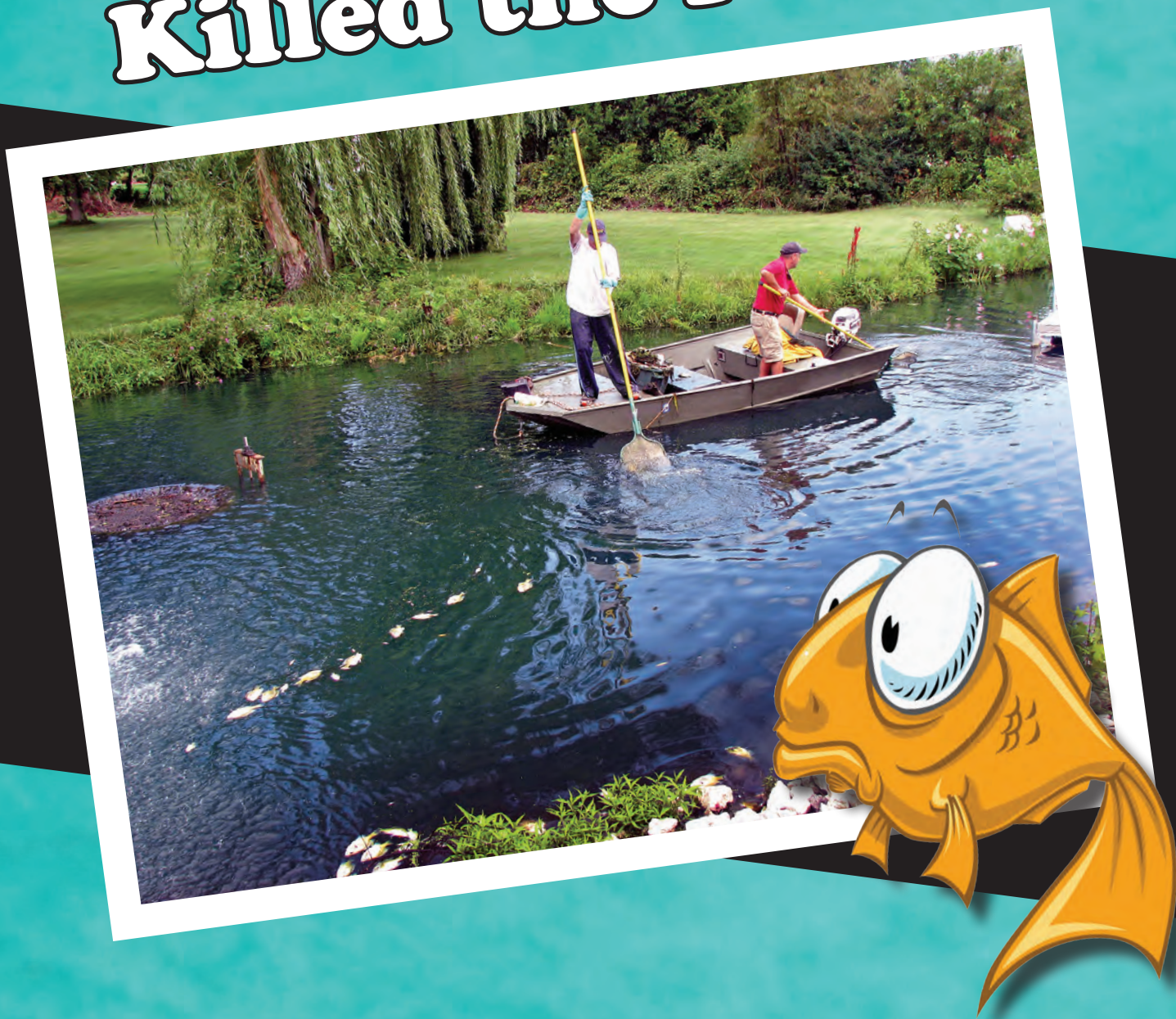


# What ? Killed the Fish



**Using Observation, Sampling, and Science to Solve the Mystery**

# **What Killed the Fish?**

**Using Observation, Sampling, and Science  
to Solve the Mystery**

**Fred Whitford, Coordinator, Purdue Pesticide Programs**

**Joe Becovitz, Pesticide Program Specialist, Office of Indiana State Chemist**

**Bob Robertson, District Fisheries Biologist, Indiana Department of Natural Resources**

**Brian MacGowan, Wildlife Extension Specialist, Purdue University**

**Gerry Blase, Manager, Asplundh Railroad Division**

**Bob Avenius, Regional Technical Director, TruGreen-ChemLawn**

**Jim Donahoe, President, Aquatic Weed Control**

**Dean Zimmerman, District Wildlife Biologist, Indiana Department of Natural Resources**

**Arlene Blessing, Editor and Designer, Purdue University**



# What Killed the Fish?

Questions arise whenever a pond owner discovers dead fish floating on the surface or lying along the shore, especially after a recent pesticide application to the pond or to neighboring property: Did the pesticide cause the fish kill?

Some pesticides are toxic to fish, but most fish kills are not caused by pesticide applications. In order to cause a fish kill, a recently applied pesticide must make its way to a pond in a concentration that is toxic to fish. Although that is possible, in many cases rain dilutes the pesticide before it reaches the pond. Always consult the pesticide label to determine the safe amount of time between application and the likelihood of rain.

