Ingredient	Trade name	Use	EPA Signal Word[1]	Solubility in Water	Eco-Acute Toxicity for Invertebrates	Eco-Acute Toxicity for Fish	Environmental Degradation	Residual
2,4-D: Dimethylamine salt of 2,4-dichlorophenoxyacetic acid	2,4-D Amine Weed Killer	Weed	Danger	Emulsifiable[2] (MSDS)	Brown shrimp had a small increase in mortality of 2 mg/l over a 48-hr exposure period (Cornell).	Some formulations of 2,4-D are highly toxic to fish while others are not. LC_{50} ranges b/w 1.0 mg/l to 100 mg/l for cutthroat trout, depending on formulation (Cornell).	Soil microbes break down the 2,4-D adsorbed to soil. Rates of breakdown vary with sediment load, amount of nutrients, and dissolved organic carbon (Cornell).	The compound has been detected in groundwater supplies in at least 5 States and Canada, and has been detected in surface waters throughout the U.S. at very low concentrations (Cornell). Studies have shown that 2,4-D is susceptible to photodegradation resulting in the formation of carbon dioxide, 1,2,4-benzenetriol, 2,4-dichlorophenol and then proceeds to a secondary photolysis forming humic acides (Crosby and Tutass, 1966; Hautala, 1978).
acrolein	Magnacide H	Weed	Danger	Soluble (MSDS)	48 Hr LC_{50}[3] for Daphnia magna (water flea) is 22 ppb[4] (MSDS)	96 hr LC_{50} for bluegill sunfish is 24 ppb	Mineralization to CO_2 (MSDS). Acrolein volatizes and has a short degradation half life (SFEI).	Under field conditions, the $T_{1/2}$[9] was 6 to 10 hours in freshwater and 4.2 in soil-water mixtures (MSDS).
Diquat dibromide	Reward	Weed	Warning	718000 mg/l @ 20°C & pH 7.2 (MSDS)	LC_{50}/EC_{50}[5]0.77-1.19 ppm for water flea (MSDS). The shell growth of eastern oysters was not noticeably affected with exposure to 1 ppm of diquat for 96 hours (Cornell).	LC_{50}/EC_{50} 14.8 ppm for trout, 13.9 ppm for Bluegill (MSDS). The 8 hr LC50 for rainbow trout is 12.3, 28.5 ppm for Chinook salmon, 20.4 ppm for fingerling trout (Cornell).	Sinks in water after 24hr where it is immobile (MSDS). Strongly sticks to clay particles or organic matter in the soil for long periods of time and strong chemical bonds formed by the adsorption[6] make the herbicide biologically and chemically inactive (Cornell).	Residues of diquat have been found to persist in soil for many years with very little degradation. If soil adsorption sites become saturated, groundwater quality can be affected (Cornell). Diquat dibromide is persistent and binds nearly irreversibly to soil (EPA, RED).
fluridone	Sonar	Weed	Caution	Disperses in water (MSDS). 0.0012g/100ml water (Cornell).	Moderately toxic to daphnia magna. 48 hr acute is 6.3 mg/l (Cornell).	Moderately toxic to fish. 96 hr for bluegill sunfish is 12 mg/l and for rainbow trout is 11.7 mg/l (Cornell).	In aquatic environment photolysis is the primary method of degradation. Microbes and vegetation may also aid dissipation process. (Cornell).	In water, the half-life is estimated to be 20 days or 90 days for hydrosoil (Cornell).
triclopyr	Garlon 3A	Weed	Caution	Miscible[7] (MSDS)	LC_{50} for Daphnia magna (water flea) is 1170 ppm for triclopyr salt. LC_{50} for Daphnia magna: 132 ppm for triclopyr amine (DPR).	LC_{50} for rainbow trout is 117 ppm, LC_{50} for bluegill sunfish is 148 ppm	Triclopyr is not strongly adsorbed to soil particles, has potential mobility, and is fairly rapidly degraded by soil microorganisms. The major means of degradation is photodecomposition (the action of sunlight).	Triclopyr was tested but not found in a host of groundwater sites throughout the country. The $T_{1/2}$ in soil is between 30 and 90 days and $T_{1/2}$ of a breakdown product is between 8 and 279 days (Cornell). In natural water, oxamic acid is the main photodegradation product with low molecular-weight organic acids as minor products (Woodburn et al., 1993a; McCall et al., 1986).

