David Suzuki Foundation

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Drugs used in the salmon farming industry

A variety of chemicals, including **antibiotics, pesticides and fungicides** are used on salmon farms to treat disease outbreaks. These drugs are often administered to the fish through their feed. Since salmon are mostly raised in open marine netcages, most of the drug, or its metabolic byproducts, end up in the marine environment through uneaten feed or the salmon's excrements (1). The distribution and environmental impact of these chemicals is a cause of great concern.

Antibiotics

The most common antibiotic used is oxytetracycline, with 6.4 metric tonnes used on B.C. salmon farms in 1998 (2). Others include fluorfenicol and a class known as sulfonamides. It has been shown that oxytetracycline is poorly absorbed by the intestinal tract of the salmon (3). Consequently much of the drug is excreted unchanged into the marine environment, where it distributes itself between the sediment and water column, or is ingested by wild sealife (4). Studies show that some antibiotics, including oxytetracycline and fluorfenicol, persist in the environment, and marine sediment acts as a long-term reservoir for them (5).

Not surprisingly, investigators have shown that antibiotics can significantly alter the microbial community found in marine sediment. Not only can the total amount of bacteria be reduced, but also the relative abundance among the different species is altered. Sediment-dwelling bacteria provide a number of key services, in particular the cycling of nutrients such as nitrogen, phosphorous and sulfur. Measurements reveal that antibiotics found in marine sediment near salmon farms lower the conversion rates for sulphates and nitrates.

What consequences may arise from an altered marine microbial community has not been studied. There is also the question of the possible effects of any chemicals produced when the fish metabolically convert the administered antibiotic. For example, when salmon ingest florfenicol, the fish converts some of the antibiotic to florfenicol amine. There are no studies on how this, or other antibiotic metabolites, can affect the natural marine community.

One area that has received a great deal of study, is the increase in antibiotic-resistant bacteria in sediment under fish farms, in farmed salmon, and in wild organisms caught near salmon farms. The implications that this has for human health is covered in some of our other information sheets. With respect to the marine environment, however, it should be mentioned that increases in antibiotic-resistant bacteria leads to increased use of antibiotics on the salmon farm, increasing the environmental risks.

Pesticides

Sea lice infestations often cause problems at salmon farms, and are the primary reason that pesticides are used. The fish are treated with these chemicals in one of two ways. One is by using a tarpaulin to isolate the fish within the netcage and then adding the chemical in the seawater. After 30-60 minutes, the tarpaulin is removed and the solution is released to the marine environment (6). This method is used for pesticides such as cypremethrin , dichlorvos and azamethiphos. Other pesticides, such as ivermectin, are administered within the feed.

The Canadian Pest Management Regulatory Agency has only approved azamethiphos for use against sea lice. Although not approved, the other pesticides are used with the permission of a veterinarian, often with little or no data available on their effects on the marine environment.

Sealice and Ivermectin

In BC, sealice are often treated using ivermectin. A high proportion of the administered chemical is excreted unchanged by the salmon, and accumulates in marine sediment beneath and in the vicinity of the fish farm. It can take 90 - 240 days for just half of the chemical in the sediment to decompose. Recent analysis of sediment under salmon farms has shown levels of ivermectin up to 6.8 milligrams (mg) per kilogram of sediment. This concentration went down with distance from the farm, but in some samples still showed a concentration of 5.4 mg per kg of sediment 35 metres from the netcage. The accumulation of ivermectin was also expressed as amount per unit area. This gave figures of .675 mg per square metre (m-2) for under the cage and .357 mg m-2 for the sample at 35 metres from the netcage.

Ivermectin has the ability to disrupt neurological processes. It also can bind to biological membranes, increasing their permeability to chloride ions (a main component of sea water) (7). It therefore has the potential to be toxic to a wide variety of marine organisms. To date studies have shown the chemical to be very toxic to many species that live in or on the seabed.

Table 1: Studies which show lethal effects of ivermectin on various marine organisms	
Asterias rubens(a starfish)(7)	5 mg/kg
Corophium Íolutator (sediment worm)(7)	0.05 mg/kg</td>
Crangon septemspinosa (a shrimp)(8)	8.5 micrograms per gram of feed shrimp has access to.
Arenicola marina (a marine worm)(9)	0.018mg/kg
8 species of *polychaetes* (a class of marine worms)(10)	8 - 80 mg/ sq. metre depending on species.

Table 1 lists some of the species that have been tested and the concentrations of ivermectin for which the species begins to die off. It can be seen that the concentrations that are lethal to these organisms are in the range of what has been measured under and near salmon farms (see paragraph above).

The lethal effect of ivermectin on the polychaetes is particularly interesting. This large class of marine worms is often a crucial part of many marine food chains. They also are key to the decomposition of accumulated organic matter, such as fish feces and uneaten feed that accumulates under salmon farms. The worms constantly turn over the marine sediment allowing oxygenated water to reach aerobic decomposing bacteria. Without these worms, the marine sediment can become depleted in oxygen and proper decomposition cannot occur.

Two of the other pesticides, cypermethrin and azamethiphos, used on salmon farms have also been shown to have toxic effects on marine organisms. A recent study showed that cypermethrin is lethal to lobster larvae at concentrations of 0.06 to 0.16 micrograms per litre of seawater (11). The same study showed that azamethiphos killed shrimp and adult lobster at concentrations of 50 micrograms per litre of seawater. Sub-lethal concentrations of azamethiphos at 5 and 10 micrograms per litre were also shown to reduce spawning in female lobster.

The use of pesticides on salmon farms results in negative impacts on marine organisms found near the salmon farm. The effect on many more marine organisms needs to be studies, as well as the effects of sub-lethal concentrations, which has received very little attention.

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