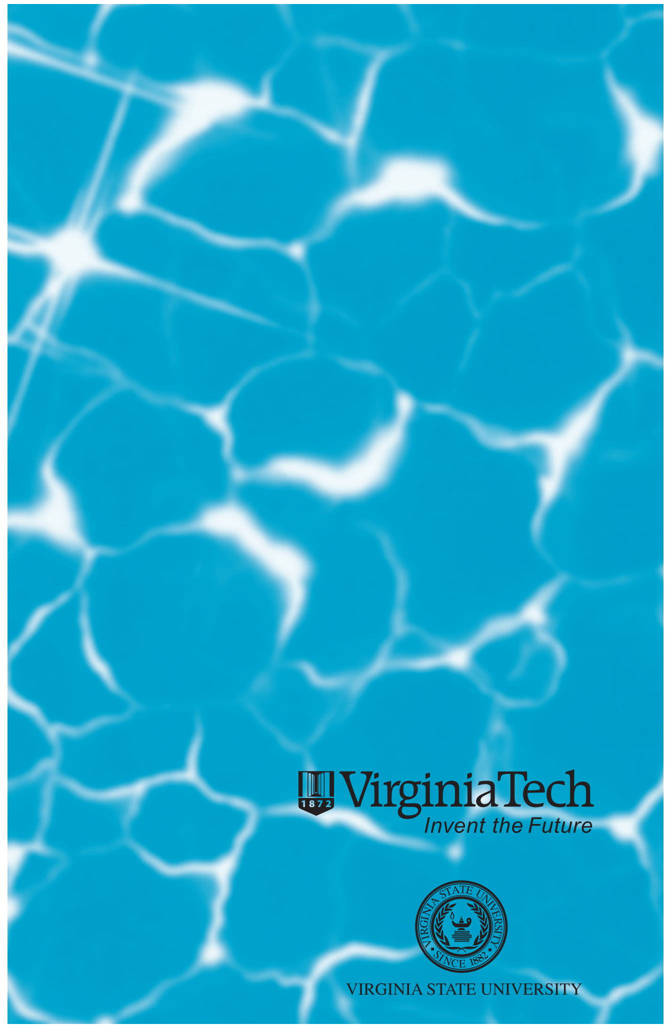
# Pesticides and Aquatic Animals: A Guide to Reducing Impacts on Aquatic Systems

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## Introduction

Fisheries and aquatic resources (ponds, lakes, rivers, streams, and oceans) are exceptionally valuable natural assets enjoyed by millions of Americans. They provide citizens with generous long-term benefits in return for minimal care and protection. These benefits can be direct financial ones that provide employment, profit, and dollar savings. For example, the seafood industry provides jobs for commercial fishers, wholesalers, and retailers. More indirect, but equally valuable, benefits of fish and aquatic ecosystems include recreational boating, sport fishing, swimming, relaxation, and natural beauty.

Appreciation of fisheries and aquatic systems has been accompanied by increasing concern about the effects of growing human populations and human activity on aquatic life and water quality. Pesticides are one group of toxic compounds linked to human use that have a profound effect on aquatic life and water quality.

Pesticides are substances used to control pests, including insects, water weeds, and plant diseases. Naturally-occurring pesticides have been used for centuries, but widespread production and use of modern synthetic pesticides did not begin until the 1940s. Today, pesticides are big business. Over a billion pounds of pesticides are used in the United States at a value of $8 billion per year.

Pesticides are beneficial chemicals. They can protect against forest and farm crop losses and can aid in more efficient food production. They are used to slow the spread of destructive forest insects like the gypsy moth. They are used to establish and maintain lawns and recreational areas. They are used to help reduce malnutrition and starvation of humans and animals. Pesticides also have been instrumental in controlling many insect-borne human diseases such as malaria, encephalitis, and bubonic plague. They promote public safety on roads, railroads, powerlines, and rights-of-ways.

### Chemical Control

#### Advantages

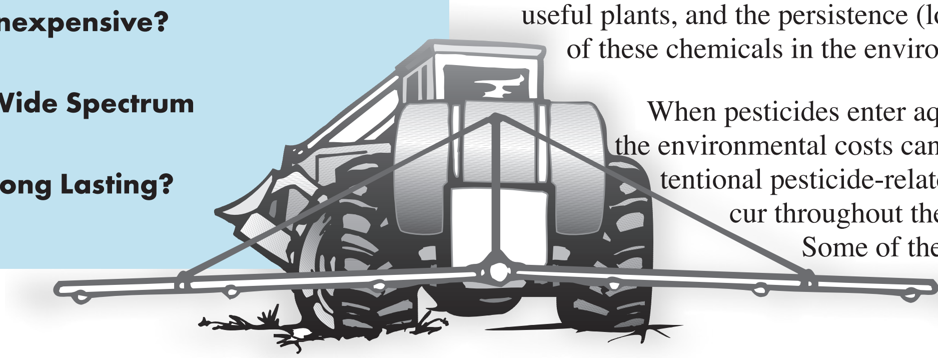
- ✔ Simple to Apply
- ✔ Rapid Effect
- ✔ Inexpensive?
- ✔ Wide Spectrum
- ✔ Long Lasting?

### Chemical Control

#### Disadvantages

- ▲ Toxic
- ▲ Water-Use Restrictions
- ▲ Fish Kills
- ▲ Retreatment Necessary
- ▲ Expensive
- ▲ Long-Lasting
- ▲ Taste Problems
- ▲ Odor Problems

Pesticides are (1) relatively easy to apply, (2) generally cost-effective and, (3) the only practical method of control in some situations. However, the benefits of pesticides are not derived without consequences. Pesticides must be used with great care so that the health of humans, animals, and the environment are protected. Disadvantages of pesticides include their toxicity to some humans, animals, and useful plants, and the persistence (long life) of some of these chemicals in the environment.



When pesticides enter aquatic systems, the environmental costs can be high. Unintentional pesticide-related fish kills occur throughout the United States. Some of these kills have been large, involving thousands of fishes, as well as frogs, turtles, mussels, water birds, and other wildlife. Fish and other wildlife species, including rare and endangered ones like the peregrine falcon, bald eagle, and osprey, have been victims of pesticide poisoning. Pesticide use is one of many factors contributing to the decline of fish and other aquatic species.

Protection of wildlife and water quality is possible when using pesticides. If pesticides are selected wisely, used in combination with other pest control measures, and applied safely, the pollution of our surface waters and contamination of aquatic life can be avoided.

The purpose of this publication is to serve as a general guide for those who may use pesticides in or around natural wetlands, lakes, ponds, rivers, and streams. In this publication, we provide information about the toxicity and safe use of pesticides that have the potential to enter aquatic systems.

## Registration of Pesticides:

All pesticides used in the United States must be registered according to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The Environmental Protection Agency (EPA) is responsible for administering this law. The EPA has the authority to register, restrict, or prohibit the use of pesticides. Pesticide registration decisions balance the risks involved with the benefits.

The EPA decides whether to register a pesticide after considering many characteristics including: (1) the ingredients, (2) manufacturing process, (3) physical and chemical properties, (4) environmental state (mobility, volatility, breakdown rates, accumulation potential in plants and fish), (5) toxicity to animals, and (6) carcinogenic or mutagenic properties.

The EPA can approve or disapprove the registration of new pesticides, and may further restrict or cancel the registration of those in use. For example, DDT, aldrin, dieldrin, heptachlor, mirex, and toxaphene were banned from use (registration canceled) in the United States in 1972, 1974, 1974, 1983, 1977, and 1982 respectively. The use of endrin was highly restricted in 1979. State agencies also require the registration of pesticides used within their boundaries.

## The Pesticide Label

A pesticide label containing information on use and safety must be attached to all pesticide containers. The label includes the product name, name and amount of active ingredients, EPA registration number and establishment number, name and address of the manufacturer, and net contents.

**The Pesticide Label**

- ✔ **Trade Name**
- ✔ **Active Ingredient**
- ✔ **Directions for use**
- ✔ **Toxicity Rating**
- ✔ **EPA Registration number**


The use classification (general use or restricted use) is noted on the label. The signal word (danger, warning, or caution) provides information about hazard classification. Precautionary statements inform users of handling requirements, procedures, and special concerns. Directions for use specify legal application sites, rates, and mixing and handling instructions. The pesticide label is a binding legal agreement between the EPA, the registrant, and the user. It is illegal to use a pesticide in a way or place not specified on the label.

"Restricted-Use Pesticides" are those that must be handled with special care. A pesticide can be classified as restricted-use because it is particularly toxic to fish, birds, or mammals. They may also be so classified because of potential environmental effects. These can be used only by a trained, certified pesticide applicator.