Ingredient	Trade name	Use	EPA Signal Word[1]	Solubility in Water	Eco-Acute Toxicity for Invertebrates	Eco-Acute Toxicity for Fish	Environmental Degradation	Residual
Copper sulfate pentahydrate	Triangle Brand Copper Sulfate Crystal	Weed	Caution	83.1 g/100cc water @ 30°C (MSDS)	Direct application of copper sulfate to water may cause a significant decrease in populations of aquatic invertebrates, plants & fish (Cornell). The LC50 for daphnia is 600 ppb (MSDS). The 10 day LC50 for Hyalella azteca amphipod is 35 µg/L (SFEI).	The LC 50 for bluegill is 0.65 ppm and for trout is 0.056 ppm (MSDS). Copper sulfate is very toxic to fish and the toxicity varies with the species and the physical and chemical characteristics of the water. Even at the recommended rates of application, it can be poisonous to trout and other fish, especially in soft or acid waters (Cornell).	Copper is partly washed down to lower soil levers, partly adsorbed to soil, partly changed to breakdown products. Less often it can precipitate, i.e. form an insoluble solid that is separate from the liquid. (Cornell).	Copper is strongly bioaccumulated. Copper ions are strongly adsorbed to soil. As a naturally-occuring substance that is highly soluble in water, copper can persist indefinitely. Copper has a high potential for poisonous activity in plants and can persist months after it is applied (Cornell).
Dipotassium salt of endothall	Aquathol K	Weed	Warning	Miscible (MSDS). 100g/kg at 20°C (Cornell)	Endothall has a low toxicity to crustaceans and a medium toxicity to aquatic insects (Cornell). EC_{50} for water flea is 72-319.5 mg/l (MSDS).	Inorganic salts of endothall in aquatic formulations are safe to fish in 100-500 ppm concentrations. However, amine salts of endothall are more toxic to fish than dipotassium endothall (Cornell). For Aquathol K: LC_{50} for rainbow trout is 107-528.7 mg/l, LC_{50} 316-501.2 mg/L for bluegill sunfish (MSDS)	Material degrades by indigenous microbial population to CO_2 and other non-toxic byproducts (MSDS).	Endothall disappears from soil in 7-21 days. T1/2 is 4-5 days in clay soils and 9 days in high organic content. Its half-life is 4 to 7 days in surface water (Cornell). Dipotassium salt: endothall dipotassium salt, potassium cation and endothall acid can be found mainly in the water column. N,N-dimethylalkylamine salt: endothall N,N-dimethylalkylamine salt, coco-alkylamine cation and endothall acid are present. Coco-alkylamine cation is taken up by sediment, endothall acid will persist <10 days in the water column and N,N-dimethylalkylamine will be found in both sediment and water (EPA, Environmental Fate & Ecological Risk Assessment of Endothall, 2005).
isopropylamine salt of imazapyr	Habitat	Weed	Caution	Soluble (MSDS)	The 48-hr LC_{50} was >150 ppm for Daphnia magna using 99.6 % of the active ingredient (EPA Memo).	The 96-hr LC_{50} is >148 ppm for rainbow trout and >150 ppm for bluegill (EPA Memo).	Imazapyr photodegrades rapidly in water (EPA memo)	Imazapyr has 2+ half-lives within 14 days, i.e. 25% remains. The North Coast Water Quality Control Board has done monitoring of streams after forest herbicide aerial spraying and no herbicide residues above 14 ppb have been found and 95% are below 10 ppb (EPA Memo)
Glyphosate	Rodeo	Weed	Caution	Miscible (MSDS)	There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms (Cornell). EC_{50} in water flea is 918 mg/L (MSDS).	LC_{50} for rainbow trout is >2500 mg/l (MSDS). LC_{50} for rainbow trouth is 38 ppm, 120 mg/l for bluegill sunfish (Cornell).	Glyphosate is highly adsobed on most soils especially those with high organic content. Microbes breakdown glyphosate. Photodecomposition is minor.	$T_{1/2}$ for pond water is 12 days to 10 weeks (Cornell). For all aquatic systems, sediment appears to be the major sink for glyphosate residue (Department of Pesticide Regulations, Fate Review)
petroleum hydrocarbon	GB-1111	Vector	Caution	Zero (MSDS)		This product is toxic to fish and other aquatic organisms (Label).		

