



# Agricultural Pesticide Impacts on Prairie Wetlands

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**M**odern agriculture has shifted from many small farms where several crops were grown to fewer large farms focused on limited cash crops. Today's modern agriculture with its big machinery favors large fields of single crops, drainage of lowlands, increased use of fertilizers and pesticides, and improved varieties of crops suited to growing on marginal soils. In the Upper Midwest, these changes have profoundly altered the landscape.

The public's increased environmental awareness has raised concerns about pesticide use and wetland loss. At the same time, American farmers are struggling to keep crop production costs down while efficiently raising a marketable product.

Prairie wetlands are valuable to farmers as well as to fish and wildlife. We must understand how they are affected by pesticide use.

### **Why are wetlands important?**

Since the first Euro-Americans arrived on the prairie, wetlands have been seen as obstacles to the productive use of land. Even as late as the 1950s, wetlands were regarded as wastelands whose productive use could only be realized through drainage or filling. This alteration was accomplished with great zeal by funding from several state and federal programs. Since the late 1960s, the public has become more aware of the functions and values of wetlands.

#### ***Fish and wildlife habitat***

Wetlands provide fish and wildlife habitat-food, water, and cover-critical to the survival of a wide variety of plants and animals, including a number of threatened and endangered species.

Freshwater wetlands are one of the most productive ecosystems in the world. The food value of the plants comes when dead leaves are broken down by microorganisms in the water to form small particles of organic matter called "detritus." Detritus is the principal food of many small aquatic invertebrates that, in turn, are food for amphibians, reptiles, fish, birds, and mammals.

#### ***Water quality***

Wetlands improve water quality by acting as a pollution filter to remove nutrients, process chemical and organic wastes, and reduce sediments. The public has become increasingly aware of the adverse effects of "nonpoint" sources of pollutants, such as runoff from agricultural fields, on water quality.

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*"To destroy the homes and the food of wildlife is perhaps worse in the long run than direct killing."*

— Rachel Carson (*Silent Spring*, p. 73).

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#### ***Flood protection***

Wetlands are natural storm buffers. They store flood waters that overflow streambanks or surface water that collects in potholes. Consequently, adjacent and



**The scud is one of many invertebrates found in prairie wetlands and is eaten by many species of wildlife. -Photo by George Swanson.**



**Prairie pothole wetlands once dotted the landscape of the north central states and the prairie provinces of Canada. A product of the last glaciers, these wetlands are important for many reasons. Millions have been converted to other uses in the last 150 years. - Photo by Ted LaGrange. Department of Natural Resources.**

downstream property is protected from flood damage. The speed of flood waters also is slowed, reducing water erosion damage, flood heights, and damage to agricultural crops. In turn, water retention in some wetlands replenishes groundwater and surface water, both of which help maintain water tables during times of drought.

### ***Recreation***

Wetlands provide endless opportunities for recreation such as boating, swimming, hiking, and birdwatching. They also are the source of many natural products such as timber, fish, wildlife, and water supply and grazing for livestock. On a deeper level, their beauty has inherent aesthetic value as well. In recent years the public has increasingly recognized these values as vital to the future prosperity of the country.

### **Status of Prairie Wetlands**

Prairie wetlands occur primarily in North Dakota, South Dakota, Minnesota, and Iowa in the United States, and in the prairie provinces of Canada. These wetlands were formed following the retreat of glacial ice sheets during the last Ice Age. Since that time, an estimated 3 million acres of wetlands have been lost in North Dakota (60 percent loss of original wetlands), 0.7 million acres in South Dakota (35 percent loss), 9.7 million acres in Minnesota (53 percent loss), and 2.3 million acres in Iowa (99 percent loss). The majority of losses occurred when wetlands were converted to farmland. Drainage of prairie wetlands continues because cash crops provide economic returns and single-crop farming uses large, specialized equipment, which is difficult to maneuver around wetland areas.

