

DIOXIN LEVELS IN FISH CAUGHT FROM THE BALTIC SEA IN 2001-2002

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Introduction

The Baltic Sea is a semi-enclosed brackish water sea that is surrounded by 9 North European countries. Despite major reductions in the emissions of polychlorinated dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs), and biphenyls (PCBs) during the past decades, high levels of these persistent pollutants have still been measured in sediments and fish^{1,2}. In July 2002, a new regulation of the European Commission (EC) came into force, setting a maximum limit of 4 pg WHO-TEQ/g fresh weight (f.w.) for the muscle meat of fish which is intended for human consumption³. PCDD/F levels that exceeded the maximum limit had been analyzed in Baltic herring, and thus, it became prohibited to sell herring within the European Union. The domestic markets in Finland and Sweden received a contemporary exemption from the regulation, however, it was required that the levels of PCDD/Fs and dioxin-like PCBs in fish will be monitored.

It is expected that fatty fish such as Baltic herring and salmon accumulate PCDD/Fs most efficiently, and thus, previous surveys have been focused on these species^{2,4}. However, there are several other commercially important, fat and lean fish species in the Baltic Sea as well. An extensive survey was undertaken to analyze the levels of PCDD/Fs and PCBs in various marine and fresh water fishes that were collected in 2001 and 2002. This paper presents the PCDD/F levels in fish that had been collected from different locations in the Baltic Sea.

Methods and Materials

Fish were caught by recruited professional fishermen from the Bothnian Bay, Bothnian Sea, Archipelago Sea, 2 sampling areas in the Gulf of Finland, and southern Baltic Proper (Figure 1), and trained personnel preserved the sample fish and delivered them to the laboratory. The investigated species were Baltic herring (*Clupea harengus*), sprat (*Sprattus sprattus*), salmon (*Salmo salar*), perch (*Perca fluviatilis*), flounder (*Platichthys flesus*), pike (*Esox lucius*), pike-perch (*Stizostedion lucioperca*), burbot (*Lota lota*), and whitefish (*Coregonus lavaretus*). The weights, lengths, and ages of the fish based on otoliths, scales or bones were determined, and the samples were transported frozen to the laboratory.

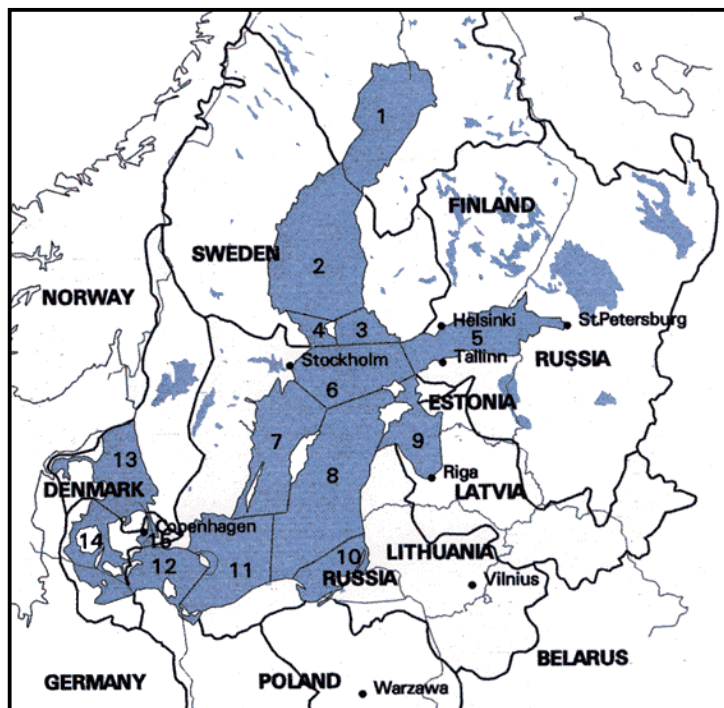


Figure 1: Fish Sampling Locations: 1 = Bothnian Bay, 2 = Bothnian Sea, 3 = Archipelago Sea, 5 = Gulf of Finland, 11 = Southern Baltic Proper (Bornholm Basin)

Pooled samples of small fish species were formed by homogenizing 10-15 individual fishes with their heads and guts removed. Large fish species were filleted, and fillet slices (with skin) of 3 individuals were pooled.

The samples were freeze-dried, and extracted with toluene in a Soxhlet apparatus. The lipid percent was determined gravimetrically from the extract. Then the extracts were purified and fractionated by eluting them through 4 different columns. PCDD/Fs were analyzed from concentrated samples by high-resolution mass-spectrometer (HRGC/HRMS). The analytical procedure has been previously described in more detail⁵.

Results and Discussion

There was an increasing trend in the PCDD/F concentrations in Baltic herring with age, although the variation among individuals was relatively large (Figure 2). The correlation coefficient R^2 with a 2nd order polynomial regression curve ($y = -6.18 + 2.93x - 0.07x^2$) was 0.68. The correlation equation predicts that a 4-year-old herring would contain approximately 4.4 pg WHO-TEQ/g f.w. of PCDD/Fs, and the increase in concentration would be almost linear until about 11 years. Previously, a rule of thumb was created based on the concentrations measured in Baltic herring that was caught from the Gulf of Finland. The rule, according to a linear correlation, suggested

that the PCDD/F levels in 4-year-old herring would be approximately 4 pg WHO-TEQ/g f.w.². Hence, younger herring would not exceed the EC maximum limit.

