Economic instruments are designed to influence the behavior of resource users. An example is emissions charges, which can reduce resource conflicts by encouraging aquaculturists to either reduce emissions (and avoid the charges), or to pay charges to compensate for their damages. Common examples of economic instruments are fees and charges on resource use and refundable-deposit schemes.

Selected Responses From Overseas

Access To Fish Stocks

As a general rule, the wide availability of spat for many aquaculture species (e.g. oysters, mussels or trout) means that there tends to be relatively few access conflicts over fish stocks between aquaculture and other users, at least in Australia. However, the potential for conflict over broodstock exists anywhere that aquaculture operators require access to wild supplies of highly valuable juveniles, such as lobster or tuna. In such cases, aquaculture operators could be in conflict with wild harvesters over access to stocks.

In Australia, aquaculture access to juvenile tuna is currently settled through a market system since southern bluefin tuna, the key farmed species, are subject to individual transferable quotas (ITQs). Aquaculture operators who wish to access juvenile tuna must buy quota for the fish. A similar market based system exists in New Zealand where access to valuable juvenile fish stocks, such as crayfish or eels, is determined through the ITQ system.

The impact of the use of ITQ systems to ensure an efficient distribution of tuna in Australia has been well documented (e.g. Campbell, Battaglene, and Brown, 1996). The scheme is generally considered to have been effective at improving the efficiency of the commercial fishery, where quotas have been reallocated to the more efficient operators. With the system including aquaculture operators, over 90 per cent of Australian southern bluefin tuna harvested under the ITQ system was used for fattening in tuna farms in 1998-99 (Australian Fisheries Management Authority personal communication, 15 June 1999).

Similarly, Runolfsson (1997) suggests that the New Zealand ITQ system experience has led to an improvement in stock management, with improved fish catches and quality. There is also some evidence of reduced fishing effort. The instrument extends the former management system to cover native fishers and aquaculturists and so assists in the efficient allocation of stock rights. In this way, other major user groups of the stock are also explicitly covered in the biological management of the stock.

Some aquaculture operators wish to see the New Zealand quota scheme extended to recreational users of the resource in order to avoid on-going concerns about harvests. The wild capture scallop fishery is managed under an ITQ system, with some scallop operators artificially seeding public bays to enhance scallop stocks for harvest later on. While commercial harvest in the public areas of the enhanced fishery are limited under the ITQ system, recreational and indigenous harvests are not limited (M. Arbuckle, Chief Executive, Challenger Scallop Enhancement Company, Nelson, New Zealand, personal communication, September 1997).

Access To Water

In many cases, access to water for aquaculture is determined through siting processes, and controlled through environmental management instruments. That is, aquaculture operators must acquire permission to use an area on which water supplies are available. Providing they are successful in acquiring the site, access to water is allowed, with certain restrictions imposed (for example, to ensure water quality etc.). The use of water is then often regulated according to environmental controls on emissions.

In other cases, water allocation has been conducted separately. In Mexico, for instance, water allocation has been made according to preference criteria. The Federal Water Act of 1971 details priority order against nine kinds of water use. Aquaculture is seventh after a number of other activities such as domestic use and the watering of livestock (Van Houtte, Bonucci, and Edeson, 1989).

In Zambia, different water uses are classified as primary, secondary or tertiary, with water for irrigation and fish breeding classified as a secondary use and the watering of animals as a primary use (Van Houtte et al., 1989). Interestingly, Zambian land owners who demonstrate a need for water for a secondary use may claim another's surplus on the eventual payment of compensation for expense incurred by the deprived party in making the claimed water available (Van Houtte et al., 1989).

The Zambian approach has the potential to increase the benefits to the community from allocating water by avoiding waste. In principle, the approach could generate even further benefits if it could be extended to facilitate water trading. If that occurred, not only could 'deprived' users be compensated for the costs of surrendering water, but trade could be used to ensure that water rights move into the hands of those users who value it the most. Water trading already exists in parts of Australia, such as in New South Wales (New South Wales Department of Land and Water Conservation, 1998). Aquaculture operators are free to engage in this trade.

Water allocation in some countries is controlled through specific limits (standards) on water extraction. This is the case, for instance, for freshwater aquaculture in Ireland (European Commission, 1995). Volume based standards for aquaculture water may improve the equity of access to water resources, but their effects on the efficiency or flexibility of water use are uncertain. Fixed water allocations are unlikely to ensure that the most efficient quantity of water is allocated to aquaculture, if the value of aquaculture changes. Any reduction in the value of aquaculture would imply that less water should be allocated to aquaculture, while an increase would imply the reverse. It therefore seems unlikely that this approach would ensure that water was allocated in a way that generated the highest benefit to society. On the other hand, the system could promote certainty to aquaculture operators about the quantity of water that they could access, so that there may be some advantages for investment.