Many remaining prairie wetlands are not providing all their potential benefits because they are adversely affected by pollutants. Although wetlands can handle a certain level of pollutants, excessive amounts can overpower them. For example, nitrogen and phosphorus from fertilizers can increase growth of algae and other water plants. This depletes oxygen concentrations, causing fish kills and undesirable water quality (unpleasant taste, appearance, and odor). High concentrations of heavy metals and pesticides can cause severe changes in wetlands, thus reducing their beneficial use by wildlife and people alike.

### Use of pesticides

Pesticide use is an important part of today's agriculture, but heavy reliance on chemicals often has a negative effect on wetlands. The relatively small size of prairie wetlands, the short distance between wetlands, and their closeness to croplands allow agricultural pesticides to enter prairie wetlands through direct or indirect routes. From 1966 to 1984 in North Dakota, herbicide use increased 356 percent and insecticide use increased 170 percent. Increased pesticide use is due, in part, to greater use of multi-year, single-crop farming. This makes crops vulnerable to pests that multiply year after year.

Although conservation tillage reduces soil erosion and requires less fuel, time, and labor for crop production than conventional tillage, it often requires increased use of pesticides to control weed and insect pests present in crop residues. The majority of herbicide applications are with ground equipment, which limits the off-target loss of the applied chemicals. However, aerial applications of insecticides in North Dakota increased from 21

percent of treatments in 1978 to 59 percent in 1984. Aerial application poses the greatest hazard to wetlands because of overspray and drift.

Perhaps the most critical factor in the use of pesticides on croplands is the time of application. Most pesticides are applied to agricultural crops in the spring and early summer. This application coincides with spring rains, which can carry substantial amounts of pesticides in cropland runoff. The first runoff events normally occur in April through June—the peak period of growth and reproduction in wetlands for aquatic plants and insects, and the waterfowl that feed on them. The prairie pothole region in the Midwest and Canada comprises only 10 percent of the waterfowl breeding area of North America, but produces 50 percent of the duck crop in an average year. Thus, pesticides in prairie wetlands can be particularly devastating to waterfowl populations.

### Pesticide impacts on wetlands

Pollution of wetlands by agricultural pesticides can cause different types of damage, from altering the growth of aquatic plants to reducing waterfowl reproduction. This happens when broad-spectrum pesticides directed at pests in cropland accidentally injure plant and animal species in nearby wetlands.

#### *Herbicide types and descriptions*

Herbicides are, by definition, toxic to plants. They can be separated into two groups based on their mode of action. **Contact herbicides** are applied in sufficient amounts to thoroughly cover stems and leaves of growing plants, affecting only the parts of the plant they actually "contact." **Translocated (or systemic)**





If aerial applications of pesticides must be used, pilots should be instructed to avoid spraying of wetlands and immediately adjacent areas. Many pesticides are toxic to wildlife or kill plants or invertebrates important to their survival. - Photo by Marlin Rice, Iowa State University Extension.

**herbicides** “move” to other parts of a plant from the point of application (contact with foliage, soil incorporation, irrigation water uptake, etc.), where they alter normal plant functions such as growth, respiration, or photosynthesis. While some herbicides have a direct effect on nontarget vertebrate wildlife, most do not. By reducing plant cover and availability, however, herbicides may have indirect effects on wildlife populations.

### *Insecticide types and descriptions*

Insecticides are generally more toxic to animals than herbicides. Most modern insecticides are not as persistent as some used in the past, such as DDT. They also break down more quickly in the environment and generally do not accumulate to high concentrations in animal bodies.

The two primary groups of insecticides in use today are **organophosphates and carbamates**, both of which kill pest insects by damaging their central nervous systems. Unfortunately, these insecticides have the same action on nontarget aquatic and terrestrial insects, fish, and wildlife. A

third group of insecticides that has increasingly been used against pest insects in recent years is **pyrethroids**. These insecticides are synthetic formulations of naturally occurring insecticides that also damage the nervous systems of nontarget animals. However, toxic effects in birds and mammals are much less than those in fish, which have nervous systems that are more sensitive to these chemicals.

