

Endocrine Disruption


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Outline

- ▶ What is Endocrine Disruption?
 - ▶ How does it work?
- ▶ Examples of Endocrine Disruptors
 - ▶ Bisphenol A
 - ▶ DDT
 - ▶ Atrazine
- ▶ Implications for Survival
- ▶ Why Endocrine Disruption is the MAIN reason for declines
- ▶ Final Remark

What is Endocrine Disruption?

- ▶ Endocrine disruptors are chemicals that, at certain doses, can interfere with the endocrine (or hormone) system
- ▶ These disruptions can cause cancerous tumors, birth defects, and other developmental disorders

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How does it work?

- ▶ When absorbed in the body, an endocrine disruptor can:
 - ▶ decrease or increase normal hormone levels (left)
 - ▶ mimic the body's natural hormones (middle)
 - ▶ alter the natural production of hormones (right).

Source: <http://www.niehs.nih.gov/health/topics/agents/endocrine/>

Examples of Disruptors

- ▶ Bisphenol A
 - ▶ Can act as a thyroid hormone antagonist
- ▶ DDT
 - ▶ Can act as an estrogen mimic
 - ▶ Can act as a corticosteroid mimic
- ▶ Atrazine
 - ▶ Can induce gonadal abnormalities
 - ▶ Can induce hermaphroditism

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Review

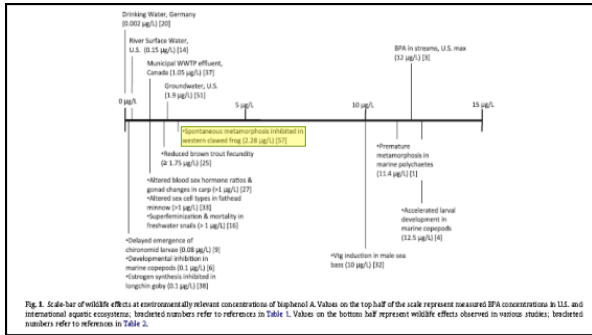
Bisphenol A exposure, effects, and policy: A wildlife perspective

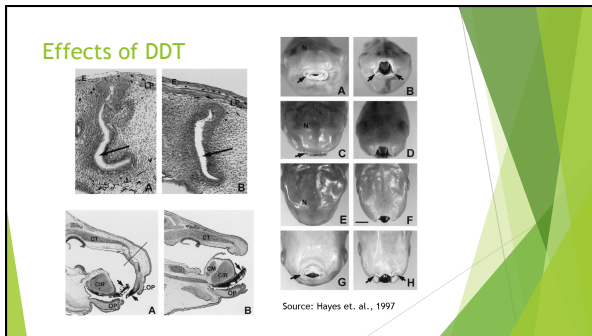
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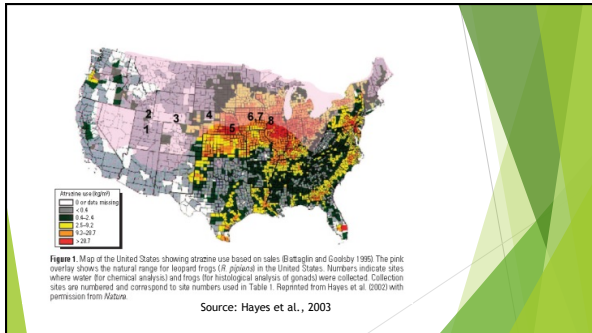
Concentration	Species	Effect
2.28 µg	Western Clawed Frog	Inhibition of spontaneous metamorphosis
22.8 µg	African Clawed Frog (Larvae)	Complete sex reversal
200 µg	Japanese Pond Frog	Tadpole tail malformations
4600 µg	African Clawed Frog (Embryo)	Abnormal gut coiling, edema, microcephaly, decrease in body length





Atrazine

- ▶ 70-80 million pounds of active ingredient sold every year since 2001
- ▶ Currently the #2 most common herbicide used in the United States
 - ▶ #1 is glyphosate
 - ▶ Source: EPA's Pesticide Industry Sales and Usage - Market Estimates 2007
- ▶ EPA reported that \$2 billion/year in sales of crop would be lost if farmers did not have access to Atrazine for controlling grasses
 - ▶ Source: http://www.epa.gov/pesticides/reregistration/atrazine/atrazine_update.htm
- ▶ In 2007, EPA reported that Atrazine does not negatively impact amphibian gonadal development
 - ▶ Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP) hosted in June 2012



Effects of Atrazine

- ▶ 25 ppb Atrazine once every three days
- ▶ 10 fold decrease in normal levels
- ▶ "We hypothesize that atrazine induces aromatase and promotes the conversion of testosterone to estrogen. This disruption in steroidogenesis likely explains the demasculinization of the male larynx and the production of hermaphrodites."
- ▶ Males are reproductively dead
 - ▶ IF sperm can be generated, 10% fertility
- ▶ Genetically male female frogs produce only male offspring
 - ▶ Wipe out populations due to skewed sex ratios

Group	Testosterone (Ng/ml)
Control Males	~4.2
Atrazine-Treated Males	~0.5
Control Females	~1.5

Source: Hayes et al., 2002

Implications for Survival

- ▶ Inhibition of spontaneous metamorphosis
 - Reduced ability to escape predation
- ▶ Decreased testosterone
 - Reduced ability to reproduce
- ▶ Complete sex reversal
 - Reduced ability to propagate
- ▶ Tadpole tail malformations
 - Reduced mobility
 - Competition and predation implications
- ▶ Abnormal gut coiling
 - Reduced ability to digest food
- ▶ Edema
 - Mobility and development implications
- ▶ Microcephaly
 - Reduced life span
 - Reduced cognitive ability
- ▶ Developmental inhibition
 - Reduced ability to feed, breathe
 - Competition and predation implications (gape)

**Endocrine Disruptors:
The MAIN Reason for Amphibian Declines!**

- ▶ The human population is growing exponentially
 - ▶ Greater demand for plastics, food (herbicides and pesticides)
- ▶ All of these chemicals are artificial and associated with water pollution
 - ▶ Peak runoff rates occur during spring
 - ▶ Peak amphibian activity occurs during the same period
- ▶ Atrazine is the most common contaminant of ground and surface water
 - ▶ 0.5 million pounds per year are deposited in precipitation in the US
 - ▶ Contamination can spread more than 600 miles from the point of application
- ▶ Perhaps emergent diseases (ranavirus, chytrid) are not emergent at all
 - ▶ Maybe what is emergent is the inability to mount proper immune responses as a result of pesticide exposure (Hayes et al., 2006)

Final Remark

- ▶ "Unfortunately, almost all research on amphibian population declines has focused on single factors or multiple factors considered individually with little consideration for interactions" (Sparting et al., 2003)

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