Ingredient	Trade name	Use	EPA Signal Word[1]	Solubility in Water	Eco-Acute Toxicity for Invertebrates	Eco-Acute Toxicity for Fish	Environmental Degradation	Residual
diflubenzuron	Dimilin 25W	Vector	Caution	1 ppm in water @ 20°C (MSDS)	EC50 for oyster larvae was 130 ppm. Insects and other arthropods are most susceptible in the pre-molting stage. For instance, fiddler crabs, exposed for as little as one week at levels up to 50 ppb exhibited limb regeneration effects (Cornell).	LC_{50} for bluegill sunfish is 660 ppm and for rainbow trout is 240 ppm (Cornell).	Rate of degradation is dependent of the particle size. Smaller particles break down more quickly. Breaks down to form DFBA and CPU and some amount of PCA (Cornell).	Residues could not be detected 72 hours after an application of 110 g/hectare of field water. Other studies suggest half-lives of one to three weeks (Cornell). Diflubenzuron bioaccumulates with the maximum uptake tissue concentrations being 1.7 mg/kg for fillet, 3.3 mg/kg for whole fish, and 4.7 mg/kg for viscera (EPA, RED).
temephos	1% Skeeter Abate	Vector	Caution	Negligible (MSDS)	Both freshwater aquatic invertebrates and marine invertebrates are highly susceptible to temephos (Cornell).	LD_{50}[8] ranges from 0.16 to 3.49 mg/kg for rainbow trout and 1.44 to 21.8 mg/kg for bluegill sunfish (Cornell).	Little information is available (Cornell).	Current evidence suggests that the compound has a low persistence in the environment (Cornell). Transformation prducts, such as temephos sulfoxide, temephos sulfone, temephos sulfide and sulfone phenols do not bind to soil as strongly as temephos and are, therefore, more likly to migrate to and remain dissolved in the water. Temephos, being a hydrophobic chemical and thus more likly to bind to fatty substances, has the potential to bioconcentrate and depurate (EPA, RED).
s-methoprene	Altosid Briquets	Vector	Caution	Very low solubility - 0.51 to 1 ppm (MSDS)	Methoprene use as mosquito larvicide poses some hazard to freshwater invertebrates, but major effects are unlikely. Altosid had very little effect, if any, on 35 species of exposed nontarget organisms including earthworms, waterfleas, damselflies, snails, tadpoles, and mosquito fish (Cornell). LC_{50} for Daphnia: 360 ppb (0.36 ppm) (MSDS).	LC_{50} for rainbow trout is 38 ppm (MSDS), 4.39 ppm (Cornell University), 4.62 ppm in bluegill (Cornell), 120 mg/l (120 ppm) for bluegill sunfish (MSDS).	Hydrolysis: $T_{1/2}$[9] >4 weeks. Photolysis: $T_{1/2}$ <10 hours. Soil: $T_{1/2}$: ~10 days (MSDS). Microbial and photodegradation are rapid in both water and soil (Cornell).	Methoprene is not persistent in soils and is unlikely to contaminate groundwater (Cornell). In aqueous solutions exposed to natural sunlight, complete degradation occurs within days resulting in the formation of at least 50 minor photolysis products. Further, uncharacterized methoprene residues accumulate in edible tissues of bluegill sunfish and crayfish at maximum bioconcentration factors of 457 and 75, respectively (EPA, RED).
Bacillus thuringiensis, subsp. Israelensis	VectoBac 1200L	Vector	Caution	Disperses in water (MSDS)	Death occurs in some nontarget insect species when B.t. is applied at rates used for mosquito control. Results of other experimental testing do not suggest that B.t. adversely affects nontarget insects or aquatic invertebrates. It did not have negative effects on frogs and salamanders (Cornell).	Rainbow trout and bluegills exposed for 96 hours to B.t. technical material, at concentrations of 560 and 1000 ppm, did not show adverse effects (Cornell).	As a biological entity, it is subject to death and inactivation. It is degraded rapidly in UV light; $T_{1/2}$ = 3.8 hrs under normal sunlit conditions (Cornell).	Settles out or adheres to suspended organic matter (Cornell). Bt toxins degrade in the phyllosphere with exposure to UV light, however, Bt toxins may persist in soil for several months and Bt spores, which are nontoxic, may persist in the environment (EPA, RED).