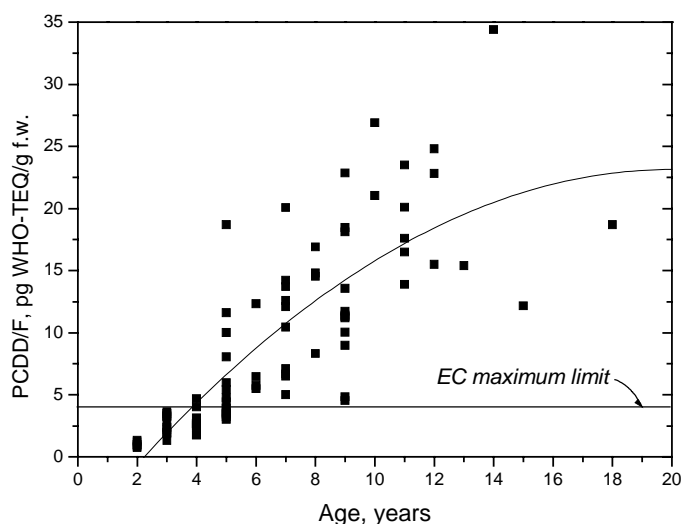


Figure 2: PCDD/F Concentrations in Baltic Herring Individuals

Next, PCDD/F levels in several fish species caught from the Baltic Sea were investigated in pooled samples in which the average age of the fish ranged from 3 to 5 years. The data set comprised 31 pools collected from different locations.

Only the salmon samples caught from the northern Baltic Sea contained PCDD/F levels that exceeded the EC's maximum permissible limit (Figure 3). The average level in herring, 2.6 pg WHO-TEQ/g f.w. was lower than predicted. This was probably due to the different sampling areas which were included in the pooled samples, and the average age in the pools, which was < 4 years.

The high levels of PCDD/Fs in salmon were associated with a high lipid content, an average of 15% in the salmon caught from the northern Baltic Sea. Pearson's correlation coefficient between the PCDD/F concentration (ln-transformed data) and lipid percent in the 31 fish pools was 0.68. Lipid content also explained some of the regional variability: the significantly lower contaminant levels in the salmon and herring collected from the southern Baltic Proper as compared to the northern stocks were, in part, due to the lower lipid contents in the south. However, there were also species specific factors affecting the PCDD/F levels, which can be noted from the Figure 3 where the fish species have been arranged in the order of decreasing lipid percent from the left to the right.

It can be concluded that the PCDD/F levels in most of the fish species remain below the maximum permissible limits, especially if young fish, 3-5 years old or younger, are preferred. Neither the age nor the lipid content of the fish alone were sufficient predictors of the PCDD/F concentrations in the investigated fish.

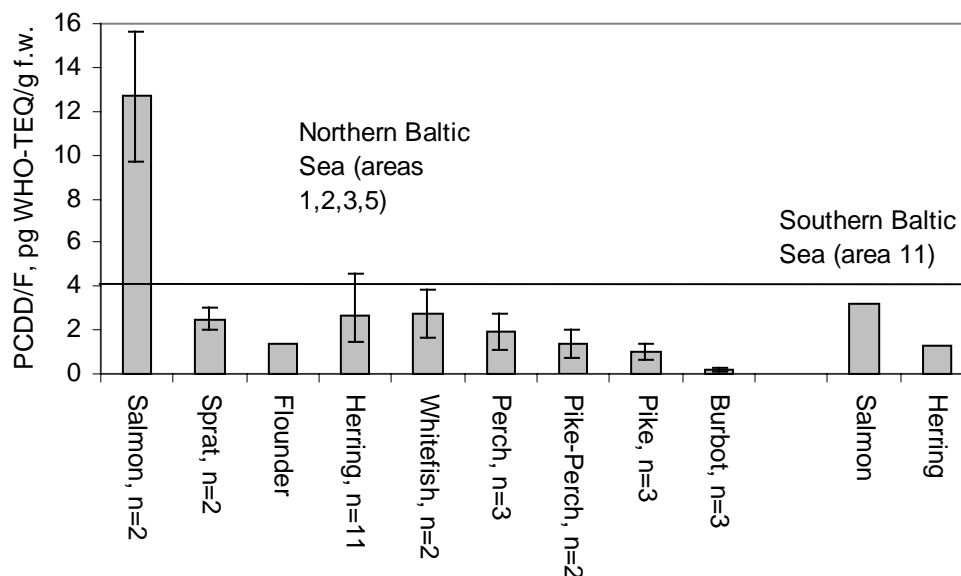


Figure 3: PCDD/F Concentrations in Different Fish Species (age 3-5 years) Arranged in the Order of Decreasing Lipid Percent

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