**Hazard Ratings**

| Toxicity | LC50 (mg/L) |
|---|---|
| Minimal | > 100 |
| Slight | 10 - 100 |
| Moderate | 1 - 10 |
| High | 0.1 - 1.0 |
| Extreme | 0.01 - 0.1 |
| Super | < 0,01 |

## Aquatic Toxicology

Aquatic toxicology is the study of the effects of environmental contaminants on aquatic organisms, such as the effect of pesticides on the health of fish or other aquatic organisms. A pesticide's capacity to harm fish and aquatic animals is largely a function of its (1) toxicity, (2) exposure time, (3) dose rate, and (4) persistence in the environment.

Toxicity of the pesticide refers to how poisonous it is. Some pesticides are extremely toxic, whereas others are relatively nontoxic. Exposure refers to the length of time the animal is in contact with the pesticide. A brief exposure to some chemicals may have little effect on fish, whereas longer exposure may cause harm.

The dose rate refers to the quantity of pesticide to which an animal is subjected (orally, dermally, or through inhalation). A small dose of a more toxic chemical may be more damaging than a large dose of a less toxic chemical. Dosages can be measured as the weight of toxicant per unit (kilogram) of body weight (expressed as mg pesticide/kg of body weight) or as the concentration of toxicant in the water or food supply (usually expressed as parts per million, ppm or parts per billion, ppb).

A lethal dose is the amount of pesticide necessary to cause death. Because not all animals of a species die at the same dose (some are more tolerant than others), a standard toxicity dose measurement, called a Lethal Concentration 50 (LC50), is used. This is the concentration of a pesticide that kills 50% of a test population of animals within a set period of time, usually 24 to 96 hours.

Hazard ratings ranging from minimal to super toxic and LC50s for commonly used insecticides, herbicides, and fungicides are presented in Tables 3, 4 and 5 at the end of this publication. For example, the 24-hour LC50 of the insecticide permethrin to rainbow trout is 12.5 ppb. This means that one-half of the trout exposed to 12.5 ppb of permethrin died within 24 hours, indicating super toxicity of this pesticide to trout.

Exposure of fish and other aquatic animals to a pesticide depends on its biological availability (bioavailablility), bioconcentration, biomagnification, and persistence in the environment. Bioavailability refers to the amount of pesticide in the environment available to fish and wildlife. Some pesticides rapidly breakdown after application. Some bind tightly to soil particles suspended in the water column or to stream bottoms, thereby reducing their availability. Some are quickly diluted in water or rapidly volatize into the air and are less available to aquatic life.

Bioconcentration is the accumulation of pesticides in animal tissue at levels greater than those in the water or soil to which they were applied. Some fish may concentrate certain pesticides in their body tissues and organs (especially fats) at levels 10 million times greater than in the water.

Biomagnification is the accumulation of pesticides at each successive level of the food chain. Some pesticides bioaccumulate (buildup) in the food chain. For example, if a pesticide is present in small amounts in water, it can be absorbed by water plants which are, in turn, eaten by insects and minnows. These also become contaminated. At each step in the food chain the concentration of pesticide increases. When sport fish such as bass or trout repeatedly consume contaminated animals, they bioconcentrate high levels in their body fat. Fish can pass these poisons on to humans.

## Persistence of Pesticides

Persistence refers to the length of time a pesticide remains in the environment. This depends on how quickly it breaks down (degrades), which is largely a function of its chemical composition and the environmental conditions. Persistence is usually expressed as the "half life" (T1/2) of a pesticide. Half-life is the amount of time required for half of the pesticide to disappear (the other half remains). Half-life of pesticides can range from hours or days, to years for more persistent ones.

Pesticides can be degraded by sunlight (photodecomposition), high air or water temperatures (thermal degradation), moisture conditions, biological action (microbial decay), and soil conditions (pH). Persistent (long-lasting) pesticides break down slowly and may be more available to aquatic animals.

## Pesticide Formulations

The active ingredient (pesticide) is combined with other inert ingredients (carriers, solvents, propellants) to comprise the formulated pesticide product. In some cases the inert ingredients may cause concern for aquatic life. Pesticides may be purchased in solid (granules, powders, dusts) or liquid (water, oil sprays) form. A major concern in using either solid or liquid forms of pesticides is their misapplication.

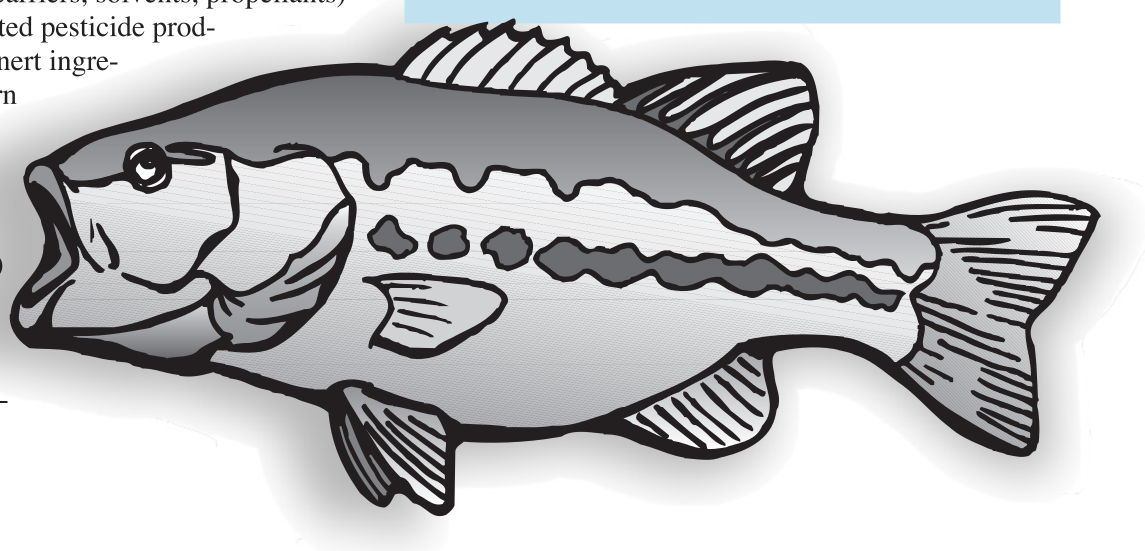
## Sublethal Effects

Not all pesticide poisonings result in the immediate death of an animal. Small "sublethal" doses of some pesticides can lead to changes in behavior, weight loss, impaired reproduction, inability to avoid predators, and lowered tolerance to extreme temperatures.

Fish in streams flowing through croplands and orchards are likely to receive repeated low doses of pesticides if continuous pesticide applications run-off fields. Repeated exposure to certain pesticides can result in reduced fish egg production and hatching, nest and brood abandonment, lower resistance to disease, decreased body weight, hormonal changes, and reduced avoidance of predators. The overall consequences of sublethal doses of pesticides can be reduced adult survival and lowered population abundance.

### Sublethal Effects

- ✔ **Weight Loss**
- ✔ **Low Diseases Resistance**
- ✔ **Sterility**
- ✔ **Reduced Egg Production**
- ✔ **Loss of Attention**
- ✔ **Low Predator Avoidance**



## Habitat Alteration

Pesticides can reduce the availability of plants and insects that serve as habitat and food for fish and other aquatic animals. Insect-eating fish can lose a portion of their food supply when pesticides are applied. A sudden, inadequate supply of insects can force fish to range farther in search of food, where they may risk greater exposure to predation.

Spraying herbicides can also reduce reproductive success of fish and aquatic animals. The shallow, weedy nursery areas for many fish species provide abundant food and shelter for young fish. Spraying herbicides near weedy nurseries can reduce the amount of cover and shelter that young fish need in order to hide from predators and to feed. Most young fish depend on aquatic plants as refuge in their nursery areas.

Aquatic plants provide as much as 80% of the dissolved oxygen necessary for aquatic life in ponds and lakes. Spraying herbicides to kill all aquatic plants can result in severely low oxygen levels and the suffocation of fish. Using herbicides to completely "clean up" a pond will significantly reduce fish habitat, food supply, dissolved oxygen, and fish productivity.

The landowner who sprays a weedy fenceline with herbicides may unintentionally kill the trumpet vine on which hummingbirds feed and the honeysuckle that nourish deer and quail. Similarly, the landowner who unnecessarily sprays his water plants kills the plants that fed the insects that fed the fish that fed the farmer. Casual use of herbicides for lake or farm pond "beautification" may reduce fish populations.

