NEBRASKA GAME PARKS
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NEBRASKA POND GUIDE

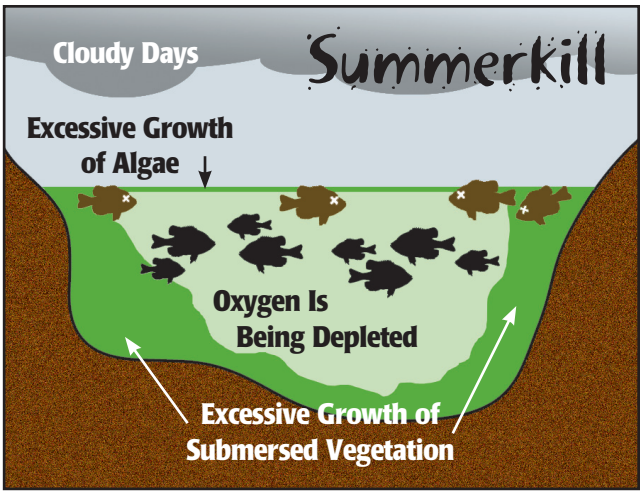
Private Waters Program
Management Assistance for Lakes, Ponds, Pits & Streams

RESOLVING COMMON MAINTENANCE PROBLEMS
FISH KILLS

Fish populations in a pond are constantly experiencing mortality. Some can have an annual mortality rate as high as 50%. Most of these deaths can be attributed to natural causes, with predation being the most common. It is also common to see some dead fish along shoreline areas. These fish likely died as a result of old age, minor disease outbreaks, handling, or spawning stress. When large numbers and a variety of sizes of different species are found dead, a major fish kill has occurred. Contrary to popular belief, fish kills are rarely caused by an overpopulation of fish. A pond will naturally stay within its capacity to support fish under normal conditions. Common causes of fish kills are suffocation due to lack of oxygen, poisoning, and disease or parasite infestations. Knowing about these causes can help pond owners prevent fish kills.

FISH KILLS DUE TO SUFFOCATION

Most of the dissolved oxygen in a pond is a product of plant photosynthesis. Oxygen can also enter the pond by absorption through the water surface, especially when there is wind and wave action. Dissolved oxygen levels can vary significantly throughout the year or even during a day. Critically low dissolved oxygen levels can result from certain combinations of environmental conditions and pond characteristics. Low dissolved oxygen is the most common cause of fish kills in ponds, often occurring in summer, winter, or as a result of seasonal water column turnover. Once oxygen levels reach a critically low point, only aeration or the addition of fresh aerated water can prevent a fish kill.



Summerkill

Summer fish kills can result in the total or partial die-off of a pond's fish community. Summerkills can occur when certain environmental conditions cause a substantial decline in dissolved oxygen levels. This type of fish kill is most common in small, shallow, heavily vegetated ponds containing a large amount of decomposing organic material.

Excessive vegetative growth, especially algae, in a pond can lead to a fish kill. Sunny conditions result in a long period of plant photosynthesis that produces high dissolved oxygen levels during late afternoon; however, during the night, oxygen is used for respiration by plants, fish, insects, and other organisms, and organic decomposition. If the oxygen produced during the daytime is insufficient to carry all pond life through the night, a fish kill will result. As long as the weather is sunny, oxygen production

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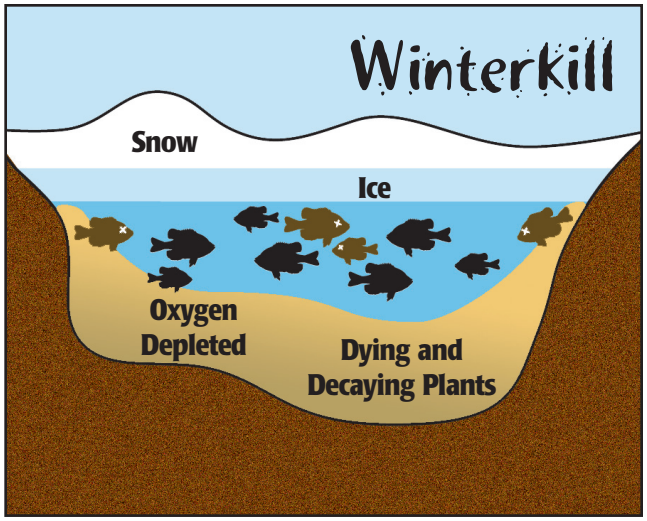
is usually adequate; however, several consecutive calm, cloudy days can result in vegetation dying (particularly algae) and decomposing, reducing the pond's dissolved oxygen levels to the point that fish may not survive - especially during the night. These conditions are confounded during the summer when air and water temperatures are greater than 80 degrees and calm conditions prevail. Also, once water attains these higher temperatures, it is unable to retain high levels of dissolved oxygen. The most obvious sign of an oxygen problem is fish gasping or gulping at the surface, particularly in the early morning hours (shortly after sunrise). A summerkill usually results in larger fish dying first with minimal, if any, effect on other aquatic animal life, such as aquatic insects, frogs, and turtles.

