Brief Communication Communication brève

Trends in antimicrobial use in Marine Harvest Canada farmed salmon production in British Columbia (2003–2011)

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Abstract — Marine Havest Canada has significantly reduced its antimicrobial usage in salmon farming over the last 8 years. Change has come about largely through improvements in production, health management, and livestock selection. However, antimicrobial treatments are still required for stomatitis and bacterial kidney disease. Lack of efficacious vaccines and the limited number of licensed antimicrobials available to the industry continue to be of concern.

Résumé — Tendances de l'utilisation des antimicrobiens dans la production de saumons d'élevage de Marine Harvest Canada en Colombie-Britannique (2003–2011). Marine Havest Canada a significativement réduit son utilisation d'antimicrobiens dans l'élevage du saumon au cours des 8 dernières années. Le changement s'est produit surtout à l'aide d'améliorations au niveau de la production, de la gestion de la santé et de la sélection des poissons d'élevage. Cependant, les traitements antimicrobiens sont toujours requis pour la stomatite et la maladie rénale bactérienne. L'absence de vaccins efficaces et le nombre limité d'antimicrobiens homologués disponibles dans l'industrie continuent de susciter des préoccupations.

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The use of antimicrobials in food-producing animals has become controversial in light of global concern regarding an increased incidence of multiple antimicrobial resistant bacteria which could potentially be a human health risk (1–4). Assessment of the degree of risk associated with antimicrobial use is complicated by limited data on antimicrobial use across the various agri-food sectors (poultry, pork, beef, dairy, and aquaculture).

Antimicrobial use in salmon farming in British Columbia (BC) differs from use in the other Canadian agri-food sectors in that all treatments are: i) by veterinarian prescription only; ii) for clinical disease (i.e., there are no prophylactic treatments); iii) reported to and monitored by the regulatory authority, currently Fisheries and Ocean Canada (DFO) [prior to December 2010, BC Ministry of Agriculture and Lands (BC MAL) oversaw regulation]; and iv) delivered to food production fish via medicated feed. Additionally, the number of licensed antimicrobials for use in BC farmed salmon is limited to 4 — Aquaflor® (florfenicol) (Merck Animal Health, Summit, New Jersey, USA), Romet-30® (sulfadimethoxine/ormetoprim) (Aquatic Health Resources, Minnetonka, Minnesota, USA), Tribrissen-40 powder® (sulfadiazine/trimethoprim) (Merck Animal Health), and Terramycin Aqua® (oxytetracycline) (Phibro Animal Health, Regina, Saskatchewan) (5).

Starting in 1995, BC MAL began tracking and reporting antimicrobial use by the BC salmon farming industry, and as of December 2010, DFO assumed the collection and reporting responsibilities and will continue to make annual antimicrobial usage information available to the public via their Web site (6). From 1995 through 2009 the industry achieved an 87.5% reduction in antimicrobial use (7). A number of changes and improvements have driven this significant change and fully understanding it requires a look back to the start of the industry, which began during the early 1980's in southern BC's "Sunshine Coast" region. Initially the industry farmed Pacific salmon (Chinook salmon, *Oncorhynchus tshawytscha,* and Coho salmon, *O. kisutch*) but over time, production switched to rearing Atlantic salmon *(Salmo salar)*. During the same period the industry relocated farms away from the Sunshine Coast, an area with warmer water temperatures and a high incidence of harmful plankton blooms to more northerly locations which provided an environment better suited to the salmon. By 2006, over 90% of farmed salmon produced in BC were Atlantic salmon.

Disease concerns between farmed Pacific and Atlantic salmon differ. Farmed Pacific salmon have a much higher occurrence and severity of bacterial kidney disease (BKD) compared to farmed Atlantic salmon (8). Bacterial kidney disease is a slow-developing, chronic disease caused by the Gram-positive

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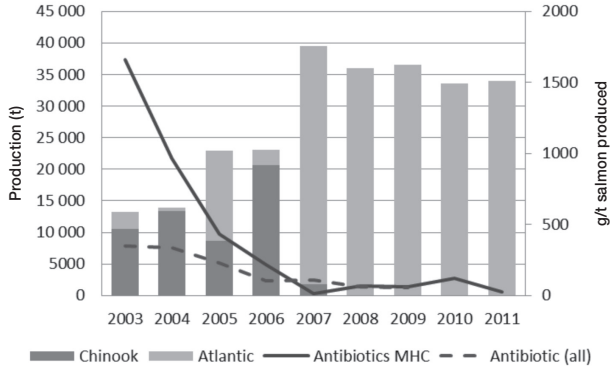

Figure 1. Annual Marine Harvest Canada production (2003–2011) of Chinook and Atlantic salmon [tonnes (t)] and annual use of antibiotics (g/t) salmon produced. Annual antibiotic use by the entire BC salmon farming industry is also shown for (2003–2009) (7).