Natural mortality of fish occurs in ponds throughout the year. The discovery of a few dead fish might not imply a problem with the pond water. Fish die from many natural causes such as infectious disease, parasites, stress caused by spawning or rapidly changing water temperatures, lightning, and old age. Some die after being caught and released by fishermen. A few dead fish may look like a disaster, but remember: most ponds contain 200–300 pounds of fish per surface acre.

**Ponds and lakes provide aesthetic benefits as well as water retention and recreation opportunities.**

Jim Donahoe



# Winter Fish Kills

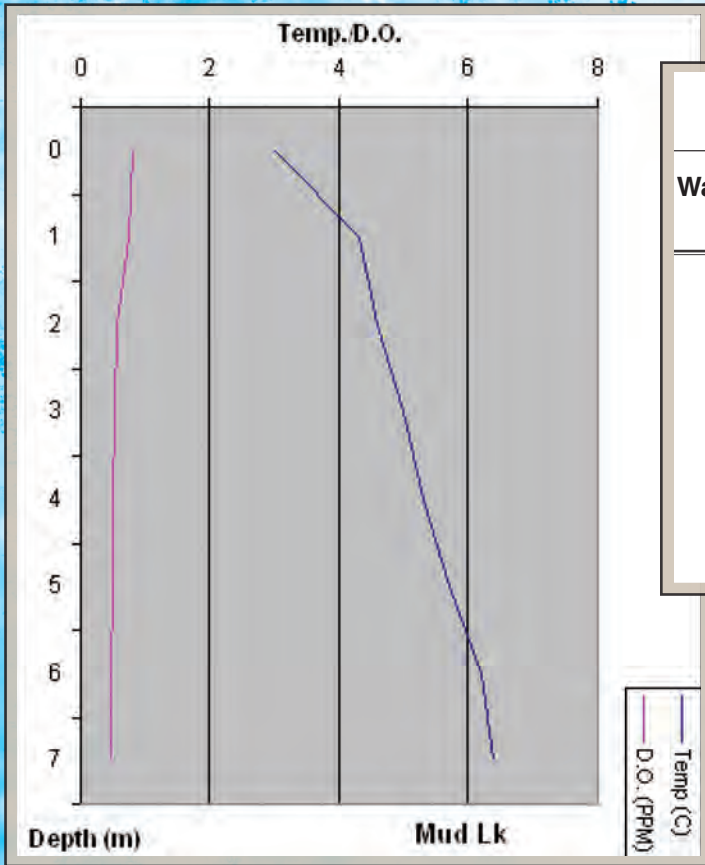
If a pond isn't deep enough (8–14 feet in Indiana), it may not have the water volume necessary to maintain a healthy fish population during long periods of ice and snow cover. Prolonged dark conditions under deep snow and ice cause dissolved oxygen levels to drop enough that fish in shallow ponds can begin to die.

Besides depth, the quantity of weeds in the pond prior to winter plays a role: the more weeds, the more decaying material using oxygen. Shallow ponds typically are weedier than deeper ponds; therefore, the odds of fish dying from decaying vegetation is greater in shallow ponds.

The loss of some or even all of the fish in a pond may go unnoticed if the kill occurs in early winter. Sometimes a rotten egg smell is noted when cutting through the ice of a pond with seriously low oxygen levels. Winter kills are often discovered as the ice melts and dead fish appear along the shoreline. Winter kills can be prevented through aeration or the removal of snow from the ice.