Ponds can become stratified during the summer, particularly those that are relatively deep and protected from the wind. Water density varies according to temperature, with the colder, denser water occurring at the bottom. The surface water normally has sufficient dissolved oxygen, while the denser bottom water may contain little or no oxygen because it is being depleted by bacterial decomposition of organic matter. This is especially true in ponds with excessive vegetation. The differences in water densities keep the pond water from mixing. But, a rapid inflow of cool surface runoff from a summer thunderstorm, combined with strong winds and waves, can result in mixing the surface water with the oxygen deficient bottom water. During this thermal turnover, or inversion, a fish kill can result. Lightning strikes can also cause a fish kill in the immediate impact area.

Winterkill

Winter fish kills result when oxygen levels fall too low to support fish under the ice. Since ice acts as a seal and prevents the absorption of oxygen directly from the atmosphere, oxygen produced by plant photosynthesis is crucial. Clear, thick or even



cloudy ice typically allows enough sunlight penetration for plants. But, ice blanketed with snow allows very little sunlight penetration, so plants are unable to survive and produce a sufficient amount of oxygen. Oxygen levels drop due to plant decomposition and respiration by the various aquatic organisms. If snow cover persists for an extended period of time, the oxygen will be completely depleted, resulting in a fish kill. This usually happens in shallow ponds which have large amounts of organic matter, such as decaying aquatic vegetation or livestock wastes. Winterkills can be severe enough to kill all the fish and other aquatic life, including frogs and turtles, in a pond. Often, bullheads and carp are the only fish to survive winterkills. In these cases, the pond should be renovated with rotenone and restocked with appropriate pond species, provided adequate depth is present.

Seasonal Turnover Kill

Some ponds that contain relatively large amounts of deep water that annually stratifies can experience a fish kill when the pond turns over, producing conditions similar to an inversion. These ponds thoroughly mix in both spring and fall when surface and deep water temperatures are the same. Wind can facilitate the mixing.

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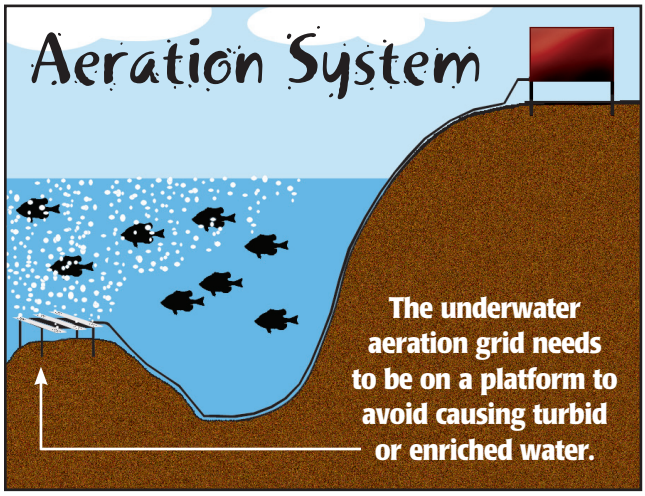
PREVENTING FISH KILLS DUE TO SUFFOCATION

Most of these types of fish kills can be avoided if a pond contains sufficient depths to prevent excessive growth of aquatic vegetation and to store enough oxygen during critical time periods, especially winter. See Pond Depth and Slopes section of **PG13-1** for details.