## How Fish are Exposed

Fish and aquatic animals are exposed to pesticides in three primary ways (1) dermally, direct absorption through the skin by swimming in pesticide-contaminated waters, (2) breathing, by direct uptake of pesticides through the gills during respiration, and (3) orally, by drinking pesticide-contaminated water or feeding on pesticide-contaminated prey. Poisoning by consuming another animal that has been poisoned by a pesticide is termed "secondary poisoning." For example, fish feeding on dying insects poisoned by insecticides may themselves be killed if the insects they consume contain large quantities of pesticides or their toxic byproducts.

**Reducing the Risk:** Prior to using a pesticide, consider the following:

**1. Use a Pesticide Only When Necessary**

- Is the problem bad enough to justify the use of a toxic chemical? Are there alternative ways of treating the problem? Landowners should consider the costs and consequences of pesticide treatment relative to the problem.

**2. Use Less Toxic Pesticides**

- One way to reduce the effects of pesticides on aquatic systems is to use those chemicals that are least poisonous to aquatic life. The tables presented at the end of this booklet give information about the relative toxicity of many of the agricultural pesticides. Select the least toxic material.

**3. Use Safe/Sensible Application Methods**

- The first rule of responsible pesticide use is to read and then reread the pesticide label and follow the directions precisely. Label instructions sometimes can be confusing. If you don't understand the instructions, contact your Extension Agent, your supplier, or the pesticide company for more information.
- Pay particular attention to warning statements about environmental hazards on the label. Look for: "This product is toxic to fish." If you see such a warning, consider another pesticide or an alternative control method.
- Ensure that your application equipment is in good working condition. Check for leaks, replace worn parts, and carefully calibrate your equipment.
- When preparing the pesticides for application, be certain that you are mixing them correctly.

### Why Weeds?

- ✔ **Excess Fertility**
- ✔ **Shallow Water**
- ✔ **Exotic Invaders**
- ✔ **Fast Reproduction**

- Never wash spray equipment in lakes, ponds, or rivers. If you use water from natural ponds, lakes, or streams, use an antisiphon device to prevent backflow.
- If you are applying pesticides near water, check the label to find the recommended buffer zone. Buffer strip widths between the water and the treatment areas vary. Leave a wide buffer zone to avoid contaminating fish and aquatic animals.
- Store and dispose of unused chemicals and their containers according to the label instructions.
- Avoid pesticide drift into nontarget areas, or applications during wet, windy weather that might promote runoff to non-target streams, ponds, or lakes. Spray on calm days, or early in the morning or evening when it is less windy.
- Pesticide applicators are liable for downstream fish kills and pesticide contamination.

## Plant Reproduction?

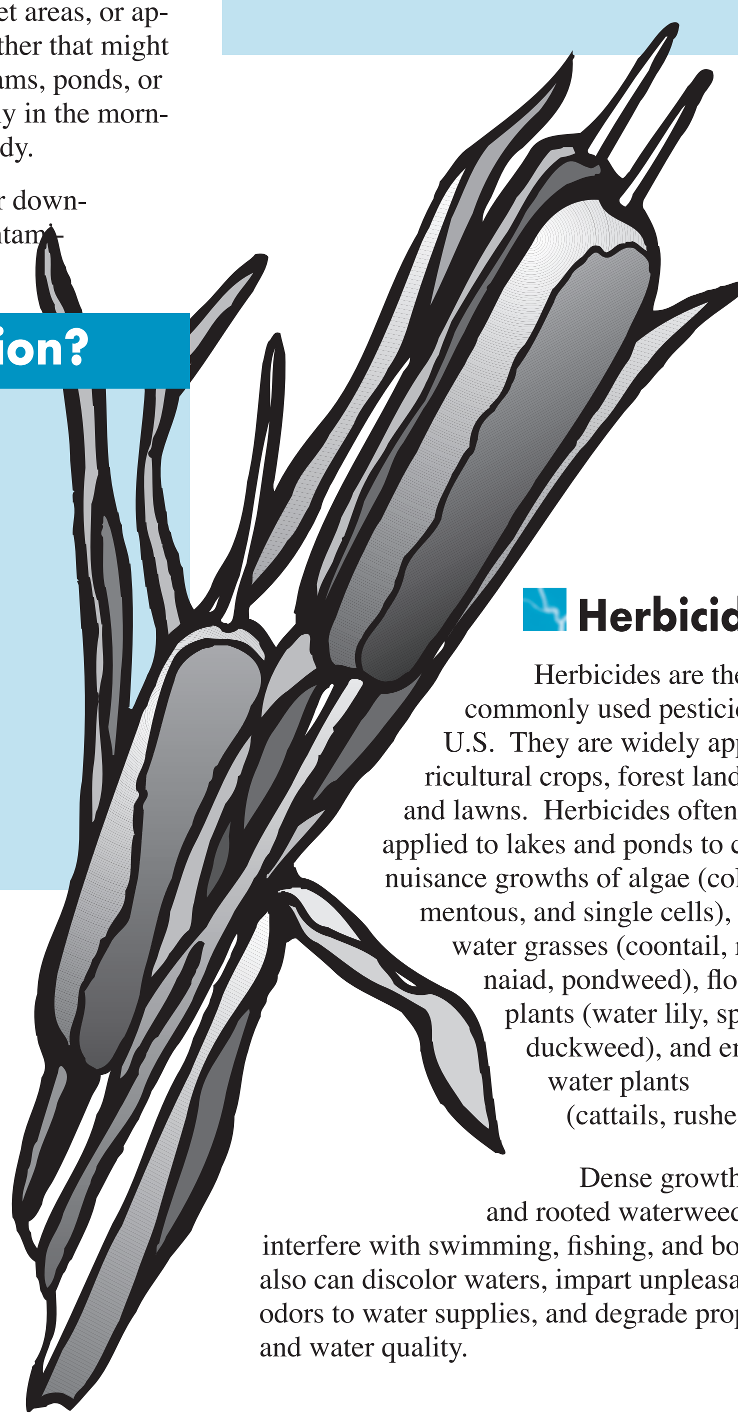
- ✔ **Budding**
- ✔ **Fragmentation**
- ✔ **Rhizomes**
- ✔ **Tubers**
- ✔ **Spores**
- ✔ **Seeds**

## Types of Pesticides

Pesticides are categorized according to their target use. The three major groups of pesticides are herbicides (weed control), insecticides (insect control), and fungicides (disease control). Nematicides are pesticides used to control soil, leaf, and stem-dwelling nematodes (round worms). An acaricide is a pesticide that controls mites and ticks.

## Weed Prevention

- ✔ **Stop Fertilizer Runoff**
- ✔ **Upstream Settling Basin**
- ✔ **Steep Shoreline Slope**
- ✔ **Wide Buffer Zone**
- ✔ **Exclude Livestock**



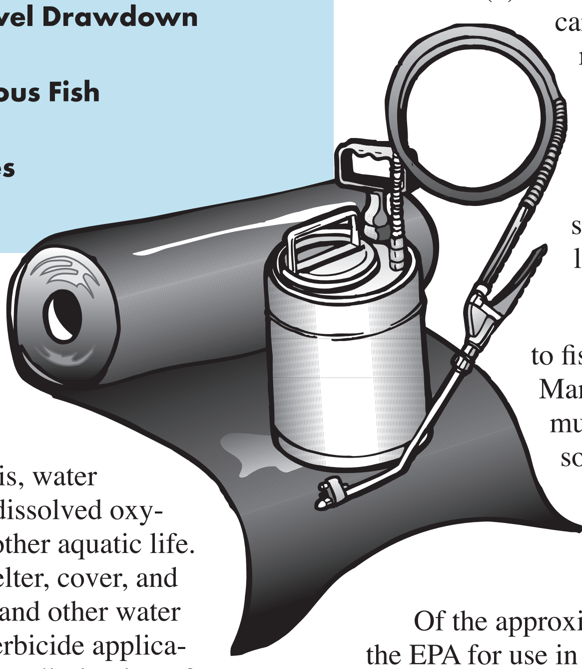
## Herbicides

Herbicides are the most commonly used pesticides in the U.S. They are widely applied to agricultural crops, forest lands, gardens, and lawns. Herbicides often are directly applied to lakes and ponds to control nuisance growths of algae (colonial, filamentous, and single cells), submersed water grasses (coontail, milfoil, naiad, pondweed), floating water plants (water lily, spatterdock, duckweed), and emergent water plants (cattails, rushes, reeds).

Dense growths of algae and rooted waterweeds can interfere with swimming, fishing, and boating. They also can discolor waters, impart unpleasant taste and odors to water supplies, and degrade property values and water quality.

