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EFFECTS OF MARINE FISH PRODUCTION IN CULTURE CAGES ON COASTAL WATER CONDITIONS: THE CANARY ISLANDS CASE

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Summary

The fish-net cage culture located in coastal waters represents an alternative activity to overfishing. In the Canary Islands, the main species farmed are the gilthead seabream, *Sparus auratus* (90%) and the seabass, *Dicentrarchus labrax* (10%). The diameter of the net-cages is between 15 and 25 metres. The height is approximately 10-12 metres.

The fish-net cage culture is an uncontrollable source of contaminants in the marine ecosystem. The main sources of environmental disturbance associated with this activity are the fish excrement and the excess feed, not ingested by fish. In the area studied, for an annual production of fish of 1000t, are discharged in the ecosystem 120 t of nitrogen and 17 t of phosphorus, nutrients which contribute towards eutrophication. These quantities of nitrogen and phosphorus are equivalent to the quantities present in effluent waste water for a population of 20000 persons.

Furthermore, the fish-net cage culture may produce disturbance of the fauna and loss of biodiversity, degradation of the benthos, accumulation of anti-bacterial residuals, increment of the presence of antibiotic-resistant bacteria, reduction of bacterial activity, increment of micro-organisms, persistence of antibiotics in the sediments, competition between farmed and wild species, accumulation of feed which may be toxic to flora and fauna, excessive nutrient enrichment, disturbances associated with cage cleaning, and the increment of toxicity due to anti-fouling products, as has already been reported in the bibliography.

Keywords: Fish net-cage culturist, environmental disturbance, Canary Islands.

Introduction

The installation of cages in areas close to the coastline, designed to farm and fatten fish, is an economic activity which has received great support within the EU. This activity has two basic aims: to cover the demands for fish by compensating the deficits in the fisheries within the European Union whilst reducing the catches of natural resources, thereby protecting endangered shoals of wild species.

Within these broad guidelines, it has been the policy of the Government of the Canary Islands to produce incentives for installations and development of the aquiculture industry in the Archipelago via the concession of licenses to set up floating fish-cages in the coastal waters of the islands.

Aquiculture has always been presented as a 'white' industry, free of pollutants. However, as occurs with other battery animal production, the activity actually generates several contaminating residual products. In the case of fish-farming in floating cages in coastal waters, these substances are dumped directly into the surrounding water mass. The contaminating substances are mainly chemical products, residues of undigested feed and excrement produced by the fish themselves. Moreover, since these are produced in the open sea, the possibility of controlling the waste is much less than when such is produced on land nor is it feasible to carry out normal waste processing mechanisms in order to avoid pollution of the environment.

Description of the cages

At the moment, in the Canary Islands, 6 fish-cage installation concessions have been granted, amounting to a total of 110 cages with an annual production of around 3100 tons of gilthead seabream, *Sparus auratus* and seabass, *Dicentrarchus labrax*, and covering an area of coastal seawater of around 270000 m2. These cages are structures which measure between 15 and 25 metres in diameter, 12 metres deep which are anchored at between 20 and 40 metres depth. Each cage may contain up to a maximum of 90000 juvenile specimens.

The environmental effect of the cages

The concession implies the so-called Environmental Management Plan which consists in taking a series of physical, chemical and biological parameters but which does not include micro-biological controls or checking the quality of the waste water, nor any other kind of sanitary control.

Amongst the effects which may be triggered by the installation of fish-farming concessions on the surrounding environment, we can list the emission of Nitrogen and Phosphorus. These elements are produced by two sources: the excrement of the very fish themselves and the residues of unconsumed food. The problem of the increased nitrogen and phosphorus in the environment is that it produces an upsurge in biological activity and, therefore, organic matter (eutrophication).

The amounts of emissions of N and P as a result of the fish farming of the gilthead seabream and the seabass, per 100 Tm of fish production, is shown in the following Table 1 (Molina-Dominguez *et al.*, 1997). We can see that for each 100 tons of culture/year, there is an emission of 12 tons Nitrogen (80.1% N supplied) and 1.7 tons of Phosphorus (68.7% of the total P). These data coincide with other figures given by Wu (1995) and Klaoudatos *et al.*, (1996) for fish farming.

In order to give a more comprehensive picture of the real quantities produced, we can compare the figures with their equivalent in human waste water. The N content in averagely contaminated urban waste water is 50g/m^3 (García-Méndez and Marañón Maison, 1996). The 372 Tm produced potentially by the fish culture cages and filtered into the environment would be equivalent to a volume of waste water of some 7500000m^3. If we consider a consumption, for the whole population, of around 300l/habitant x day, the 110 fish-cages emit the same quantity of N per year as a population of 70,000 inhabitants, with no processing or control. This, in the case of Gran Canaria, amounts to an increase of 10%

Table 1: Supply and dumping of food used in fish-farming of gilthead seabream and seabass in Gran Canaria.