Scott Banfield



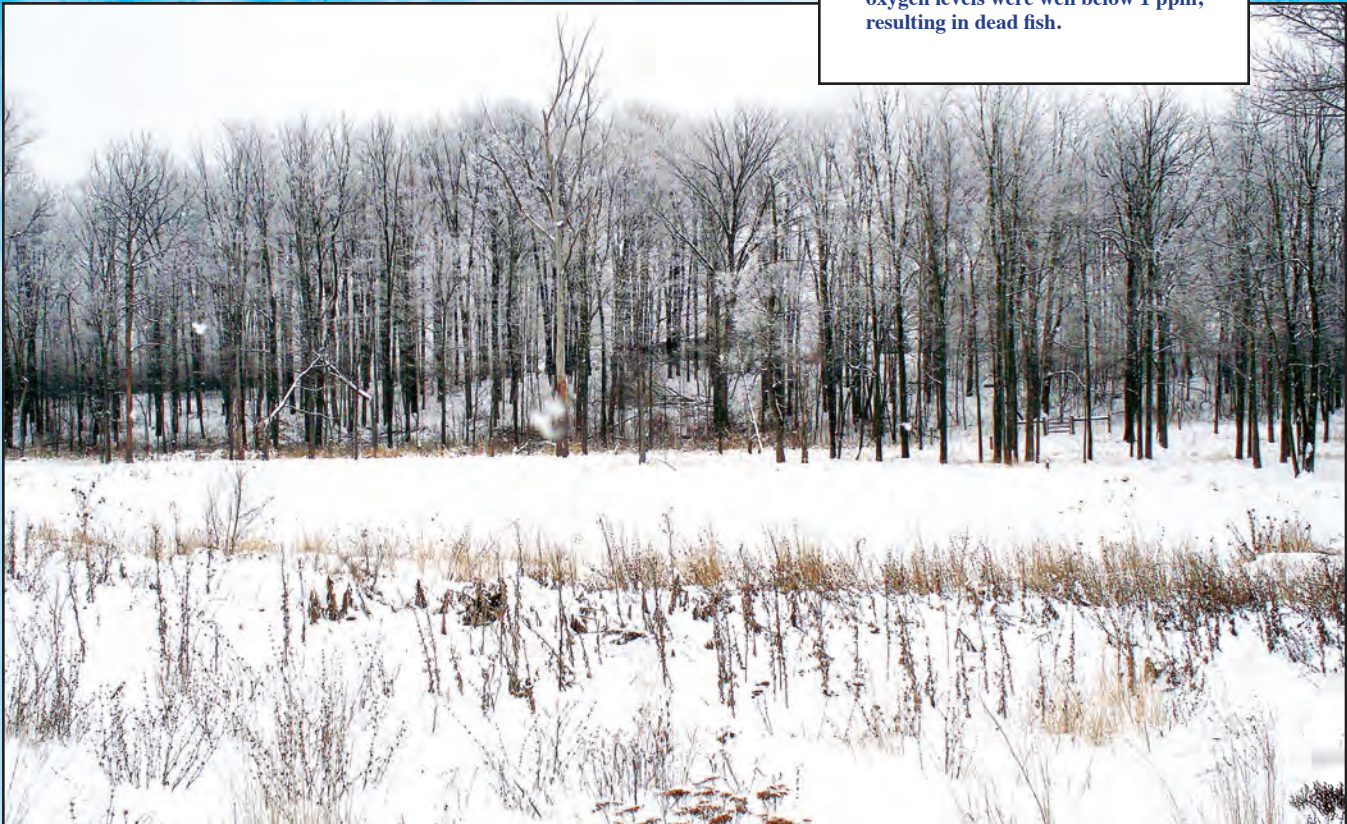


### Banfield Pond, February 7, 2009

Water Depth (ft.)	Temp (C)	Dissolved Oxygen (ppm)
0	3.0	0.82
1	4.3	0.75
2	4.6	0.57
3	5.0	0.52
4	5.3	0.50
5	5.7	0.49
6	6.2	0.48
7	6.4	0.46

Fish commonly die from insufficient oxygen during winter snow and ice cover. Fish begin appearing at the surface at 3 ppm and often begin dying when oxygen levels reach 2 ppm. In this shallow pond (p. 6-7) oxygen levels were well below 1 ppm, resulting in dead fish.

Scott Banfield



# Summertime Fish Kills in Ponds

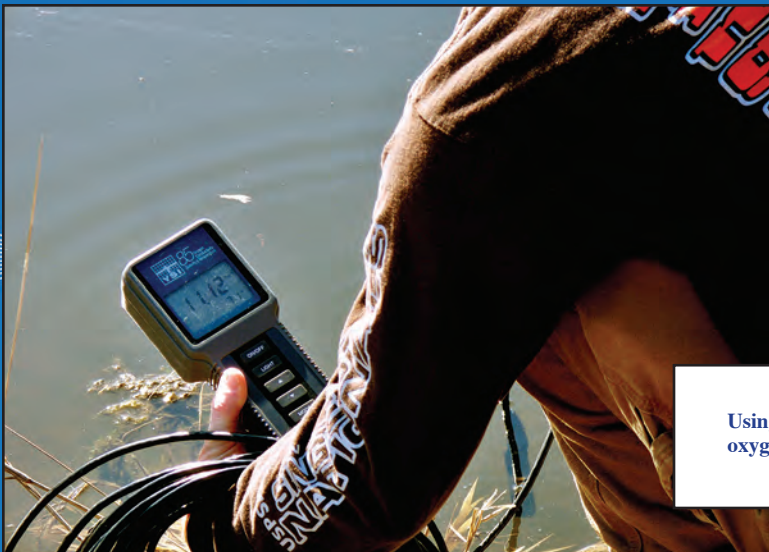
A low dissolved oxygen level is the most common cause of fish kills in ponds. Oxygen depletion can be caused by one or more factors during the summer, but water temperature is the most significant. The amount of dissolved oxygen is directly related to water temperature: warm water holds less dissolved oxygen than cold water.

Pond “turnover” typically occurs during early spring and fall and is caused by a change in circulation in a body of water. Dense water on the bottom of a pond contains low levels of oxygen; when it mixes with the buoyant surface water, low dissolved oxygen levels result throughout the pond. Spring and fall winds can cause this mixing, but heavy rains during July and August can also trigger such a turnover. Dead fish are found three to seven days after a storm.

A large die-off of aquatic plants or algae — occurring naturally or from a herbicide application — can cause low dissolved oxygen during the decomposition process. Care should be taken when applying chemicals to aquatic plants in warm water during mid to late summer. Treating a third of the pond’s surface at one time, depending on the abundance of vegetation, and waiting 10 to 14 days between treatments may help prevent oxygen depletion. If plants are managed early, there is often no need for major treatments.

Overstocking or overfeeding fish in a pond can be a contributing factor. For more information about fish kills in ponds, see FNR 69, *Fish Kills in Indiana — Their Causes and Prevention*, listed under Resources on page 29.

Scott Banfield



Using a meter to record dissolved oxygen levels.