## Plant Control

- ✔ **Hand Removal**
- ✔ **Mechanical Harvesting**
- ✔ **Water Level Drawdown**
- ✔ **Herbiverous Fish**
- ✔ **Herbicides**



Limited numbers of aquatic plants growing in ponds and lakes are beneficial. Through photosynthesis, water plants provide most of the dissolved oxygen necessary for fish and other aquatic life. They also provide food, shelter, cover, and nursery areas for sport fish and other water animals. The purpose of herbicide application is to limit plant growth. Elimination of all aquatic plants is not beneficial.

Nutrient-rich, shallow, clear waters are highly susceptible to water weed invasions. Algae and water weeds can exhibit rapid growth. Water plants can reproduce quickly because they have the ability to reproduce by seeds, fragmentation, budding, rhizomes, tubers, and spores. Some species can reproduce using several of these methods. Non-native water weeds are especially problematic because they have no native insect or animal to control their growth.

Abundant water weeds are usually a symptom of overfertilization. The lasting solution to a weed problem is to reduce fertilizer runoff. Herbicides only treat the symptoms of overfertilization (the weeds); the real cause (excessive nutrients) remains after herbicide treatment. Unless the nutrients are removed, they will endlessly stimulate successive algae blooms and rooted weed growths. In this sense, herbicides are only a short-term, cosmetic treatment.

Prevention is the best way to reduce water weed problems. Constructing ponds and lakes with steep slopes that drop quickly into deep water reduces weed growth. Construction of a sediment basin upstream from a pond or lake will help reduce the sediment and nutrient loads entering a water body.

Algae and waterweeds can be controlled by a number of nonchemical methods. Herbicides may not always be the most efficient or safest water weed control technique. Other effective water weed control methods include (1) stocking plant-eating fish like the grass carp, (2) hand or mechanical weed removal by cutting, uprooting, and harvesting, (3) dredging and deepening shallow, weedy areas, (4) lake drawdowns, (5) using chemical dyes or black plastic to eliminate light and shade-out weeds, and (6) using pond liners to prevent rooting.

Herbicides generally are less toxic to fish and aquatic life than insecticides. Many are short-lived and do not accumulate in the environment. However, some are highly toxic to aquatic animals and should be avoided or used with extreme caution near water ways and aquatic environments.

Of the approximately 200 herbicides registered by the EPA for use in the United States, only about 10 are labeled for use in aquatic systems (Tables 1 and 3).

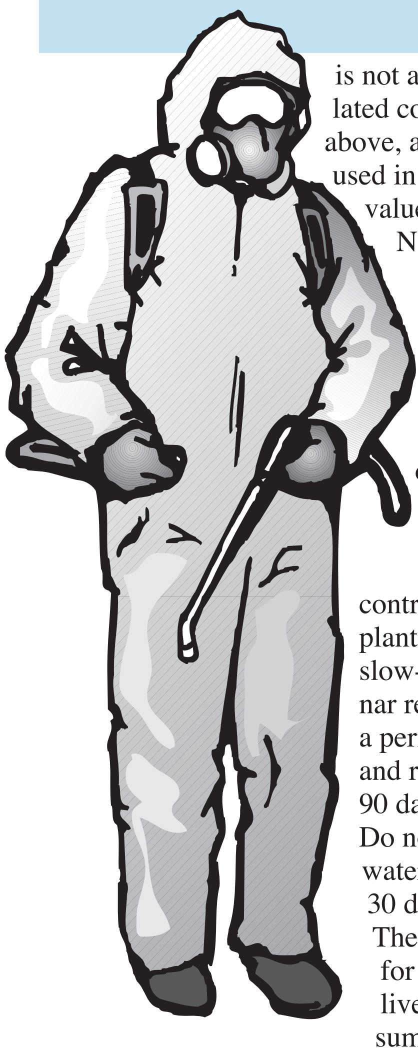
**Endothall** compounds (Aquathol and Hydrothol) are registered by EPA as aquatic herbicides, but they are relatively toxic to fish at rates near those needed to kill water weeds. The Hydrothol formulation is the most risky to use in fish ponds. Endothall cannot be used in irrigation water, livestock water, or in food crop or food fish areas without withholding restrictions (Table 2).

Fortunately, there are a number of other less toxic, but effective, herbicides that are registered for use in aquatic systems. The five herbicides most commonly used in ponds and lakes include copper sulfate, fluridone, glyphosate, zx, and diquat (Table 3).

**Chelated copper** complexes and **copper sulfate** (Bluestone) are used to control algae, not rooted aquatic plants. Most algae species are effectively controlled by these herbicides. However, copper is a toxic metal that is long-lived (persistent) in the environment. Copper sulfate can be toxic to fish and aquatic animals at concentrations near levels used to control algae, especially in soft water. Copper toxicity increases as water hardness decreases. Copper sulfate

## Chemicals

- **Copper Compounds**
  - **Copper Sulfate**
- **Fluridone**
  - **Sonar**
- **2,4-D**
- **Glyphosate**
  - **Rodeo**
- **Diquat**
  - **Weedtrine**
- **Endothall**
  - **Aquathol**
  - **Hydrothol**



is not as safe to use as chelated copper compounds listed above, and it should not be used in soft waters (alkalinity values less than 50 mg/L). No water-use restrictions are associated with copper compounds.

**Fluridone** (Sonar) is perhaps the safest of the registered herbicides to use in fish ponds. It is expensive and will not kill algae, but effectively controls submersed aquatic plants. It is a persistent, slow-acting herbicide. Sonar residue may persist for a period of 2 to 12 months, and results may take 30 to 90 days to be noticeable. Do not use Sonar-treated water for crop irrigation for 30 days after application. There are no restrictions for fishing, swimming, or livestock or human consumption.

**Glyphosate** (Rodeo) is best used for control of emergent and shoreline weeds such as cattail, reeds, rushes, smartweeds, and some floating-leaf plants like water lily and lotus. It is usually applied to the plant and not directly to the water. It is quickly bound to suspended particles and bottom sediments and is rapidly inactivated. It has no waiting period or withdrawal restrictions for irrigation water, livestock water, fish consumption, or swimming. Use only those glyphosate products labeled and specially-formulated for aquatic systems. Some glyphosate products contain additives that are toxic to aquatic organisms.

**2,4-D** (Aquacide, Aqua-Cleer, Weedar, Weed-Rhap, Weedestroy, Weedtrine ) is effective for controlling submersed aquatic plants. These compounds rapidly and completely decompose in about 3 weeks. Toxicity of these herbicides increases as pH decreases. They are less effective at pHs greater than 8, and more toxic in acidic waters (pH<6). Depending on the formulation, 2,4-D can be highly toxic to rainbow trout. 2,4-D should not be used in water for irrigation, livestock, or domestic purposes.

**Diquat** (Diquat, Aqua-Clear, Aqua-Quat, Watrol, Weedtrine) is a wide-spectrum herbicide that can be used to control algae and submersed weeds, but it is not especially effective on emergent weeds. A 14-day waiting period is required by law before diquat-treated water can be used for livestock consumption, crop irrigation, or drinking. There are no restrictions for fishing, but a 1-day waiting period is required before swimming. Diquat is rarely found in treated water after 10 days.

Fish kills may occur after herbicide application, even when the herbicide used is not directly toxic to fish. Fish die indirectly from suffocation, rather than herbicide poisoning, because masses of rotting water weeds killed by the herbicide decompose, reducing oxygen levels.

When using herbicides, treat one-half (or less) of the lake at a time to allow fish freedom to move to untreated, oxygen-rich areas of the pond or lake. Apply herbicides during the spring when water temperatures are cooler and dissolved oxygen levels are higher than in summer. Some herbicides are not as toxic at colder temperatures. Apply in early spring when weeds are small and not well established, and when fewer weeds are present to decompose.

## Application Timing

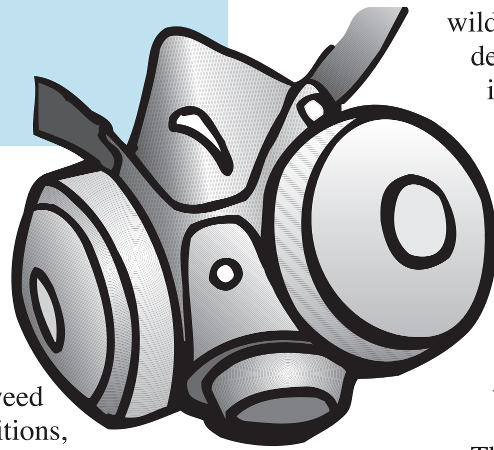
- ✔ **Early Spring**
- ✔ **Small Weeds**
- ✔ **Actively Growing**
- ✔ **Less Decay**
- ✔ **Cool Water**

Application rates in aquatic systems depend on a number of factors. Important considerations are extent of area treated, water depth, water temperature (stratification), water exchange (flow) rates, weed density, weed species, weather conditions, water clarity, and suspended particles.

