

## Fertilizers and Eutrophication

### The Main Cause of Amphibian Declines

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## Objectives

- What is eutrophication?
- General effects on amphibian quality of life
- Indirect effects on amphibians
- Space / time effects on amphibian habitats

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## What is Eutrophication?

Natural aging of lakes/streams due to **nutrient enrichment**

- Nitrogen(N)
- Phosphorus(P)
- essential for plant growth
- excess nutrients** promote heavy algae growth
- debate over which excess nutrient is most detrimental

Eutrophication accelerated by human activities that increase nutrient loading rates to water

Sharpley et al. 1999

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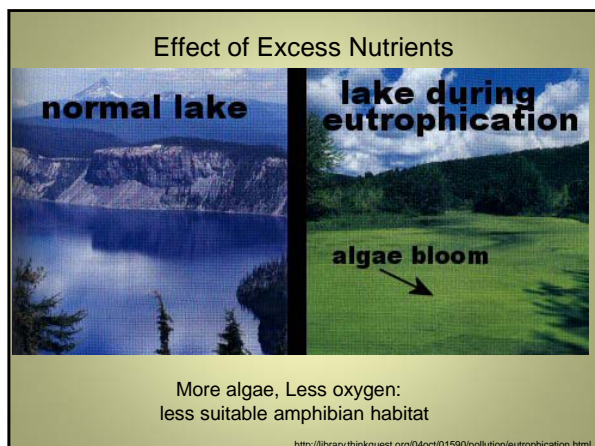
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
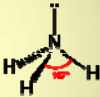
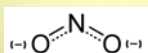
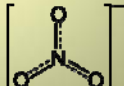
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**Nitrogen in the aquatic environment**

- Ammonium ion  
 $\text{NH}_4^+$
- Ammonia  
 $\text{NH}_3$
- Nitrite  
 $\text{NO}_2^-$
- **Nitrate** — most abundant, least toxic  
 $\text{NO}_3^-$

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**Nitrogen Concentrations**

Natural N levels in groundwater  
~3 mg/L

anthropogenic contamination > 3 mg/L

In aquatic ecosystems near agriculture and urban areas  
[ $\text{NO}_3^-$ ] levels > 100 mg/L

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### Excess Nitrogen Sources

- **Fertilizers**
  - agricultural and urban
  - main focus
- Livestock
- Precipitation
  - Exhausts from cars and industry
- Industrial and human wastes

Enters ecosystems through runoff, percolation

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### Nitrogen-Based Fertilizer Use in USA

- 25 years
- 1960: 2.5 million tons
- 1985: ~11.9 million tons

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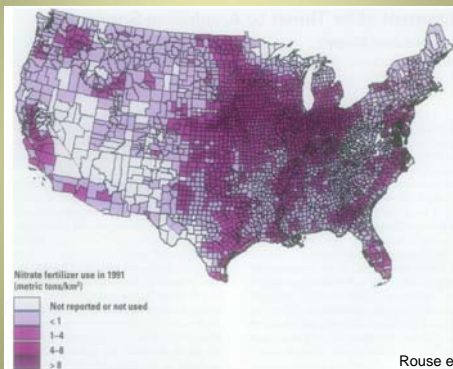
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### 1991: Nitrogen Fertilizer Use in USA



Rouse et al. 1999

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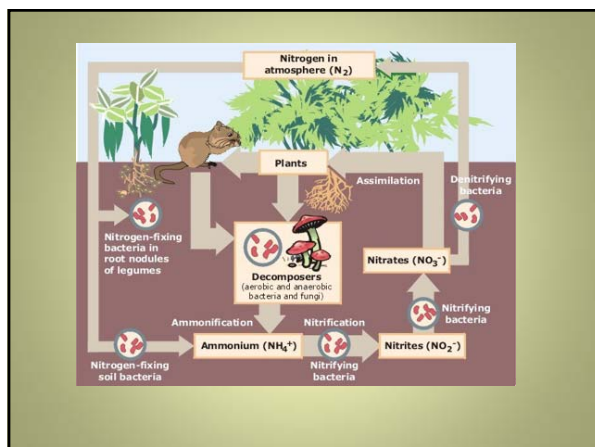
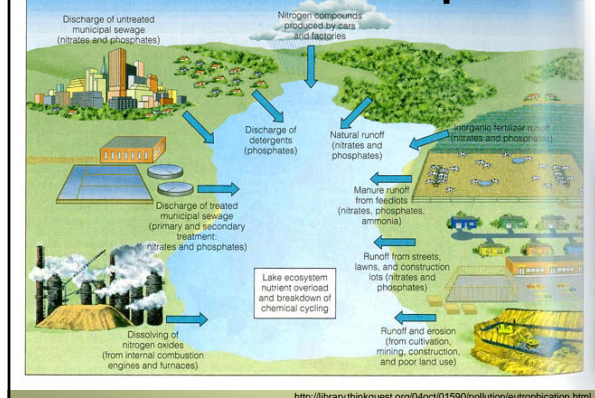
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## Sources of Cultural Eutrophication



