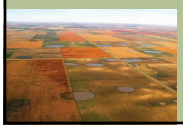
Abiotic Stressors:

an overview of introduced stressors and their interactions



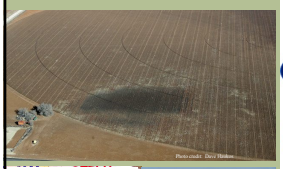
J. Patrick W. Cusaac, Ph.D.

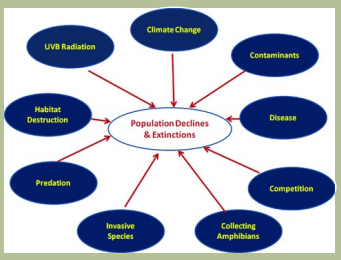
College of Agricultural Sciences and Natural Resources

University of Tennessee – Knoxville

What is an abiotic stressor??

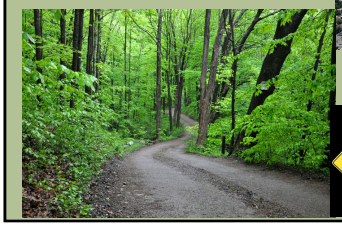
A non-naturally occurring factor that causes stress in an organism.

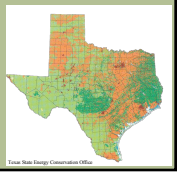




Habitat modification…

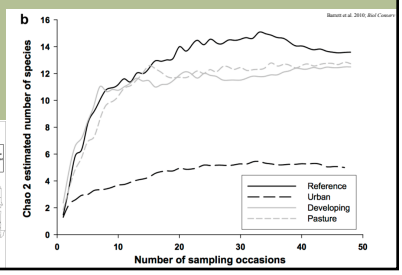
- Probably THE leading hypothesis for amphibian declines
  - Somewhat of an umbrella term
  - What are some types of habitat modification?





Habitat modification…

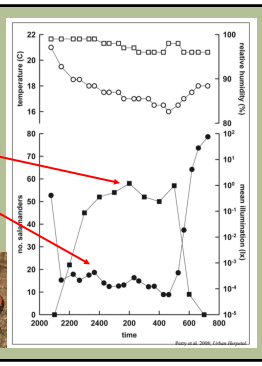
- Urbanization is associated with reduced amphibian species richness… Why??
  - Decreased upland habitat
  - Decreased breeding habitat (streams in this case)
  - Modified versions of both habitats (e.g., monocultures)
  - Increased traffic
  - Increased runoff
  - Pollution



Barrett et al. 2010; *Biol Conserv*

Habitat modification…

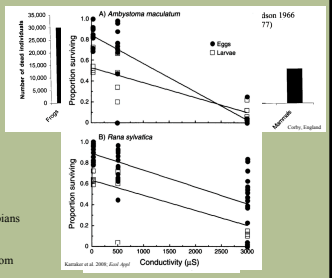
- Light pollution can affect activity patterns of amphibians
  - Primarily nocturnal movers reduce activity during light period
  - Example: *Plethodon cinereus*



Perry et al. 2008; *Urban Herpetol.*

Habitat modification…

Andrews et al. 2008; *Herpetol Conserv*



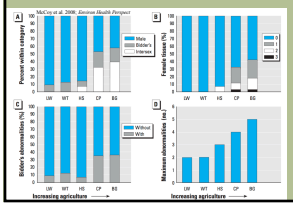
dson 1966
77)

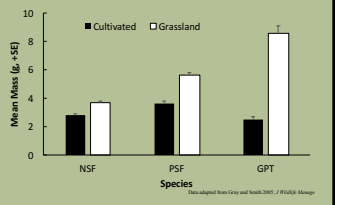
Karraker et al. 2008; *Ecol. Appl*

- Roads can cause many problems for amphibians
  - Fragment habitats (including migration corridors)
    - Road mortality is a significant threat to amphibians
    - Esp. migratory species and explosive breeders
  - Altered hydrology (from increased drainage flow)
  - Pollution (road salts, petroleum distillates, PAH's from coal tar sealants, etc.)

