



Fisheries  
and Oceans

Pêches  
et Océans

## MEMORANDUM NOTE DE SERVICE

To A John Davis  
Iola Price  
Ron Ginetz

From De Don Noakes  
Director  
Pacific Biological Station

Security Classification - Classification de sécurité	
Our file - Notre référence	
Your File - Votre référence	
Date	December 11, 1996

Subject  
Object

### DFO FISH HEALTH SUBMISSION TO EA REVIEW

Attached is a draft of the Fish Health Section of the Department's submission to the Provincial Environmental Assessment Review of Salmon Aquaculture. Mike Kent coordinated the development of this section with assistance from many others in the Fish Health and Parasitology Section. A summary of this section will be included in the Executive Summary which is yet to be prepared.

I would appreciate receiving any comments you may have on this section. I will forward drafts of other sections when available.

  
Don Noakes

attach.

cc: M. Kent (memo only)  
A. Steele

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## FISH HEALTH (DRAFT 10 Dec. 1996)

The Department of Fisheries and Oceans (DFO) has a mandate to protect and promote the health of wild fisheries resources (both truly wild and enhanced stocks), as well as a mandate to promote aquaculture, in the Pacific Region. As part of these mandates, the Department has active fish health programs that deal with the interaction between private aquaculture and wild stocks. Two of the prime concerns are avoidance of the introduction of exotic pathogens with imported stocks and minimizing the amplification, release and transfer of indigenous pathogens between farmed fish and wild fish (Kent 1994).

### I. EXOTIC DISEASES.

Long before the birth and rapid growth of the salmon aquaculture industry in British Columbia, DFO had been intimately involved with programs to avoid introduction of exotic fish pathogens into the region. This has largely been accomplished through two major instruments: first, the Federal Fish Health Protection Regulations (FHPR) (introduced in 1977) and, second and more recently, the Federal-Provincial Policy for the Importation of Atlantic Salmon into British Columbia (established in 1985). The importation policy was developed as a response to the requests from industry for eggs and fish from other geographic regions. The details of these regulations and policies are dealt with in Section \_\_\_\_, and their impact on fish

health in the Pacific Region is reviewed here only in brief.

Under the Federal-Provincial policy only salmonid eggs (i.e., no live fish) may be imported into the Region. Furthermore, eggs must originate from specific disease-free sources in accordance with the policy to prevent the importation of vertically transmitted diseases (i.e, parent to progeny). The eggs and the resulting fry must be held in a quarantine facility, the effluent water of which must be disinfected and released to the ground (see Policy Section for details).

These "eggs only" rules are central to the avoidance of exotic pathogens. For example, the often-quoted introduction of furunculosis into Norway from Scotland with Atlantic salmon occurred with infected fish, not eggs (Johnsen and Jensen 1994). However, there is evidence of transfer of one important pathogen (i.e., the IHN virus) between continents with eggs (Arkush et al. 1989; Yoshimizu 1996). Transmission of the virus with eggs is thought to occur only when eggs are improperly disinfected (Amos et al. 1989; Yoshimizu et al. 1989; Lapatra et al. 1990).

**Egg disinfection.** Egg disinfection is a process designed to kill pathogens present on the surface of fish eggs. The process is ineffective against pathogens located within eggs. However, because only a few fish viruses and bacteria are known to be transmitted intra-ovum, egg disinfection is effective in controlling the egg-mediated spread of fish pathogens. The process is most effective if the disinfectant (usually an iodine

containing compound) is applied to eggs that have been washed to 1) free them of organic matter (such as ovarian fluid and milt) which reduces the effectiveness of the disinfectant and 2) to reduce the pathogen load on the egg surface. Egg disinfection can be carried out before water-hardening (while the eggs are resistant to handling shock) or following incubation in flowing water to the eyed stage (at which stage the eggs again become resistant to handling shock).

Concerns raised about the efficacy of egg disinfection with respect to fish viruses (e.g., IHN and VHS viruses) that are not carried intra-ovum are not warranted. For example, in the face of IHN virus in Alaska, the successful and large-scale sockeye enhancement program owes much of its success to egg disinfection. The studies (Eskildsen et al. 1974; Goldes and Meade 1995) that gave rise to concerns about the efficacy of egg disinfection were carried out with experimentally infected eggs where unrealistically large numbers of virus particles were applied to the eggs (Eskildsen et al. 1974; Goldes and Meade 1995) or where the disinfection times were far too short (Eskildsen et al. 1974). With respect to the first item, the numbers of viral particles to be eliminated by egg disinfection would, in practice, be orders of magnitude lower because of the washing that, ideally, should precede disinfection. In fact, with eyed eggs which are disinfected only after incubation in flowing water for several weeks, the number of virus particles to be eliminated by surface disinfection would be essentially zero! Thus

disinfection at this stage is merely an added precaution. With respect to the second item, it is now well recognized that disinfection times of only 5 minutes are inadequate. Current practices involve disinfection for of eggs for 10 min at 100 ppm iodine.