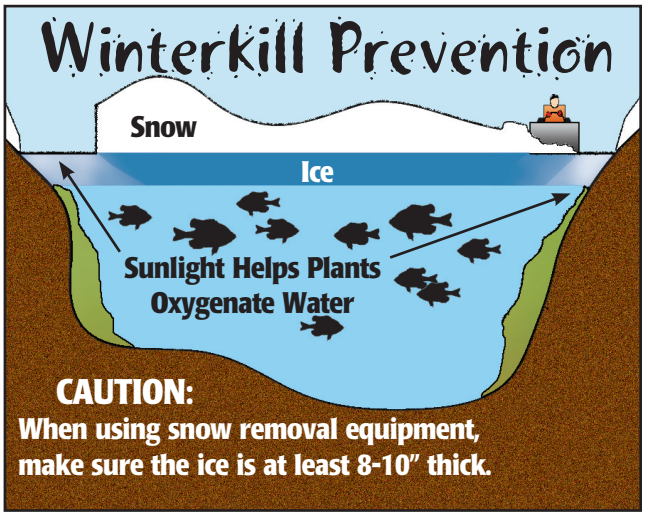
These types of fish kills can also be prevented by installing aeration or water circulating systems that will oxygenate the water year-round. Install the aerator diffuser (air stone) in the deepest part of the pond; however, do not allow it to rest on the bottom as this will stir up organic materials, accelerating their decay and increasing oxygen consumption. Algal blooms can result if large amounts of bottom nutrients are carried to the surface as the bubbles rise. Either place the diffuser on a pedestal or in a weighted 5-gallon bucket, or suspend it at least 2 feet off the bottom. When using a circulation system, install the water circulator near the deeper part of the pond and orientate it so that it can circulate the majority of the pond.

If an aeration system is really churning the water and the rising air bubbles have caused an excessive up-welling of bottom sediment and/or nutrients, the pond can become turbid or have an extensive algal bloom. If either occurs, the diffuser should be raised up some more, or the output decreased, or another diffuser added. If another diffuser is added, make sure the delivery hose sections that are coming from the "t" in the main delivery line to each diffuser are the same length to facilitate similar outflows.



Both aeration and water circulating systems will maintain an open water area during the winter and facilitate oxygen absorption directly from the atmosphere. Cutting a single hole in the ice during the winter isn't very effective because not enough water gets exposed to the air.

Winterkills can also be prevented by removing snow from the pond. Three inches of ice, covered by 5 inches of snow, will block 99% of the incoming sunlight. Remove snow from 30 to 50% of the pond surface or just in shoreline areas where submergent vegetation would be located beneath the ice. Make sure the ice is at least 4 inches thick before walking on it to shovel snow, or at least 8 to 10 inches thick before using snow removal equipment (i.e. small tractor with a blade).



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FISH KILLS DUE TO POISONING

Fish kills can be caused by the improper use or spills of many chemicals, including insecticides, herbicides, fertilizers, and petroleum products. Pesticides can enter a pond from an agricultural field, golf course, or lawn. Some pesticides can be very toxic to fish. Luckily, many are short-lived and usually breakdown and become non-toxic to fish before they enter a pond. Many pesticides can cause a fish kill when applicators are careless and allow the spray or its drift to enter the pond directly. A fish kill can also occur when storm runoff carrying pesticide-laden soil particles enters a pond immediately after an application.

Fish kills resulting from chemical poisoning can be extensive and affect all fish species. They are also characterized by small fish dying sooner than larger fish. Many species of aquatic vertebrates, such as turtles, frogs and tadpoles, and other aquatic organisms, can also be killed or adversely affected. If sub-lethal pesticide dosages continue to enter a pond for an extended time period, they can affect fish food production, alter fish reproduction, or become an additional stressor that decreases fish resistance to low dissolved oxygen levels and diseases. By choosing a proper site for pond construction, many of these problems can be avoided. Landowners also need to consider pond health when choosing chemicals to use in the watershed.