Ingredient	Trade name	Use	EPA Signal Word[1]	Solubility in Water	Eco-Acute Toxicity for Invertebrates	Eco-Acute Toxicity for Fish	Environmental Degradation	Residual
monomolecular film	Agnique MMF	Vector	Caution	Insoluble (MSDS)	LC_{50} for Daphnia: 1.9 mg/L (MSDS)	LC_{50} for Rainbow Trout: 98 mg/kg, LC_{50} for Bluegill: 290 mg/kg (MSDS)		Average persistence in the environment under standard use conditions is 5 - 14 days at recommended dosage rates (MSDS).
Bacillus sphaericus	VectoLex CG	Vector	Caution	Partially suspends/soluble in water (MSDS)	EC_{50} (120 hr) for Selanastrum capricornutum: 2.2 mg/L and LC_{50} (96hr) for Mysidopsis bahia: >100 mg/L (DPR).	Various tests revealed no expected harm to non-target organisms (EPA).		If environment is suitable then it is persistent and self-replicates (EPA).
Highly refined petroleum distillate	BVA 2 Mosquito Larvicide Oil	Vector	Caution	Insoluble (MSDS)		Toxic to fish and other aquatic organisms (Label).		
Rotenone		Fish	Danger[10]/ Caution	0.02 mg/l @ 20°C (Cornell)	Aquatic invertebrates have a wide range of sensitivity to rotenone with the 96 hr LC_{50} randging from 0.002 to 100 mg/l (Cornell).	96 hr LC_{50} for rainbow trout is 23 µg/l (or ppb) and 2.6 µg/l for channel catfish (Cornell).	Rotenone breaks down readily by exposure to sunlight and is broken down in soil and in water (Cornell).	Nearly all of the toxicity of the compound is lost in 5 to 6 days of spring sunlight or 2 to 3 days of summer sunlight. The T1/2 in both soil and water is between 1 to 3 days (Cornell).
Antimycin A	Fintrol	Fish	Danger - Poison		96 hr LC_{50} for Midge is between 0.9 and 0.22 µg/L (USDI).	96 hr LC_{50} for bighead carp was 4.6 µg/l and for silver carp was 6.3 µg/l, for goldfish was 5.7 µg/l (USDI, US Geological Survey).	Antimycin A is made up of 4 active components: A_1, A_2, A_3, and A_4 (Journal of Antibiotics). Antimycin A_1 degrades via hydrolysis to form blastmycic acid and antimycin lactone. These products then degrade to form fatty acids (Journal of Pharmaceutical Sciences).	$T_{1/2}$ less than 20 minutes. Seldom persists more than 7 days (Derse, Lee and Morton of the WARF Inst.).

Endnotes

1. EPA Signal Word: A signal word is a description of the acute (short-term) toxicity to humans of a formulated pesticide product. The signal words are: DANGER, WARNING, & CAUTION. The assignment of a signal word to a pesticide product is based on acute oral, dermal, or inhalation toxicity or on effects to skin or eyes.
2. Emulsifiable: Held in suspension with water, but not mixed.
3. LC stands for "Lethal Concentration". The concentration of a chemical in water that kills 50% of the test animals in a given time (~ 4 hours) is the LC50 value.
4. ppb is parts per billion or mg/l *(10^{-3}) or ppm* (10^{-3})
5. EC50 is the median effective concentration. It is a statistically derived concentration of a substance in an environmental medium expected to produce a certain effect in 50% of test organisms in a given population under a defined set of conditions (IUPAC).
6. Adsorption: The accumulation of a substance on the surface of a solid.
7. Miscible: Mixes.
8. LD stands for "Lethal Dose". LD_{50} is the amount of a material, given all at once, which causes the death of 50% of a group of test animals.
9. $T_{1/2}$ is short for half-life, the time it takes for half of a substance to degrade.
10. Rotenone is highly toxic and carries the signal word Danger on its label when formulated as an emulsified concentrate. (Note: DFG is planning to use a liquid form of rotenone in its Lake Davis project.)