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AMBIENT AQUATIC LIFE WATER QUALITY CRITERIA FOR 2,4,5-TRICHLOROPHENOL

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NOTICES

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FOREWORD

Section 304(a)(1) of the Clean Water Act requires the Administrator of the Environmental Protection Agency to publish water quality criteria that accurately reflect the latest scientific knowledge on the kind and extent of all identifiable effects on health and welfare that might be expected from the presence of pollutants in any body of water. Pursuant to that end, this document proposes water quality criteria for the protection of aquatic life. These criteria do not involve consideration of effects on human health.

This document is a draft, distributed for public review and comment. After considering all public comments and making any needed changes, EPA will issue the criteria in final form, at which time they will replace any previously published EPA aquatic life criteria for the same pollutant.

The term "water quality criteria" is used in two sections of the Clean Water Act, section 304(a)(1) and section 303(c)(2). In section 304, the term represents a non-regulatory, scientific assessment of effects. Criteria presented in this document are such scientific assessments. If water quality criteria associated with specific stream uses are adopted by a State as water quality standards under section 303, then they become maximum acceptable pollutant concentrations that can be used to derive enforceable permit limits for discharges to such waters.

Water quality criteria adopted in State water quality standards could have the same numerical values as criteria developed under section 304. However, in many situations States might want to adjust water quality criteria developed under section 304 to reflect local environmental conditions before incorporation into water quality standards. Guidance is available from EPA to assist States in the modification of section 304(a)(1) criteria, and in the development of water quality standards. It is not until their adoption as part of State water quality standards that the criteria become regulatory.

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Introduction

2,4,5-Trichlorophenol (2,4,5-TCP) is a crystalline solid at room temperature. It is soluble in water up to 2,000 mg/L, has an ionization constant (pKa) of 7.0 to 7.4 (Ahlborg and Thunberg 1980; Doedens 1964; U.S. EPA 1980), and a log n-octanol/water partition coefficient of 3.70 (Hansch and Leo 1979). 2,4,5-TCP is used as an algicide, fungicide, and bactericide and as an antimildew and preservation agent in cooling towers, pulp mills, and in hide and leather processing (Ahlborg and Thunberg 1980; U.S. EPA 1980). It is also used in the production of the pesticides erbon, fenchlorphos, fenoprop (2,4,5-TP), hexachlorophene, and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) (Ahlborg and Thunberg 1980; Buikema et al. 1979; Doedens 1964; Kozak et al. 1979; Stolzenburg and Sullivan 1984).

Contamination of waters with 2,4,5-TCP and other chlorophenols has resulted from the use of chlorophenoxyacetic acid herbicides containing chlorophenolic impurities, from the chlorination of waste treatment plant effluents, and from pulp bleaching (Ahlborg and Thunberg 1980; Buikema et al. 1979; Jolley et al. 1976; Rockwell and Larsen 1978). Residues have been detected in fish and other organisms collected downstream from pulp mills (Paasivirta et al. 1985). Considerable concern has been expressed that 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) can be an impurity in 2,4,5-TCP (Anonymous 1976; Firestone et al. 1972).

At very low concentrations, some phenolic compounds impair the odor and/or taste of water and fish. 2,4,5-TCP has a taste threshold concentration in water of 1 μg/L and an odor threshold concentration of 200 μg/L (Dietz and Traud 1978). However, Shumway and Palensky (1973) did not observe flavor impairment in rainbow trout exposed to 320 μg/L for 48 hr.

An understanding of the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses"

(Stephan et al. 1985), hereinafter referred to as the Guidelines, and the response to public comment (U.S. EPA 1985a) is necessary in order to understand the following text, tables, and calculations. Results of such intermediate calculations as recalculated LC50s and Species Mean Acute Values are given to four significant figures to prevent round off error in subsequent calculations, not to reflect the precision of the value. The criteria presented herein supersede the aquatic life information in a previous criteria document (U.S. EPA 1980) because these criteria are based on additional information. The latest literature search for information for this document was conducted in July, 1986; some more recent information was included. Data that are in the files of the U.S. EPA's Office of Pesticide Programs concerning the effects of 2,4,5-TCP on aquatic life and its uses have not been evaluated for possible use in the derivation of aquatic life criteria.