FISH KILLS DUE TO DISEASES AND PARASITES

Fish kills can also result from disease and parasites. Although viruses, bacteria, and fungi can all cause disease outbreaks, they usually do not result in massive fish die-offs. But, when a die-off does occur, it is often dominated by one species. Mortality can occur during early spring, when a fish's disease resistence is low due to winter and pre-spawning stressors. Even post-spawning stress can lead to fish mortality which can be higher than pre-spawn mortality when conditions are right. If fish populations are out of balance and there is a high density of one species of fish, particularly crappies, a disease outbreak can result in a substantial fish kill. Angler-caught fish mishandled during the release process are more susceptible to infections and diseases. Environmental conditions, such as prolonged periods of low dissolved oxygen, extreme pH levels, and high temperatures, can also stress fish and make them more susceptible to diseases. Although most fish have some parasites, they are normally not a problem for healthy fish. Like diseases, parasites can cause mortality if fish are already stressed from other factors. Maintaining good water quality and balanced fish populations will keep fish healthy and less susceptible to disease and parasite problems. See **PG13-11** for detailed information about fish diseases and parasites.

Consequences of Fish Kills

Most fish kills do not result in elimination of the entire fish community. The severity of a fish kill depends on environmental conditions, the size and depth of the pond, and the type of kill. The adverse conditions that caused the kill may not have occurred throughout the entire pond, and unaffected areas will provide a refuge until conditions improve. For example, a partial kill caused by pesticides associated with storm runoff may occur in the area near the inlet and nowhere else, as a result of dilution.

Depending on the severity of the fish kill and the species involved, the remaining fish populations may not return to previous levels or provide the same quality of fishing. If undesirable fish species, such as carp, bullheads, or green sunfish, were present prior to the kill and were not affected by it, they may then overpopulate the pond due to reduced

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competition and lack of predation by largemouth bass. Fish populations that have suffered die-offs should be assessed to determine what needs to be done to restore the pond's fishery. See Assessing Fish Populations section of **PG13-4** for details.

Reporting Fish Kills

Contact the nearest Commission district office, the Nebraska Department of Environmental Quality (NDEQ), (402) 471-2186, or the 24-hour NDEQ/State Patrol pollution complaint hotline, (402) 471-4545, regarding fish kills that may be due to toxic substances. Contact a Commission fisheries biologist or the Private Waters Specialist in Lincoln to discuss extensive fish kills and their consequences.

ADDITIONAL AERATION INFORMATION

The first step is to determine if aeration is needed. A deepening project should be considered instead of aeration for most shallow water situations. However, aeration can be used during drought conditions to maintain a fishery until the pond/lake refills.

Aeration systems are usually installed for several reasons: expansion of available fish habitat (providing oxygen in water depths normally devoid of oxygen – common problem in most sandpits and some dugout ponds); improvement of water quality (keeping bottom oxygenated results in bottom sediment retaining phosphorous, thus reducing algal blooms); and prevention of winterkills and summerkills.

Decomposition of organic material (primarily dying/dead aquatic vegetation) uses up available oxygen in the water and can lead to low dissolved oxygen levels during both winter and summer months particularly in shallow water bodies. Aquatic vegetation dieoffs usually occur when excessive amounts of vegetation are present and available sunlight is cut off for an extended period of time. As mentioned earlier, sunlight penetration can be cut off by excessive snow cover and thick ice, or by extended periods of cloudy days during summer months, or when severely silt-laden runoff following thunderstorms dirties up pond/lake water upon entering.

There are various aeration systems available including electrical, wind-generated, and solar-powered. An electrical aeration system needs to have the following basic components:

- power source
- air compressor
- delivery hose/tubing
- diffuser

The air compressor is designed to draw in air and force it through a delivery system to the diffuser on the pond's bottom. Although most air compressors can be adjusted in the field for either 120 or 240 volts, the 240v is preferred especially if the delivery line runs more than 300 feet from the main power line. The best situation is when the power source is readily available at the site. Then it is just a matter of running a short power line to the fuse box. Portable generators can be used if there isn't power readily available. Purchase a generator that has a large fuel capacity for extended operation. The kilowatt rating should be at least twice the motor horse power (i.e. 3 kilowatt or 3000 watts for 1½ horse power). Check with the generator manufacturer to be sure. The air compressor should have a case/box surrounding it to protect it from the elements with a lock to lessen the likelihood of vandalism. This structure should be ventilated to prevent the compressor from overheating. The case/box should be constructed so as to allow easy access to the compressor for periodic maintenance.

The delivery system is usually ½ inch factory weighted hose or polyethelene tubing. It should be buried below the frost line to the water's edge and kept underground a short distance out into the water. Non-factory weighted 1 inch hose/tubing can also be used as long as it is periodically weighted by attaching 1 brick every 5 feet with plastic zip ties. Or the delivery system can be buried in the exposed

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pond/lake bottom prior to filling. The delivery system needs to be anchored to prevent it from floating up off the bottom and becoming snagged by anglers or frozen into the ice during the winter.