**It is common for fish to die from oxygen depletion in shallow ponds such as these. Dense vegetation (above) indicates shallow water.**





**This pond was mismanaged and a thick mat of algae was allowed to develop over most of the surface. Subsequently, the entire pond was treated at higher-than-labeled rates, causing a fish kill. The copper sulfate product used to treat the pond should have been applied at labelled rates to only half the pond at each application.**

Both photos courtesy of Office of Indiana State Chemist





# Visit the Site

## After a Complaint

Determining the cause of a fish kill can be complicated, but often a thorough investigation is all that is needed. The best way to start an inspection of the site is to collect some facts. Fish can die from a number of causes such as inadequate dissolved oxygen in the water, petroleum, algae bloom, manure runoff or chemical spill, a sudden change in water temperature, infectious diseases or parasites, septic system discharge, an aquatic pesticide application, or excessive silt or mud runoff.

Evidence dissipates quickly, so it is important to respond to fish kill complaints immediately. The more time that elapses between the fish kill and the inspection, the less likely you are to determine the cause.

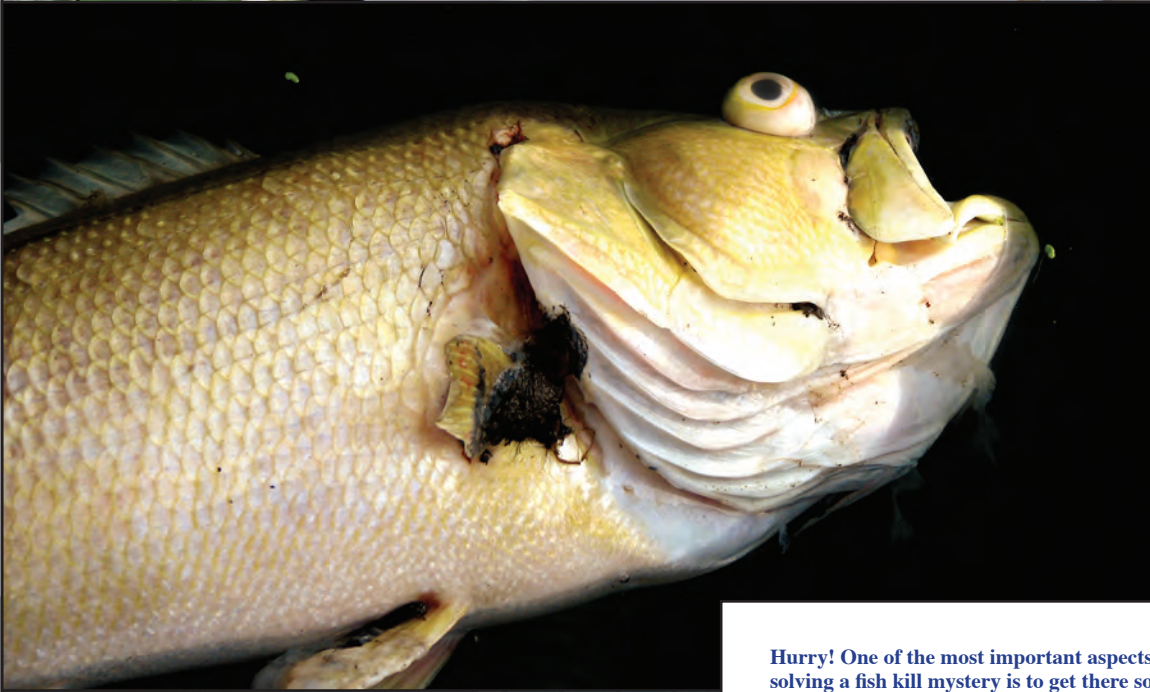
Call your local Purdue University Cooperative Extension Service educator to see if he or she has received other complaints of fish kills in the area. If the fish kill occurs in a private pond, determine whether it drains to state waters such as lakes, streams and rivers, and most ditches. If a fish kill occurs in waters of the state, or if the fish kill might drain to these waters, contact the Indiana Department of Natural Resources at 800-TIP-IDNR. Also notify the Indiana Department of Environmental Management at 888-233-7745. The sooner they are notified, the quicker they can begin their investigation in a public body of water.

Take detailed notes, ask questions, and take photographs (and possibly a video) when visiting the site. Record all related conversations with owners, witnesses, etc. Following are some important facts to gather during an investigation.

**The accurate recording of all findings is critical in determining why fish died. It is important to interview and record observations from anyone who actually saw the fish kill take place. Their information is valuable in solving the fish kill mystery.**



Steve Lochmann



**Hurry!** One of the most important aspects of solving a fish kill mystery is to get there soon after the first dead fish is sighted. Floating fish decay rapidly, hampering the analysis of their tissues for chemicals and disease.

