Impacts of the fishery, disease, and contaminants on Baltic salmon (*Salmo salar* L.) in the sea

Lars Karlsson[1], Rickard Bjerselius[2], Marie Aune[2], Per Ola Darnerud[2], Anders Glynn[2], Mats Tysklind[3], and **Ulf-Peter Wichardt[4]**
[1]Institute of Freshwater Research, National Board of Fisheries,
Brobacken, SE-814 94 Älvkarleby, Sweden
[2]Swedish National Food Administration,
P.O.Box 622, SE-751 26 Uppsala, Sweden
[3]Environmental Chemistry, Department of Chemistry,
Umeå University, SE-901 87 Umeå, Sweden
[4]Fish Health Control Program,
SE-814 70 Älvkarleby, Sweden

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Baltic salmon (*Salmo salar* L.) are normally subjected to the environment in the brackish Baltic Sea throughout their marine life, since few migrate into the Atlantic. This paper assesses the impacts of three factors, the fishery, disease and contaminants, on salmon survival during their marine phase in the Baltic. Two factors are strictly anthropogenic, whereas the third factor, prevalence of diseases, is weakly and the link is normally difficult to verify.

The salmon fishery in the Baltic takes place mainly in the offshore area, primarily with drift nets and long lines (Karlsson and Karlström 1994). Catch records and tag recoveries provide an overview of the offshore fishery. A low proportion of river recoveries of tagged salmon from the early 1960s to the early 1990s (Fig. 1), reflecting the high level of fishery exploitation, resulted in the loss of several river populations of salmon, and in severe reductions in the size of many of the populations that survived. The period of intense size-selective drift-net fishing coincided with a decline in spawner weight by age and a lower mean age of spawners (Fig. 2). When exploitation decreased in the early 1990s, salmon weight by age started to increase, indicating resilience to depressed weights; but other factors, such as smolt size, winter temperature, and changes in prey abundance may also have contributed to increased growth at sea.

Fig. 1. Percentage of tagged salmon recovered in rivers. Data are from Swedish tagging records during 1952–1997.

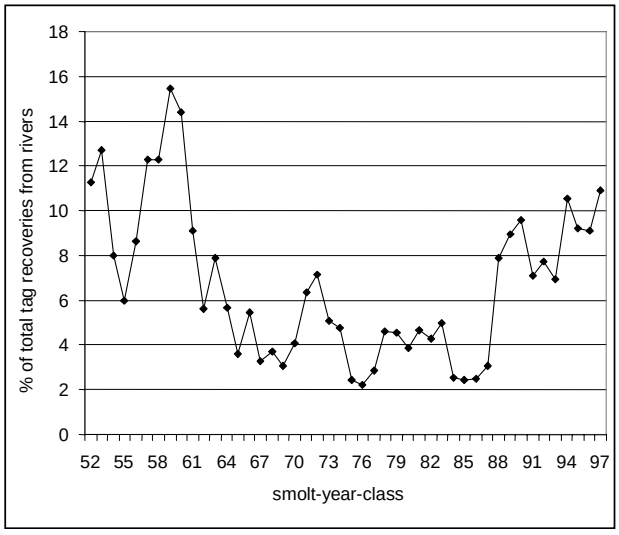
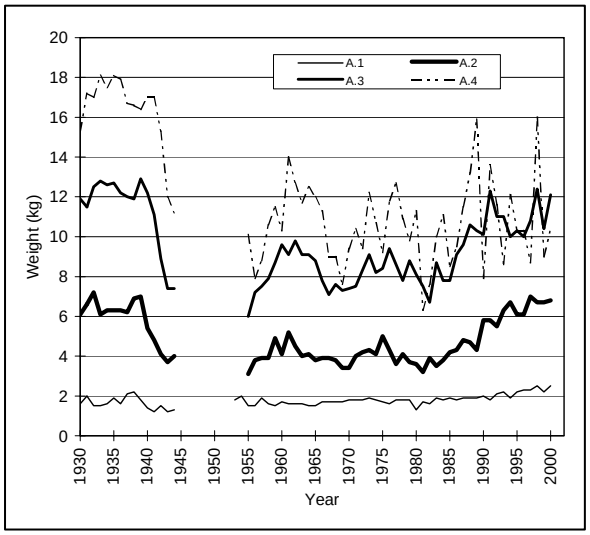


Fig. 2. Annual mean weight of spawners in the northern part of the Baltic, Gulf of Bothnia. Values from 1930-44 are based on catch statistics for the rivers Oulu and Torne. Values from 1952–2001 are based on Swedish tagging records.