Acute Toxicity to Aquatic Animals

Data that can be used, according to the Guidelines, in the derivation of Final Acute Values for 2,4,5-TCP are presented in Table 1. The rainbow trout, *Salmo gairdneri*, was the most sensitive freshwater species with a 96-hr LC50 of 260 μg/L. The cladoceran, *Daphnia magna*, was the most resistant species, with a 48 hr EC50 of 2,660 μg/L. The range of acute values for fish was from 260 μg/L in the trout to 3,060 μg/L in the guppy, *Poecilia reticulata*. A similar range for invertebrates extended from 336 μg/L in the amphipod, *Gammarus pseudolimnaeus* to 2,660 μg/L in *Daphnia*.

The effect of pH on the acute toxicity of 2,4,5-TCP was examined with the guppy, *Poecilia reticulata* (Saarikoski and Viluksela 1981,1982; Salkinoja-Salonen et al. 1981). The 96-hr LC50s at pH = 6, 7, and 8 were 990, 1,240, and 3,060 μg/L, respectively. The freshwater criterion was not made pH-dependent because data are available for only one species.

Freshwater Species Mean Acute Values (Table 1) were determined from the available acute values. Genus Mean Acute Values (Table 3) were the same as the Species Mean Acute Values. Of the ten freshwater genera for which mean acute values are available, the most sensitive genus, Salmo, is about 10 times more sensitive than the most resistant, Daphnia. The freshwater Final Acute Value for 2,4,5-TCP was calculated to be 199.2 μg/L using the procedure described in the Guidelines and the Genus Mean Acute Values in Table 3. The Final Acute Value is lower than the lowest available Species Mean Acute Value.

The stock of 2,4,5-TCP that was used in freshwater acute tests reported by Sabourin et al. (1986) and Spehar (1986) was found to contain 14.2 ng/g of the contaminant, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) (Durhan 1986). This resulted in estimated 2,3,7,8-TCDD concentrations in the exposure water as high as 115 pg/L (Table 1). It is not known if 2,3,7,8-TCDD concentrations of 115 pg/L or less had an effect upon the observed toxicity. Concentrations of 2,3,7,8-TCDD were not determined in the other freshwater acute tests.

Tests of the acute toxicity of 2,4,5-TCP to resident North American saltwater animals have been performed with six species of invertebrates and five species of fish (Table 1). The range of acute values for invertebrates extends from 492 μg/L for the amphipod, Rhepoxynius abronius (Battelle Ocean Sciences 1987) to 3,830 μg/L for adult mysids, Mysidopsis bahia (U.S. EPA 1978). The range of acute values for saltwater fish is narrower, from 566 μg/L for both juvenile English sole, Parophys vetulus, and adult Pacific sand lance, Ammodytes hexapterus (Battelle Ocean Sciences 1987) to

1,660 μg/L for both juvenile sheepshead minnows, Cyprinodon variegatus (Heitmuller et al. 1981) and juvenile inland silversides, Menidia beryllina (Hughes and Pruell 1987).

The 24- and 96-hr LC50s differed little with both mysids and sheepshead minnows (Heitmuller et al. 1981; U.S. EPA 1978). In contrast, mortalities continued throughout acute tests with polychaete worms, archiannelids, and inland silversides (Battelle Ocean Sciences 1987). Rao et al. (1981) found that 2,4,5-TCP was about twice as toxic to molting grass shrimp as it was to intermolt shrimp. The effect of environmental factors such as salinity and temperature on the acute toxicity of 2,4,5-TCP to saltwater animals is not known.

Of the ten genera for which saltwater Genus Mean Acute Values are available (Table 3), the most sensitive genus, Rhepoxynius, is about 7.8 times more sensitive than the most resistant, Mysidopsis. The six most sensitive genera are within a factor of 1.8 and include four invertebrates and two fishes. The saltwater Final Acute Value for 2,4,5-TCP was calculated to be 472.9 μg/L, which is lower than the mean acute value for the most sensitive tested saltwater species.

Chronic Toxicity to Aquatic Animals

The available data that are useable according to the Guidelines concerning the chronic toxicity of 2,4,5-TCP are presented in Table 2. In a seven-day life-cycle test with Ceriodaphnia dubia, all organisms died at a concentration of 1,480 μg/L (Spehar 1986). A concentration of 746 μg/L did not cause mortality, but significantly reduced production of young. A concentration of 375 μg/L affected neither survival nor reproduction. The resulting chronic value was 528.9 μg/L and the acute-chronic ratio was 3.294 (Table 2).