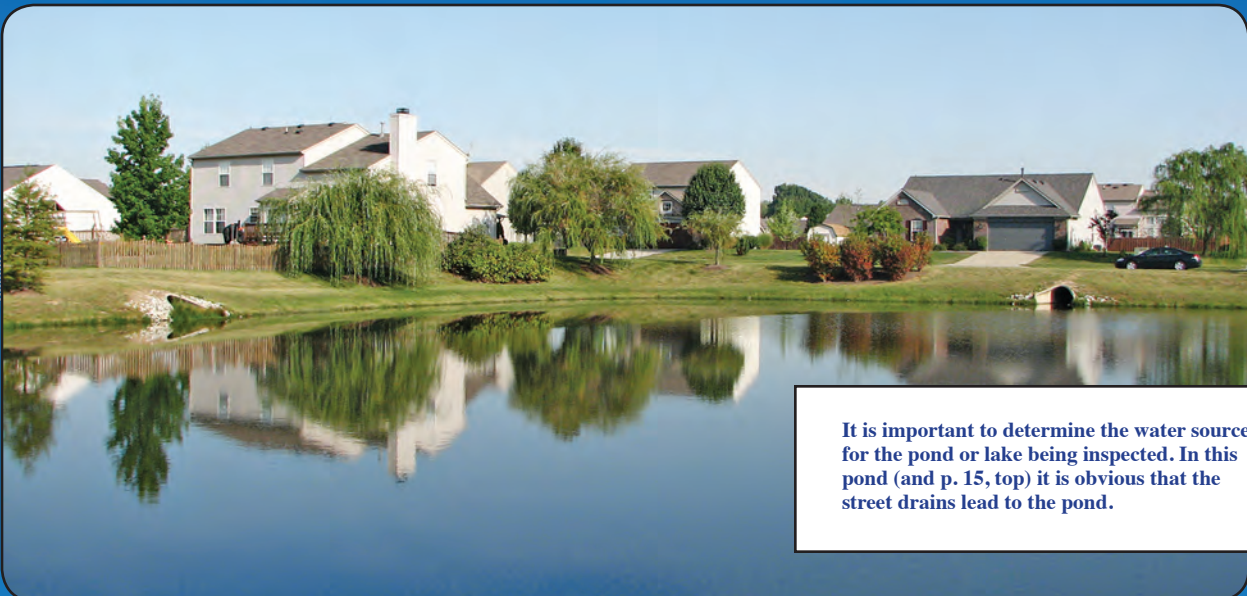


## *General Information*

- Date and time the fish kill was discovered.
- Date and time you visited the site.
- Location of the pond and whether it drains to waters of the state.
- Name, address, and phone numbers of the pond owner.
- Name, address, and phone numbers of the person who discovered the fish kill (if different than the owner).
- Name, address, and phone numbers of any other parties present.
- Name, address, and phone numbers of the person/company that had made a pesticide application in the area.

## *Physical Evidence*

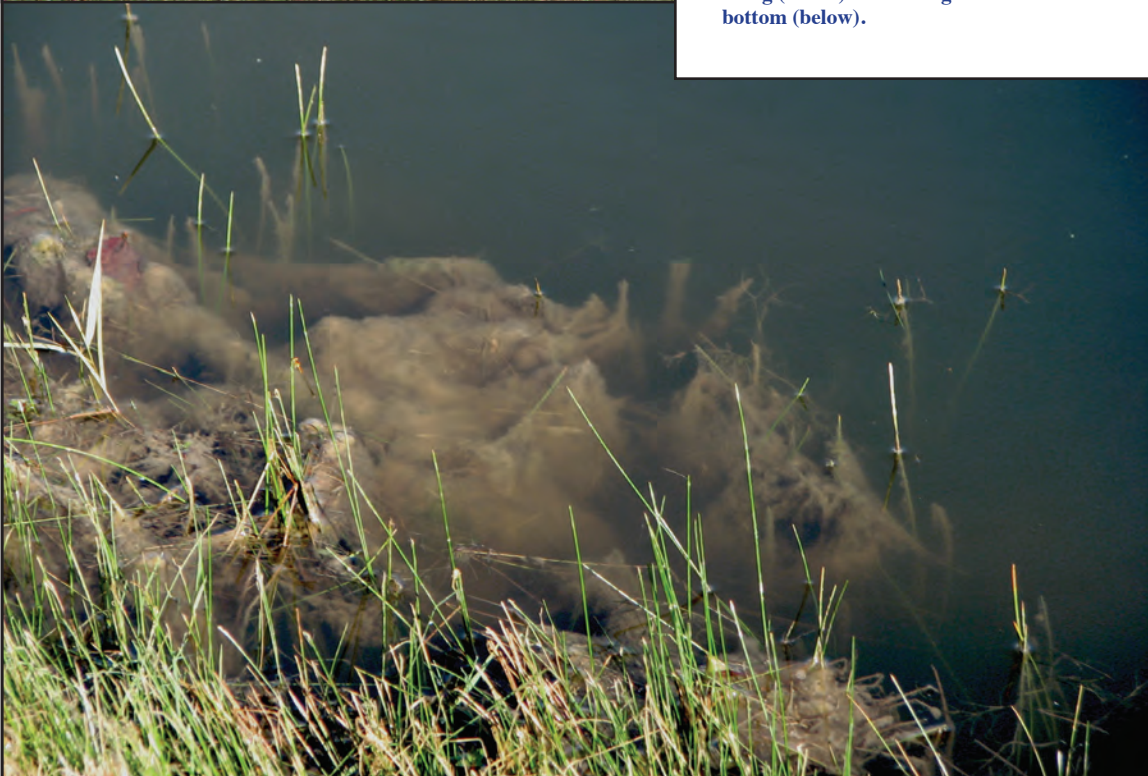
- Vegetation around water (present, absent, dead or dying).
- If pesticides have been applied to nearby cropland or residential sites, determine the direction of drainage from those sites; i.e., do those sites drain into the pond?
- Note the location of inlets and their sources.
- Any types of construction projects nearby (e.g., driveway resurfacing).
- Odor of the water.
- Time of sample (lowest dissolved oxygen occurs at sunrise).
- Water temperature.
- Dissolved oxygen measured at one foot depth or by profiling from surface to bottom at two-foot intervals at the deepest part of the pond.