Identification of the weed or pest is critical in planning an effective control strategy. The relative effectiveness of different aquatic herbicides varies depending on the weed species (Table 1). Consult with your Extension Agent on weed identification prior to selecting a herbicide.

Applying the right amount of herbicide is especially important to achieve good control, avoid nontarget toxicity, eliminate unnecessary expense, and comply with the legal requirements. After application of a herbicide, comply with the required waiting period before using water for irrigation, livestock watering, swimming, or fishing (Table 2).

In addition to herbicides, biological control animals can be stocked to feed on water weeds. Grass carp is a fish that will eat a wide variety of submersed, emersed, and floating weeds. Some plants such as filamentous algae, cattails, rushes, and watershield are not preferred by grass carp and are not well controlled by this fish. Because grass carp is an exotic fish, most state fish and game agencies require that you obtain a permit to stock this species. Only sterile (triploid) grass carp should be stocked so that this non-native does not reproduce and outcompete native fishes. Recommended stocking rates range from 7 to 15 fish per surface acre of water.



## Insecticides

The 1962 publication of Rachel Carson's *Silent Spring* directed public attention to the effects that pesticides, primarily insecticides, were having on wildlife and the environment. When this book was written, the predominant insecticides used were synthetic chemicals called organochlorine insecticides (OCs).

The most infamous OC is DDT (dichlorodiphenyltrichloroethane). Its effect on fish, wildlife, and natural environments was devastating. Other OC insecticides, including aldrin, toxaphene, dieldrin, mirex, and heptachlor, were also very toxic to fish and wildlife, and they are banned from use in the United States. The ban on many OC insecticides in the United States has been important in the survival of fish and aquatic species and the protection of water quality.

The four main types of agricultural insecticides used today are pyrethroids (PYs), organophosphates (OPs), carbamates (CBs), and biological insecticides (BIs).

PYs, especially synthetic ones, are the most toxic group of insecticides to fish and aquatic invertebrates. They should be used with extreme caution near waterways. Despite the fact that PYs are highly toxic to aquatic animals, they seldom cause fish kills because: (1) they are strongly absorbed to bottom muds, (2) they are short lived and usually last only days, (3) they rapidly decompose in 1 to 10 days when exposed to sunlight, and (4) they usually are applied at lower rates compared to the other insecticides.

Many OP and CB insecticides are extremely hazardous to fish and wildlife. Fish kills involving these insecticides have been documented. OP insecticides can bioconcentrate in fish, frogs, tadpoles, and toads to levels that pose hazards to their predators. OP and CB insecticides are water soluble and metabolized quickly. They generally have short persistence (half-lives of days to months), and their residues do not pose long-term problems for aquatic animals. The CB insecticide carbofuran is extremely toxic to wildlife and fish.

Some BI insecticides are less hazardous to fish and other aquatic animals, because many target specific insects (narrow spectrum). BIs include microbials and insect growth regulators. For example, the microbial, *Bacillus thuringiensis* (BT), is a bacterium that causes disease in some insects, but does not harm other animals or plants. Insect growth regulators affect the normal growth and development of some insects. For example, Diflubenzuron (Dimilin) inhibits the formation of an insect's hard exoskeleton (outer shell). Some insect growth regulators can harm beneficial aquatic invertebrates and thus reduce the food supply for young fish.

## Fungicides

Fungicides, like herbicides, generally are not as highly toxic to fish and aquatic animals as insecticides. However, some fungicides have been banned due to their adverse effects on the environment. Fungicides containing mercury were discontinued for home and agricultural use in the United States in 1976. Mercurial fungicides accumulated in the environment and concentrated up the food chain, causing fish kills.

Some currently-registered fungicides are extremely toxic to aquatic organisms. Some fungicides are poisonous to beneficial soil invertebrates. Their use should be avoided or carefully managed near aquatic systems.

### Application Rates

- ✔ **Algae or Rooted Weeds**
- ✔ **Water Depth**
- ✔ **Weed Species**
- ✔ **Weed Density**
- ✔ **Water Exchange**
- ✔ **Water Temperature**
- ✔ **Turbidity**
- ✔ **Weather**

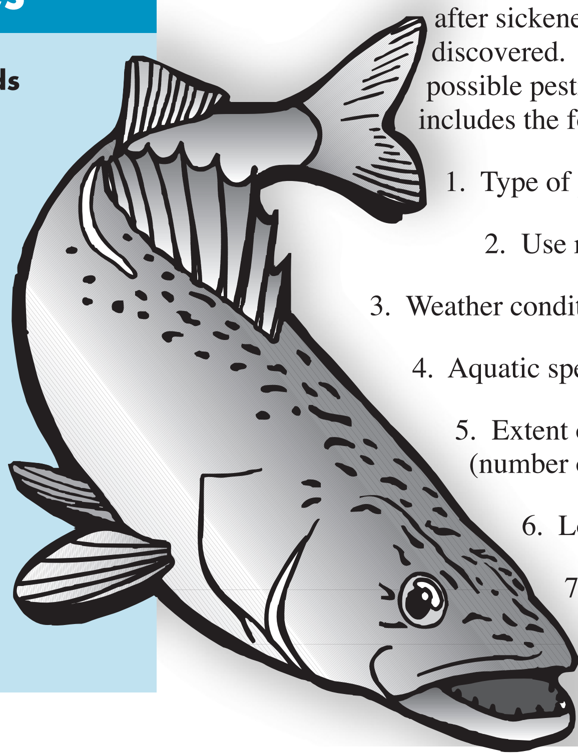
## Detection of Fish Kills

Pesticide exposure of fish and other aquatic life may be a more widespread problem than most people realize. Most pesticide-related fish kills go unreported and, in documented cases, the number of fish killed is often underestimated. The underwater conditions, including water clarity and depth, and the small size and camouflage coloring of many fish, particularly young fish, make accurate counts difficult. Scavengers quickly remove carcasses from a kill site. Dying and stressed fish may hide in dense cover or leave the area completely.

The remoteness of many streams and wetlands often diminishes chances of detection of fish kills. When dead fish are found after a pesticide application, the incident may go unreported because it is not considered important, or because of fear of liability. Sometimes no association is made between a kill and a past pesticide application because of the amount of time that has elapsed. These factors and others tend to obscure the full impact that some pesticides are having on fish and aquatic systems.

## Reporting Pesticide Spills

If you have knowledge of sick or dead fish and aquatic life that you suspect may have been poisoned by pesticides, please contact your local game warden or the United States Fish and Wildlife Service immediately. Please notify an official as soon as possible after sickened or dead wildlife are discovered. Information about possible pesticide-related incidents includes the following:



1. Type of pesticide product
2. Use rates
3. Weather conditions
4. Aquatic species involved
5. Extent of the problem (number of fish killed)
6. Location
7. Size of pond or lake affected

Pesticide accidents or incidents that constitute a threat to any person, to public health or safety, and/or to the environment must be reported to the responsible state agency. Initial notification must be made by telephone within 48 hours of the occurrence. A written report describing the accident or incident must be submitted within 10 days of the initial notification.

In Virginia, initial telephone contact and written reports should be directed to the Virginia Department of Agriculture and Consumer Services, Office of Pesticide Services, Enforcement and Field Operations, P.O. Box 1163, Richmond, VA 23218, call (804) 371- 6560. In the event of an emergency release which may impact others or other property, notify the Virginia Department of Emergency Services at 1-800-468-8802.

If the accident or incident involves a spill, the applicator should contact the responsible state agency to determine whether the release is governed under SARA Title III (the community Right-to-Know Law). Reporting under this regulation is determined by the chemical hazard and the volume of the released chemical. If required, the applicator must notify the National Response Center at 1-800-424-8802.

## Endangered Species and Pesticides

Congress passed the Endangered Species Act (ESA) in 1973 to protect animals and plants that are in danger of becoming extinct and to protect their habitat. The ESA requires that any action authorized by a Federal agency, such as the registration of pesticides, does not harm threatened or endangered species or their habitat.

The EPA plans to identify pesticide products that have the potential to jeopardize endangered or threatened species by a statement on the label. This statement will instruct users to determine if there are any limitations on the pesticide's use in the county where it is to be applied.

