Marine Policy 38 (2013) 205–213

Contents lists available at SciVerse ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Interactions between aquaculture and fisheries

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ARTICLE INFO

Article history:
Received 4 May 2012
Received in revised form
29 May 2012
Accepted 29 May 2012
Available online 18 June 2012

Keywords:
Aquaculture
Seafood market
Aqua feed
Fishery economics
Food security
Environmental sustainability

ABSTRACT

Aquaculture is increasingly interacting with fisheries from a socio-economic perspective at the level of the global food market. In addition, since 36% of landings from fisheries are used for the production of fishmeal and fish oil, which are essential feed elements for many aquaculture species, another source of interaction is at the level of the aqua feed market. The relevance of the interactions between the two sectors is becoming more evident as the process of transition from fishing to farming has reached a pivotal point, with almost 50% of the fish food supply now coming from aquaculture. The analyses on aquaculture and fisheries interactions often result in diverging views. This paper reviews the main positions in the recent scientific literature, structuring the discussion along the following themes: food market interactions; comparison of resources use by means of Life Cycle Assessment; use of fishmeal and fish oil and aqua feed markets; impacts on small pelagic fish stocks; food security; technical substitution of fishmeal and fish oil with alternative ingredients. The review is not aimed at taking a definitive position in respect of these complex issues but rather at summarising the different scientific contributions and indicating possible areas for further research. Research on fisheries and aquaculture interactions is considered beneficial in terms of policy support especially now that the reform of European Common Fishery Policy is assigning greater relevance to the growth of aquaculture and to its role in terms of socio-economic development for coastal and rural communities. In a more global perspective, the understanding of interactions between aquaculture and fisheries is important to evaluate the respective contributions to food security goals and the implications in terms of environmental sustainability and resource use efficiency.

1. Introduction

The latest FAO report on the state of the world fisheries and aquaculture [1] indicates in 2009 a global aquaculture production of 55.1 million tonnes (aquatic plants excluded) and global marine catches of 90 million tonnes. Around 27.3 million tonnes of global marine catches were destined for non-food purpose, of which 20 million tonnes went into reduction to fishmeal and fish oil. Over the last decade, the figures from FAO showed the world aquaculture production continuously growing, while during the same period the amount of captured fish used for fishmeal and fish oil production remained relatively stable (Fig. 1).

The average year to year growth rate for aquaculture production between 1970 and 2009 was 8.3%, compared to 4.9% for poultry, 2.9% for pig, 1.8% for sheep and goats, 1.4% for cattle and 1.2% for fisheries. While the trend in productivity gain for agriculture and livestock production after the "green revolution" is slowing down, aquaculture has still to exploit its full potential to increase productivity through the domestication of new species [2], genetics, genomics and selective breeding [3], and more in general through an intensification of production systems [4]. The expansion of aquaculture in respect to fisheries can be considered as the latest process of animal domestication and transition from "hunting to farming". The figure of almost 50% (45.7%) of global supply of seafood coming in 2009 from aquaculture represents a pivotal point in this transition.

Global forecasts on food security [5,6] indicate that aquaculture will compensate for the stagnating supply of seafood from fisheries and give an important contribution in feeding the growing human population with valuable animal proteins. This represents on one side an opportunity in responding to food security needs and alleviating the pressure on marine resources but, on the other side, raises several sustainability concerns [7].

With the increasing contribution from aquaculture to seafood supply the interactions between fisheries and aquaculture are expected to become even more important and therefore deserve exhaustive investigations from socio-economic and biological perspectives.

A key element that characterises aquaculture in respect of fisheries is the higher degree of control on the production process that is associated to stronger property rights. Anderson [8] pointed out that there is a tendency of fisheries to become closer

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http://dx.doi.org/10.1016/j.marpol.2012.05.037

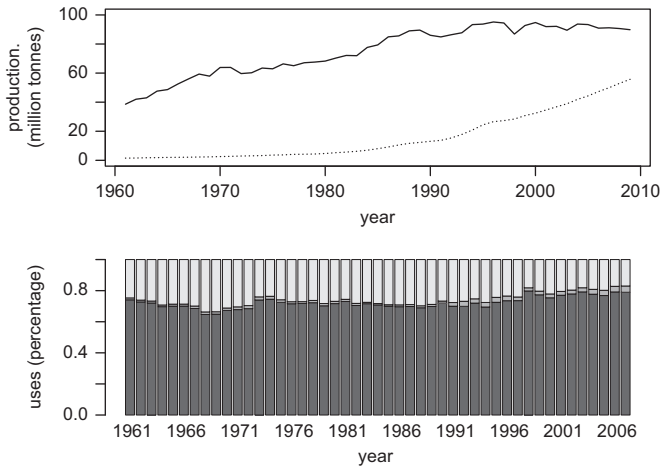

Fig. 1. Production from aquaculture and fishery (dotted and solid lines in chart above) and uses for food, other uses and feed (dark grey, medium grey and light grey in chart below) (source: FAO). The transition from fishing to farming has reached a pivotal point with farmed fish now representing almost 50% of total seafood supply. Contrary to pessimistic predictions the expansion of aquaculture has not resulted in higher use of capture fish for fishmeal production.

to aquaculture since fishery management and in particular the adoption of fishing quota are introducing the equivalent of property rights on the common pool resource of fish stocks.

