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Calculator: Elisabeth Harrahy, Ph.D.

SECONDARY VALUES FOR BENZENE (CAS # 71-43-2)

A search was conducted for information on the toxicity of benzene to fish and other aquatic life using the ECOTOX database. It was determined that data are available to meet six out of the eight requirements. Because there are data for a Daphnid species, it is possible to calculate a secondary acute value for benzene.

Cold Water

To calculate a secondary acute value (SAV), the lowest genus mean acute value (GMAV) in the database is divided by the secondary acute factor (SAF; an adjustment factor corresponding to the number of satisfied requirements).

SAF for six out of eight requirements met = 5.2

Lowest GMAV = 9,086.88 μg/L (*Oncorhynchus spp.*)

SAV = GMAV/SAF
= 9,086.88/5.2
= 1,747.48 μg/L

There are currently no acceptable chronic data for benzene. Therefore, a secondary chronic value may be calculated only by using default acute-chronic ratios.

SACR = Geometric mean of 18, 18, and 18 = 18

SCV = SAV/SACR
= 1,747.48/18
= **97.08 μg/L**

So, for cold water, the secondary acute value for benzene is 1747 μg/L (rounded from 1747.48) and the secondary chronic value is 97 μg/L (rounded from 97.08).

Warm Water Sportfish

The five species of cold water fish drop out of the database when calculating secondary values for warm water. Therefore, the lowest GMAV is for *Ceriodaphnia dubia*.

SAF for six out of eight requirements met = 5.2

Lowest GMAV = 10,155 μg/L (*Ceriodaphnia dubia*)

SAV = GMAV/SAF

= 10,155/5.2
= 1,952.88 μg/L

There are currently no acceptable chronic data for benzene. Therefore, a secondary chronic value may be calculated only by using default acute-chronic ratios.

SACR = Geometric mean of 18, 18, and 18 = 18

SCV = SAV/SACR
= 1,952.88/18
= **108.49 μg/L**

So, for warm water sportfish, the secondary acute value for benzene is 1953 μg/L (rounded from 1952.88) and the secondary chronic value is 108 μg/L (rounded from 108.49).

Table 1. Requirements for calculation of an acute toxicity criterion for protection of aquatic life for benzene, and corresponding acute toxicity data.

Species Name	Common Name	Duration/ Endpoint	Value µg/L	Reference #[a]	Source
1. At least one salmonid fish in the family Salmonidae, in the class Osteichthyes.					
Oncorhynchus gorbuscha	**pink salmon**	**96-h/LC50**	**17,090**	**4**	**AQUIRE**
Oncorhynchus gorbuscha	**pink salmon**	**96-h/LC50**	**5,280**	**4**	**AQUIRE**
Species Mean Acute Value (SMAV; geometric mean of LC50 values for this species) = 9,499.22					
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**9,200**	**12**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**2,247**	**15**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**5,900**	**16**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**5,300**	**17**	**AQUIRE**
Oncorhynchus mykiss	**rainbow trout**	**96-h/LC50**	**9,200**	**13**	**AQUIRE**
SMAV = 5,686.71					
Oncorhynchus nerka	**sockeye salmon**	**96-h/LC50**	**10,760**	**4**	**AQUIRE**
SMAV = 10,760					
Oncorhynchus tshawytscha	**Chinook salmon**	**96-h/LC50**	**11,730**	**4**	**AQUIRE**
SMAV = 11,730					
Genus Mean Acute Value (GMAV; geometric mean of SMAVs for this genus) = 9,086.88					
Thymallus arcticus	**Arctic grayling**	**96-h/LC50**	**14,710**	**4**	**AQUIRE**
SMAV = 14,710					
2. At least one non-salmonid fish from another family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species.					
Ictalurus punctatus	**channel catfish**	**96-h/LC50**	**425,000**	**12**	**AQUIRE**
Ictalurus punctatus	**channel catfish**	**96-h/LC50**	**425,000**	**13**	**AQUIRE**

SMAV = 425,000

Lepomis macrochirus	**bluegill**	**96-h/LC50**	**22,490**	**1**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**100,000**	**12**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**230,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**100,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**600,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**450,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**290,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**370,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**260,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**102,000**	**13**	**AQUIRE**
Lepomis macrochirus	**bluegill**	**96-h/LC50**	**165,000**	**13**	**AQUIRE**

NOTE: The LC50s varied by more than a factor of 10, but the majority of the results were nearer to the highest outlier. This indicates bluegill might be relatively tolerant, so all the values were used to calculate the SMAV.

SMAV = 180,329.64

3. At least one planktonic crustacean (e.g., cladoceran, copepod).

Ceriodaphnia dubia	**water flea**	**48-h/EC50**	**10,155**	**2**	**AQUIRE**

SMAV = 10,155

Daphnia magna	**water flea**	**48-h/EC50**	**31,245**	**5**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**10,000**	**6**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**22,000**	**7**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**22,000**	**7**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**9,230**	**7**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**10,000**	**7**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**11,730**	**7**	**AQUIRE**
Daphnia magna	**water flea**	**48-h/EC50**	**10,000**	**7**	**AQUIRE**

SMAV = 14,182.92

Daphnia pulex	**water flea**	**48-h/LC50**	**345,000**	**8**	**AQUIRE**
Daphnia pulex	**water flea**	**48-h/LC50**	**265,000**	**8**	**AQUIRE**

SMAV = 302,365.67

Since the two SMAVs in *Daphnia* varied by more than a factor of 10 and the majority of results were for the more sensitive *D. magna*, that SMAV shall be used as the GMAV.