Habitat modification…

- Cultivation affects species composition, morphometrics, demographics, etc

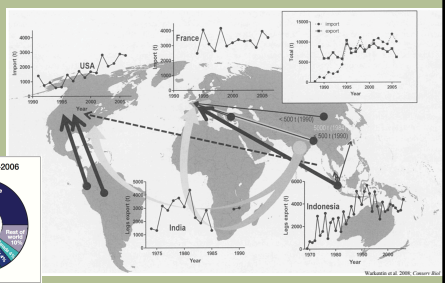




- Can also affect individual paramaters of fitness
  - Intersex in *Rhinella marinus*

Harvesting wild amphibians

- Wild amphibians are harvested for:
  - Food
  - Bait
  - Pet trade
  - Medicinal use



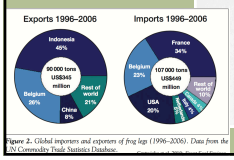
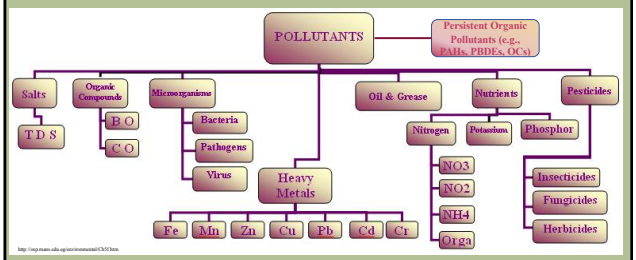


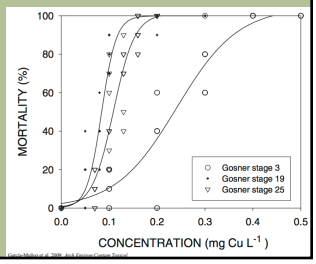
Figure 2. Global importers and exporters of frog legs (1996–2006). Data from the UN Commodity Trade Statistics Database.

Pollution



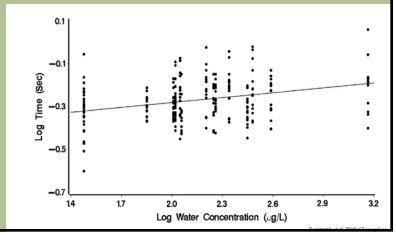
Pollution

- A LOT of variability in effects from various pollutants
  - Variability both within and between species
  - Ex: copper sulfate in *Epidalea calamita* (natterjack toad)



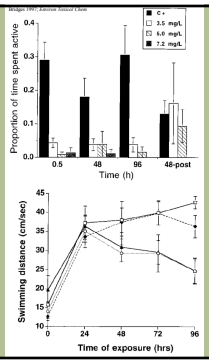
Pollution

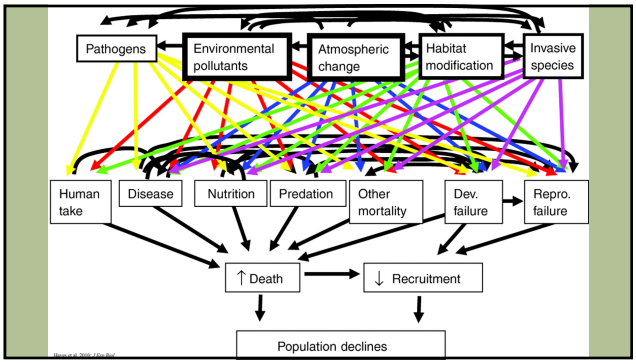
- A LOT of variability in effects from various pollutants
  - Effects do not always involve mortality
  - Ex. PAH's in *Notophthalmus viridescens*



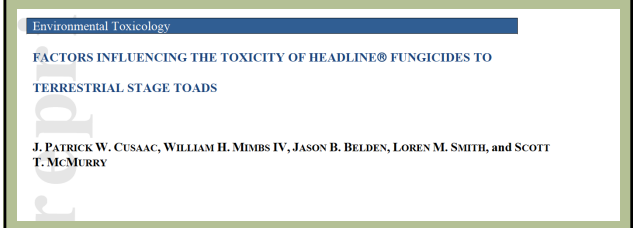
Pollution

- A LOT of variability in effects from various pollutants
  - Ex 2. Swimming performance in larval *Lithobates blairi*
  - Sublethal carbaryl:
    - Reduced activity and lower sprint distance… Why?...