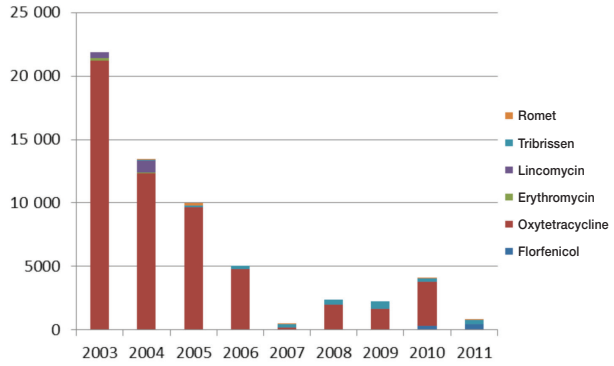

Figure 2. Total volume (kg) of active antimicrobial by year, 2003–2011.

intracellular bacterium *Renibacterium salmoninarum,* and as a consequence, often requires treatment later in the fish life cycle. The current in-feed treatment for BKD is oxytetracycline (OTC) at a dosage of 100 mg OTC/kg fish for 10 to 14 d. The macrolides lincomycin and erythromycin have been tried, but poor treatment efficacy with lincomycin and palatability issues with erythromycin limited their use.

Atlantic salmon, on the other hand, have different disease challenges which are usually experienced early in their saltwater life cycle and are associated with Gram-negative bacteria. The diseases which require antimicrobial treatments are caused by bacteria which are endemic to the Pacific Northwest — furunculosis *(Aeromonas salmonicida),* vibriosis *(Vibrio ordalii, Listonella anguillarum),* enteric redmouth *(Yersinia ruckeri),* and stomatitis *(Tenacibaculum maritimum)*. While 100% vaccination of fish in freshwater and improved vaccine efficacy have reduced the need for treatment to almost zero for furunculosis, vibriosis, and enteric redmouth, stomatitis continues to cause clinical disease in smolts newly entered to saltwater and no commercially produced vaccine is available for this disease. Treatment of disease caused by Gram-negative bacteria has been with one of the following antimicrobials: Romet 30, Tribrissen 40, or Aquaflor. Terramycin Aqua was also used prior to the licensing of Aquaflor in 1997. The therapeutic dosage for the Gram-negative bacterial diseases with florfenicol is significantly lower than that required for BKD (10 mg florfenicol/kg fish for 10 d *versus* 100 mg OTC/kg fish for 10 to 14 d). Bacterial kidney disease does occasionally occur and requires treatment in Atlantic salmon but with a much lower incidence than in Chinook salmon (7). Bacterial kidney disease management in all farmed salmon is focused on: i) preventing vertical transmission through improved broodstock health programs, and ii) preventing horizontal transmission through improved freshwater/saltwater management and biosecurity protocols.

Antimicrobial usage data from other agri-food sectors in Canada (e.g., beef, swine, poultry) is neither tracked nor reported to the public and, even though the BC salmon farming amalgamated data have been easily accessed by the public since 1995, the data are sometimes criticized for its lack of detail. To address this concern, summarized data from Marine Harvest Canada's (MHC) annual antimicrobial use covering the years 2003 through 2011 is presented. Having undergone several mergers in recent years, MHC is currently the largest salmon farming company in BC and has increased its annual harvest volume from 13 000 tonnes (t) in 2003 to 34 000 t in 2011, 48% of all farmed Atlantic salmon in BC. During this same period, there was a move from primarily Chinook salmon production in 2003 to 100% Atlantic salmon production by 2008. Data were taken from in-house prescription files and production databases and were restricted to antimicrobial use in freshwater and saltwater stages of production and exclude broodstock populations.

Figure 1 shows the change in proportion of Chinook and Atlantic salmon harvested annually and the corresponding grams of active antimicrobial used per tonne harvested (g/t). The data show a substantial decrease in antibiotic usage, with the largest drop following the switch from Chinook to Atlantic salmon. In 2003, all of the prescriptions (n = 58) written were for Chinook salmon with 60% (n = 35) of them for grow-out sized fish ($>$ 500 g, $<$ 3.5 kg). In comparison, in 2006 there were half as many prescriptions written (n = 27): 93% (n = 25) were for Atlantic salmon populations, while 2 were for Chinook salmon populations. Of these, over 81% (n = 22) were prescriptions for populations with fish weighing $<$ 500 g; 4 prescriptions were for grow-out sized fish, and one was for harvest sized fish ($>$ 3.5 kg). The reduction in total number of prescriptions and size or age of fish the prescriptions were written for resulted in a reduction in total annual volume of antimicrobials used.