In a 90-day early life-stage test with rainbow trout (Spehar 1986), a concentration of 441 μg/L caused 100% mortality of swim-up larvae. A concentration of 208 μg/L did not affect hatchability or swim-up larvae, but significantly ($P \leq 0.05$) decreased survival of juveniles. No adverse effects were observed at 108 μg/L or below. The chronic value and acute-chronic ratio were 149.9 μg/L and 1.734, respectively (Table 2).

Fathead minnows, Pimephales promelas, exposed to 160 μg/L were not adversely affected in an early life-stage test (Spehar 1986). Reduced growth and approximately 50% mortality occurred at 342 μg/L. Complete mortality was observed at 673 and 1,322 μg/L. The chronic value was 233.9 μg/L and the acute-chronic ratio was 5.421 (Table 2).

The stock 2,4,5-TCP that was used in the freshwater chronic tests reported by Spehar (1986) contained up to 14.2 ng/g of 2,3,7,8-TCDD (Durhan 1986). This resulted in estimated maximum 2,3,7,8-TCDD concentrations in the exposure water of 40.9 pg/L in the Ceriodaphnia test, 6.3 pg/L in the rainbow trout test, and 18.8 pg/L in the fathead minnow test. It is not known at present if 2,3,7,8-TCDD at these concentrations had any effect upon the observed toxicity.

The chronic toxicity of 2,4,5-TCP has been measured in salt water with the inland silverside, Menidia beryllina (Hughes and Pruell 1987). In this early life-stage test, 86% of the embryos exposed to 104 μg/L died before hatching. Survival of both embryos and fry was reduced at 59.6 μg/L, but no effects were detected at 25.1 μg/L. The resulting chronic value was 38.68 μg/L, and the acute-chronic ratio was 42.92 (Table 2).

The available Species Mean Acute-Chronic Ratios are 3.294, 5.421, and 1.734 in fresh water and 42.92 in salt water (Table 3). The freshwater Final Acute-Chronic Ratio of 3.140 was calculated as the geometric mean of the three ratios, whereas 42.92 was used as the saltwater Final Acute-Chronic Ratio. Division of the freshwater and saltwater Final Acute Values by the respective Final Acute-Chronic Ratios results in freshwater and saltwater Final Chronic Values of 63.44 and 11.02 µg/L, respectively. These Final Chronic Values are lower than the lowest available respective chronic values in fresh and salt water.

Toxicity to Aquatic Plants

Two toxicity tests with exposure periods of four or more days have been conducted on 2,4,5-TCP with aquatic plants (Table 4). An EC50, based on reduction of chlorophyll a, was 1,200 µg/L for the freshwater green alga, *Selenastrum capricornutum* (U.S. EPA 1978). The EC50, based on reduction in chlorophyll a, was 890 µg/L for the saltwater diatom, *Skeletonema costatum*, whereas the EC50 based on cell counts was 960 µg/L (U.S. EPA 1978). These concentrations are above the Final Acute Values for 2,4,5-TCP. A Final Plant Value, as defined in the Guidelines, cannot be obtained because no test in which the concentrations of 2,4,5-TCP were measured and the endpoint was biologically important has been conducted with an important aquatic plant species.

Bioaccumulation

In a bioconcentration test with the fathead minnow, equilibrium of ^{14}C-labeled 2,4,5-TCP between water and fish occurred within 24 to 48 hr at exposure concentrations of 4.8 and 49.3 µg/L (Call et al. 1980). At the higher concentration, 78.6% of the radiolabel was associated with 2,4,5-TCP at the end of the 28-day uptake phase. The BCF was 1,410 and the half-life was 12 hr (Table 5).

Inland silversides, Menidia beryllina, that survived a 28-day early life-stage toxicity test accumulated 2,4,5-TCP to concentrations between 47.2 and 71.3 times the concentration measured in test solutions (Table 5). Bioconcentration factors for grass shrimp, Palaemonetes pugio, exposed for one hour to ^{14}C-trichlorophenol were 13 for intermolt and 32 for new molt stages (Table 6). Concentrations after 12 hours of exposure of intermolts were highest in the digestive tract and hepatopancreas and lowest in the cephalothorax and abdomen. Shrimp depurated 96% of accumulated 2,4,5-TCP in 24 hr (Rao et al. 1981).