Managing Waste Discharge

Waste discharge is managed using a wide variety of instruments. A number of countries attempt to ensure minimal waste discharge through the use of bans on particular activities. In Ecuador the destruction of mangrove for aquaculture is prohibited (Nash, 1995), as is the case for Florida in the United States (Zajicek, 1998) and the Philippines (Philippine Ministry of Fisheries, no date; Van Houtte et al., 1989).

While bans can be effective in limiting pollution in the short term, their effects on preventing resource use conflicts and ensuring resource use efficiency can be limited in the long term. First, unless equivalent bans are put on alternative damaging substitute practices, resource conflicts may continue to arise. Second, the socially desirable level of particular activities or inputs in an area may change with developments in technology, changes in the value of aquaculture products or changes in community preferences. As a result, the efficiency of resource use over time under a ban may be diminished.

Under a ban regime the threat of the suspension or withdrawal of permits may encourage operators to ensure that they do not exceed prescribed emission levels or bans. In Florida, for example, 'illegal' emissions (excessive or banned releases) may result in the suspension or withdrawal of permits for operation. However, bans may also remove the incentives for industry to develop environmentally friendly technology beyond that which satisfies legislation. In addition, the use of a ban does not allow any recognition of the tradeoffs between the potential benefits from aquaculture and waste emissions. It may be that, in some cases, a small level of emissions has a relatively low impact on a region, while generating significant returns.

As with bans, standards are commonly used to minimize waste emissions. Standards provide target minimum or maximum limits for producers. Standards allow aquaculture operators to select the response to changes in market conditions that best suits them. For instance, operators may have the incentive of adjusting the amount of feed used on a site in order to meet the standard emission. This allows for the differences in the natural characteristics of each site to be accommodated in a more efficient manner.

Standards have been widely applied by governments to control the environmental effects of aquaculture. The European Union, for example, establishes directives for water quality standards for bathing or drinking water which member states must observe (European Commission, 1995). Many member states also attempt to mitigate aquaculture pollution by imposing limits on the amount of feed input to, or effluent released from, farms (table A).

Other regulatory approaches to mitigating environmental impacts include the use of siting guidelines to anticipate and prevent likely impacts and conflicts. In Canada, the physical location of a salmon farm is important in determining its capability to operate on a sustainable basis in the environment. The principle is simply to prevent adverse effects by avoiding interaction with sensitive habitats or areas of intensive use by wild marine species.

Site guidelines can be relatively transparent and simple to implement, but cannot be relied on to reduce the cumulative effects of aquaculture. Recent studies on the Bay of Fundy (New Brunswick, Canada) have indicated that, although environmental impacts have generally been minimal on a site-by-site basis, area wide impacts have been identified where a relatively high number of sites exist (New Brunswick Department of Fisheries and Aquaculture, 1997).

Governments may place other physical restrictions on aquaculture farms. In Ecuador, all construction of fish ponds and hatcheries must allow for a security strip of at least 200 meters calculated from the point where agricultural farms start (Van Houtte et al., 1989). Minimum separation distances between farms and other farms and sites may reduce the risk of spillover effects from aquaculture, but may limit the overall productive capacity of a region. The risk of externalities needs to be weighed against the potential benefits of farming before introducing minimum separation distances.

As regulatory instruments, standards, site guidelines and bans have the advantage that they offer authorities a high degree of control over the behavior of aquaculture operators. Unfortunately, they may require a large amount of information to determine efficient standards, sites or zones for the aquaculture activity. To be effective, they also require governments to perform a relatively large degree of monitoring and to enforce compliance which may require the imposition of stiff penalties. Regulatory instruments can thus be expensive to establish and operate successfully.

An alternative to regularly instruments is a pricing mechanism that is aimed at efficient waste management. Pricing mechanisms generally take the form of taxes or charges on resource use — for instance, emission charges. These work by encouraging operators to either reduce their emissions (where it is cheaper for them to avoid the charges by doing so) or to pay the charges (where it is cheaper than to reduce their emissions). The revenues generated through the payment of charges could be regarded as compensation to the community for the loss of benefits incurred through the existence of waste. The charges could be used to fund a number of activities including the cleanup of waste emissions by government authorities.

Pricing mechanisms can be a useful means for governments to reach targeted levels of emissions. Pricing mechanisms targeted specifically at managing aquaculture impacts (taxes or charges on pollutants) exist in Hungary (Nash, 1995), Belgium and the UK (European Commission, 1995). In the Netherlands, fish farmers are required to pay a 'pollution tax' to the water authorities regardless of whether the discharge goes into the sewage system or directly into the surface water (European Commission, 1995).

