

Unreliability of SWRCB's Use of "NAS Criteria" to Evaluate Pesticides Impacts on Aquatic Life¹

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The SWRCB staff, as part of the Toxic Substances Monitoring Program (TSMP), NAS Criteria has been using what they call "NAS" criteria for evaluating excessive fish tissue concentrations. These values are numeric concentrations that were suggested by the National Academy of Science (NAS) and the National Academy of Engineering (NAE) in their 1972 Blue Book of water quality criteria (NAS/NAE, 1973). These values are presented in Table 1.

The NAS/NAE (1973), as part of discussing the development of these values, stated:

"Present knowledge is not yet sufficient to predict or estimate safe concentrations of these compounds in aquatic systems. However, residue concentrations in aquatic organisms provide a measure of environmental contamination. Therefore, specific maximum tissue concentrations have been recommended as a guideline for water quality control.

For the protection of predators, the following values are suggested for residues in whole fish (wet weight): DDT (including DDD and DDE) – 1.0 mg/kg; aldrin, dieldrin, endrin, heptachlor (including heptachlor epoxide), chlordane, lindane, benzene hexachloride, toxaphene, and endosulfan – 0.1 mg/kg, either singly or in combination.

Aquatic life should be protected where the maximum concentration of total PCB in unfiltered water does not exceed 0.002 µg/L at any time or place, and the residues in the general body tissues of any aquatic organism do not exceed 0.5 µg/g."

The senior author of this report (G. Fred Lee) was an invited peer reviewer to the NAS/NAE for the "Blue Book" water quality criteria. He is, therefore, familiar with how these criteria were developed and the considerable uncertainty associated with critical tissue residue levels for protection of aquatic life in higher-trophic-level organisms. Upon learning that the SWRCB and the Regional Boards were using these values in evaluating excessive bioaccumulation of chemicals in fish tissue, he contacted the Chair

¹ Excerpt and adapted from, Lee, G. F. and Jones-Lee, A., "Organochlorine Pesticide, PCB and Dioxin/Furan Excessive Bioaccumulation Management Guidance," California Water Institute Report TP 02-06 to the California Water Resources Control Board/Central Valley Regional Water Quality Control Board, 170 pp, California State University Fresno, Fresno, CA, December (2002).

<http://www.gfredlee.com/OCITMDLRpt12-11-02.pdf>

Table 1
Recommended Maximum Concentrations of Organochlorine Pesticides in
Whole (Unfiltered) Water, Sampled at Any Time and Any Place

Organochlorine Pesticides	Recommended Maximum Concentration (µg/L)	Suggested Values for Tissue Residues (mg/kg), wet weight
Aldrin	0.01	0.1
DDT	0.002	1
TDE	0.006	
Dieldrin	0.005	0.1
Chlordane	0.04	0.1
Endosulfan	0.003	0.1
Endrin	0.002	0.1
Heptachlor	0.01	0.1
Lindane	0.02	0.1
Methoxychlor	0.005	
Toxaphene	0.01	0.1
PCBs	0.002	0.5

Source: NAS/NAE (1973)

of the Blue Book water quality criteria committee (Carlos Fetterolf), the National Academy of Sciences, the US EPA, and others to obtain their assessment of the reliability of the suggested critical tissue residues presented in the Blue Book (which were largely based on 1960s information) as appropriate for use today to judge excessive concentrations of bioaccumulatable chemicals in aquatic life.

The chairman of the NAS/NAE (1973) Blue Book Criteria Committee (Fetterolf, pers comm., 1996), who was also former chief biologist for the state of Michigan water pollution control program and former executive secretary of the Great Lakes Fisheries Commission, indicated that it is inappropriate to use the 1972 “NAS” Blue Book values as being reliable today for estimating excessive concentrations of chemicals in aquatic life tissue. The US EPA, any state other than California, and the National Academy of Sciences do not recognize the “NAS” values used by the SWRCB and the Regional Boards as reliable screening values for determining excessive concentrations of chemicals in aquatic organism tissue.

The National Academy of Sciences Committee on Evaluation of the Safety of Fishery Products, Food and Nutrition Board, Institute of Medicine, staff member F. Ahmed was contacted regarding whether the NAS recognized the NAS/NAE Blue Book of fish tissue guidelines. While the NAS has published a book on Seafood Safety (Ahmed, 1991), Ahmed did not know that the 1972 Blue Book so-called “guidelines” existed, and indicated that they are not recognized by the NAS as being reliable today.