No U.S. FDA action level or other maximum acceptable concentration in tissue, as defined in the Guidelines, is available for 2,4,5-TCP. Therefore, a Final Residue Value cannot be calculated.

Other Data

Additional data on the lethal and sublethal effects of 2,4,5-TCP on aquatic species are presented in Table 6. Exposures of an alga, Chlorella pyrenoidosa, to 2,4,5-TCP for 3 days at concentrations from 1,000 to 10,000 µg/L reduced chlorophyll by 12 to 100% (Huang and Gloyna 1967, 1968). The 24-hr EC50 for the protozoan, Tetrahymena pyriformis, was 680 µg/L (Yoshioka et al. 1985). A 24-hr exposure to 1,912 µg/L caused 100% mortality of lymnaeid snails (Batte and Swanson 1952). A 24-hr EC50 of 2,080 µg/L was obtained with the cladoceran, Daphnia magna (Devillers and Chambon 1986). A 48-hr exposure of rainbow trout to 2,4,5-TCP at 1,000 µg/L resulted in 100% mortality (Shumway and Palensky 1973). LC50s of 900, 533, and 1,700 µg/L were obtained at 24 hr with the brown trout, guppy, and goldfish, respectively.

Ribo and Kaiser (1983) reported a 30-min EC50 of 1,300 μg/L, based on reduction in light production by the photoluminescent bacterium, Photobacterium phosphoreum (Table 6). Rao et al. (1981) found that exposure to 500 and 750 μg/L for 9 days inhibited limb regeneration by the grass shrimp, Palaemonetes pugio. Limb regeneration was not affected in 100 μg/L.

Unused Data

Some data on the effects of 2,4,5-TCP on aquatic organisms were not used because the tests were conducted with species that are not resident in North America (e.g., Hattori et al. 1984; Hosaka et al. 1984; Nagabhushanam and Vaidya 1981). Kaiser et al. (1984), LeBlanc (1984), and Persson (1984) compiled data from other sources. Bringmann and Kuhn (1982) cultured organisms in one water and conducted tests in another. Dojlido (1979) did not specify which trichlorophenol was used. Blackman et al. (1955a,b) conducted tests at pH below 6.5.

Results were not used when the test procedures were not adequately described (Knie et al. 1983). Studies by Kobayashi et al. (1984) on the sulfate conjugating enzyme system and McKim et al. (1985) on the efficiency of chemical uptake by fish gills did not provide data pertinent to water quality criteria.

Summary

The acute toxicity of 2,4,5-trichlorophenol to freshwater animals ranged from 260 μg/L for the rainbow trout to 2,660 μg/L for Daphnia magna. The acute toxicity of 2,4,5-TCP to the guppy increased as the pH of the water decreased. Chronic toxicity values for three freshwater species ranged from

150 to 529 µg/L, and the three acute-chronic ratios ranged from 1.734 to 5.421. A freshwater alga was affected at a concentration of 1,220 µg/L. A BCF of 1,410 was obtained with the fathead minnow.

Acute values for 2,4,5-trichlorophenol are available for eleven saltwater animal species in ten genera and range from 492 µg/L for the amphipod, Rhepoxynius abronius, to 3,830 µg/L for the mysid, Mysidopsis bahia. The six most sensitive species include three crustaceans, two fishes, and a polychaete worm and their acute values are all within a factor of 1.8. The only saltwater species with which a chronic test has been conducted is the inland silverside, Menidia beryllina. The chronic value is 38.68 µg/L, and the acute-chronic ratio is 42.92. The saltwater diatom, Skeletonema costatum, was affected by 890 µg/L. BCFs determined with the inland silverside ranged from 47 to 71.

National Criteria

The procedures described in the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that, except possibly where a locally important species is very sensitive, freshwater aquatic organisms and their uses should not be affected unacceptably if the four-day average concentration of 2,4,5-trichlorophenol does not exceed 63 µg/L more than once every three years on the average and if the one-hour average concentration does not exceed 100 µg/L more than once every three years on the average. Because sensitive freshwater animals appear to have a narrow range of acute susceptibilities to 2,4,5-trichlorophenol, this criterion will probably be as protective as intended only when the magnitudes and/or durations of excursions are appropriately small.