In Ecuador, tax incentives are used to encourage farmers to minimize pollution. The government offers tax exemptions or special incentives to shrimp farmers to acquire a system of treatment for water approved by the Directorate General for Fisheries, in order to avoid pollution (Van Houtte et al., 1989).

Deposit—refund schemes may be applied to ensure the minimization of environmental damage. Under these schemes, funds are set aside at the outset of operations to guard against environmental degradation. The funds are returned to the operator at the expiration of the permit, provided that the environmental standards set out in the permit are met. If the operator goes out of business or fails to meet the conditions of operation and environmental standards required, the funds would instead be used to clean up the area.

Observed use of deposit—refund schemes in this study was relatively limited. In New Zealand, provisions exist under the Resource Management Act for the requirement of a bond but, to date, this option has not been taken up for aquaculture operations at all. In British Columbia, the salmon farming industry maintains a blanket performance bond of Can$25 000, to cover rehabilitation costs in the event of an operator abandoning a farm site. In all cases, the bonds relate to reclamation.

Blanket bonds to cover rehabilitation are unlikely to be the most efficient means of ensuring rehabilitation. For a start, unless accurately estimated, the required deposits may be insufficient to cover rehabilitation expenses, in which case, sites may be inadequately restored or the government could be left with the problem of restoring the area. Second, the incentive for operators to adequately rehabilitate a site is likely to be diminished in the knowledge that the industry or government is prepared to ultimately take responsibility to finish clearing up an area. In practice the impact that this bond scheme places on individual operators to effectively rehabilitate a site is unclear.

The New Brunswick (Canada) provincial government requires operators to restore aquaculture sites to the satisfaction of the Minister within ninety days of ceasing operations at a site. If this is not done then the Crown will restore the site and the operator is liable for all expenses associated with the restoration. The potential of this instrument to encourage operators to observe environmental requirements may be greater than for the case of salmon farming in British Columbia. However, the effectiveness of the measure relies on the extent to which the government incurs significant costs for rehabilitation. Furthermore, it cannot be relied on to achieve rehabilitation if the company goes out of business. Unfortunately, no information was available during this study to establish how successful this policy instrument had been in New Brunswick to ensure complete rehabilitation.

Managing Escaped Fish

In practice, there are economic incentives for farmers to keep stock in their net cages, since escaped fish lead to reduced commercial harvests. This has led to the development of operating practices designed to address the various underlying causes of escapes. Similarly improved siting and farm design have enabled farms to reduce escapes resulting from damaged net cages caused by storms.

Where fish escapes are still a risk, specific polices and regulations have been developed. In Tasmania and British Columbia, the provincial governments require that a buffer zone (eg., one kilometer) is established between salmon farms and the mouths of salmonid bearing streams. The intention behind this measure is to reduce the potential negative effects of farm salmon on wild stocks.

The ability of this measure to reduce the negative effects of fish escapes on wild stocks is questionable, given the ability of salmon to cover large distances. Furthermore, as technology improves, such a rigid restriction may be unnecessary and may excessively constrain aquaculture development. The development of closed-wall systems in salmon farms, for example, may mean the risk of fish escapes is largely removed (see Holland and Brown, 1998). As a result, the inflexibility of this instrument may result in an inefficient use of space.

Alternatively, countries may impose bans or restrictions on the use of imported fish altogether in order to reduce the escape of fish and/or their introduction of diseases. The European Union, for example, requires that all regions in the Community are defined free or not of contagious diseases (Westergaard, 1992). Areas that are designated not free of disease are subject to bans or restrictions on trade and fish movement. Accordingly, member states wanting to designate free zones must submit all farms in that zone to regular health checks, including the taking of samples for laboratory examination.

The use of bans on fish imports to mitigate fish escapes has some obvious benefits. Providing that the member states in the European Union have the opportunity to undergo timely tests to determine their disease/disease-free status, bans need not penalize a country — or the Community — by restricting production. Nevertheless, if tests are not conducted in a timely manner, the bans may mean the loss of production opportunities and the loss of benefits to the Community.

Conclusions

While both regulatory and economic instruments were used to manage aquaculture resource overseas, regulatory instruments predominated (table B). In particular, bans and standards were commonly imposed as a means of controlling externalities related to aquaculture.

However, regulatory instruments cannot always be relied on to lead to an efficient distribution of resources across sectors, especially in the event of technological change. As well, such regulations may take the onus of responsibility for environmentally sensitive production out of the hands of aquaculture operator, rather than encouraging operators to develop and adopt environmentally friendly methods of production.