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“Like winds and sunsets, wild things were taken for granted until progress began to do away with them.”

— Aldo Leopold

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### *Other pesticides*

Other types of agricultural chemicals used to either reduce seed damage or increase the effectiveness of pesticide applications may also adversely affect plants and animals. These include fungicides and fumigants, surfactants, and drift retardants. Although used in smaller quantities than herbicides and insecticides, they must be used with caution to reduce effects on nontarget plants and animals.

### *Pesticide lethal and sub-lethal effects*

The negative impacts of agricultural pesticides are more dramatic when plants and animals are observed dead after only a short period of exposure. This type of **lethal effect** is caused by direct, short-term exposure of animals to a pesticide either by eating contaminated food, by drinking contaminated water, by breathing the pesticide, by absorbing the pesticide through the gills or skin, or by swallowing the pesticide while grooming. Plants are exposed by uptake of contaminated water through their roots or by direct pesticide deposits on leaf surfaces.

Aquatic plants, like algae, are more sensitive than fish or invertebrates to contaminants such as herbicides. They form the base of the aquatic food web and impacts on them can cause adverse effects on all higher animal levels in a wetland ecosystem.

However, the worst effects of pesticides on wetlands are those that harm a plant or animal in some way that cannot be observed immediately. These **sub-lethal effects** are due to pesticide-induced changes in the functions of enzymes, cells, or organs of plants and animals that in turn alter how a plant or animal competes for living space and food, avoids predators, reproduces, etc. Plants or animals harmed by pesticides may show these changes in two ways: altered population structure or altered community or ecosystem structure. For example, when a waterfowl population is altered, the flock may

contain only adults and no juveniles because the youngsters were susceptible to pesticide poisoning. In a community or ecosystem structure harmed by sub-lethal pesticide exposure, a predator species may have been destroyed, resulting in excessively large populations of the animals who were once prey.

When a wide variety of agricultural pesticides are used on croplands near wetlands, wetland plants and animals may be exposed to several herbicides and insecticides at the same time. This makes it difficult to determine if the wetland species were harmed from direct exposure to a single pesticide or indirectly through secondary changes in their population or ecosystem. In addition, pesticides break down in the environment, making it hard to tell whether toxic effects are linked to the original pesticide or its breakdown products.



Mallard ducks are only one of hundreds of species that depend, directly or indirectly, upon wetlands for food, water, cover, and space to grow. - Photo by George Swanson

# Commonly used pesticides in the prairie wetland region

Chemical name	Trade name	Chemical group	Effect on aquatic plants and animals
<b>Herbicide</b>			
Dicamba	Banvel, Brushbuster, Marksman	DB	Unknown toxicity to aquatic plants; low toxicity to aquatic invertebrates and fish
Endothal	Endothal, Aquathol, Hydrothol	DC	Highly toxic to algae; toxic to aquatic invertebrates; slightly toxic to fish
MCPA	Shamrox, Zelan	P	Unknown toxicity to aquatic invertebrates; moderate toxicity to fish and birds
Triallate	Far-Go, Avadex	TR	Moderately toxic to aquatic plants, invertebrates, and fish
Trifluralin	Treflan	T	Nontoxic to aquatic plants; moderately toxic to aquatic invertebrates and fish; low toxicity to birds
2,4-D	Weed-B-Gon, Aqua-Kleen, Tributon	P	Highly toxic to aquatic plants; moderately toxic to aquatic invertebrates; slightly toxic to fish
<b>Insecticide</b>			
Carbaryl	Sevin, Devicarb, Dicarbam	C	Unknown effects on aquatic plants; highly toxic to aquatic invertebrates; low toxicity to fish; some bird and mammal populations reduced; some bioaccumulation in fish and some aquatic plants
Carbofuran	Furadan	C	Nontoxic to aquatic plants; highly toxic to aquatic invertebrates, fish, birds, and frogs; moderately toxic to mammals
Fenvalerate	Pydrin	PY	Unknown effects on aquatic plants; very highly toxic to aquatic invertebrates and fish; low toxicity to birds and mammals
Malathion	Maltox, Sumitox, Vegfru Malatox	OP	Nontoxic to aquatic plants; very highly toxic to aquatic invertebrates; moderately toxic to fish; some bird and mammal populations reduced
Parathion	Alkron, Bladan, Folidol, Orthophos	OP	Nontoxic to aquatic plants; very highly toxic to aquatic invertebrates; highly toxic to fish, birds, and mammals
Terbufos	Counter	OP	Unknown effects on aquatic plants; very highly toxic to aquatic invertebrates; highly toxic to fish, birds, and mammals

