

This Week's Citation Classic

CC/NUMBER 24
JUNE 13, 1983

Brungs W A. Effects of residual chlorine on aquatic life.

J. Water Pollut. Contr. Fed. 45:2180-93, 1973.

[National Water Quality Laboratory, Environmental Protection Agency,
Duluth, MN]

A critical review of the literature on the effects of total residual chlorine on aquatic life is presented with a summary of its uses for wastewater disinfection and antifouling of cooling water systems. Interpretative conclusions are made and recommendations are presented for concentrations to protect freshwater aquatic life from adverse effects of these uses. [The SCI® indicates that this paper has been cited in over 150 publications since 1973, making it the most-cited paper ever published in this journal.]

William A. Brungs
Environmental Research Laboratory
US Environmental Protection Agency
Narragansett, RI 02882

March 31, 1983

"The most interesting aspect of this publication is that I did not initiate the effort because of self-motivation. As part of a federal regulatory agency, the US Environmental Protection Agency (EPA), I was asked by the regional administrator in Chicago to review the data on the effects of total residual chlorine on aquatic life because investigators in Michigan had documented adverse environmental effects in streams below wastewater treatment plants. This review was conducted when I was a staff member at the EPA Laboratory in Duluth, Minnesota, which has responsibility for research on the effects of pollution on freshwater aquatic life.

"As I became more involved in reviewing the literature, my interest became very intense since the subject was complex and fascinating. I became almost obsessed with finding every piece of information, necessitating innumerable personal contacts to obtain unpublished data and so-called 'grey literature.' I was continually amazed at the level of developing concern about the effects of chlorine. For several years before this study, I had read many reviews on similar subjects and was im-

pressed by the fact that most did little more than present observations and data. A critical review that evaluated test methods, authors' interpretations, data validity, etc., seemed necessary, though rarely done by others. No secondary citations were acceptable, only original presentations of data were used. In addition, a useful review needed to be interpretative, analytical, conclusive, and provide guidance to those who had a need for this synthesis.

"Another eventual interesting aspect was that, after publication, I was invited by the Water Pollution Control Federation, which had published the initial review, to present an updated review at its annual meeting in Miami. I continued the review, under the same conditions, to include two to three more years of data. After presentation, I submitted it for publication and it was rejected. To say the least, I was depressed and confused at this apparent inconsistency. Subsequently, it was published,¹ but that was anticlimactic.

"Since publication of the second review, I have been intimately involved in a series of biannual conferences on the environmental impact and health effects of water chlorination. The proceedings of the fourth conference are in print.^{2,3} Most recently, I have finished an aquatic life criterion document⁴ for freshwater and saltwater aquatic life with the assistance of Douglas Middaugh at the EPA Laboratory in Gulf Breeze, Florida. After 11 years of the continuing review, I'm afraid it may never end, but, I guess, the need for such critical reviews is always present.

"The main reason for this publication having been highly cited is that it was the first critical, comprehensive review for residual chlorine and it became available just as the EPA and environmental awareness was in a fantastic growth curve. In addition, standards and regulations were being developed for numerous chemicals and industries, among which wastewater treatment plants and power generating stations were high on the list and guidance on the environmental effects of chlorination was in perfect timing with the need.

"One last interesting fact is that I was coauthor on an earlier publication⁵ that also was a *Citation Classic*. My role in that was relatively small, so I am exceedingly pleased with this recognition."

1. Brungs W A. *Effects of wastewater and cooling water chlorination in aquatic life*. Springfield, VA: National Technical Information Service, 1976. 46 p. EPA Report No. 600/3-76-098.
2. Jolley R L, Brungs W A, Cotruvo J A, Cumming R B, Mattice J S & Jacobs V A, eds. *Water chlorination: environmental impact and health effects. Vol. 4. Book 1. Chemistry and water treatment*. Ann Arbor, MI: Ann Arbor Science Publishers, 1983. 788 p.
3., *Water chlorination: environmental impact and health effects. Vol. 4. Book 2. Environment, health, and risk*. Ann Arbor, MI: Ann Arbor Science Publishers, 1983. 699 p.
4. Brungs W A & Middaugh D P. *Aquatic life criterion document for total residual chlorine*. Unpublished paper, 1982. 54 p.
5. Mount D I & Brungs W A. A simplified dosing apparatus for fish toxicology studies. *Water Res.* 1:21-9, 1967. [Citation Classic. *Current Contents/Agriculture, Biology & Environmental Sciences* 12(24):16, 15 June 1981.]