



Eutrophication (algal blooms) in Big Mallard Marsh.
(Photo courtesy of North Dakota Department of Health)



A fish kill in North Dakota.
(Photo courtesy of North Dakota Game and Fish Department)

Environmental Implications of Excess Fertilizer and Manure on Water Quality

Mary Berg, Area Extension Livestock Environmental Management Specialist, Carrington Research Extension Center
Miranda Meehan, Extension Livestock Environmental Stewardship Specialist
Tom Scherer, Extension Agricultural Engineer

When nutrients and other pollutants associated with animal manures and commercial fertilizers are not managed properly, they can affect plant and animal life (including humans) negatively. Some of these impacts include algae blooms causing the depletion of oxygen in surface waters, pathogens and nitrates in drinking water, and the emission of odors and gases into the air.

Nutrients from manure and fertilizers enter lakes and streams through runoff and soil erosion. Generally, when soil-test nitrogen (N) and phosphorus (P) increase, greater amounts of plant-available N and P move with water. Runoff water from fields with high soil-test N and P may contain a high level of these dissolved nutrients, increasing the risk of contaminating streams, wetlands and lakes.

In addition, erosion carries fine particles of soil that are enriched with nutrients. Eroded soil particles with attached nutrients will accumulate as sediment in water resources and serve as a source of available nutrients during long periods of time.

Oxygen Depletion

When manure or commercial fertilizers enter surface water, the nutrients they release stimulate microorganism growth. The growth and reproduction of microorganisms reduce the dissolved oxygen content of the water body.

Without sufficient dissolved oxygen in surface water, fish and other aquatic species suffocate. The resulting dead fish and other aquatic species degrade the water quality and cause unpleasant odors.

Weed Growth and Algae Blooms

The number of plants and algae in a lake, pond or other water body increase with an increased supply of nutrients, particularly N and P. N and P are present in manure in sufficient quantity to be used as fertilizer for crop growth and will have a similar effect on algae and aquatic plants. As with crops, nutrient availability is the critical factor in the growth of aquatic plants and algae.

The nutrient present in the least amount for growth will limit the production in the aquatic system. Introduction of even small amounts of the limiting nutrient to crops or aquatic systems can increase production substantially. In the case of agricultural crops, this is a good thing.

However, increased production of aquatic plants and algae is not healthy for water resources. Eutrophication is the term used to describe the natural or human-accelerated process whereby a water body becomes abundant in aquatic plants and low in oxygen content.

As these aquatic plants die, microorganisms use the organic matter as a food source. Once again, the microorganisms grow and reproduce and use up the oxygen in the water. Any increase in the amount of aquatic plant growth ultimately will result in a reduced dissolved oxygen content of the water body, eventually suffocating fish and other aquatic species.

In addition to oxygen depletion, the potential exists for the algae to be toxic. Blue-green algae (cyanobacteria) can cause rashes, nausea and respiratory problems in humans and has been documented that it kills livestock that drink from affected water storages. See the NDSU Extension publication “Cyanobacteria Poisoning (Blue-green Algae)” at <http://tinyurl.com/NDSU-blue-green-algae> for more information.

Ammonia Toxicity

Ammonia-contaminated runoff from fresh manure application sites is toxic to aquatic life. At high levels, ammonia in surface water will kill fish. Fish are relatively sensitive to ammonia in water. Concentrations as low as 0.02 parts per million (ppm) may be lethal. Surface water that manure impairs also may experience changes in species diversity because of ammonia toxicity.

Fecal Organisms

The fresh manure from warm-blooded animals has countless microorganisms, including bacteria, viruses, parasites and fungi. Some of the organisms are pathogenic (disease causing), and some of the diseases that animals carry are transmittable to humans, and vice versa.

Many states use fecal coliform bacteria as an indicator of pollution from warm-blooded animals, including humans. The test for fecal coliforms is relatively simple and inexpensive, compared with testing for specific pathogens.

Some fecal coliforms can be found in natural water sources, even without the influence of humans or their domestic animals. Birds, beaver, deer and other wild animals contribute fecal coliforms to surface water directly or in runoff.

Contamination from runoff and natural deposition are not the only ways for water to become impaired. If manure applications are mismanaged near wells, the risk of bacterial contamination of the groundwater via the well is greatly increased. Therefore, avoid surface application of manure where it can come into direct contact with a well or other drinking water supply. In addition, when grazing near surface water sources, take measures to restrict livestock use.

Nitrates

High levels of nitrates can be toxic to livestock and humans. Nitrates are not adsorbed to soil materials, so they may leach to groundwater. In some instances, stored or land-applied manures or nitrogen fertilizers have caused high concentrations of nitrates in water. Because nitrates freely leach down through the soil profile, nitrogen that is not used for crop or plant growth can reach the groundwater easily.

Nitrate in itself is not toxic to animals, but at elevated levels, it causes a disease called nitrate poisoning. See the NDSU Extension publication “Nitrate Poisoning of Livestock” (<http://tinyurl.com/NitratePoisoning>) for more information.

High levels of nitrates in drinking water are known to cause methemoglobinemia (blue-baby syndrome) in human infants and other warm-blooded animals. In humans and livestock, nitrates interfere with oxygen uptake in the circulatory system.

Odors and Gases

Manure odors can be a nuisance for nearby neighbors and communities. Constant nuisance odors can degrade the quality of life for anyone subjected to them. In addition, people have a wide range of susceptibility to health effects from odors.

Gases are emitted from facilities throughout the year but are released at the highest rates during agitation, pumping and application of liquid manure systems or during cleanout and application of solid manure systems. Volatilization of ammonia to the atmosphere may become a water quality problem near animal production facilities when it is returned to the earth dissolved in rainfall.

Summary

If managed properly, fertilizers and animal manures benefit crop production without causing environmental problems. In any management scenario, the manager must be aware of the possible negative consequences of mismanagement.

For additional information on water quality, see these other NDSU Extension Service publications:

- “Phosphorus Behavior in the Environment”
- “Nitrogen Behavior in the Environment”

This publication was authored by Ron Wiederholt, NDSU Extension Service southeast district director, and Bridget Johnson, former NDSU Extension area nutrient management specialist.

For more information on this and other topics, see www.ag.ndsu.edu

The NDSU Extension Service does not endorse commercial products or companies even though reference may be made to tradenames, trademarks or service names. NDSU encourages you to use and share this content, but please do so under the conditions of our Creative Commons license. You may copy, distribute, transmit and adapt this work as long as you give full attribution, don't use the work for commercial purposes and share your resulting work similarly. For more information, visit www.ag.ndsu.edu/agcomm/creative-commons.

County commissions, North Dakota State University and U.S. Department of Agriculture cooperating. NDSU does not discriminate in its programs and activities on the basis of age, color, gender expression/identity, genetic information, marital status, national origin, participation in lawful off-campus activity, physical or mental disability, pregnancy, public assistance status, race, religion, sex, sexual orientation, spousal relationship to current employee, or veteran status, as applicable. Direct inquiries to Vice Provost for Title IX/ADA Coordinator, Old Main 201, NDSU Main Campus, 701-231-7708, ndsuoaa@ndsu.edu. This publication will be made available in alternative formats for people with disabilities upon request, 701-231-7881.