

# Science for Environment Policy

## Salmon aquaculture could incorporate seaweed and sea urchins to reduce nitrogen enrichment

**Farming fish together with seaweed and other species could help improve the sustainability of aquaculture and reduce pollution.** A new study provides a tool for designing sustainable fish farming systems and calculates their potential to recycle waste. An example of a salmon farming system incorporating seaweed and sea urchins could reduce nitrogen releases to the environment by 45%.

**Over half of the 158 million tonnes of fish and aquatic plants produced globally every year come from farmed systems<sup>1</sup>**, i.e. aquaculture. If aquaculture is to produce enough to meet the increasing demand for seafood whilst protecting the environment, it will be crucial to ensure that the increase in aquaculture production is done sustainably.

One way to increase the sustainability of intensive finfish farming is to incorporate other species into farming systems that can filter and recycle fish waste. Seaweed, for instance, can use the nitrogen in fish excretions for growth. However, impractically large crops may be needed to deal with the levels of waste produced in commercial fish farms. Therefore, scientists and farm owners are developing systems combining several different species to create a better balance between waste production and uptake. These systems can be termed integrated multitrophic aquaculture (IMTA). The species involved can become products in themselves, potentially increasing revenue for fish farmers.

In the current study, the researchers created a modelling tool for designing an efficient IMTA system at any site based on the proposed species. They used data from Scottish farms to simulate a sea salmon farming system that combined growth models for Atlantic salmon (*Salmon salar*), a type of sea urchin (*Paracentrotus lividus*) and an algae or seaweed (*Ulva lactuca*) commonly known as sea lettuce. Their hypothetical system was composed of nine 90-metre wide salmon cages capable of producing 1000 tonnes of salmon and requiring 65 tonnes of nitrogen – in fish feed form – every 18 months.

They established parameters for the other two species based on an in-depth literature review. These included a maximum growth rate and optimum light intensity for the seaweed. The model simulates growth and nutrient production within the system, calculating how much biomass is produced and how efficiently nutrients are recovered. It assumes the only nitrogen available to the sea urchins and seaweed comes from the waste produced by the salmon and that 38% of the nitrogen that enters the system as fish food becomes salmon biomass, meaning it is removed when the fish are harvested.

The model system should produce 342 tonnes of seaweed and 20 tonnes of sea urchins every 18 months, in addition to the 1000 tonne target for salmon. The model predicts that, of the 40 tonnes of nitrogen excreted by the fish, only 22 tonnes enter the environment due to recovery by seaweed and sea urchins. Seaweed is predicted to account for two thirds of the uptake.

By contrast, a non-IMTA, salmon-only system would release all 40 tonnes (45% more nitrogen) to the environment. In such a farm, measures would be put in place to manage the nitrogen build-up in the form of ammonia, in order to prevent stress and disease in fish<sup>2</sup> and to maintain the quality of fish products.

According to the researchers, sea lettuce has great potential to consume and degrade pollutants in aquaculture environments, which could be improved even further by establishing IMTA systems further south, where seaweed growth would be less limited by light and water temperature. However, they suggest it would be unrealistic to aim for 100% nitrogen recovery, particularly in an open-sea system. The model's adaptability lies in the fact that it incorporates the growth models of different species as sub-models and could therefore be used to design sustainable fish-farming systems for a range of species and local environments.



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1.FAO. (2014). Report highlights growing role of fish in feeding the world. FAO, 19th May 2014. <http://www.fao.org/news/story/en/item/231522/icode/>

2.Pollution Solutions. (2014). The Management of Ammonia Levels in an Aquaculture Environment. *Pollution Solutions*, 5th February. [https://www.pollutionsolutions-online.com/articles/water-wastewater/17/chris\\_serjeant/the\\_management\\_of\\_ammonia\\_levels\\_in\\_an\\_aquaculture\\_environment/1557/](https://www.pollutionsolutions-online.com/articles/water-wastewater/17/chris_serjeant/the_management_of_ammonia_levels_in_an_aquaculture_environment/1557/)