## Integrated Pest Management

Integrated pest management (IPM) is a system using a variety of methods, including pesticides, to reduce pest populations to acceptable levels. IPM was developed in response to overdependence on pesticides. Factors such as groundwater contamination, increasing cost of agricultural chemicals, consumer concerns about pesticide residues on foods, and concern for the environment encourage the use of IPM.
IPM strategies include:

1. Cultural control (crop rotation and selected planting dates to avoid pests).

2. Host resistance (using plants and livestock that are resistant to pests).

3. Mechanical control (uprooting, weed harvesting, cultivation, and use of insect traps)

4. Biological control (stocking grass carp to feed on water weeds)

5. Chemical control with pesticides

6. Sanitation

The key to sound pest control strategies is to determine the extent of the problem. In IPM, pesticides are not applied until pest populations reach an unacceptable (economical or aesthetic) threshold. Rather than indiscriminately applying pesticides, IPM protects naturally-occurring insect predators, parasites, and pathogens to keep pest populations at acceptable levels.

The importance of pest control exerted by naturally-occurring beneficial organisms is usually unnoticed, but its value is significant. For example, as much as 40 percent of the water weeds in a lake can be eliminated by natural plant-eating water animals (aquatic insects, crayfish, herbivores fish) or parasites. IPM takes advantage of these natural controls. IPM programs occur in many places nationwide. They may be applied in

### Water-use Restrictions

- ✔ **Fishing**
- ✔ **Swimming**
- ✔ **Irrigation**
- ✔ **Livestock**
- ✔ **Drinking**

many situations ranging from home gardens to commercial water weed management.

An increased interest in sustainable agriculture is evidence of the movement toward more diverse cropping systems. Some of the benefits of diverse systems include reduced soil erosion, improved water quality, enhanced nutrient cycling, and reduced pesticide inputs. These systems are economically competitive with conventional farming systems and also good for fish and wildlife.

Many fish and wetland species live in waters that run through farmland. Activities on the farm, including pesticide use, can affect fish and water quality far downstream. Farmers and landowners who use pesticides can protect aquatic habitats by first considering whether pesticide treatment is really necessary. If pesticides must be used, use the least toxic product that will do the job and apply it according to the label. Avoid important wildlife habitats such as wetlands, stream sides, and pond and lake shores. Use the following Best Management Practices.

## Best Management Practices for Protecting Water Quality

1. Use Integrated Pest Management (IPM) practices so chemical controls will be used only when necessary. Before using any pesticide, be sure the application is needed, and can be accomplished safely and effectively.

2. Evaluate chemical control options. Select the option that is least likely to have a negative impact on water quality. Select products that minimize waste and applicator exposure.

3. Read and follow all label directions. Use pesticides only as directed. Pay careful attention to application site requirements, methods, and rates. Pesticide label directions are not advice, they are legal requirements.

4. Use care when mixing and loading pesticides. Be sure the equipment is working correctly and is properly calibrated. Prepare only the amount of pesticide mix needed for the immediate application.

5. Apply pesticides at the proper time. Consider weather and pest life cycle when planning applications.

6. Store pesticides safely in a ventilated, well lighted, and secure area free from flooding.

7. Dispose of empty containers and rinse water properly.

8. Keep records of all pesticide use. Records will allow evaluation of pest control efforts and help plan future treatments.

## Toxicity Tables

The tables provided at the end of this publication give toxicity information for many of the common pesticides used in and near aquatic ecosystems. Acute effects are those that occur rapidly in animals following a single dose or single exposure to a chemical. Death is the acute effect most commonly used in toxicity testing. The acute toxicity of chemicals toxic to aquatic animals usually is reported as a LC50 value. The LC50 value is the concentration of a chemical in water (usually milligrams/liter or ppm, parts per million) that can kill 50 percent of the test animals in a given period of time. An exposure time of 24, 48, or 96 hours is given. The more toxic the pesticide, the lower its LC50 value will be.

The toxicity of pesticides to aquatic animals is influenced by many factors. These include the species, age, sex, and condition of an animal, water temperature, and the pesticide formulation. As a result, several LC50 values can exist for the same chemical.

Aquatic toxicity data for ready-to-use pesticides is not generally available. Tables 3, 4, and 5 provide acute toxicity data of technical (manufacturing) grade pesticide active ingredients. However, the actual toxicity of a pesticide is dependent on the formulation, and its use dilution. Acute toxicity information for fish was gathered from five primary references marked with an * in the following suggested publications list. The lowest (most toxic) value is reported.

**Table 1. Relative effectiveness of aquatic herbicides for the control of selected water weeds.**

| Plant Species | Copper Sulfate | Dichlobenil | Diquat | Endothal K | Fluridone | Glyphosate |
|---|---|---|---|---|---|---|
| Algae | | | | | | |
| Filamentous | Good | Good | | | | |
| Chara | Good | Good | | | | |
| Nitella | Good | Good | | | | |
| Submersed Plants | | | | | | |
| Bladderwort | | Good | Good | | Excellent | |
| Coontail | | Excellent | Excellent | Excellent | Excellent | |
| Elodea | | Excellent | Excellent | | Good | |
| Watermilfoil | | Good | Excellent | Excellent | Good | |
| Parrotfeather | | Fair | Excellent | Excellent | Good | |
| Hydrilla | | Fair | Good | Good | Excellent | |
| Pondweed | | Excellent | Good | Excellent | Excellent | |
| Slender Naiad | | Excellent | Excellent | Excellent | Excellent | |
| Southern Naiad | | Good | Good | Poor | Good | |
| Floating Plants | | | | | | |
| Duckweed | | | Excellent | Poor | Excellent | |
| Watermeal | | | Fair | | Fair | |
| Emersed Plants | | | | | | |
| Bullrush | | | | | Poor | Good |
| Cattail | | | Good | | Fair | Excellent |
| Spatterdock | | Good | | | Good | Excellent |
| Water lilly | | | | | Good | Excellent |
| Watershield | | | | | Excellent | |

**Table 2. Waiting period (days) before using water after application of aquatic herbicides.**

| Herbicide | Irrigation | Fishing | Livestock | Swimming |
|---|---|---|---|---|
| Fluridone (Sonar) | 30 | 0 | 0 | 0 |
| Glyphosate (Rodeo) | 0 | 0 | 0 | 0 |
| Copper sulfate | 0 | 0 | 0 | 0 |
| Diquat | 14 turf 5 | 0 | 14 | 1 |
| Endothal | | | | |
| Aquathal K | 14 | 3 | 14 | 1 |
| Aquathal G | 7 | 3 | 14 | 1 |
| Dichlobenil | 90 | 90 | — | — |

### Table 3. Toxicity to fish of commonly used herbicides.

| Toxicity Classification | $LC_{50}$ (mg/L*) | Toxicity Classification | $LC_{50}$ (mg/L*) |
|---|---|---|---|
| super | < 0.01 | slight | 11 - 100 |
| extreme | 0.01 - 0.10 | minimal - nontoxic | > 100 |
| High | 0.11 - 1.0 | | |
| moderate | 1.1 - 10 | *1 mg/L = 1 part per million (ppm)* | |

| Chemical Name | Commonly Used Trade Name | Toxicity Classification | 96-hour[a] $LC_{50}$ (mg/L) Rainbow trout[b] | 96-hour[a] $LC_{50}$ (mg/L) bluegill[b] |
|---|---|---|---|---|
| acetochlor | Harness, Surpass | high | 0.5 | 1 |
| acifluorfen | Blazer | slight | 17 | 31 |
| alachlor | Lasso, Micro-Tech, Partner | moderate | 2 | 3 |
| ametryn | Evik | moderate | 9 | 4 |
| atlazine | AAtrex | moderate-slight | 5 | 16 |
| benefin | Balan | extreme | 0.08 | 0.06 |
| bensulide | Betasan | high | 0.7 | 0.8 |
| bentazon | Basagran | minimal | 109 | 116 |
| bromacil | Hyvar | slight | 56-75 *(48hr)* | 71 *(48hr)* |
| bromoxynil | Buctril | extreme | 0.1 | 0.06 |
| butylate | Sutan | moderate | 4 | 7 |
| chlorimuron | Classic | slight-minimal | 50 | > 100 |
| Clomazone | Command | slight | 19 | 34 |
| copper (chelated) complex | K-Tea, Komeen | high-moderate | 0.2 4[d] | 1 - 8[d] |
| copper sulfate | bluestone | moderate-high | 0. 1[d] | 0.8 - 7[d] |
| 2,4-D | Aqualeer, Weedar, Weedestroy | slight-high | 1 - 100[C] | > 100 |
| 2,4-DB | Butoxone, Butyrac, Embutox | moderate | 2 | 8 |
| DCPA | Dacthal | minimal-nontoxic | - | > 100 |
| dicamba | Banvel, Clarity, Vanquish | slight | 135 | 135 |
| dichloberlil | Casoran, Norosac | slight-moderate | > 18 (48h, guppy) | > 6 |
| diclofop | Hoelon | high | 0.25 | 0.54 |