The procedures described in the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that, except possibly where a locally important species is very sensitive, saltwater aquatic organisms and their uses should not be affected unacceptably if the four-day average concentration of 2,4,5-trichlorophenol does not exceed 11 μg/L more than once every three years on the average and if the one-hour average concentration does not exceed 240 μg/L more than once every three years on the average. Because sensitive saltwater animals appear to have a narrow range of acute susceptibilities to 2,4,5-trichlorophenol, this criterion will probably be as protective as intended only when the magnitudes and/or durations of excursions are appropriately small.

Implementation

As discussed in the Water Quality Standards Regulation (U.S. EPA 1983a) and the Foreword to this document, a water quality criterion for aquatic life has regulatory impact only after it has been adopted in a state water quality standard. Such a standard specifies a criterion for a pollutant that is consistent with a particular designated use. With the concurrence of the U.S. EPA, states designate one or more uses for each body of water or segment thereof and adopt criteria that are consistent with the use(s) (U.S. EPA 1983b,1987). In each standard a state may adopt the national criterion, if one exists, or, if adequately justified, a site-specific criterion.

Site-specific criteria may include not only site-specific criterion concentrations (U.S. EPA 1983b), but also site-specific, and possibly pollutant-specific, durations of averaging periods and frequencies of allowed excursions (U.S. EPA 1985b). The averaging periods of "one hour" and "four days" were selected by the U.S. EPA on the basis of data concerning how rapidly some aquatic species react to increases in the concentrations of some aquatic pollutants, and "three years" is the Agency's best scientific judgment of the average amount of time aquatic ecosystems should be provided between excursions (Stephan et al. 1985; U.S. EPA 1985b). However, various species and ecosystems react and recover at greatly differing rates. Therefore, if adequate justification is provided, site-specific and/or pollutant-specific concentrations, durations, and frequencies may be higher or lower than those given in national water quality criteria for aquatic life.

Use of criteria, which have been adopted in state water quality standards, for developing water quality-based permit limits and for designing waste treatment facilities requires selection of an appropriate wasteload allocation model. Although dynamic models are preferred for the application of these criteria (U.S. EPA 1985b), limited data or other considerations might require the use of a steady-state model (U.S. EPA 1986). Guidance on mixing zones and the design of monitoring programs is also available (U.S. EPA 1985b,1987).

Table 1. Acute Toxicity of 2,4,5-Trichlorophenol to Aquatic Animals

Species	Method[a]	pH	LC50 or EC50 (μg/L)	Species Mean Acute Value (μg/L)	Reference
		FRESHWATER SPECIES			
Hydra (adult), *Hydra* sp.	S, M	7.17	1,340[b]	1,340	Sabourin et al. 1986
Cladoceran, *Daphnia magna*	S, U	7.4-9.4	2,660	2,660	LeBlanc 1980
Cladoceran, *Ceriodaphnia dubia*	S, M	7.6-7.9	1,742[c]	1,742	Spehar 1986
Amphipod (adult), *Gammarus pseudolimnaeus*	S, M	7.37	336[d]	336	Sabourin et al. 1986
Mayfly (nymph), *Leptophlebia* sp.	S, M	7.15	672[e]	672	Sabourin et al. 1986
Annelid (adult), *Lumbriculus variegatus*	S, M	7.37	611[f]	611	Sabourin et al. 1986
Rainbow trout (juvenile), *Salmo gairdneri*	F, M	7.75	260[g]	260	Spehar 1986
Fathead minnow (juvenile), *Pimephales promelas*	F, M	7.7-7.9	1,268[h]	1,268	Spehar 1986
Guppy (0.40-0.60 g), *Poecilia reticulata*	R, M	6	990[i]	-	Saarikoski and Viluksela 1981,1982
Guppy (0.40-0.60 g), *Poecilia reticulata*	R, M	7	1,240	-	Salkinoja-Salonen et al. 1981, Saarikoski and Viluksela 1981, 1982

Table 1. (continued)