Case Study:



Environmental Toxicology

FACTORS INFLUENCING THE TOXICITY OF HEADLINE® FUNGICIDES TO TERRESTRIAL STAGE TOADS

J. PATRICK W. CUSAAC, WILLIAM H. MIMBS IV, JASON B. BELDEN, LOREN M. SMITH, and SCOTT T. MCMURRY

Laboratory toxicity studies suggest amphibians may be at risk from pyraclostrobin-based fungicides…

SETAC PRESS

Environmental Toxicology and Chemistry, Vol. 28, No. 11, pp. 2475–2480, 2010
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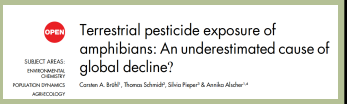
DOI: 10.1002/etc.297

Short Communication

ACUTE TOXICITY OF FUNGICIDE FORMULATIONS TO AMPHIBIANS AT ENVIRONMENTALLY RELEVANT CONCENTRATIONS

JASON BELDEN,* SCOTT MCMURRY, LOREN SMITH, and PARIS RUELLEY
Department of Zoology, 729 LSW, Oklahoma State University, Stillwater, Oklahoma 74078, USA



OPEN

Terrestrial pesticide exposure of amphibians: An underestimated cause of global decline?

SUBJECT AREAS:
ENVIRONMENTAL CHEMISTRY
POPULATION DYNAMICS
AGRIECOLOGY

Carsten A. Brühl[1], Thomas Schmidt[2], Silvia Pieper[2] & Annika Alscher[1,2]

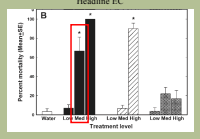
Ecotoxicology
DOI 10.1007/s10646-015-1603-x

CrossMark

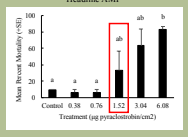
Acute toxicity of Headline® fungicide to Blanchard's cricket frogs (*Acris blanchardi*)