DB - dichlorobenzoic acid  
PY - pyrethroid

DC - dicarboxylic acid  
T - toluidine

C - carbamate  
TR - triallate  
P - phenoxyacetic acid  
OP - organophosphates

## How can wetlands be protected?

Between the 1780s and the 1980s, the lower 48 states lost an average of more than 60 acres of wetlands every hour. By the 1980s, the remaining wetlands constituted only 5 percent of the land surface, in many states even less. Restoration of wetlands by some states and federal agencies is occurring in certain parts of the country, but it is falling short of the current loss rate. Other wetlands, although not being drained or filled, are being degraded and are no longer providing benefits to fish and wildlife or human populations.

Our remaining wetlands must be protected and treated in a gentler manner. Pesticide users must be aware of how their actions affect wetlands and the plants, animals, and human life that depend on them. Safe and effective use of pesticides must become the way of doing business to protect our vital wetlands.

### *Private Landowners*

- Use different formulations of pesticides or a suitable substitute in places where runoff or drift from application may enter a wetland.
- Use ground application (especially soil incorporation) rather than aerial pesticide application.
- Instruct chemical applicators to avoid overspray of wetland areas.
- Maintain unsprayed buffer strips around wetlands to trap pesticide carrying sediments.
- Seek compatible uses for wetlands, such as waterfowl production, fur harvest, hay and forage, and hunting and trapping leases, rather than draining and filling wetlands for cropland.
- Restore wetlands to hold surface

runoff and maintain water tables during times of drought.

### *Corporate shareholders or managers*

- Manage corporate-held wetlands to avoid wetland alteration or minimize damage during pesticide use.
- Conserve wetlands by supporting wetland incentives such as the North American Waterfowl Management Plan.
- Donate wetlands to conservation agencies for tax credits.

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“We must change our philosophy, abandon our attitude of human superiority and admit that in many cases in natural environments we find ways and means of limiting populations of organisms in a more economical way than we can do it ourselves”.

— G.C. Ulyett (*Silent Spring*, p. 231)

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### *Private citizens*

- Encourage public agencies to assist pesticide users by providing good advice on safe, effective pest control.
- Comment on permit applications for activities in wetlands regulated by Section 404 of the Clean Water Act.
- Support wetland conservation by buying federal duck stamps from your local post office to support wetland acquisition.
- Encourage federal legislators to support the North American Wetlands Conservation Fund.

### *Farmers*

- Use conservation tillage practices such as contour strip-till and reduced till.
- Rotate crops to increase soil fertility



(thus reducing fertilizer use) and to break the life cycle of crop pests (thus reducing pesticide use).

- Use integrated pest management:
  - Inspect crops for pests frequently.
  - Identify pests correctly to evaluate the probable damage the pests could inflict on the crop if left unchecked.
  - Select chemical and nonchemical control measures to reduce crop losses.

All of us—landowners, private citizens, and farmers must work together to protect our prairie wetlands and to protect the future productivity of our land base.

## Help is available by contacting

- County or area extension staff
- Integrated pest management consultants at state land-grant universities
- District conservationists with the Soil Conservation Service
- Fish and wildlife biologists or managers associated with county, state, or federal conservation or natural resource agencies
- Sustainable agricultural organizations

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