| Chemical Name | Commonly Used Trade Name | Toxicity Classification | 96-hour[a] $LC_{50}$ (mg/L) Rainbow trout[b] | bluegill[b] |
|---|---|---|---|---|
| diquat | Aqua-clear, Aqua-Quat, Weedtrine | slight-moderate | 10 | 115 |
| diuron | Karmex | moderate | 6 | 6 |
| endothall | Aquathol, Hydrothol | high | 0.14 | 0.94 |
| EPTC | Eptam, Eradicane, Shortstop | slight | 19 | 27 |
| fluazifop-p-butytl | Fusilade | moderate | 5.4 | |
| fluometuron | Cotoran, Meturon | slight | 47 | 96 |
| fluridone | Sonar | slight | 12 | l6 |
| fosarnine | Krenite | minimal | 415 | 278 |
| glyphosate | Roundup, Rodeo | slight | 38 | 120[d] |
| hexazinone | Velpar | minimal | 320 | 370 |
| "inert" dyes | Aquashade | - | - | - |
| irnazapyr | Arsenal,Chopper, Contain | minimal | > 100 | > 100 |
| lactofen | Cobra | moderate | 3.7 | 2.1 |
| linuron | Lorox, Linex | slight | 16 | 16 |
| metolachlor | Dual, Pennant | moderate-slight | 2 | 15 |
| metribuzin | Lexone, Sencor | slight | 42 | 80 |
| napnpamide | Devrinol | moderate-slight | 9 | 20 |
| naptalam | Alanap | slight-minimal | 76 | 354 |
| nofflurazon | Solicam, Zorial | moderate | 6 | 200 *(catfish)* |
| oryzalin | Surflan | moderate | 3 | 3 |
| oxadiazon | Ronstar | hugh | 9 (carp) | *o.g* |
| oxyfluorfen | Goal | high | 0.4 | 0.2 |
| paraquat | Gramoxone | slight | 15 | 13 |
| pendimethalin | Prowl, Stomp | high | 0.1 | 0.2 |
| picloram | Tordon | moderate-slight | 3.1 | 13.5 |
| prometryn | Caparol, Cotton-Pro | moderate | 3 | 10 |
| propanil | Stam | moderate | 3 | 4 |
| simazine | Princep | moderate-slight | 3 | 16 |

**Table 3. (continued) Toxicity to fish of commonly used herbicides.**

| Chemical Name | Commonly Used Trade Name | Toxicity Classification | 96-hour[a] $LC_{50}$ (mg/L) Rainbow trout[b] | bluegill[b] |
|---|---|---|---|---|
| sulfometuron | Oust | slight | 13 | 13 |
| tebuthiuron | Spike | minimal | 144 | 112 |
| terbacil | Sinbar | slight-minimal | 46 | 103 |
| triclopyr | Garlon, Pathfinder | minimal | 117 | 148 |
| trifluralin | Treflan, Elancolan, Trim | Super-extreme | 0.01 *(young trout)* | 0.02 *(young bluegill)* |
| vernolate | Vernam | moderate | 10 | 8 |

[a]*Toxicity values are determined by 96h exposure time unless otherwise specified*

[b]*Toxicity values are for rainbow trout and bluegill sunfish unless otherwise specified*

[C]*Toxicity depends on formulation*

[d]*Toxicity depends on pH - more toxic in water with low alkalinity*

## Table 4. Toxicity to fish of commonly used insecticides, miticides, and nematicides

| Toxicity Classification | $LC_{50}$ (mg/L*) | Toxicity Classification | $LC_{50}$ (mg/L*) |
|---|---|---|---|
| super | < 0.01 | slight | 11 - 100 |
| extreme | 0.01 - 0.10 | minimal - nontoxic | > 100 |
| High | 0.11 - 1.0 | | |
| moderate | 1.1 - 10 | *1 mg/L = 1 part per million (ppm)* | |

| Chemical Name | Commonly Used Trade Name | Toxicity Classification | 96-hour[a] $LC_{50}$ (mg/L) Rainbow trout[b] | bluegill[b] |
|---|---|---|---|---|
| abamectin | Affirm, Avid | super-extreme | 0.003 | 0.01 |
| acephate | Orthene, Monitor, Payload | minimal | >1000 | 20.50 |
| aldicarb | Temik | high-moderate | 0.9 | 1.5 |
| azinphos-methyl | Guthion | extreme | 0.003 | 0.004 |
| *Bacillus thuringiensis* | Dipel, Thuricide,Vectobac | minimal | > 1,000 | - |
| bendiocarb | Dycarb, Ficam, Turcam | high | - | ().4 |
| cabaryl | Sevin | moderate | 1.3 | 10 |
| carbofuran | Furadan | high | 0.3 | 0.2 |
| chlorpyrifos | Killmaster II, Brodan, Eradex | super-extreme | 0.003 | 0. 01 |
| cypermethrin | Ammo, Cynoff, Fury | super | 0.0008 | 0.002 |
| diazinon | Diazinon | moderate-slight | 2.6 | 16 |
| diflubenzuron | Dimilin | minimal | - | >100 |
| dimetlsoate | Cygon | moderate | 6.2 | 6 |
| disulfoton | Di-Systom | high-moderate | 1.9 | ().3 |
| endosulfan | Thiodan | super | 0.001 | 0.001 |
| esfenvalerate | Asana | super | 0.0003 | 0.0003 |
| ethoprop | Mocap | moderate-slight | 13.8 | 2.1 |
| oxydemeton-methyl | Metasystox-R | moderate-slight | 4 | 11 |
| esfenvalerate | Ectrin, Pydrin | super | 0.004 | - |
| fluvalinate | Mavrik | super | 0.003 | 0.0009 |
| fonofos | Dyfonate | extreme-super | 0.02 | 0.007 |
| lindane | Lindane | super-extreme | 0.002 | 0.03 |
| malathion | Cythion | extreme | 0.07 | 0.02 |

**Table 4. (continued) Toxicity to fish of commonly used insecticides, miticides, and nematicides.**

| Chemical Name | Commonly Used Trade Name | Toxicity Classification | 96-hour[a] $LC_{50}$ (mg/L) Rainbow trout[b] | bluegill[b] |
|---|---|---|---|---|
| methamidophos | Monitor | slight | 25 | 34 |
| methidathion | Supracide | extreme-super | 0.01 | 0. 002 |
| methiocarb | Mesurol | high | 0.6 | 0.2 |
| methomyl | Lannate | high-moderate | 3.4 | 0.8 |
| methoxychlor | Methoxychlor | extreme | 0.01 | 0.03 |
| methyl parathion | Penncap-M | high-moderate | 2.8 | 1.0 |
| naled | Dibrom | high-moderate | 0.2 | 2. 2 |
| oxamyl | Vydate | moderate | 4.2 | 5. 6 |
| parathion | Parathion, Paraspray | extreme-high | 0.8 | 0. 02 |
| permethrin | Ambush, Pounce | super | 0.003 | 0.005 |
| phorate | Holdern,Thimet | super-extreme | 0.01 | 0.001 |
| phosmet | Imidan | extreme | 0.02 | 0.02 |
| propoxur | Baygon | moderate | 6.6 | 3.7 |
| pyrethrin | Various | extreme | - | 0.04 |
| resmethrin | Scourge | super | 0.002-0.0003 | 0.003 -0.0008 |
| rotenone | Rotenone, Rotacide | extreme | 0.03 | 0.02 |
| temephos | Abate | extreme-slight | 0.2 - 3.5 | 1.4 - 21.8 |
| terbufos | Counter | super-extreme | 0. 01 | 0.004 |
| tetrachlorvinphos | Rabon | high | - | 0.5 |
| trichlorfon | Dylox, Proxol | extreme-high | 0.07 | 0.2 |

[a]*Toxicity values are determined by 96h exposure time unless otherwise specified*

[b]*Toxicity values are for rainbow trout and bluegill sunfish unless otherwise specified*