J. Patrick W. Cusaac[1] · Shane A. Morrison[1] · Jason B. Belden[1] · Loren M. Smith[1] · Scott T. McMurry[1]

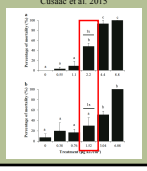
Belden et al. 2010
Headline EC



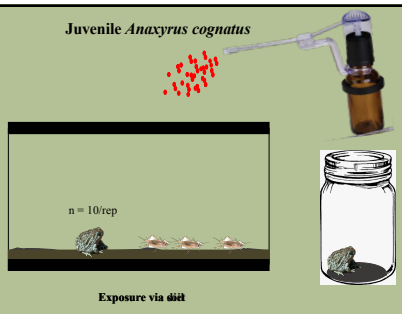
Cusaac et al. (2017)
Headline AMP



Cusaac et al. 2015

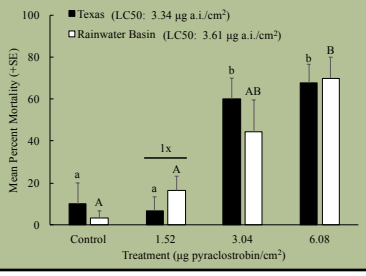


Juvenile *Anaxyrus cognatus*

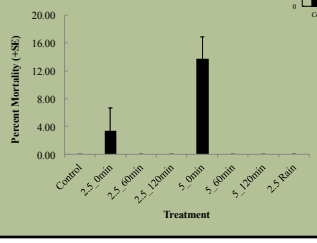


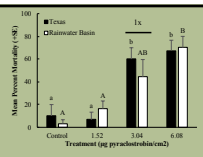
Exposure via diet

Soil Exposure
Anaxyrus cognatus

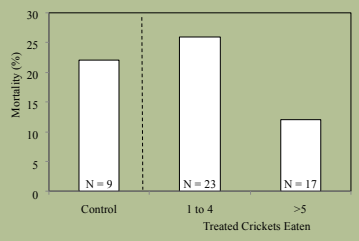


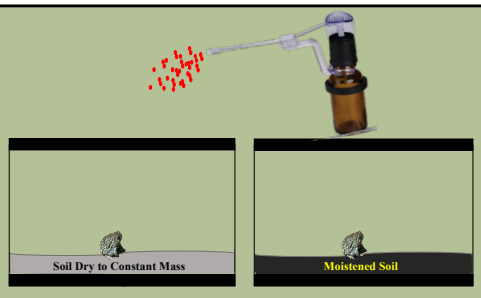
Soil Exposure
Anaxyrus cognatus





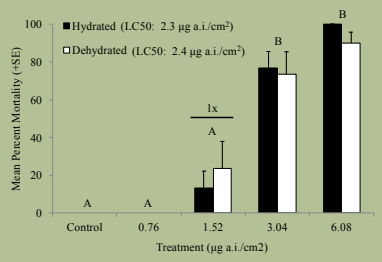
Dietary Exposure
Anaxyrus cognatus

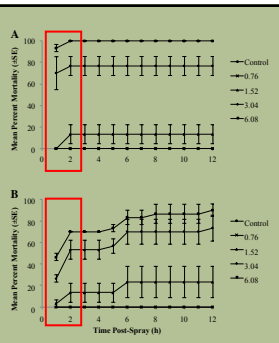


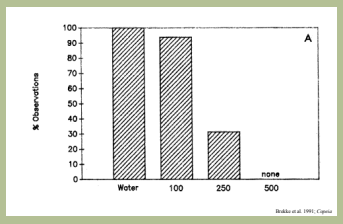


Dehydrated Exposure

Anaxyrus cognatus

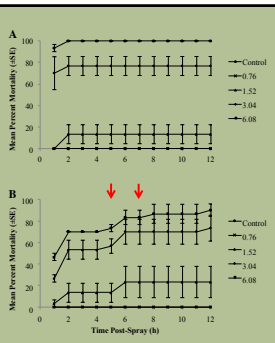


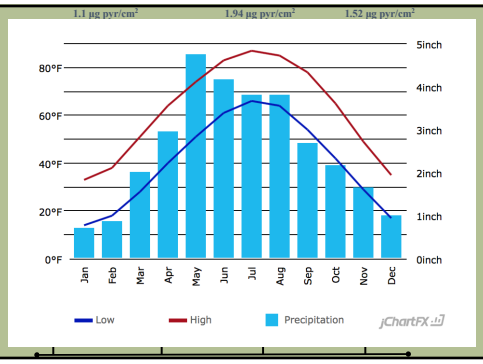




Brakke et al. 1991, Copeia

Toads will avoid contact with substrate when osmotically unfavorable…


A
B
Mean Percent Mortality (±SE)
Time Post-Spray (h)
Control
0.76
1.52
3.04
6.08


1.1 µg pyr/cm²
1.94 µg pyr/cm²
1.52 µg pyr/cm²
80°F
60°F
40°F
20°F
0°F
5inch
4inch
3inch
2inch
1inch
0inch
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Low
High
Precipitation
jChartFX

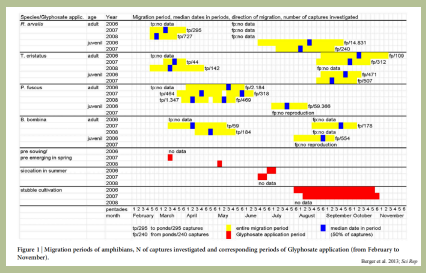
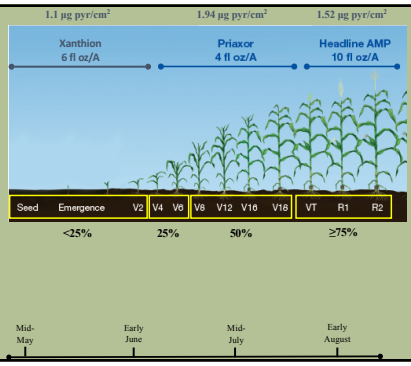
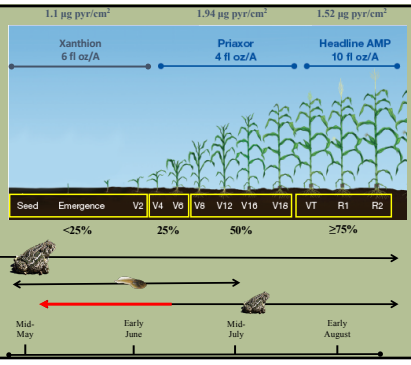


Figure 1 | Migration periods of amphibians, N of captures investigated and corresponding periods of Glyphosate application (from February to November).

Berger et al. 2013, *Sci Rep*





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