	Food suplied (x100 t of culture)	Dumped into environment (x100 t of culture)
Total weight (kg)	245.000	170.000
N content (kg)	15.000	12.000
P content (kg)	2.500	1.700

population or the equivalent in waste produced by the 3 million tourists who visit the island each year (3 million tourists x nine days' stay x 0.3 m^3 of water consumption per day x 50g of N/m^3 = 405 tons of N).

Other effects on the environment

Other environmental factors generated by marine fish-farming installations which have been detected are the following: degradation of the sea beds, reduction of the oxygen available in the water, alteration of the benthic flora and fauna with loss of biodiversity, an increase in the micro-organisms present in the water, competition between the cultures and wild specimens for available resources, the accumulation of antibiotics and their toxic effect on the organisms, generation of bacterial strains resistant to antibiotics and the assimilation of anti-fouling substances by the organisms.

The organic matter deposited on the beds generate changes in the physical, chemical and biological characteristics of the sediments in a radius of at least thirty metres around the installations, at times extending up to one kilometre (Klaoudatos *et al.*, 1996; Karakasis *et al.*, 1997).

The organic matter deposited on the sediments is degraded by the micro-organisms which are present in the environment. When the biological demand for oxygen is high, the micro-organisms use most of the oxygen present in the water column to degrade the organic matter. The result is severe stress or death of all the creatures which depend upon the oxygen dissolved in the water for their existence. When this occurs and conditions of anaerobiosis (lack of oxygen) are produced, there is, besides, generation of gases such as methane which are toxic for many organisms (Wu,1995).

The deposits of large quantities of organic matter on the sea beds produce, characteristically, a decrease in the species which exist in the area i.e. loss of biodiversity. Once the flora and fauna of any given area has been altered, it may take up to two years, after the activity has ceased there, for any kind of recovery to take place. Meanwhile, the sea beds are characteristically occupied by opportunistic benthic macrofauna (Henderson *et al.*, 1995).

Moreover, certain food additives used in fish farming, together with some antibiotics, are enormously toxic for marine organisms such as amphipods, polychaetes and starfish which are to be found in the adjacent areas to the installation, since the substances produce neuromuscular paralysis in these animals (Davies *et al.*, 1998).

The dumping of waste products generates a massive increase in the micro-organisms present in the water, such as bacteria, protozoa and parasites which infect the cultured

species. The presence of these micro-organisms not only represents a potential danger to the health but also conditions the quality of the water and its use for other activities (Leong, 1992; Dehadrai, 1997).

The animals freed in a given area may form colonies and live there permanently, moving out other endemic species. Besides, these animals freed accidentally may generate extreme phenomena of competition for space and food resources with the native species (Gowen and Rosenthal, 1993).

Antibiotics are probably the chemical products used in this production which generate most controversy. The frequent recourse made to antibiotics by fish-farming companies, in marine environments, as remedies or treatment for illnesses in the cultivated fish allows these substances to filter through to the sea sediments and to form part of the same. Of the antibiotics used, approximately 70-80% of the total weight of the quantities introduced in culture filter through to the environment and the sediments, maintaining intact their anti-microbe characteristics (Hektoen *et al.* 1995; Capone et al, 1996; Herwig and Gray, 1997). The presence and permanence of the antibiotics in the sediments may mean that these are bio-accumulated by certain species (Capone *et al.*, 1996). On other occasions, the use of antibiotics may cause microbe activity to be halted and, as a result, that organic matter deriving from the cultures is not degraded but is rather accumulated, producing a muddy cloud with long-lasting impact (Holmer, 1992; Holmer and Kristensen, 1992).

The use of bacterial agents which may be accumulated in the sediments generates, with time, the appearance of strains which are resistant to antibiotics. These strains are to be found both in the water column and in the sediments. This decreases the quality of the water in the areas surrounding the fish-farming installations (Wu, 1995; Herwig and Gray, 1997).

The use of anti-fouling products is one more source of contaminants introduced in the marine media via the cultures. The anti-fouling products are highly toxic for the fauna. The absorption and assimilation of organic-metallic elements present in the water column is mainly produced by aquatic organisms and are bio-accumulated by the molluscs and crustaceans in the area and, as such, can affect Man when he consumes these animals (Wu, 1995; Blanck and Dahl, 1996; Austen and McEvoy, 1997).

Conclusions

The effects produced by the fish-cages on the environment make it necessary to take a series of measures:

1. Avoid installation of fish-cages close to beaches since the waste can produce negative effects upon the same.
2. Avoid the installation of marine fish-cages in areas of ecological interest such as areas where there are marine sea-grasses which are endangered ecosystems to be protected within the European Union.
3. Establish marine fish-cages using similar legislation as is imposed upon urban waste water filtered through underwater sewage pipes.
4. Limit the location of marine fish-cages to areas with significant dynamics and not to areas of sedimentation.

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