GMAV = 14,182.92

4. At least one benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish).

5. At least one insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge).

Chironomus thummi	**midge**	**48-h/LC50**	**100,000**	**3**	**AQUIRE**

SMAV = 100,000

6. At least one fish or amphibian from a family in the phylum Chordata not already represented in one of the other subdivisions.

Carassius auratus	**goldfish**	**96-h/LC50**	**34,420**	**1**	**AQUIRE**

SMAV = 34,420

Cottus cognatus	**slimy sculpin**	**96-h/LC50**	**15,400**	**4**	**AQUIRE**

SMAV = 15,400

Gambusia affinis	**western mosquitofish**	**96-h/LC50**	**386,000**	**11**	**AQUIRE**

SMAV = 386,000

Gasterosteus aculeatus	**threespine stickleback**	**96-h/LC50**	**24,830**	**4**	**AQUIRE**

SMAV = 24,830

Pimephales promelas	**fathead minnow**	**96-h/LC50**	**24,600**	**18**	**AQUIRE**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**12,600**	**18**	**AQUIRE**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**33,470**	**1**	**AQUIRE**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**32,000**	**1**	**AQUIRE**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**15,590**	**19**	**AQUIRE**
Pimephales promelas	**fathead minnow**	**96-h/LC50**	**24,600**	**19**	**AQUIRE**

SMAV = 22,429.28

7. At least one organism from a family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca).
   Lymnaea stagnalis **great pond snail** **96-h/LC50** **620,000** **14** **AQUIRE**
   SMAV = 620,000
8. At least one organism from a family in any order of insect or any other phylum not already represented in subdivisions 1 through 7.

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[1]Pickering, Q.H. and C. Henderson. 1966. Acute toxicity of some important petrochemicals to fish. Journal of the Water Pollution Control Federation 38(9):1419-1429.

[2]Rose, R.M., M.S.J. Warne, and R.P. Lim. 1998. Quantitative structure-activity relationships and volume fraction analysis for nonpolar narcotic chemicals to the Australian cladoceran *Ceriodaphnia*. Arch. Environ. Contam. Toxicol. 34(3):248-252.

[3]Slooff, W. 1983. Benthic macroinvertebrates and water quality assessment: Some toxicological considerations. Aquatic Toxicology 4:73-82.

[4]Moles, A. S.D. Rice, and S. Korn. 1979. Sensitivity of Alaskan freshwater and anadromous fishes to Prudhoe Bay crude oil and benzene. Trans. Am. Fish. Soc. 108(4):408-414.

[5]Bobra, A.M., W.Y. Shiu, and D. Mackay. 1983. A predictive correlation for the acute toxicity of hydrocarbons and chlorinated hydrocarbons to the water flea (*Daphnia magna*). Chemosphere 12(9-10):1121-1129.

[6]Janssen, C.R. and G. Persoone. 1993. Rapid toxicity screening tests for aquatic biota. 1. Methodology and experiments with *Daphnia magna*. Environmental Toxicology and Chemistry 12:711-717.

[7]MacLean, M.M. and K.G. Doe. 1989. The comparative toxicity of crude and refined oils to *Daphnia magna* and *Artemia*. Environment Canada, EE-111, Dartmouth, Nova Scotia. p.64.

[8]Canton, J.H. and D.M.M. Adema. 1978. Reproducibility of short-term and reproduction toxicity experiments with *Daphnia magna* and comparison of sensitivity of *Daphnia magna* with… Hydrobiologia 59(2):135-140.

[11]Wallen, I.E., W.C. Greer and R. Lasater. 1957. Toxicity to *Gambusia affinis* of certain pure chemicals in waters. Sewage Ind. Wastes 29(6):695-711.

[12]Johnson, W.W. and M.T. Finley. 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. Resource Publication No. 137, U.S. Fish and Wildlife Service, U.S.D.I., Washington, D.C. 98 pp.

[13]Mayer, F.L.J. and M.R. Ellersieck. 1986. Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals. Resource Publication No. 160, U.S. Fish and Wildlife Service, U.S.D.I., Washington, D.C. 505 pp.

[14]Erben, R. and Z. Pisl. 1993. Acute toxicity for some evaporating aromatic hydrocarbons for freshwater snails and crustaceans. Int. Rev. Gesamten Hydrobiol. 78(1):161-167.

[15]Hodson, P.V., D.G. Dixon, and K.L.E. Kaiser. 1984. Measurement of median lethal dose as a rapid indication of contaminant toxicity to fish. Environmental Toxicology and Chemistry 3(2):243-254.

[16]Galassi, S., M. Mingazzini, L. Vigano, D. Cesareo, and M.L. Tosato. 1988. Approaches to modeling toxic responses of aquatic organisms to aromatic hydrocarbons. Ecotoxicology and Environmental Safety 16(2):158-169.
[17]DeGraeve, G.M., R.G. Elder, D.C. Woods, and H.L. Bergman. 1982. Effects of naphthalene and benzene on fathead minnows and rainbow trout. Arch. Environ. Contam. Toxicol. 11(4):487-490.
[18]Geiger, D.L., L.T. Brooke, and D.J. Call. 1990. Acute toxicities of organic chemicals to fathead minnows (*Pimephales promelas*), Vol. 5. Center for Lake Superior Environmental Studies, University of Wisconsin- Superior, Superior, WI. I:332.
[19]Marchini, S., M.L. Tosato, T.J. Norberg-King, D.E. Hammermeister, and M.D. Hoglund. 1992. Lethal and sublethal toxicity of benzene derivatives to the fathead minnow using a short-term test. Environ. Toxicol. Chem. 11(2):187-195.