## Excess nutrients affect amphibian quality of life

Permeable skin **absorbs** nitrogen

Many studies provide evidence of harmful effects of excess N:

- reduced growth, feeding, and mobility of adults leads to weight loss and mortality
- Positive correlation:  $[\text{NO}_3^-]$  and malformations

Amphibians not affected in the same way

- **More difficult** to identify and solve the problem of excess nutrients
- Reason why fertilizers are the #1 cause of declines

Rouse et al. 1999

### Indirect Effects of Fertilizers

Eutrophication affects tadpoles by promoting **multi-host parasite systems**

Trematode parasite *Ribeiroia ondatrae*

-infects → birds → snails → **amphibian larvae**

Johnson et al., 2007

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- Two related mechanisms to explain how snail hosts affect tadpoles:

1) More nutrients, more resources for more infected snails

2) Less mortality of infected snails

-more resources → larger, stronger snails

Result:

More amphibians negatively affected by snail hosts

-malformations, mortality

Johnson et al., 2007

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### Eutrophication affects various species

Excess nutrients

affect all amphibians, but effects vary by species

-mainly negative effects (Peltzer et al., 2007)

harmful affect on amphibian prey (Rouse et al. 1999)

-less food

less harmful or beneficial effects for amphibian predators

-more amphibian mortality

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## Runoff and Soil Leaching

- Fertilizers affect wildlife over space and time (Hamer et al. 2003)
- 10-25% of nitrogen applied as fertilizers runs off into adjacent running waters (Maitland, 1984)

Hamer et al. 2003

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## Fertilizer Use Extends Beyond Agriculture

### Urea spread in forests

- Forest fertilizers affect amphibian behavior and survival

### Urban settings

lawns, parks, golf courses

Marco et al., 2000

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## Forest Fertilizers

- Urea – promotes timber growth

Marco, 2000

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## Fertilizers: The most important factor of amphibian decline

### Increase Amphibian vulnerability:

- parasites
- diseases – stress of excess nutrients
- deformities – greater predator capture
- mortality
- prey vulnerable to excess nutrients – no food for amphibians

### Effects of Fertilizers not isolated:

- runoff /soil leaching spread excess fertilizers to habitats
- excess nutrients persist in ecosystems over time
- continued and increased fertilizer use perpetuates the problem

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## Works Cited

- Hamer et al. 2003. Amphibian decline and fertilizers used on agricultural land in south-eastern Australia. *Agriculture Ecosystems and Environment* 102: 299-305.
- Johnson et al. 2007. Aquatic eutrophication promotes pathogenic infection in amphibians. *PNAS* 104: 40
- Marco et al. 2000. Sensitivity to urea fertilization in three amphibian species. *Archives of Environmental Contamination and Toxicology* 40:406-409.
- Maitland, P.S.1984. The effects of eutrophication on aquatic wildlife. Jenkins, D., (ed.) *Agriculture and the environment*. Cambridge, NERC/ITE, 101-108. (ITE Symposium, 13).
- Peltzer, Paola et al. 2006. Effects of agricultural pond eutrophication on survival and health status of *Scinax Nasicus* tadpoles. *Ecotoxicology and Environmental Safety* 70: 185-197.
- Rouse et al. 1999. Nitrogen Pollution: An assesment of its threat to amphibian survival. *Environmental Health Perspectives* 107.10: 799-803
- Sharpley, A.N., T.D., T.Sims, J.Lemunyon, R. Stevens, and R. Parry. 1999. *Agricultural Phosphorus and Eutrophication*. U.S. Department of Agriculture, Agricultural Research Service, ARS-149, 42 pp.

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