Species	Method[a]	pH	LC50 or EC50 (µg/L)	Species Mean Acute Value (µg/L)	Reference
Guppy (0.40-0.60 g), *Poecilia reticulata*	R, M	8	3,060	1,948	Saarikoski and Viluksela 1981,1982
Bluegill (0.32-1.2 g), *Lepomis macrochirus*	S, U	6.7-7 8	450	450	Buccafusco et al. 1981
		SALTWATER SPECIES			
Polychaete worm (adult), *Nereis virens*	S, U	31[c,j]	884	884	Battelle Ocean Sciences 1987
Archiannelid (immature), *Dinophilus gyrociliatus*	S, U	31[c,j]	1,770	1,770	Battelle Ocean Sciences 1987
Mysid (adult), *Mysidopsis bahia*	S, U	24[c,j]	3,830	3,830	U.S. EPA 1978
Amphipod (adult), *Rhepoxynius abronius*	S, U	30[c,j]	492	492	Battelle Ocean Sciences 1987
Grass shrimp (intermolt adult), *Palaemonetes pugio*	R, U	10[c,j]	1,120	-	Rao et al. 1981
Grass shrimp (molting adult), *Palaemonetes pugio*	R, U	10[j]	640	846 6	Rao et al. 1981
Coon stripe shrimp (juvenile), *Pandalus danae*	S, U	30[j]	606	606	Battelle Ocean Sciences 1987

Table 1. (continued)

Species	Method[a]	Salinity (g/kg)	LC50 or EC50 (µg/L)	Species Mean Acute Value (µg/L)	Reference
Sheepshead minnow (juvenile), Cyprinodon variegatus	S, U	25	1,660	1,660	Heitmuller et al. 1981 U.S. EPA 1978
Inland silverside (juvenile), Menidia beryllina	F, M	30	1,660	1,660	Hughes and Pruell 1987
Atlantic silverside (juvenile), Menidia menidia	S, U	32	1,440	1,440	Battelle Ocean Sciences 1987
Pacific sand lance (adult), Ammodytes hexapterus	S, U	30	566	566	Battelle Ocean Sciences 1987
English sole (juvenile), Parophrys vetulus	S, U	30	566	566	Battelle Ocean Sciences 1987

[a] S = static; R = renewal; F = flow-through; M = measured, U = unmeasured.

[b] The highest 2,4,5-TCP exposure in this test was estimated to contain 115 pg/L of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), based upon the concentration of 2,3,7,8-TCDD measured in the stock material.

[c] The highest 2,4,5-TCP exposure in this test was estimated to contain 82.1 pg/L of 2,3,7,8-TCDD, based upon the concentration of 2,3,7,8-TCDD measured in the stock material.

[d] The highest 2,4,5-TCP exposure in this test was estimated to contain 41.6 pg/L of 2,3,7,8-TCDD, based upon the concentration of 2,3,7,8-TCDD measured in the stock material

[e] The highest 2,4,5-TCP exposure in this test was estimated to contain 38.9 pg/L of 2,3,7,8-TCDD, based upon the concentration of 2,3,7,8-TCDD measured in the stock material

Table 1. (continued)

[f] The highest 2,4,5-TCP exposure in this test was estimated to contain 41.6 pg/L of 2,3,7,8-TCDD, based upon the concentration of 2,3,7,8-TCDD measured in the stock material.

[g] The highest 2,4,5-TCP exposure in this test was estimated to contain 4.9 pg/L of 2,3,7,8-TCDD, based upon the concentration of 2,3,7,8-TCDD measured in the stock material.

[h] The highest 2,4,5-TCP exposure in this test was estimated to contain 29.9 pg/L of 2,3,7,8-TCDD, based upon the concentration of 2,3,7,8-TCDD measured in the stock material.

[i] Not used in calculation of the Species Mean Acute Value because the pH is outside the range of 6.5 to 9.0 (U.S. EPA 1976).

[j] Salinity (g/kg), not pH.

Table 2. Chronic Toxicity of 2,4,5-Trichlorophenol to Aquatic Animals

Species	Test[a]	pH	Chronic Limits (µg/L)[b]	Chronic Value (µg/L)	Reference
			FRESHWATER SPECIES		
Cladoceran, *Ceriodaphnia dubia*	LC	7.6-7 9	375-746[c]	528.9	Spehar 1986
Rainbow trout, *Salmo gairdneri*	ELS	7.75	108-208[d]	149 9	Spehar 1986
Fathead minnow, *Pimephales promelas*	ELS	7.7-7.9	160-342[e]	233.9	Spehar 1986
			SALTWATER SPECIES		
Inland silverside, *Menidia beryllina*	ELS	30[f]	25.1-59.6	38 68	Hughes and Pruell 1987