All correspondence should be addressed to L. Karlsson.
e-mail: lars.karlsson@fiskeriverket.se

Discussions on salmon diseases during the 1990s focused on the high mortality in many salmon stocks, caused by M74, a syndrome resulting primarily from a low level of vitamin B1 (thiamine). Consequently, little is known about the impact of many other diseases on the marine survival of salmon. Records from sampling in Swedish brood-stock fisheries from 1986 to 2001 indicated the prevalence of viral and bacterial pathogens in salmon (Table 1). However, the presence of only one viral disease, IPN-V was demonstrated. Furunculosis was identified on several occasions during the period, and one case of renibacteriosis was recorded. The sources of infections are believed to be in the marine environment, since the diseases, with the exception of yersiniosis, have not been demonstrated in rivers where brood-stock holding facilities are located.

Table 1. Notifiable diseases demonstrated in sea-run salmon in Swedish brood-stock fisheries during the period 1986–2001. The number of brood-stock holding facilities varied in the range from 8 to 12 and about 1000 fish were examined annually.

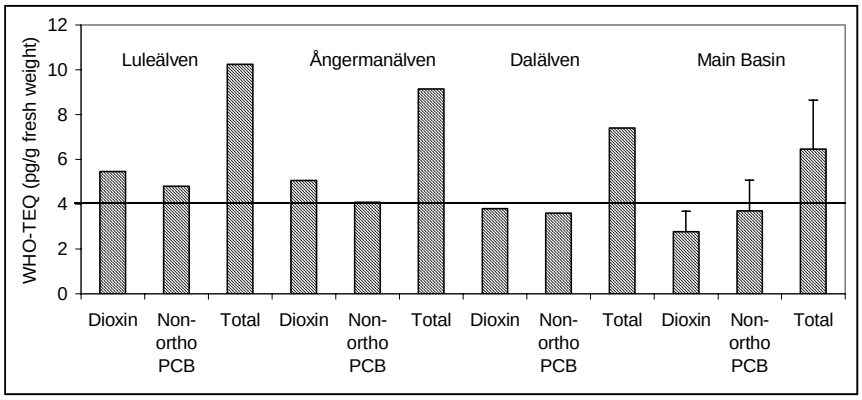
River	Disease (year of detection)
Torneälven	Furunculosis (1986)
Luleälven	Furunculosis (1986) and yersiniosis (2001)
Umeälven	Furunculosis (1990)
Ljusnan	Infectious pancreatic necrosis (IPN-V) serotype Sp (1998), renibacteriosis (1998) and furunculosis (1998)
Dalälven	Infectious pancreatic necrosis (IPN-V) serotype Ab (1992)
Mörrumsån	Furunculosis (1990)

In the same period, the number of cases of IPN-V was low and sporadic in Swedish commercial fish farms along the Baltic coast. However, in recent years, more than 70% of these farms have been infected with BKD and furunculosis. The low rate of infection in salmon brood-stock fisheries may indicate that spreading of pathogens from commercial fish farming activities has been low in areas where salmon migrate. The future development will depend in part on disease regulations as well as industry efforts to control diseases.

Due to increasing human activity and resulting pollution in the Baltic region and elsewhere, persistent contaminants have accumulated (by means of air- and water-mediated transport), which can also affect salmon populations in the Baltic. The restricted water exchange between the Baltic and the North Atlantic has contributed to increased levels of persistent organochlorine compounds in Baltic salmon, compared to levels in neighbouring parts of the North Atlantic. Because the EU has established a maximum level of dioxin for fish and fish products intended for human consumption (4 pg WHO-TEQ/ g fresh weight, Council regulation 2375/2001), there is now a major interest dioxin levels in fish.

The toxicity of dioxins (PCDD/PCDF) to fish and mammals appears to be of the same order of magnitude (Van den Berg et al. 1998). For salmon and Baltic herring (*Clupea harengus*, data not shown), observed levels of dioxin are close to or exceed the threshold (Fig. 3). In addition, several dioxin-like PCBs (non-ortho PCB 77, 81, 126, 169) also have toxic effects, which add to that of the TEQ of dioxin. At the same time, no evidence unequivocally shows that current dioxin levels adversely influence salmon physiology. Monitoring of Baltic biota reveals decreasing concentrations of PCB and DDT from the 1970s (Olsson et al. 2000), whereas from 1988 to 1999, dioxin levels in Baltic herring were constant (Contaminant Research Group, Swedish Museum of Natural History, personal communication). Sweden and Finland currently have an exemption from the Council regulation that allows national marketing of fish that exceed the threshold level for dioxin. In Sweden, the exemption is based on recommendations from the Swedish National Food Administration to certain risk groups (i.e. women and girls of fertile age and high consumers) to restrict their consumption of fatty fish from the Baltic region. Expiration of this exemption on 31 December 2006 will influence the commercial fishery and trade in Baltic salmon.

Fig. 3. WHO-TEQ (pg/g fresh weight) levels of dioxin, non-ortho PCBs (dioxin-like PCB) and the summed levels in salmon in 2000 (Main Basin - 2001). Samples of muscle tissue of salmon spawners (n=10) from three rivers in the northern Baltic, Gulf of Bothnia, are pooled for analysis. Individual analyses are from feeding-salmon (mean and SD, n=10) in the Main Basin. The threshold of 4 pg/g fresh weight is indicated.



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