**It is important to determine the water source for the pond or lake being inspected. In this pond (and p. 15, top) it is obvious that the street drains lead to the pond.**



**Dead pond vegetation can be indicative of a pesticide treatment. Notice the dead cattails among a few still living (above) and the algae mat that has sunk to the bottom (below).**





All photos on this page courtesy of Office of Indiana State Chemist

Several inlets (right) drained from a neighboring horse pasture (top) into the pond (center), causing a fish kill (p. 17, top). Notice the brown color of the water, which is an indication of sediment being washed into the pond during recent rainfall.





## ***Biological Evidence***

- Species and numbers of dead fish.
- Other animals that have died (e.g., turtles, frogs, crayfish, insects).
- Size of the dead fish: small or large? variety of sizes?
- Unusual appearance of the dead fish (e.g., flared gills, open mouths, curved spines).
- State of decomposition: recent death? two-three days? a week? longer than a week?
- Unusual behavior such as fish swimming at the surface, gasping for oxygen, or fish jumping onto the bank; snails climbing onto vegetation to get out of the water; tadpoles gulping near the surface.
- Dead or dying plants (might be evidence of spray drift or runoff).

**Observations are critical in determining the cause of a fish kill. Write down a description of all living and dead animals in and around the pond (e.g., crayfish, turtles, etc.). Record the number, size, and species of dead fish as well as any unusual behavior of live fish, such as swimming near the surface to get oxygen or jumping onto the bank.**

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Fish jumping onto the bank

Ron Bedwell

Office of Indiana State Chemist



Fish gulping for air near the surface

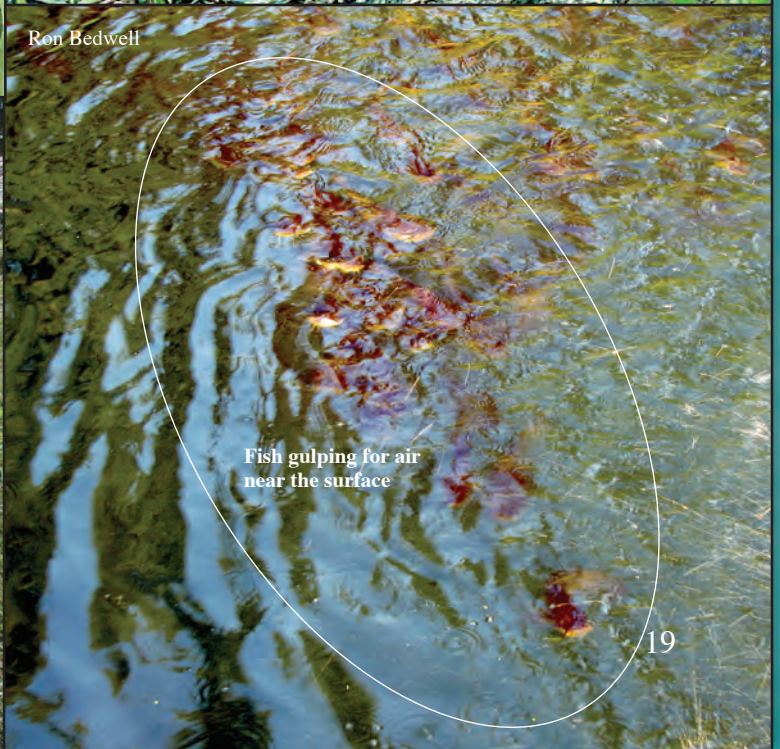
Ron Bedwell



Ron Bedwell



Ron Bedwell



Fish gulping for air near the surface

## *Environmental Evidence*

- Previous rapid weather changes, including thunderstorms and lightning.
- Preceding weather conditions: recent temperatures, cloud cover, precipitation, and wind speed and direction up to five days previously.
- Color of the water (black, green, etc.).
- Clarity of the water (clear, opaque, cloudy from silt).
- Recent pond treatments (e.g., chemical control for algae, submerged aquatic weeds, or emergent plants such as cattails).
- Recent treatments to surrounding area (e.g., fertilizer applications or chemical treatments to the lawn or ornamental plants, or around the outside of the home).
- Method of chemical application.
- Name and amount of chemical used.
- Whether any pond aerators are used; and, if so, their depth of placement.

## **Fish and Water Samples**

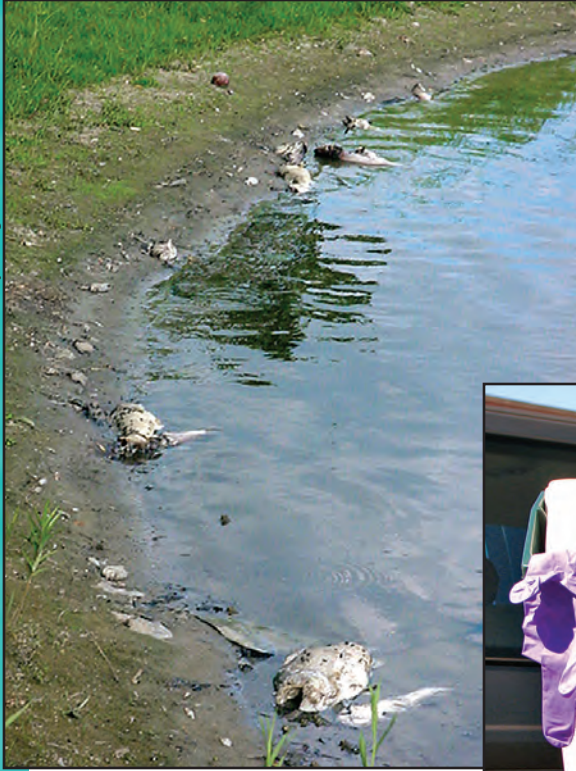
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Fish and water samples must be taken to confirm whether or not a pesticide or fertilizer applied nearby killed the fish. *Water* samples must be taken as soon as possible — within hours of the fish kill — while *fish* samples can be taken within hours or days, depending on the air temperature. Water samples taken more than three days after discovery of the fish kill may not be useful in determining a cause.

