Nitrate Pollution:

An Unseen threat to Amphibian Populations

Threats to Amphibian Survival

- Loss of amphibians on our planet is mainly due to the destruction of habitat.
- Pollution is a less visible and potentially insidious threat to amphibian survival.
- Nitrate is an example of a pollutant which now occurs in many watercourses around the world at concentrations which can kill amphibians.

Nitrate: What is it?

- Nitrate is a natural compound present in all ecosystems. It is one of the chemicals essential to plant life but too much can be a problem for plants and animals. It is also a component of chemical and manure based fertilizers.
- Nitrate can enter watercourses and ponds from sources such as areas of high fertilizer use, livestock feedlots and pastures, and sewage treatment areas.
- Nitrate is applied to fields and lawns as a nutrient for plants but during rainstorms it can be washed directly into nearby ponds and streams via surface flow or through tile drainage systems.
- Nitrate and ammonia are components of manure that can also run-off into amphibian habitats.
- Sewage treatment areas often release high levels of nitrate into water courses.

How are Amphibians Exposed to Nitrate?

- Amphibians are at the highest risk of exposure and are most sensitive to nitrates when they are in the egg and tadpole stage of the amphibian life cycle.
- For most amphibian species, the egg and tadpole life stages occur in the water during the months when fertilizers and other chemicals reach their peak application levels.

How Toxic is Nitrate to Amphibians?

- Studies examining nitrate toxicity to selected native North American amphibian species indicate that nitrate concentrations required to kill 50% of the tadpoles are in the range of 13 to 40 parts per million (ppm).
- Although studies have not been conducted on amphibians outside North America, it is suspected that species from other parts of the world are also being affected.
- Chronic effects on amphibians (reduced feeding, reduced swimming, and developmental deformities) occur at concentrations as low as 2-5 ppm in some species.

What is "ppm"?

"Parts per million" (ppm) is a term used to express pollutant measurements in air, soil, water, or tissues. By way of example, one ppm is equivalent to one ice cube (5 grams) in 5 tonnes of ice. Many of the vitamins we require for survival are effective at ppm concentrations in our body. Similarly, pollutants can be toxic at these low concentrations.

What Concentrations of Nitrate are Found in Watercourses?

- Of the 8545 water samples collected in the 1990s from states and provinces bordering the Great Lakes, 19.8% contained nitrate concentrations exceeding 2 ppm which can cause developmental effects in amphibians. Some of the samples (3.1%) contained concentrations of nitrate above 10 ppm that could be lethal to amphibian tadpoles.
- Studies in the United Kingdom indicate that peak concentrations of 30 to 50 ppm nitrate could be expected in many bodies of water.

How Can We Reduce this Problem?

- By reducing the amount of fertilizer being applied to fields and residential lawns, we can reduce the potential for nitrate entering into local watercourses after rainstorms.
- Tile drainage systems could be placed deeper into the soil thereby reducing the chance that nitrate will be carried into them.
- Watercourses can be fenced to prevent livestock from arbitrarily entering the water.

- Fencing also keeps the livestock from flattening the vegetation around the edges of watercourses. This reduces nitrate concentrations in streams by not only eliminating direct deposition of manure, but also by allowing the surrounding area to become revegetated.
- Environment Canada's Great Lakes Clean-Up Fund has funded programs to reduce runoff and fence watercourses in the watersheds of Hamilton Harbour, Big Otter Creek, Wheatley Harbour, Detroit River, Severn Sound, Bay of Quinte, and the St. Lawrence River.
- The use of vegetated buffer zones around watercourses in urban and rural areas reduces the concentrations and loadings of nitrate entering the surface water through runoff by retaining the nitrate in soil and plants.
- Effective vegetated buffer strips can range from mixed woodlands to a strip of grass and can vary in size from a few metres in width to hundreds of metres.
- Examples of actual successes with vegetated buffer zones include a 24 metre grass buffer which reduced nitrate concentrations in water runoff from 10 ppm to below 1 ppm and a 19 metre mixed woodland buffer which reduced concentrations of nitrate from approximately 7 ppm to 0.5 ppm in the water that entered the stream.

Other Benefits of Vegetated Buffer Zones:

- In addition to removing nitrates, buffers can improve shelter and spawning or nesting habitat for amphibians and birds.
- Buffers can also reduce the amounts of phosphorous and sediments that enter watercourses. This helps to keep oxygen levels high so that fish, such as trout and salmon, can survive.
- Forested buffers adjacent to mid-sized streams can moderate temperatures, stabilize banks, reduce erosion, and provide important sources of organic matter to stream communities. This keeps water courses clean and healthy for invertebrates, amphibians, birds, fish, and mammals.

An Example of Success

Before: A landowner contact program in the Hamilton Harbour watershed in Ontario, Canada, recognized that the presence of unfenced livestock and the loss of vegetation near and within a watercourse were contributing to increased levels of nitrate and ruining the habitat for wildlife species such as amphibians, fish and birds.

After: The Hamilton Region Conservation Authority in partnership with the Clean Rural Beaches Project (Ontario Ministry of Environment & Energy) provided monetary subsidies to the farmer for a portion of the fencing cost. The habitat revegetated in one year.

Sources of Information:

Castelle, A.J., Johnson, A.W., and C. Connolly. 1994. Wetland and stream buffer size requirements- a review. J. Environmental Quality 23:878-882. Peterjohn, W.T. and D.L. Correll. 1984. Nutreint dynamics in agricultural watershed: observations on the role of a riparian forest. Ecology 65:1466-1475. Rouse, J.D., Bishop, C.A., Struger, J. 1999. Nitrogen Pollution: An assessment of the impact on amphibians. Env. Health Persp. 107(10): 1-6.