**Table 5. Toxicity to fish of commonly used fungicides.**

| Toxicity Classification | $LC_{50}$ (mg/L*) | Toxicity Classification | $LC_{50}$ (mg/L*) |
|---|---|---|---|
| super | < 0.01 | slight | 11 - 100 |
| extreme | 0.01 - 0.10 | minimal - | > 100 |
| High | 0.11 - 1.0 | nontoxic | |
| moderate | 1.1 - 10 | *1 mg/L = 1 part per million (ppm)* | |

| | | | 96-hour[a] $LC_{50}$ (mg/L) | |
|---|---|---|---|---|
| **Chemical Name** | **Commonly Used Trade Name** | **Toxicity Classification** | **Rainbow trout[b]** | **bluegill[b]** |
| benomyl | Benlate, | high | 0.2 | 0.2 |
| captan | Agrox, Captan, Captec | extreme-moderate | 0.06 | 0.12 |
| carboxin | Vitavax | high-moderate | > 0.1 | 1.2 |
| chlorothalonil | Bravo, Daconil,Terlanil | high | 0.3 | 0.3 |
| coppersutfate | Basicop,Bluestone | high-moderate | 0.14 | 0.8-7.3[d] |
| fenarimol | Rubigan | high | 2 | 0.9 |
| fosetyl -Al | Aliette | minimat | 428 | - |
| iprodione | Rovral | moderate | 4 | 6 |
| mancozeb | Dithane, Fore, Manzate | high-moderate | 2 *(48h)* | *1* |
| maneb | Maneb, Manex | high-moderate | 2 *(48h)* | *1* |
| metalaxyl | Ridomil | minimal | > 100 | > 100 |
| metiram | Polyram | high-slight | 1 | 85 *(carp)* |
| PCP | Pentachlorophenol | high | 0.2 *(48h)* | - |
| PCNB | Terraclor | high | 0.6 | 0.1 |
| propiconazole | Alamo, Orbit,Banner, Tilt | high-moderate | 0.9 | 1.3 |
| thiophanate-methyl | Topsin | moderate | 9.4 | - |
| thiram | Thiram, Spotrete | high-moderate | 0.1 | 0.2 |
| triadimefon | Bayleton | slight | 14 | 11 |
| triforine | Funginex | minimal | > 1000 | > 1000 |
| vinclozolin | Ronilan, Ornalin | slight-minimal | 53 | 130 *(guppy)* |
| ziram | Ziram | moderate | 5 (5h, *goldfish)* | - |

[a]*Toxicity values are determined by 96h exposure time unless otherwise specified*

[b]*Toxicity values are for rainbow trout and bluegill sunfish unless otherwise specified*

[c]*Toxicity depends on formulation*

[d]*Toxicity depends on pH - more toxic in water with low atkalinity*

## Suggested Publications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## Pesticide Resource Agencies

The National Response Center 1-800-424-8802

EPA National Pesticide Telecommunications Center. General Information, Corvalis, Oregon. 1-800-858-7378

U.S. Environmental Protection Agency, Office of Pesticide Programs, Ecological Effects Branch, 401 M St. H7507-C, Washington, DC 20460. Call Incident Data to (703) 305-7347

Virginia Department of Agriculture and Consumer Services. Office of Pesticide Service, Enforcement and Field Operations. P.O. Box 1163. Richmond, VA 23218, (804) 371-6560.

Virginia Department of Environmental Quality. Report all pesticide spills into water to 2111 North Hamilton Street P.O.B. 11143 Richmond, VA 23230. Call the nearest District Office: Virginia Beach (804) 552-1840; Richmond (804) 527-5020; Woodbridge (703) 490-8922; Bridgewater (540) 828-2595; Roanoke (540) 562-3666, Abingdon (540) 676-4800.

Virginia Cooperative Extension. General information. Virgina Tech Pesticide Program, Blacksburg, VA 24061 (540) 231-6543

Virginia Department of Game and Inland Fisheries. Report all wildlife and fish kills. Richmond, VA (804) 367-1000.

Virginia Department of Health. Toxicology Information, Bureau of Toxic Substances,

109 Governors Street, Room 918, Richmond, VA 23219 (804) 786-1763

Virginia Department of Emergency Services. 1-800-468-8892.

## Terminology

**acaricide** - A pesticide that controls mites and ticks.

**active ingredient** - The ingredient in a pesticide product that controls or repels a pest.

**acute toxicity** - The capacity of a chemical to cause death or injury from a single dose or exposure. LC50 is used to indicate the degree of acute toxicity for aquatic animals.

**beneficial insects** - Insects that are useful to humans. For example, pollinators, pest predators, and pest parasites.

**bioconcentrate -** The accumulation of a chemical in tissues of an animal at levels greater than in the environment.

**biomagnify** - The increase in concentration of a chemical in animals at each succeeding level of the food chain.

**dose rate** - Quantity of pesticide to which an animal is exposed, a measure of exposure.

**exposure -** Contact with a pesticide**.**

**fungicide** - A pesticide that controls fungi.

**half-life.** The amount of time required for half of the pesticide residue to disappear from soil, water, plants, or animals**.**

**herbicide** - A pesticide that controls plants or inhibits their growth.

**insecticide** - A pesticide that controls insects.

**label** - A legal document attached to the pesticide container, which is a binding agreement between the pesticide registrant, EPA, and the user.

**Lethal Dose 50 (LD50)** - The dose of a chemical that kills 50 percent of the group of test animals. It is usually expressed as milligrams of chemical per kilogram of body weight of the test animal.

**Lethal Concentration 50 (LC50) -** The concentration of a chemical in the diet or in the water that kills 50 percent of a group of test animals over a specified length of exposure.

**necropsy** - A postmortem (after death) examination of an animal to determine the cause of death.

**nematacide** - A pesticide that controls nematodes.

**non-target organism** - Any animal or plant other than the intended target of a pesticide application.

**persistence** - The length of time a pesticide remains in the environment. Usually expressed as the half-life (T1/2) of a chemical.

**pesticide** - Any substance used for controlling, preventing, destroying, or repelling any pest.

**pesticide formulation** - The ingredients, active and inactive (including solvents and propellants), in a pesticide.

**rodenticide** - A pesticide that controls rodents.

**sublethal exposure** - exposure to a pesticide at levels not causing direct mortality, but potentially resulting in reduced survival or reproductive success.

**toxicant** - A poisonous substance capable of causing death or adverse effects to plants and/or animals.

## AQUATIC HERBICIDE SOURCES

Athea Laboratories Inc., P.O. Box 23926 Milwaukee, WI 53223.

Albaugh Inc., 1517 N. Akeny Blvd. Suite A, Ankeny, IA 50021

Applied Biochemists, 5300 W. County Line Road, 96 North, Mequon, WI 53092

Aquacide Co.,1627 9th St., White Bear Lake, MN 55110, (800)328-9350

Aquashade Inc., 6120 W. Douglas Ave., Milwaukee, WI 53218

A & V Incorporated, N62 W22632 Village Drive, Sussex, WI 53089, (205) 288-3185

Chem One Corp., 15150 Sommermeyer, Houston, TX 77041-5308

ELF Atochem North America, 2000 Market St., Philadelphia, PA 19103, (205) 288-3185

Frank Miller & Sons Inc., 13831 S. Emerald Ave., Chicago, IL 60627

Great Lakes Biochemical Co. Inc., 6120 W. Douglas Ave., Milwaukee, WI 53218

Griffin Corporation, P.O. Box 1847, Valdosta, GA 31603, (912) 244-7954

Helena Chemical Co., 6075 Poplar Ave., Suit 500, Memphis, TN 38119.

I. Schneid Inc., 1429 Fairmont Ave., N.W., Atlanta, GA 30381.

Monsanto Agricultural Company, 700 Chesterfield Parkway North, St. Louis, MO, 631987 or 800 N. Lindbergh Blvd., St. Louis, MO 63167, (919) 556-7124

NCH Corporation. 2727 Chemsearch Blvd., Irving, TX 75062.

PBI/Gordon Corporation, 1217 W. 12th Street, P.O. Box 4090, Kansas City, MO 64101, (816) 421-4070

Phelps Dodge Refining Corporation, Box 20001, El Paso TX, 79998.

Qualis Inc., 4600 Park Ave., Des Moines, IA 50321

Riverdale Chemical Co., 425 W. l94th St., Glenwood, IL 60425, (317) 780-1944

Rhone-Poulenc Ag Company, P.O. Box 12014, 2 T. W. Alexander Drive, Research Triangle Park, NC 27709, (919) 859-6070

SEPRO Corporation, 11550 N. Meridian St., Suite 200, Carmel, IN 46032, (800)419-7779

State Chemical Manufacturing Co., 3100 Hamilton Ave., Cleveland, OH 44114.

Uniroyal Chemical Co., Inc., 74 Amity Road, Bethany, CT 06524, (919) 848-9675

Zeneca Agricultural Products, Box 15458 Wilmington, DE. 19850-5458 or 1800 Concord Pike, Wilmington, DE 19897, (800) 759-2500

*Reviewed by Michelle Davis, research associate, Fisheries and Wildlife*