Table 2. (continued)

Acute-Chronic Ratio

Species	pH	Acute Value (µg/L)	Chronic Value (µg/L)	Ratio
Cladoceran, *Ceriodaphnia dubia*	7.6-7.9	1,742	528 9	3.294
Rainbow trout, *Salmo gairdneri*	7.75	260	149.9	1 734
Fathead minnow, *Pimephales promelas*	7.7-7.9	1,268	233 9	5.421
Inland silverside, *Menidia beryllina*	30[c]	1,660	38 68	42.92

[a] LC = life-cycle or partial life-cycle; ELS = early life-stage

[b] Results are based on measured concentrations of 2,4,5-trichlorophenol.

[c] Maximum 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) concentrations of 5 3 and 10.6 pg/L were estimated to be present at 2,4,5-TCP concentrations of 375 and 746 µg/L, respectively, based upon concentrations of 2,3,7,8-TCDD measured in the stock material.

[d] Maximum 2,3,7,8-TCDD concentrations of 1.5 and 3.0 pg/L were estimated to be present at 2,4,5-TCP concentrations of 108 and 208 µg/L, respectively, based upon concentrations of 2,3,7,8-TCDD measured in the stock material.

[e] Maximum 2,3,7,8-TCDD concentrations of 2.3 and 4.8 pg/L were estimated to be present at 2,4,5-TCP concentrations of 160 and 342 µg/L, respectively, based upon concentrations of 2,3,7,8-TCDD measured in the stock material

[f] Salinity (g/kg), not pH

Table 3. Ranked Genus Mean Acute Values with Species Mean Acute-Chronic Ratios

Rank[a]	Genus Mean Acute Value (µg/L)	Species	Species Mean Acute Value (µg/L)[b]	Species Mean Acute-Chronic Ratio[c]
		FRESHWATER SPECIES		
10	2,660	Cladoceran, *Daphnia magna*	2,660	-
9	1,948	Guppy, *Poecilia reticulata*	1,948	-
8	1,742	Cladoceran, *Ceriodaphnia dubia*	1,742	3 294
7	1,340	Hydra, *Hydra* sp.	1,340	-
6	1,268	Fathead minnow, *Pimephales promelas*	1,268	5 421
5	672	Mayfly, *Leptophlebia* sp.	672	-
4	611	Annelid, *Lumbriculus variegatus*	611	-
3	450	Bluegill, *Lepomis macrochirus*	450	-
2	336	Amphipod, *Gammarus pseudolimnaeus*	336	-
1	260	Rainbow trout, *Salmo gairdneri*	260	1 734

Table 3. (continued)

Rank[a]	Genus Mean Acute Value (µg/L)	Species	Species Mean Acute Value (µg/L)[b]	Species Mean Acute-Chronic Ratio[c]
		SALTWATER SPECIES		
10	3,830	Mysid, *Mysidopsis bahia*	3,830	-
9	1,770	Archiannelid, *Dinophylus gyrociliatus*	1,770	-
8	1,660	Sheepshead minnow, *Cyprinodon variegatus*	1,660	-
7	1,546	Inland silverside, *Menidia beryllina*	1,660	42 92
		Atlantic silverside, *Menidia menidia*	1,440	-
6	884	Polychaete worm, *Nereis virens*	884	-
5	846 6	Grass shrimp, *Palaemonetes pugio*	846 6	-
4	606	Coon stripe shrimp, *Pandalus danae*	606	-
3	566	English sole, *Parophys vetulus*	566	-

Table 3. (continued)

Rank[a]	Genus Mean Acute Value (µg/L)	Species	Species Mean Acute Value (µg/L)[b]	Species Mean Acute-Chronic Ratio[c]
2	566	Pacific sand lance, *Ammodytes hexapterus*	566	-
1	492	Amphipod, *Rhepoxynius abronius*	492	-

[a] Ranked from most resistant to most sensitive based on Genus Mean Acute Value.
[b] From Table 1.
[c] From Table 2

Fresh water

Final Acute Value = 199.2 µg/L

Criterion Maximum Concentration = (199.2 µg/L) / 2 = 99.60 µg/L

Final Acute-Chronic Ratio = 3.140 (see text)