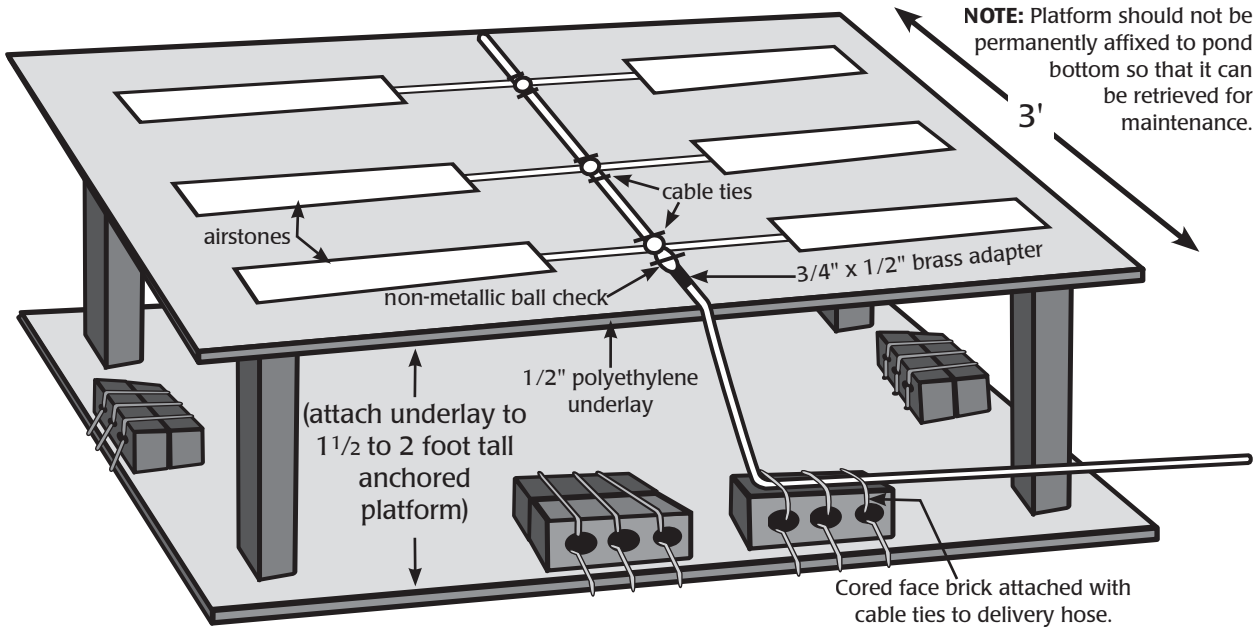
The diffuser is used to break up delivered air into very small bubbles. The diffuser can be a ceramic airstone (preferred), porous hose, or perforated PVC pipe. The delivery system should have an automatic check valve installed just before the diffuser. This will keep water from entering the delivery system and prevents freeze up during the winter if the aeration system gets turned off. The diffuser should be attached to an "anchored" platform that will hold the diffuser about 2 feet up from the bottom. This prevents circulation of bottom sediment/nutrients throughout the entire water column. Keep in mind the platform should not be permanently affixed to the pond bottom so that it can be retrieved for maintenance.

Larger bodies of water may require several compressors and diffusers. A general rule for "air output" is 1.3 cubic feet per minute per surface acre of water. For example, a ¾ horsepower 2 piston compressor can supply sufficient air output to operate either a one 6-stone diffuser or two 4-stone diffusers; whereas, a 1½ horsepower 4 piston compressor can have either two 6-stone or four 4-stone diffusers.

Although they have different power sources and "compressors," wind-generated and solar-powered aeration systems have delivery and diffuser setups similar to an electrical system. Most water circulation systems require an electrical source. Inquiries about aeration and circulation systems (setup and manufacturers) can be directed to Commission fisheries personnel.

Contacts: Jeff Blaser, Private Waters Specialist
Nebraska Game and Parks Commission
2200 North 33rd Street
Lincoln, NE 68503
402-471-5435
or area Commission fisheries biologist.