A comparison between the late 1960/early 1970 state of information on the critical concentrations of OCl to cause aquatic life toxicity, as shown in Table 1, and the US EPA (2000) CTR criteria, (Table 2) shows that there have been significant changes in

a number of these values. This is to be expected, based on the large amount of work that has been done since the late 1960s in relating the concentrations of chemicals to their effects on aquatic life. Ankley (pers. comm., 2002), of the US EPA National Health and Environmental Effects Research Laboratory Mid-Continent Ecology Division, Duluth, MN, has commented that, “*The fact that the values are the same (0.1 mg/kg) for whole host of OCs with differing mechanisms of action should be a tip off as to how reliable they may be.*” Dr. Ankley is an internationally recognized expert on aquatic organism health effects of tissue residues.

Table 2
Freshwater Column Target Values for Organochlorine Compounds

Constituent	Freshwater		Human Health (10 ⁻⁶ risk for carcinogens) For consumption of:	
	CMC (acute) (µg/L)	CCC (chronic) (µg/L)	Water & Organisms (µg/L)	Organisms Only (µg/L)
Aldrin	3	--	0.00013	0.00014
Chlordane	2.4	0.0043	0.00057	0.00059
DDT*	1.1	0.001	0.00059	0.00059
Dieldrin	0.24	0.056	0.00014	0.00014
Endosulfan	0.22	0.056	110	240
Endrin	0.086	0.036	0.76	0.81
Heptachlor	0.52	0.0038	0.00021	0.00021
Heptachlor Epoxide	0.52	0.0038	0.00010	0.00011
Hexachlorocyclohexane (including lindane), gamma-BHC	0.95	--	0.019	0.063
PCBs	--	0.014	0.00017	0.00017
Toxaphene	0.73	0.0002	0.00073	0.00075
Dioxins/Furans	--	--	0.000000013	0.000000014

Source: US EPA (2000)

-- no value provided

Criteria are based on carcinogenicity of 10⁻⁶ risk.

* DDT value cited for 4,4' DDT, but value will apply to one isomer or sum of all isomers detected.

As part of developing regulatory approaches for disposal of contaminated dredged sediments, the US Army Corps of Engineers (US ACOE, 1997) developed “The Environmental Residue-Effects Database (ERED).” This database is a compilation of information on the concentrations of chemicals in aquatic organism tissue and their apparent effects on aquatic life. The ERED is available electronically from <http://ered1.wes.army.mil/ered/index.cfm>. It was last updated June 2001. It now contains 3,463 results of 736 studies on 188 species for 222 analytes.

The issue of critical concentrations of bioaccumulatable chemicals in aquatic life tissue is one that has been addressed by the US EPA. Jarvinen and Ankley (1999) have published a review, Linkage of Effects to Tissue Residues: Development of a

Comprehensive Database for Aquatic Organisms Exposed to Inorganic and Organic Chemicals. This publication presents a comprehensive, critically-reviewed, literature-based assessment of the concentrations of chemicals found in aquatic organisms relative to observed effects on the organisms. The Jarvinen and Ankley (1999) database has well over 3,000 entries for 200 chemicals, and is based on 500 references. The organochlorine pesticide database includes 15 organochlorine pesticides, with 473 endpoints and 91 references, representing 68 aquatic species, 46 of which were freshwater.

The Jarvinen and Ankley toxicity/residue database as published by SETAC press is available in an Access database format at the web site http://www.epa.gov/med/databases/tox_residue.htm. Examination of Appendix B shows that there is a wide range of values of DDT concentrations in fish and other aquatic life that have been found to be adverse to the host organism. A comparison between the information presented in Appendix B for DDT residue concentrations relative to effects on aquatic life and the “NAS” guideline value presented in Table 1 shows that there are concentrations well above the guideline value that have been found to not be adverse to aquatic life. There are also situations where concentrations below the “NAS” value were adverse. The conclusion is that the “NAS” values are not reliable values for evaluating the potential impacts of OCIs on aquatic life that host the OCI residue, or higher-trophic-level organisms that use the residue host as food.

References

- Jarvinen, A. W. and Ankley, G. T. 1999. Linkage of Effects to Tissue Residues: Development of a Comprehensive Database for Aquatic Organisms Exposed to Inorganic and Organic Chemicals. Society for Environmental Toxicology and Chemistry. SETAC Press: Pensacola, FL.
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