As with the viruses mentioned above, it is highly unlikely that the bacterium (*A. salmonicida*) causing furunculosis in salmonids would be transmitted with eggs, especially disinfected eggs. The bacterium is not transmitted within the egg, and thus would only be transmitted to progeny when eggs are improperly disinfected. Considerable field experience indicates that this is so. In addition, laboratory tests show that eggs contain a substance that would rapidly kill any cells of the bacterium that occurred intra-ovum (Yousif et al. 1994). Further, attempts to transmit the bacterium with eggs infected by a variety of methods have consistently failed (McCarthy and Roberts 1980; Bullock and Stuckey 1987).

Our policies include a requirement that eggs be properly disinfected before shipment and on arrival in B.C. To further minimize the possibility of disease transfer, eggs from other regions must then be placed in quarantine, as already mentioned, and periodic satisfactory examinations must be undertaken on the resulting fry and fingerlings until the fish are 3 g average or for a minimum of 120 d. The fish may then be released to an isolation facility and must receive another health check prior to transfer to seawater netpens. Under this policy, 11.4 million

### ***The furunculosis model***

Much concern has been registered in B.C. that salmon farming will result in the spread of diseases from farmed salmon to wild salmon (and perhaps non-salmonid fishes). The possibility that this may occur exists because it has apparently happened elsewhere (e.g., with the disease furunculosis in Norway (Johnsen and Jensen 1994)). However, evidence to date of such an occurrence in B.C. is lacking. For example, strains of the pathogen isolated from Pacific salmon (coho and pink salmon) that pass through the area of the affected farms have had antibiotic resistance profiles quite different from those shown by the fish farm strains. It is important to note that resistance can naturally occur in bacteria with no previous exposure to man-made antibiotics

In B.C., the concern that infections on salmon farms might cross over to wild fish was heightened by the difficult-to-control outbreaks of furunculosis that occurred on some B.C. salmon farms a few years ago, by the Norwegian experience with the disease, and by the fact that in attempting to control the furunculosis outbreaks using antibiotics, strains of the causative bacterium (*A. salmonicida*) with multiple antibiotic resistance were favoured on the farms. It is true that large numbers of *A. salmonicida* cells are released into the water during furunculosis outbreaks (McCarthy 1980; Rose et al. 1989; Perez et al. 1996), thus increasing the possibility that fishes that come into contact with infected farms might become infected.

However, it is equally true that survival of the pathogen outside of the fish host is rather limited. All of the available scientific evidence, and there is lots of it, indicates that survival of *A. salmonicida* in water is at best short term, particularly in natural environments which contain other (competing) organisms, and especially in marine situations (Rose et al. 1990; Effendi and Austin 1994). In aquatic environments, the bacterium rapidly loses viability (becomes unculturable), and suspensions of the bacterium in this condition have proved impossible to resuscitate (Morgan et al. 1993) and are non-infective for salmon even when injected (Rose et al. 1989). Indeed, although the bacterium can be detected by serological means in sediments under fish farms affected with furunculosis, it has never been possible to recover the viable organism from fish farm sediments, even using the most up-to-date, selective culture methods (Nese and Enger 1993).

Therefore, likely explanations for the failure of the infection to cross over wild to salmonids include the rapid dilution of the pathogen due to tidal flushing, the rapid killing of the pathogen that occurs in sea water, the timing and duration of the exposure, and by the fact that furunculosis infections in salmonids are not easy to establish by methods other than by injection (Rose et al. 1989). (Note, the same factors would likely also mitigate against the spread of other diseases of farmed salmon to wild fish.)

On a related matter, the possibility also exists that cross

over of furunculosis to non-salmonid fishes might occur. However, the likelihood of this is small. Only the "typical" strains of the bacterium are involved in causing furunculosis in salmonids in B.C., and this form of the bacterium, although capable of infecting non-salmonids under exceptional conditions when these fishes are in very close contact with salmonids undergoing an epizootic, does not persist for long in such fishes under normal circumstances. Thus, infections of non-salmonids in the wild invariably turn out to be due to "atypical" strains of *A. salmonicida* (Wiklund 1995). The literature is becoming increasingly clear about this.

Finally, with the increased use of anti-furunculosis vaccines on salmon farms in B.C., the risks of furunculosis outbreaks occurring has been drastically reduced. The risk to wild fish in B.C. has thus been correspondingly reduced. As vaccines effective against other infectious diseases affecting farmed salmon become available (e.g., IHN), one can expect that the risk to the wild fisheries resources of B.C. posed by salmon farming will continually decrease.

### III. ANTIBIOTICS

Because of the confidentiality that exists about the types and quantities of antimicrobial drugs (henceforth referred to as antibiotics) used in salmon farming in B.C., concerns have been raised by detractors of fish farms that antibiotic use in this