Not only the two sectors are becoming similar but in economic terms they are increasingly interacting at the level of the food market and from the input side through the dependence on fishmeal and fish oil as key ingredients in aqua feed.

At the food market level the substitution between farmed and wild fish is affecting prices and the profitability of the respective industries. These interactions take place at a global scale given the role of international trade, which is particularly relevant in the case of fish products. The fate of local economies in coastal areas relying on fisheries as primary source of food and income is affected not only by shifting patterns of global fisheries [9] and allocation of fishing rights but also by an increasing share of farmed fish in international trade.

Even if markets for fish may not be fully integrated they are at least complementary. Farmed fish may complement the supply outside the fishing season and the marketing and processing after harvest are very similar. Large companies have realised that there are significant benefits in operating in both fishing and aquaculture sectors. These synergies have led to horizontal integration with fishing companies starting to merge with aquaculture enterprises and vice versa [10]. Horizontal integration brings economies of scale and allows both sectors to compensate the respective risks and volatilities in production such as stocks fluctuations in fishing and disease outbreaks in aquaculture. The possibility to provide a more diversified range of products brings advantages in marketing and is responding to the tendency by large retailers to concentrate supply sources. Finally, horizontal integration represents for many fishing companies an opportunity for expanding and overcoming limitations imposed by fishing quotas and limited entry programs.

On the input side the use of fishmeal and fish oil by the aquaculture industry represents a highly debated issue with a series of diverging views. The exceptional growth of aquaculture is seen by some as a solution to relieve the pressure on fish stocks and contributing to food security, while others argue that the dependence of aquaculture from the small pelagic fish going into the production of fishmeal and fish oil is unsustainable from an ecological and ethical point of view and will ultimately represent a hindering factor for the expansion of aquaculture.

The aim of this paper is to review the interactions between aquaculture and fisheries at the food market level, in terms of resource use efficiency and in relation to the use of fishmeal and fish oil, examining different perspectives in the recent scientific literature. This analysis is contributing to the understanding of the implications of the important transition from fishing to farming which is characterising the seafood system and which could offer the opportunity to ensure food security, economic growth in rural and coastal economies, while at the same time relieving pressure from marine fishery resources. The analysis of the interplay between aquaculture and fisheries is important to develop integrated policies covering both sector such as the new European Common Fishery Policy which is assigning higher emphasis to aquaculture also in consideration of its role in promoting growth and jobs and diversification in coastal fisheries and aquaculture-dependent communities [11].

2. Food market interactions

Economic interactions between fisheries and aquaculture at the food market level have been described, among the first, by Anderson [12] in a theoretical market model for fish products. Anderson shows how the entry of aquaculture would lower fish prices, increase total supply and reduce pressure on overexploited fisheries managed under open access and exploited beyond maximum sustainable yield (Fig. 2). This leads to positive effects on the fish stocks and an overall improved economic efficiency of the fisheries. Although the model does not consider explicitly welfare implications it can be foreseen that the lower fish prices caused by the expansion of aquaculture may determine a profit loss for fishermen in the short term.

Ye and Beddington [13] described similar consequences considering dynamic interactions and two different substitution levels between farmed and wild fish. In the case of partial substitution market interactions are indirect and less evident

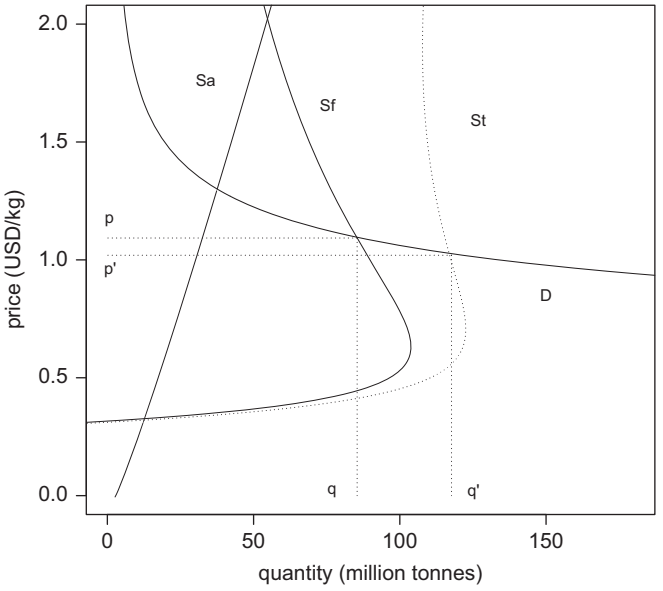

Fig. 2. Theoretical seafood market model showing the implication of the entry of aquaculture (price and quantities are illustrative and taken from Arnason [60]). Under the assumption of perfect substitution between farmed and captured fish, aquaculture supply (Sa) is adding up to the fishery supply (Sf) and generating a higher total supply (St). Given the backward bending shape of the fishery supply, the new equilibrium in respect of the global fish demand (D) results in lower prices (from p to p'), and higher quantity (from q to q'), which in turn implies lower fishing effort, higher fish stocks and in the short term lower profits for the fishermen.