Final Chronic Value = (199.2 µg/L) / 3.140 = 63.44 µg/L

Salt water

Final Acute Value = 472.9 µg/L

Criterion Maximum Concentration = (472.9 µg/L) / 2 = 236 4 µg/L

Final Acute-Chronic Ratio = 42.92 (see text)

Final Chronic Value = (472 9 µg/L) / 42.92 = 11.02 µg/L

Table 4. Toxicity of 2,4,5-Trichlorophenol to Aquatic Plants

Species	pH	Duration (Days)	Effect	Concentration (µg/L)	Reference
			FRESHWATER SPECIES		
Alga, *Selenastrum capricornutum*	-	4	EC50 (chlorophyll *a*)	1,220	U.S EPA 1978
			SALTWATER SPECIES		
Diatom, *Skeletonema costatum*	30[a]	4	EC50 (chlorophyll *a*)	890	U.S. EPA 1978
Diatom, *Skeletonema costatum*	30[a]	4	EC50 (cell count)	960	U S EPA 1978

[a] Salinity (g/kg), not pH

Table 5. Bioaccumulation of 2,4,5-Trichlorophenol by Aquatic Organisms

Species	Concentration in Water (µg/L)[a]	pH	Duration (days)	Tissue	Percent Lipids	BCF or BAF[b]	Normalized BCF or BAF[c]	Reference
				FRESHWATER SPECIES				
Fathead minnow, *Pimephales promelas*	49.3	7 36-7.62	8	Whole body	4.1	1,410	343.9	Call et al. 1980
				SALTWATER SPECIES				
Inland silverside, *Menidia beryllina*	13.7-59.6	30[d]	28	Whole body	-	47 2-71.3	-	Hughes and Pruell 1987

[a] Measured concentration of 2,4,5-trichlorophenol.

[b] Bioconcentration factors (BCFs) and bioaccumulation factors (BAFs) are based on measured concentrations of 2,4,5-trichlorophenol in water and in tissue.

[c] When possible, the factors were normalized to 1% lipids by dividing the BCFs and BAFs by the percent lipids.

[d] Salinity (g/kg), not pH.

Table 6. Other Data on Effects of 2,4,5-Trichlorophenol on Aquatic Organisms

Species	pH	Duration	Effect	Concentration (µg/L)	Reference
			FRESHWATER SPECIES		
Alga, *Chlorella pyrenoidosa*	7.0	3 days	100% reduction in chlorophyll	10,000	Huang and Gloyna 1967, 1968
Alga, *Chlorella pyrenoidosa*	7.0	3 days	12% reduction in chlorophyll	1,000	Huang and Gloyna 1967
Protozoan, *Tetrahymena pyriformis*	-	24 hr	EC50	680	Yoshioka et al. 1985
Snail, *Fossaria cubensis*	-	24 hr	100% mortality	1,912	Batte and Swanson 1952
Snail, *Pseudosuccinea columella*	-	24 hr	100% mortality	1,912	Batte and Swanson 1952
Cladoceran, *Daphnia magna*	7 8-8.2	24 hr	EC50	2,080	Devillers and Chambon 1986
Rainbow trout, *Salmo gairdneri*	7.0-8.0	48 hr	100% mortality	1,000	Shumway and Palensky 1973
Brown trout (4 5 g), *Salmo trutta*	-	24 hr	LC50	900	Hattula et al 1981
Guppy (2-3 mo), *Poecilia reticulata*	7.7	24 hr	LC50	533	Benoit-Guyod et al. 1984a,b
Goldfish (2 g), *Carassius auratus*	-	24 hr	LC50	1,700	Kobayashi et al 1979

Table 6. (continued)

Species	Salinity (g/kg)	Duration	Effect	Concentration (µg/L)	Reference
			SALTWATER SPECIES		
Bacterium, *Photobacterium phosphoreum*	20	30 min	50% reduction in light production	1,300	Ribo and Kaiser 1983
Grass shrimp (adult), *Palaemonetes pugio*	10	9 days	Inhibition of limb regeneration	500	Rao et al. 1981
Grass shrimp (intermolt adult), *Palaemonetes pugio*	10	1 hr	BCF = 13	1,000	Rao et al 1981
Grass shrimp (new molt adult), *Palaemonetes pugio*	10	1 hr	BCF = 32	1,000	Rao et al 1981

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