Some of the downward trend may be attributed to the change from antimicrobials requiring higher therapeutic dosage (i.e., OTC) to others with lower therapeutic dosage (i.e., florfenicol) (Figure 2). For example, between 2003 and 2006, OTC accounted for over 90% of the total antimicrobial volume used and this was for treatment of BKD in Chinook salmon. In 2003, there were 47 OTC prescriptions written, all in Chinook salmon for BKD; in 2006, there were 5 OTC prescriptions written for BKD, 2 of which were for Chinook salmon and 3 for Atlantic salmon. The effect of OTC on total volume of antimicrobial can be seen in 2010 when there was a total of 66 prescriptions written, with 5 of them for treatment of BKD. These 5 prescriptions

for OTC accounted for 84% of the total antimicrobial volume used in 2010. In 2011 the total volume of antimicrobial used was further reduced as no OTC was used; florfenicol and the potentiated sulfonamides accounted for 51% and 49% of the total antimicrobial volume, respectively.

Another significant change contributing to the decrease in antimicrobial usage has been the age or size of the fish requiring treatment. For example, the number of prescriptions written for fish populations < 500 g in average weight has changed from 40% in 2003 when predominately Chinook were reared, to 96% in 2011 when only Atlantic salmon were reared. As discussed earlier, Atlantic salmon experience infections more commonly when younger (i.e., < 1 y in saltwater and < 500 g in weight), compared with Chinook salmon. In 2011, 98% of the prescriptions written were for the treatment of stomatitis. Florfenicol and the potentiated sulfonamides are used to treat this disease. As the biomass requiring treatment is smaller, the total volume of antimicrobial required is correspondingly less. The added benefit is that the fish have an extended period before they are ready for harvest (average harvest weight > 5 kg), processing, and human consumption, thus the time post-treatment far exceeds prescribed withdrawal or clearance times.

Health Canada and the World Health Organization (WHO) have developed categorizations for antimicrobials based on their importance for use in human medicine (9,10). Although there are some differences, both have erythromycin in the highest level of importance for human health. Since 2005, MHC has not used erythromycin in their production fish. It is currently only used in broodstock populations to help control vertical transmission of *R. salmoninarum* (a causative agent of BKD). The erythromycin is administered by injection to individual fish in which dosage can be tightly controlled and environmental exposure limited. Even with improved disease screening, rearing conditions, and biosecurity, BKD treatment of broodstock with erythromycin is an important component of the health management plans used by the BC salmon farming industry to manage the vertical transmission of *R. salmoninarum* within the ova (11,12).

Organizations such as the Canadian Veterinarian Medical Association and WHO have developed prudent use guidelines or recommendations for use of antimicrobials in food-producing animals (1,4). Although neither is written specifically for salmon farming, the principles can be and are being applied by MHC. One area in which MHC is unable to comply relates to the recommendation to use narrow spectrum antimicrobials first. This is not possible because of the small number of antimicrobials available to the Canadian salmon farming industry. Currently, almost all antimicrobial use is extra-label, which is not a practice that Health Canada or practicing veterinarians want to see continue. Given the relatively small size of the Canadian aquaculture industry and the diversity of species reared, it is unrealistic to expect that new antimicrobials will be developed or license extensions applied for. Minor Use Minor Species programs are available through Health Canada's Veterinary Drugs Directorate, but to date have not been successful in facilitating drug availability.

Antimicrobial resistance can also develop when only 1 class of antibiotic is available for treatment, as is the current situation for BKD. Other diseases such as stomatitis often require at least 2 treatments and in some cases, as many as 5. The need to re-treat suggests that the antimicrobials available for use may not be the most appropriate, with the result that repeated treatments may select antimicrobial resistant organisms. For example, *Aeromonas salmonicida* antimicrobial resistance was documented in the BC salmon farming industry prior to the adoption of vaccination, improved efficacy of vaccines, and better management (13). At the time, the industry had 2 antimicrobials from which to choose but relied primarily on OTC. The limited number of antimicrobials available to the BC salmon farming industry is an on-going concern as it restricts the veterinarian's ability to follow prudent use guidelines.

The trend for antimicrobial use in BC farmed salmon is good, showing reductions in total usage within Marine Harvest Canada as well as industry wide (Figure 1) (7). However usage of antimicrobials in the BC salmon farming industry is still not as low as in the Norwegian industry (14). There may be a number of reasons for this. The Norwegian industry was able to replace OTC with oxolinic acid and florfenicol for their treatments, both having significantly lower therapeutic dosages than OTC (15). Additionally, the Norwegian salmon farming industry appears to more commonly experience viral diseases which are not treatable with antimicrobials, while in BC, bacterial diseases such as stomatitis and BKD are more common (16). Thus as long as OTC is the only therapeutic option for treatment of BKD in BC, antimicrobial use amounts may never get as low as in Norway (14).

Many significant improvements over the years have helped to reduce Marine Harvest Canada's antimicrobial usage: improved location and environmental conditions on farms; improved vaccine efficacy (oil versus water based intraperitoneal vaccination); improved fish health and better disease screening; as well as health management plans which include biosecurity, freshwater/saltwater husbandry and improved broodstock disease screening. It is hoped that this downward trend in antimicrobial use will continue, but without development of new efficacious vaccines for bacterial pathogens or access to an increased number and classes of antimicrobials, the trend may have plateaued.

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