3/4 VIEW OF CERAMIC AIRSTONE DIFFUSER



NEBRASKA POND GUIDE - FISH KILLS

The following information can be used for troubleshooting fish kills. Knowing what can cause a fish kill will help you prevent or lessen the severity of one.

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SPORT FISH RESTORATION

CAUSE of FISH KILL	SYMPTOMS	PROBLEM	RECOMMENDED SOLUTION(S)
Summerkill	Fish found dead and/or gasping for air at the surface, particularly in early morning hours; larger fish usually die first, little effect on other aquatic animal life (frogs, turtles, etc.).	Consecutive days and nights of cloudy, hot, still conditions; very high water temperatures (above 85 degrees) and not enough dissolved oxygen; cloudy skies prevent plants from producing oxygen; calm winds prevent mixing of oxygen into surface water; aquatic organisms' respiration and plant decomposition deplete available oxygen; shallow, weedy ponds are especially vulnerable.	Add fresh water and/ or agitate the water surface to facilitate oxygen absorption; deepen pond to limit vegetation growth and increase water volume so more dissolved oxygen can be stored and/or install an aeration system.
Inversion	Dead or gasping fish (larger fish affected first) found after a violent thunderstorm which produced heavy downpours and high winds.	Large sudden inflow of cool rainwater and strong winds cause bottom water (low in dissolved oxygen) to mix with the surface water, resulting in critically low oxygen levels throughout; can occur in shallow, weedy ponds or ponds that contain deep, stratified, stagnant water; both types in combination with large, steep drainage areas with high runoff rate; lightning can also cause a fish kill, affecting all fish species of all sizes in the immediate strike area.	Install an aeration system to circulate and aerate oxygen-deficient bottom water and/or deepen shallow water areas to restrict vegetation growth. This type of fish kill rarely occurs.
Seasonal Turnover	Dead or gasping fish (larger fish affected first) found in spring and/or fall	Stratified and/or unoxygen-ated deep water mixes with surface water in spring and fall when surface and deep water temperatures are the same, resulting in critically low oxygen levels; wind can facilitate the mixing.	Install an aeration system to circulate and aerate oxygen-deficient bottom water.

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SPORT FISH RESTORATION

CAUSE of FISH KILL	SYMPTOMS	PROBLEM	RECOMMENDED SOLUTION(S)
Phytoplankton Die-off	Fish found dead and/or gasping for air at the surface (larger fish affected first); water has a green cast or looks like it has paint floating on the surface prior to or during fish kill, or water may have a brown color during or after kill.	Nutrient-enriched ponds produce dense blooms of phytoplankton (algae) which can suddenly die-off following consecutive days and nights of cloudy, hot, still conditions; decomposition causes an oxygen shortage and gives water a brown color; dead and decomposing algae (mostly blue-green species) can release a toxin fatal to fish into the water.	Reduce nutrient inputs by diverting nutrient-enriched runoff from animal feedlots or cropland around the the pond when permissible and/or install nutrient/sediment entrapment structure(s) above the pond; consider an aeration system.
Dead Vegetation	Fish found dead and/or gasping for air (larger fish affected first) within a few days of a die-off of large amounts of aquatic vegetation.	Massive die-off of aquatic vegetation from aquatic herbicide overuse; or muddy water from storm runoff enters a pond and prevents sunlight penetration, resulting in suffocation and die-off of aquatic vegetation; large amounts of decomposing vegetation depletes available dissolved oxygen.	Shoreline should be sloped 3:1 and additional deep water areas created to limit vegetation growth; reduce nutrient inputs; consider an aeration system if unable to deepen or reslope shoreline areas.
Organic Pollution	Fish found dead and/or gasping for air (larger fish affected first) following inflow of large amount of organic matter after heavy rains.	Large amounts of decomposing matter (excess animal wastes, leaves and vegetation) deplete dissolved oxygen levels.	Prevent excess organic matter from entering or building up in the pond; use aeration to accelerate the decay process and reduce buildup.
Winterkill	Large numbers of fish of all sizes along with turtles, frogs, and other organisms found dead along shoreline soon after ice-out; few, if any, fish caught by anglers in spring as compared to the previous year.	Snow cover stays on the ice for an extended period of time, preventing sunlight penetration to plants that produce oxygen; aquatic organisms' respiration and plant decomposition deplete oxygen; shallow, heavily vegetated ponds are especially susceptible.	Remove snow if its depth is greater than 3 inches from at least 30% of pond surface or just in shoreline areas and/or install an aeration system that will also prevent complete ice cover.

