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Open Netcage Fish Farm pollution

Farmed fish are grown in net cages that float in the ocean. Pollution from fish excrement and waste from excess food is discharged directly into the marine environment. This pollution can be divided into two classes, organic and chemical.

Organic Pollution

The main source of organic pollution from salmon farms is fish excrement and uneaten feed. The amount of feces produced by farmed salmon can vary depending on feed formulations. Studies show that 25 - 50 per cent of the dry feed consumed can end up as feces(1) Other contributions to organic waste are fish mortalities that sink to the seabed(1), and fish blood from farms that harvest and bleed fish on site(2).



Waste accumulates beneath salmon farms, smothering the ocean bottom and choking out life.

Waste organic material can accumulate on the seabed below or near the netcage, as well as be suspended in the water column. By placing sediment traps beneath farms, researchers have shown that, for each square metre of sea bed, 14.7 - 52 kilograms of waste can accumulate beneath the farm, and 4.9 kilogram at the farm's perimeter, each year.

The accumulated waste can smother the organisms and set up anoxic (oxygen depleted) conditions in the seabed sediment. This effect has been measured beneath fish cages and up to 50 metres from them. As the waste decays, oxygen is consumed and other gases released such as methane, hydrogen sulphide and carbon dioxide. Oxygen depletion can also occur in the water column from the decomposition of waste that is suspended instead of being deposited on the seafloor.

The direct decomposition of farm waste is only one way in which oxygen depletion from seawater can occur. A more troubling contribution comes from nutrients such as nitrogen (N) and phosphorous (P) contained in the waste. Nutrient pollution, especially nitrogen, has been identified as a primary cause of degradation in marine waters(5). The extra nutrients from the organic waste stimulate the growth of marine plants and algae, which deplete dissolved oxygen when they die and decompose.

To get a sense of how much nutrient loading comes from salmon farms we can compare it to other man-made sources such as untreated human sewage. The average person excretes 4 kilograms N and 1.1 kilogram P per year. Typically, for every tonne of farmed salmon produced, 55 kilograms of N and 4.8 kilograms of P are excreted into the marine environment. The 49,600 tonnes of farmed salmon produced in BC in 2000 contributed as much nitrogen as the untreated sewage from 682,000 people or as much phosphorous as the sewage from 216,000 people.

Chemical Pollution

The sources of chemical pollution from salmon farms include antibiotics and other drugs, pesticides, feed additives, paints used on netcages and boats to prevent marine growth (antifouling paints), and disinfectants. Many of the chemicals used in aquaculture have been adopted from other industrial sectors and have never been evaluated with respect to their effects on marine ecosystems.

When disease outbreaks call for the use of antibiotics, the drug is administered in the farmed salmon's feed. As a result, the drugs make their way into the marine environment through uneaten feed and excretion by the salmon. The most commonly used antibiotic is oxytetracycline, with 6.4 metric tonnes used on BC salmon farms in 1998(6). At least seven other antibiotics are also used (7). For parasite infestations such as sea lice, a variety of pesticides may be used either by passing the fish through

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a bath containing these chemicals, or by adding it to the feed. A potent pesticide that is added to feed is ivermectin. Once administered, this chemical makes its way into the marine environment where it has been shown to be very toxic.

In addition to the above-mentioned drugs, there can be other additives in the feed such as colouring agents (to make the farmed salmon flesh pink), binders and antioxidant preservatives. There is also an increasing use (limited at the moment) of immunostimulants. These are chemicals that can boost the immune system of fish. There is little or no data on the environmental or human health effects of these feed additives.

The growth of marine organisms on the open netcages is a problem for salmon farmers. To reduce the number of times the nets have to be cleaned, farmers will apply antifouling paints to the nets. The most commonly used paint in B.C. is copper based, where the copper is the active ingredient. The copper can make its way into marine waters by slow leaching of the paint or when the paint is stripped during net cleaning. Another toxic metal that is emitted by salmon farms is zinc. This is because zinc sulphate is added to salmon feed as a way to help the fish avoid contracting cataracts.

In August 2001, the B.C. government released a report on a one year Interim Monitoring Program that was set up to measure some of the pollution around salmon farms (8). They found that 48 per cent of the farms had sediment concentrations of copper and zinc which were above what the government considered "safe". These government "safe" levels are 108 parts-per-million (ppm) of sediment for copper and 271 ppm for zinc. But a look at the scientific literature reveals that the so-called "safe" levels are significantly above the concentrations that have been shown to have toxic effects on marine organisms.

Some examples are:

- Serious damage to a type of shrimp occurred at 0.150 ppm of copper (9).
- The germination of a type of seaweed was prevented at copper concentrations of 0.320 to 0.470 ppm copper and 18ppm zinc (10).
- Sea urchin embryos were killed at 1.4 to 11.4 parts-per-billion copper (depending on exposure time), and 0.327 ppm zinc (11).
- At 0.8 ppm zinc, 23% mortality was observed in a sediment dwelling marine amphipod (12).
- It's been found that zinc and copper can act synergistically, with toxicity increasing when the metal are present together.

Even if the metals do not cause death, there can be sub-lethal effects. Concentrations of .212 ppm copper and .525 ppm zinc have been shown to reduce feeding and oxygen consumption for some crustaceans. The metals inhibit the chemoreceptors of marine animals, affecting food ingestion. They also can affect the nervous system, disrupting prey capture and manipulation (14).

Regulations and Enforcement

The B.C. *Waste Management Act* and the *Aquaculture Waste Control Regulation* allow for the introduction of fish feed and feces into the marine environment. The only stipulation is that if a farm uses more than 630 tonnes of dry feed annually, they must obtain a permit to do so. With respect to any human sewage created by workers on the farm, these laws do specify that this must be discharged below 15 metres sea level and not within 150 metres of commercial or recreational shellfish sources. The salmon sewage has no such restriction however. The regulations also deal with the storage or spillage of any hazardous material, but the introduction of these materials through regular farming activities, such as drugs and pesticides administered through the feed, is not covered. For antifouling paints, the *Waste Management Act* prohibits the release of copper based paints into the ocean as a result of cleaning the netcages (the slower leaching of these paints from the between cleanings isn't covered). The Act also prohibits the bleeding of harvested fish on the farm site, since the decomposition of the bloodwater removes a great deal of oxygen from the water. As we saw above, the lowering of dissolved oxygen by organic waste can have a negative impact on the marine environment.

The BC *Pesticide Control Act* restricts the storage, transport, and possession of a pesticide other than the purpose for which it is sold. It also states that any equipment or container used to premix or apply a pesticide cannot be submerged in a body of water. This of course does not cover the dispersion of a pesticide into marine waters as a result of its inclusion in salmon feed. The problem here is that this Act was developed with land based agriculture in mind and has not been changed to take into account aquaculture operations.

The BC Ministry of Environment Land and Parks recently inspected all of B.C.'s 104 active salmon farms to determine the level of compliance with the above laws. They found that, contrary to the Waste Management Act:

- The majority of the farms were not properly treating or disposing of their human waste.
- Most farms did not properly store many hazardous materials.
- About one third of the farms were bleeding fish on-site.

- All the farms disposed of waste material and waste water (containing antifouling paints) from net cleaning into the ocean.

Despite these many infractions, the B.C. government has chosen not to lay any charges. They have instead taken the approach to work with the companies to try and move towards compliance.

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