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Temperature duration frequency analysis on the St. Lawrence River (Canada) – a tool for quantifying adverse conditions during the 2001 massive fish kill

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In 2001, the most important fish kill of the St. Lawrence River history occurred in summer 2001. More than 25 000 carps (Cypririus carpio) were found dead within a six weeks period. The analyses performed on dead body have shown that the death was ultimately caused by bacterial infections with Aeromonas hydrophila and Flavobacterium sp. These bacteria are not normally sufficiently strong to affect healthy fishes; they had to be already affected by other stress factors that will lead them to be immunosuppressant. In this case, it seems that the immunosupression was physically (i.e., spawning) and environmentally (i.e., high temperatures and low water levels) induced.
The objective of this study was to confirm the likelihood of environmental stress using hydrometeorological information and methods based on the analysis of extremes. Frequency analyses were performed on air and water temperature as well as water levels. Quantiles were calculated on seasonal maxima of different durations. Results show that water temperature were abnormal for this period of the year, with return period reaching 47 years for some durations. Early in May, water temperatures as high as 340C were recorded in some shallow water areas, which is quite sufficient to stress fishes. Low water levels can explain the rapid heating of water. Return periods for water levels exceeded 13 years, with a maximum of 67 years. Other frequencies analyses performed on air temperature series reveal return period of 22 years in this variable. The results of the frequency analyses highlight the abnormal hydroclimatic conditions of summer 2001. The massive fish kill of 2001 could have been triggered by these abnormal conditions that were concomitant with the spawning period; which is known to be critical for most species. This also shows the importance of water temperature for the aquatic ecosystems and the need for the development of modeling approaches such as 2D hydrodynamic models for studying all the characteristics of the ecosystem linked with the water temperature, including thermal refuge.