

ENHANCING THE PRODUCTION OF THE OPEN OCEAN RANCH

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Ocean ranching is the process of managing fish production in an unenclosed area of the sea. It has yet to reach the sophistication of animal husbandry where it is taken as self evident that increased feed stock yields more animal protein. The Green Revolution has dramatically increased the yield per hectare, in part by the application of nitrogen to the land obtained via industrial processes. This paper looks at the evidence that a Blue Revolution in fish ranching by way of purposeful introduction of nutrients, termed ocean nourishment, is a cost effective way to provide much of the protein needed to feed the increasing world population. There will be 2 billion more people to feed by 2035.

Fish production is limited in general by a restricted recruitment of juveniles, a limitation of food (lower trophic levels) and predation. Sea ranching to date has focused on the first and third control - the production of juveniles and the restriction of fish catch. The constraint imposed by the limited feed available to the fish being ranched has not been given enough attention. This limitation can be overcome by increasing the base of the food chain, that is marine primary production. New primary production can, in turn, be increased by nourishing the ocean with appropriate nutrients to enhance photosynthesis (Jones and Young 1997).

If one adopts an agricultural model of life in the sea, it is straightforward to use a model such as Pauly and Christensen (1995) to estimate the increase in marine biomass as a result of an increase in primary production. Over the temperate and tropical ocean, on a time scale of days, photosynthesis depends on new primary production. From the export factor of say 16%, it can be shown (Jones, 2004) that primary production equals 6.25 times new primary production. Pauly and Christensen conclude that fish catch is 8% of primary production or for our example above, 50% of the new primary production.

The cost of producing additional fish in regions where nitrogen alone is the limiting nutrient can easily be calculated. Assuming reactive nitrogen sells for less than \$200 per tonne delivered to the photic zone, and a Redfield ratio of C:N of 7:1, the production of organic carbon costs \$200/7 per tonne. Carbon as fish is then $0.5 \times 200 / 7 = \$14$ per tonne. Fish are about 11% carbon giving a tonne wet weight of fish production cost \$1.5. Now some efficiency in the uptake of nitrogen should be allowed, say 70% and not all the fish can be captured. Some will die and some will be food for the next trophic level. The export factor might be lower for the additional primary production. Despite these qualifications, it is clear that the cost of ocean nourishment is a very small fraction of the value of fish produced.

Culture bottle experiments have demonstrated that nitrogen and phosphate increase the standing stock of natural assemblages of phytoplankton at a number of locations. Kyle Scottish, a loch in Scotland, was fertilized during the Second World War with the aim of increasing the fish biomass. According to Gross (1950) the nourishment brought about an increase of four to five times the weight of first year plaice and an increase also in second year plaice. This experiment was not deemed to be an economic success but the experimenters noted they did not have the data to allow an assessment of the economic factors in optimized enrichment demonstrations. While this experiment can be criticized for the lack of a control

and other problems like poor fertilizer distribution, it showed that nourishment led to “fatter fish”. The feed stock limitation to fish production had been removed.

As sea ranching implies the use of the ocean commons, issues of property rights have inhibited progress in introducing enrichment. Nixon and Buckley (2002) discuss other factors including the concerns about coastal eutrophication since the 1950s. If business is to invest in ocean nourishment to increase pelagic fish stocks, the revenue of fish licenses will need to be accessible to the suppliers of nutrients. As currents will sweep away nutrients and secondary production might be in the high seas or in another jurisdiction, it might be prudent to base investment returns on the fish supported only by new primary production.

Just as the Green Revolution has helped alleviate poverty in farming communities, might not ocean nourishment restore the health of the ocean and provide additional economic protein needed for fishing communities to escape poverty?

References

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