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The following information can be used for troubleshooting fish kills. Knowing what can cause a fish kill will help you prevent or lessen the severity of one.

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SPORT FISH RESTORATION

CAUSE of FISH KILL	SYMPTOMS	PROBLEM	RECOMMENDED SOLUTION(S)
Toxic Substances	Dead or dying fish (smaller fish affected first), frogs, tadpoles, and insects.	Pesticides, petroleum products, fertilizers, and other toxins enter the pond directly or when heavy rains wash recently applied chemicals into the pond; extent of the kill depends on the amount and dilution rate of toxins upon entry to pond (problem may be confined to just entry site).	Divert runoff coming from potentially toxic sources; install entrapment structures or buffer strips; if pesticide application is necessary for crop production, apply carefully.
Natural Causes	Some dead fish (usually larger and older fish) found along the shoreline in early or late spring.	Natural mortality caused by reduced disease resistance brought on by winter and/or spawning stressors.	Nothing, let nature take its course.

NOTE: There are times when the causes of fish kills are not obvious; the kill can result from a combination of factors.

Aeration can be accomplished with various types of aerators and/or water circulating systems.

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TECHNICAL ASSISTANCE CONTACTS

Nebraska Game and Parks Commission (Commission)
2200 N 33rd Street PO Box 30370
Lincoln, NE 68503
Private Waters Specialist 402-471-5435
Natural Heritage Program 402-471-5419

Northwest (NW) District - Alliance
Game and Parks Commission
299 Husker Road PO Box 725
Alliance, NE 69301
308-763-2940
Fisheries Division or
Wildlife Habitat Partners Section

Northwest (NW) Field Office - Valentine
Valentine State Fish Hatchery
90164 Hatchery Road
Valentine, NE 69201
402-376-8080 or 402-376-2244

Southeast (SE) District - Lincoln
Game and Parks Commission
2200 N 33rd Street PO Box 30370
Lincoln, NE 68503
402-471-7651 or 402-471-5561
Fisheries Division or
Wildlife Habitat Partners Section

Northeast (NE) District - Norfolk
Game and Parks Commission
2201 N 13th Street
Norfolk, NE 68701
402-370-3374
Fisheries Division or
Wildlife Habitat Partners Section

Northeast (NE) Field Office - Bassett
Game and Parks Commission
524 Panzer Street PO Box 508
Bassett, NE 68714
402-684-2921
Fisheries Division or
Wildlife Habitat Partners Section

Southwest (SW) District - Kearney
Game and Parks Commission
1617 First Avenue
Kearney, NE 68847
308-865-5310
Fisheries Division or
Wildlife Habitat Partners Section

Southwest (SW) Field Office - North Platte
Game and Parks Commission
301 East State Farm Road
North Platte, NE 69101
308-535-8025
Fisheries Division or
Wildlife Habitat Partners Section

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United States Department of Agriculture - Natural Resources Conservation Service (NRCS)

Federal Building, Room 152
100 Centennial Mall North
Lincoln, NE 68508
Statewide Wildlife Biologist
402-437-4100
or contact Local County Office

University of Nebraska - Lincoln, Cooperative Extension

211 Agricultural Hall - UNL East Campus
Lincoln, NE 68583
Main Office 402-472-2966
or contact Local County Office;
Water Quality Questions 402-643-2981, ext. 115

Nebraska Department of Natural Resources (DNR)

301 Centennial Mall South, PO Box 94676
Lincoln, NE 68509
Water Storage Permits 402-471-2363 or
Dam Safety Guidelines 402-471-1222

U.S. Army Corps of Engineers (ACOE)

8901 S. 154th Street, Suite 1
Omaha, NE 68138 402-896-0723
or contact the Kearney office at:
1430 Central Avenue
Kearney, NE 68847
308-234-1403

Nebraska Department of Environmental Quality (NDEQ)

1200 N Street, PO Box 98922
The Atrium, Suite 400
Lincoln, NE 68509
402-471-0096

Nebraska Association of Resources Districts (NARD)

601 S. 12th Street, Suite 201
Lincoln, NE 68508
402-471-7670
or contact your local Natural Resources District (NRD)
listed in White Pages of the phone book