NITROGEN FLUXES IN FISH CAGE FARMINGS AT THE COAST OF WESTERN GREECE

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Abstract

This study focuses on the nitrogen mass balance in a fish farm located near the Acheloos estuary. The nitrogen loss to the environment found to be 75% of the input. The nitrogen releases of dissolved and particulate forms were 51% and 24% respectively. 3% of the later was immediately deposed to the sediments under the cages while the remaining 21% resided in suspended mater recycled through the food chain and involved in more complex bio-geochemical processes. Furthermore a 6% to 45% from the deposited to the sediments nitrogen releases back to the water column, depending on the oxidation conditions.

Key words: Mass balance, nitrogen, aquaculture, Mediterranean, Greece

The purpose of this study was the estimation of how much of the nitrogen supplied with food and juveniles is recovered with the harvested fish and how much is lost to the environment in a typical Mediterranean fish farm of sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*). Furthermore we wanted to determine the percentage of particulate and dissolved nitrogen distribution in the environmental loss; how much of the particulate form is accumulated in the sediment under the cages and how much remains in suspension or is engaged in biogeochemical outside the immediate vicinity of the cages. Finally, how much of the nitrogen accumulated in the sediments emanates in the dissolved form to the overlying water. To do so we calculated the annual mass balance making the assumption that the external nitrogen input to the farm, from the open Mediterranean Sea and the atmosphere was significantly smaller than the nitrogen originating from the fish farm.

The study took place during 2002 in collaboration with the Aquaculture Center of Acheloos, a research and development company working on aquaculture production in Western Greece under the Supervision of the General Secretariat of Research and Technology, Hellenic Ministry of Development.

Prototype sediment traps were constructed and employed to collect sinking particles under the cages and to measure the sedimentation releases.

A prototype benthic chamber was constructed to study the sediment / water exchange of nitrate, nitrite, ammonium and DON under four oxidation conditions: oxygen depletion (8.00 ppm to 1.55 ppm), hypoxia (1.60 ppm to 2.10 ppm), oxygenation (2.00 ppm to 7.40 ppm) and anoxia (rapid fall to 0.20 ppm).

Ammonium, nitrate, and nitrite were determined in water samples by standard spectrophotometric methods. Total Dissolved Nitrogen (TDN) in water samples was determined following the Valderrama persulfate oxidation method [1].

Dissolved Organic Nitrogen (DON) in water samples was calculated as the difference between TDN and the Total Inorganic Nitrogen (the sum of NO_3^-, NO_2^-, NH_4^+). Samples of fish food, fish and particulate matter were frieze dried and analysed following an effective oxidation method [2].

The nitrogen fluxes were calculated on the basis of data provided by the fish farm and the determination of the average water content in nitrogen and the nitrogen concentration of the various samples (fish food, juveniles, harvest, fish loss and the particulate matter in the sediment traps).

Benthic fluxes of nitrate, nitrite, ammonium and DON, were measured with the benthic chamber using sediment and overlying water from the fish farm. Maximum fluxes for all nitrogen compounds were observed under anoxic conditions. Ammonium fluxes were always the prevailing ones giving rise to significant ammonium concentrations in the overlying water. On the contrary nitrate fluxes were always low. During oxygenation, ammonium concentrations were significantly lower. Under all oxidant conditions the nitrite concentrations were the lowest. A decrease of DON concentration in the overlying water was observed only in hypoxia.

Concerning the nitrogen mass balance, almost the entire nitrogen input to the farm during the 2002 growing season was supplied by fish food (99.8%). The recovery in harvest was 25%. The nitrogen equivalent to fish loss was negligible (0.3%). The environmental loss is considerable amounting to 59 Kg N per tonne (t) of fish produced, corresponding to 75% of the total nitrogen input to the farm. The dissolved nitrogen release amounted to 68% of the environmental loss while the particulate release amounted to 32%. Suspended solids represent 87% of the particulate release (21% of the total nitrogen input to the farm). Direct sedimentation in the immediate vicinity, under the cages represents 3% of the total nitrogen input to the farm or 13% of the particulate release.

No other similar study in the Mediterranean region is known until now. Therefore comparison is made with studies from northern European countries which show that our environmental nitrogen loss is similar to that determined by Hall et al. (67% to 71%) [3], and by Phillips et al. (79%) [4]. It is worth mentioning that the amount of nitrogen per tonne (t) of fish produced found in this study is smaller than that of the above mentioned works (95 to 102Kg N t^{-1}) in [4] and (104Kg N t^{-1}) in [4].

This could be explained partly by the smaller nitrogen concentration of the fish food used in our case and partly by the higher fish growth rate in the Mediterranean Sea due to faster fish life cycle and higher water temperature.

Finally the dissolved nitrogen fraction dominates in the environmental loss representing in the Greek case 68%, which is slightly higher than (61%) reported by Hall *et al.* [3].

References

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