Impacts of Pesticides on Aquatic Communities
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Objectives
- Why are amphibians susceptible to pesticides?
- What is a Pesticide?
- Common Pesticides.
- What Needs to be Done in the Future.

Amphibian Biology
- Amphibian: Exothermic vertebrate with a biphasic life-cycle.
- Thin permeable skin that must remain moist
  - Respiration
  - Osmoregulation

  ABSORB COMPOUNDS EASILY!
Potential Pesticide Problems

What is a Pesticide?

- Any substance or mixture of substances that intended for:
  - Preventing
  - Destroying
  - Repelling or
  - Mitigating pests

- 80,000 known pesticides used world-wide

What is a Pesticide?

- Insecticides
  - Malathion (Mosquito spray)
- Herbicides
  - Glyphosate (Round-Up)
  - Atrazine
- Fungicides
- Various other substances used in the control of pests
**Malathion**

- #1 Insecticide used in the United states and globally used.
  - Applied to terrestrial and aquatic habitats to control insect pests, including mosquitoes.
- 10-14 million kg of active ingredient applied to nearly 10^6 ha of cropland as well as home, garden, government and industrial use (Kiely et al. 2004)
  - Highly toxic to aquatic inverts and moderately toxic to larval amphibians.

(Relyea and Dieks 2008)

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**Malathion cont.**

- Relyea and Dieks 2008 indicate low concentrations of malathion, even though have no direct effect on amphibians, can indirectly cause reduced growth and development.
  - Due to effects of malathion on the assemblage of zooplankton.

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**Malathion cont.**

- Under continued disturbance, pesticides had its largest impact on the food web and, hence, on the amphibians, causing up to 43% mortality when combined with the natural constraint of a drying pond.
  - Consistent with a wide range of insecticides such as carbaryl, diazinon, endosulfan, and pyridaben (Reylea 2005)
Glyphosate is widely used to control undesirable weeds in agriculture, forestry, aquatic habitats and residences. (Relyea 2005)

Glyphosate is now the second most used pesticide in the United States and one of the most widely used in the world.
- Annual application of more than 8 million ha (Donaldson et. al)

Relyea 2005 found that Roundup caused a large reduction in survival of 3 species of tadpoles.
- Tree Frog (75%–2%)
- Toad (97%–0%)
- Leopard frog (98%–4%)

In terrestrial experiments, 3 species studied suffered substantial mortality when exposed to Roundup
- Wood frog (96%–12%)
- Tree Frog (100%–18%)
- Toad (100%–14%)

98% of all tadpoles died within three weeks and 79% of all juveniles died within one day.
Relyea 2005 states that “it is clear that ingredients present in commercially applied form of Roundup can cause high rates of mortality in several species of North American amphibians.” The elimination of 96-100% of tadpoles in water, combined with the elimination of 68-96% of juvenile frogs and toads on land, that there could be a major negative impact on amphibian populations (Relyea 2005).

Atrazine

- Widely used herbicide for control of broadleaf and grassy weeds.
- Atrazine is probably one of the most widely used herbicide in the world and one of the most common contaminants in ground and surface waters [U.S. Environmental Protection Agency (EPA)].
Tevera-Mendoza et al. (2002) showed that atrazine exposure for as little as 48 hr resulted in severe gonadal dysgenesis in African clade frogs (Xenopus laevis).

Hayes et al. showed that atrazine induced hermaphroditism at concentrations of only 0.1 ppb when administered throughout larval development.

Figure. Atrazine contamination along the Mississippi River (Goolsby and Pereira 1995). The horizontal axis shows months (February, April, June, August, October, and December) over 2 years. The dashed horizontal line shows the maximum contaminant level set by the U.S. EPA (3 ppb), and the red horizontal line shows the dose effective at producing hermaphrodites in the laboratory (0.1 ppb). The vertical red bars for each year show the timing of larval development for amphibians in each region.
Atrazine cont.

- The locality in Wyoming (North Platte River) with the highest frequency of sex reversal (92% of the males) not in the vicinity of farms, nor is it in a county that reports significant atrazine use.

Hayes et al. 2003

Atrazine cont.

- **Hayes Getting Real about Atrazine**

Direct and Indirect Global Effects of Pesticides on Amphibian Populations

- Indirectly cause reduced growth and development
  - Reduced post-metamorphic survival
  - Longer times to reproductive maturity
  - Decreased mating success
  - Few egg production
- **Sex reversal**
- **Deformities**
- Susceptibility to disease, parasites and predation
  - Mandrillon and Saglio 2008: presence of sublethal amitrole concentrations can impair predator feeding recognition process. Such an effect might be especially detrimental for amphibian populations threatened by invasive predators.
  - Rohr et al. - net effect of exposure to environmentally realistic levels of pesticides will be to elevate amphibian trematode infections.
- Death due to direct effects of pesticides
The Connection

- 1970's
  - Few extinctions
    - (localized die offs)
- Mid 1980's to now
  - Increase in extinctions
    - Localized & regional die offs in temperate and tropical areas; some in “pristine” habitats

The Future

- Pesticides have the potential to have dramatic effects on ecological communities.
- 80,000 Known Pesticides Used World-Wide.
  - Endless combination of chemicals with their effects on amphibians unknown.
  - Combined pesticides can sometimes have larger effects on amphibian survival and growth than pesticides alone (Relyea 2004)

Works Cited