By comparison, economic instruments may offer the potential to increase the efficiency of resource use both within aquaculture, and between aquaculture and other sectors. However, economic instruments were not commonly identified in the countries investigated. This need not be a sur-

Aquaculture Magazine Nov/Dec 1999
Volume 25, Number 6

prise. The OECD (1997) notes that economic instruments for resource management in the coastal zone have also not been widely applied. They attribute this in part to the limited development of the tools themselves and to the poor development of the scientific information on which they rely. In addition, it is possible that the absence of economic instruments to manage pollution in aquaculture is due to the still emerging status of the industry in many countries. It remains to be seen whether economic instruments will emerge as a more common management tool in countries as the industry becomes more established.

It is likely that in the longer term, the dominance of regulatory instruments is unlikely to continue to reflect the preferences of the community for which they were first developed, for instance, if the value of aquaculture increases. To avoid imposing greater costs on the community in the future, it may be time to consider extending the application of economic instruments such as bidding, charging or market based systems.

The success of various instruments to manage resource conflict in aquaculture has generally been difficult to determine in this study. Few reports are available that assess the effectiveness of management strategies in relation to alternative instruments. To ensure an efficient aquaculture management strategy, Australian policy makers should aim toward introducing regular evaluations of the policy measures, whether they are regulatory or economic.

References

ABARE 1993. Use of Economic Instruments in Integrated Coastal Zone Management, *ABARE report to the Coastal Zone Inquiry for the Resource Assessment Commission, Canberra.*

Campbell, D., T.Battaglene, and D.Brown. 1996. Use of individual transferable quotas in Australian fisheries, Paper presented at the International Workshop on Assessment and Distribution of Harvest Quotas in Fisheries, Aalesund, Norway, 8–11 July.

European Commission, 1995. Aquaculture and the Environment in the European Community, *Directorate-General for Fisheries, Office for Official Publications of the European Communities, Luxembourg.*

FAO Fisheries Department, 1998. Aquaculture Production Statistics 1987–1996, *FAO Fishery Information, Data and Statistics Unit, FAO Fisheries Circular no. 815, Revision 10, Rome.*

Holland, P. and D.Brown. 1998. 'Policy development in aquaculture: experiences from overseas', Outlook '98, Proceedings of the National Agricultural and Resources Outlook Conference, Canberra, 3—5 February 1998, vol. 1, Commodity Markets and Resource Management, *ABARE, Canberra, pp. 265—73.*

Holland, P. and D. Brown. 1999. Aquaculture Policy: Selected Experiences From Overseas, *ABARE Research Report 99.7, Canberra.*

Nash, C. 1995, Aquaculture Sector Planning and Management, *Fishing News Books, London.*

New Brunswick Department of Fisheries and Aquaculture, 1997. The Allocation and Administration of Marine Aquaculture Sites in the Bay of Fundy: A Discussion of Issues, *Department of Fisheries and Aquaculture, Aquaculture Division, New Brunswick, Canada, August.*

New South Wales Department of Land and Water Conservation, 1998. Water Sharing in New South Wales — Access and Use, *A Discussion Paper, Sydney, April.*

OECD, 1997. Integrated Coastal Zone Management: Review of Progress in Selected OECD Countries, *report no. OCDE/GD (97)83, Paris, Draft.*

Philippine Ministry of Fisheries (no date), Gintong—Ani For Fisheries, *Philippines.*

Runolfsson, B. 1997. 'Fencing the oceans: a rights-based approach to privatizing fisheries', Regulation: The Cato Review of Business & Government, *Cato Institute, Washington DC, vol. 20, no. 3, pp. 57–62.*

Van Houtte, A., N.Bonucci, and W. Edeson. 1989. A Preliminary Review of Selected Legislation Governing Aquaculture, *Food and Agriculture Organization, Rome.*

Westergaard, J. 1992. 'Aquaculture production and the new European sanitary legislation', in Commission for the European Communities 1992, Euroaqua '92: European Aquaculture in 1992, *Proceedings of a seminar, 30—31 May 1991, Brussels, Office for Official Publications of the European Communities, pp. 87—9.*

Zajicek, P. 1998. Environmental Permitting, Submerged Land Leases and Game Fish Tagging Policies of Select South-Eastern States, *Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture, Florida.*

* An expanded version of this article was published by ABARE and presented at *World Aquaculture '99: Bridging the Gap*, Annual International Conference and Exposition of the World Aquaculture Society, Sydney, 26 April — 2 May 1999.

Paula Holland and Debbie Brown are Principal Research Officers with the Australian Bureau of Agricultural and Resource Economics: ABARE, GPO Box 1563, Canberra ACT 2601, AUSTRALIA.

Reprinted from ***AQUACULTURE MAGAZINE***
For subscriptions or information about the magazine, please visit our website at http://www.aquaculturemag.com
or address correspondence to Aquaculture Magazine • PO Box 2329 • Asheville • NC • 28802.

See: Issue November/December 1999, page 39