***Fish Samples.*** Instruct the pond owner to collect and freeze as many recently dead and dying fish species as possible, prior to your visit. Freezing the samples will ensure that they will remain viable for meaningful results when analyzed. Each fish should be wrapped in aluminum foil, with the dull side toward the fish, and either placed on ice or in the freezer immediately. Transfer them to the analytical laboratory as soon as possible.

***Water Samples.*** Collect a gallon of water in brand new, quart- or liter-size glass bottles or jars. Amber-colored bottles are preferable, but clear bottles will work if protected from the sun. Place samples on ice, out of sunlight. Get the samples to the laboratory within twenty-four hours to avoid breakdown of materials in the samples. Testing is done for specific chemicals so, ideally, you should inform the laboratory of any product(s) in question when submitting water samples for testing.

Fish and water samples can be analyzed at the Purdue Animal Disease Diagnostic Laboratory, (765) 494-7440, for a fee. The fee is dependent on the pathological and chemical analyses desired. The Office of Indiana State Chemist, (800) 893-6637, also will analyze samples, but *only* if a complaint is filed. Commercial companies can test for specific chemicals; see “Water Testing Laboratories” listed under Resources (page 29).



Collect fish as they are dying, or very soon thereafter, if samples are to be tested for chemicals, disease, or other causes of the fish kill. Once decomposition begins, the samples will not yield usable results.

Office of Indiana State Chemist



Labels for water samples should be completed in ball point pen and affixed to the bottles, using clear packing tape. This will keep the labels legible and fixed to the bottles, even after they are filled with water.

## Reviewing the Information

It can be difficult to analyze all of the information collected from the site of a fish kill. Fish kills involving several species generally are due to environmental causes, while fish kills that affect only one species usually are due to infectious diseases or specific parasites. Use the table on page 22 as an aid in determining possible causes of fish kills.

<b>Criteria</b>	<b>Oxygen Depletion</b>	<b>Algal Bloom</b>	<b>Pesticide Toxicity</b>	<b>Disease</b>
<b>Fish behavior</b>	Gasping, swimming near the surface	Erratic swimming	Erratic swimming	Erratic swimming
<b>Size of fish</b>	Large fish die first	Small fish die first	Small fish die first	Any size
<b>Species selectivity</b>	None, if oxygen is low; carp and bullheads may survive partial depletion	None; all species affected	Usually one species dies before others	Usually one
<b>Time of fish kill</b>	Nighttime and early morning hours	Bright sun, 9 a.m.–5 p.m.	Any hour, day or night	During period of stress
<b>Plankton abundance</b>	Algae dying	Abundance of one algae species	Pesticide may kill algae	No effect
<b>Dissolved oxygen</b>	<3 ppm, usually <2 ppm	12–14 ppm	8–10 ppm	No effect
<b>Water color</b>	Brown, gray, or black	Dark green, brown, or golden	Normal	No effect

Source: Field Manual for the Investigation of Fish Kills. 1990. Fish and Wildlife Service. National Technical Information Service, 5285 Port Royal Road, Springfield, VA; Fish Kills In Indiana—Their Causes and Prevention. Purdue University. FNR 69

## **Pond Regulations and the Indiana Department of Natural Resources**

Indiana Department of Natural Resources (DNR) district fisheries biologists provide technical assistance for pond management. Pond owners may obtain information over the phone or via the Internet. District fisheries biologists can help analyze the fish kill information collected and help determine the cause(s). They can also help identify pondweed samples. A listing of Indiana's district fisheries biologists can be found at [www.in.gov/dnr/fishwild/3590.htm](http://www.in.gov/dnr/fishwild/3590.htm), as can additional information on pond management.

Private ponds that are not connected to waters of the state are not regulated by the state of Indiana, and disputes over fish kills in private ponds are not under the authority of the DNR nor the Indiana Department of Environmental Management (IDEM). The district fisheries biologists will not make a site visit to a private pond.

# Pesticide Laws and the Office of Indiana State Chemist

State and federal pesticide laws and regulations are enforced by the Office of Indiana State Chemist (OISC), which can become involved only when the person whose pond is allegedly impacted files a complaint with them. The OISC conducts the investigation, collects the appropriate samples, and provides analyses to interested parties at no cost. Their investigation determines whether the person applying the pesticide product followed label directions; it can result in no action, an official warning letter, a fine, and/or a loss of a certification credential. The OISC has a brochure at the following website that explains their investigative process: [http://www.isco.purdue.edu/pesticide/index\\_pest1.html](http://www.isco.purdue.edu/pesticide/index_pest1.html).

A pond owner thought a pesticide application to a nearby area had “sterilized” his pond. It was subsequently determined by the Office of Indiana State Chemist that the pesticide applicator had not followed label directions to stay 300 feet away from a pond or lake. The investigation confirmed — through fish, turtle, and water samples — the presence of the pesticide in the pond. It took four years for the product to clear the pond, which could only then be restocked.



Office of Indiana State Chemist



Office of Indiana State Chemist

# Advice from the Purdue Cooperative Extension Service Educator

Purdue University Extension has regional educators with expertise in pond management and aquaculture. These individuals respond to fish and weed management questions and address multiple aspects of pond management. Many of them are willing to visit farm ponds to offer their opinions and advise. Your county educator has access to water, wildlife, and pesticide specialists on the Purdue University campus who can provide additional assistance. Go to <http://www.ces.purdue.edu/anr/field/fs/countyoffices.html> to find contact information for your Agriculture and Natural Resources Extension Educator.

The Purdue University Cooperative Extension Service can provide valuable information on pond management, including pond construction, plant identification, and aquatic plant control options.

Office of Indiana State Chemist





## Making a Commitment to Pay

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It is an absolute requirement to inform your insurance carrier if you are accused of causing a fish kill; even if your policy provides the necessary coverage, failure to report could make it void. Share with the insurance representatives all information you collect, then let them do their job. Do not make any statements indicating that you will make retribution — and, for sure, don't mention any dollar amount. You could end up paying out of your own pocket!

Your insurance policy states that you cannot tell anyone that the insurance company will pay to settle a claim. It is up to the insurance company to make that determination. Never offer or pay a settlement without consulting your insurance agent. By doing so, you would be admitting guilt; and without the proper release forms, you might end up paying then *and* paying later.

Most individuals or businesses with licensed applicators who lawfully apply pesticides on customers' property have the insurance required by state law; however, individuals or businesses such as nurseries, garden centers, farms, etc., that apply chemicals on their own property may not have coverage for drift or runoff. If the materials they apply do drift or get washed downstream, they would be held personally liable. Consult with an insurance agent to make sure you have insurance to cover such an event.

## Conclusion

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People must use common sense when making pesticide and fertilizer applications to a pond. Follow label directions and watch the weather. A fish kill complaint is serious and requires a quick response and a thorough investigation. Use all the resources available to help determine the cause and resolve the problem.

Properly constructed and maintained lakes and ponds provide hours of enjoyment (p. 27).





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Nathan Long, Aquatic Control

Clyde New, C & C Aquatics

Leo Reed, Office of Indiana State Chemist

Ed Spanopoulos, Cygnet Enterprises

# Resources

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Field Manual for the Investigation of Fish Kills. 1990. U. S. Fish and Wildlife Service, Resource Publication 177. 120 pages.

Fish Kills in Indiana: Their Causes and Prevention. Purdue University Cooperative Extension Service Publication FNR-69. [www.ces.purdue.edu/extmedia/FNR/FNR-69-W.pdf](http://www.ces.purdue.edu/extmedia/FNR/FNR-69-W.pdf)

Indiana Fish Pond Management. Indiana Department of Natural Resources, Indianapolis, Indiana. 24 pages. [www.in.gov/dnr/fishwild/3356.htm](http://www.in.gov/dnr/fishwild/3356.htm).

Water Testing Laboratories. Purdue University Cooperative Extension Service Publication WQ-1. [www.ces.purdue.edu/extmedia/WQ/WQ-1-W.pdf](http://www.ces.purdue.edu/extmedia/WQ/WQ-1-W.pdf)

Wetlands, Regulations, and You — What Every Indiana Farmer Needs to Know. Purdue University CES Publication FNR-171. [www.ces.purdue.edu/extmedia/FNR/FNR-171-W.pdf](http://www.ces.purdue.edu/extmedia/FNR/FNR-171-W.pdf).



Koi ponds complement the landscape but can pose problems for the pesticide applicator. The cost of replacing Koi — hundreds to thousands of dollars apiece — is reason enough to be very careful when making fertilizer or pesticide applications near a decorative pond.

Koi ponds need good filtration, an aeration system, and regular maintenance, just like an aquarium. Many Koi pond issues involve ammonia, nitrates, nitrites, oxygen deficiency, and environmental pollutants such as oil and pesticides.

Ammonia produced from fish and plant waste is toxic to fish at concentrations of one part per million and beyond. Aquatic plants convert the ammonia to nitrates for their own nutrition; however, nitrites and nitrates produced from the incomplete oxidation of ammonia are toxic to fish. Aeration and partial water replacement are necessary to reduce nitrite levels.

The sudden death of a large number of fish, or fish gasping at the surface, indicates an oxygen deficiency caused by poor aeration, higher temperatures, or overcrowding of fish or plants. Small Koi ponds are very complicated — minor changes in pond conditions can quickly result in a fish kill — whereas larger ponds are somewhat more forgiving.

PPP-80, Solving the Fish Kill Mystery, Questions to Ask, is a tri-fold form for recording fish kill findings. It fits nicely into your glove compartment. View the form and access your copy at [www.btny.purdue.edu/PPP/](http://www.btny.purdue.edu/PPP/).

PURDUE EXTENSION  
PPP-80

PURDUE  
UNIVERSITY

# Solving the Fish Kill Mystery...



...Questions to



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