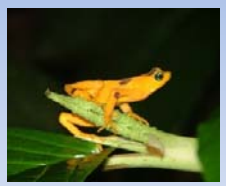
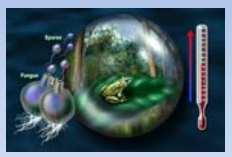
Effects of Climate Change on Amphibians





M. Kevin Hamed
Ph.D. Candidate
Dept. of Forestry, Wildlife & Fisheries

Lecture Outline

I. **Climate Change Basics**
II. **Direct Impacts**
III. **Indirect Impacts**
IV. **Synergistic Effects**

Climate Change History

- **1896 - Arrhenius publishes first calculation of global warming from human emissions of CO2.**
- **1967 - International Global Atmospheric Research Program established**
- **1990 – First IPCC report to predict warming**

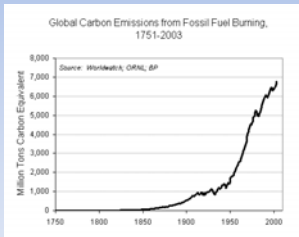
2006

ean heat wave

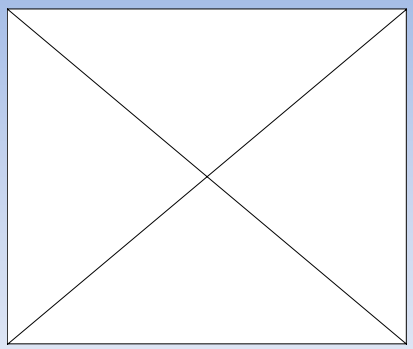
y & US

Climate Change & CO_2

- CO_2 levels 280 ppm → 379 ppm

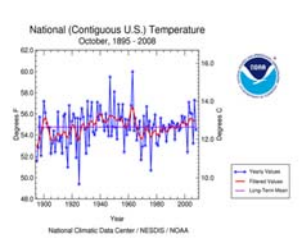


Climate Change & CO_2

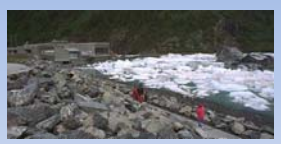


Climate Change

- 8 of the warmest years since 1850 have occurred since 1998

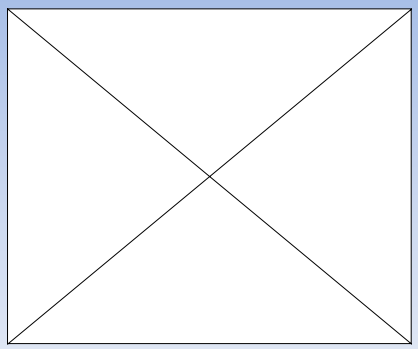


Climate Change



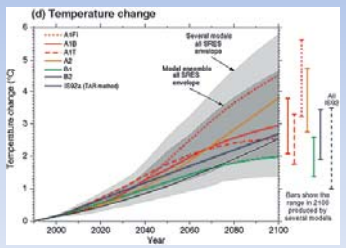
Portage Glacier Visitor Center

Impacts of Climate Change



Climate Change Predictions

- **0.2 °C per decade for the next 20 years**
- **1.0 – 4.5 °C by 2099**



(IPCC 2007)
Intergovernmental Panel on Climate Change

Climate Change & Amphibians

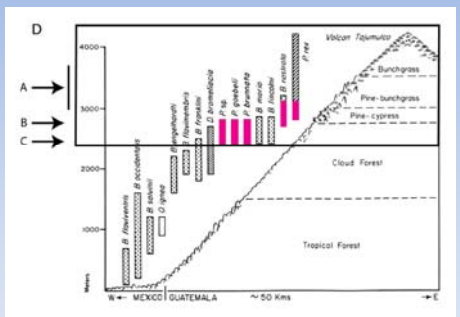
Bufo periglenes

Atelopus zeteki

Potential Direct Impacts on Amphibians

- **Montane Species**
- **Phenology**
- **Precipitation**
  Amount & Timing
- **Hydroperiod**

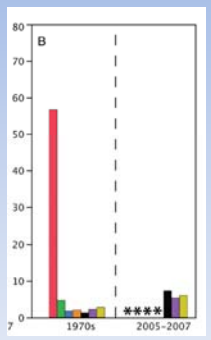
Montane Species

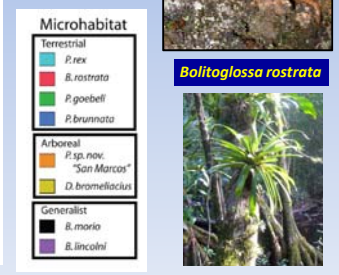


(Rovito et al. 2008)

Montane Species

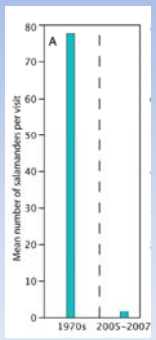
(Rovito et al. 2008)





Bolitoglossa rostrata

Montane Species



Bd?

Pseudoeurycea rex

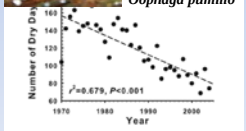
- **Only 7/62 Bd +**
  - **Low elevations and common species**

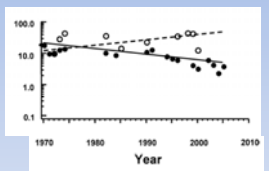
(Rovito et al. 2008)

Montane Species

La Selva, Costa Rica

Oophaga pumillo



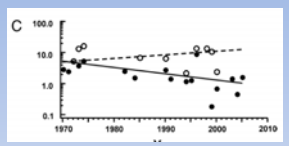


Amphibians

Bd+ 0/140

(Whitfield et al. 2007)

Montane Species



(Whitfield et al. 2007)

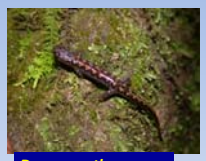
No pesticides detected

Lizards

Leaf Litter!

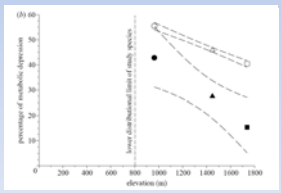
Spehnomorphus cherriei

Montane Species



Desmognathus ocoee

Desmognathus carolinensis



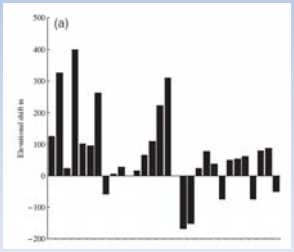
(Bernardo & Spotila 2006)

Montane Species

Madagascar

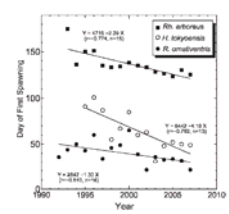
Platypelis alticola

29 – 114 m per decade

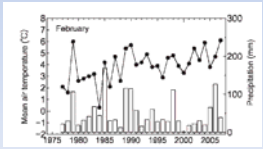


(Raxworth et al. 2008)

Phenology



Rhacophorus arboreus



(Kusano & Inoue 2008)

Phenology

- **Comparison around Ithaca, NY**
  1900 - 1912 & 1990 - 1999

1 - 2.3°C

10 – 13 days earlier

P. crucifer
H. versicolor
R. sylvatica
R. catesbiana

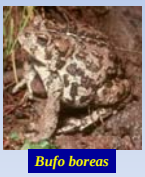
No change

B. americanus
R. clamitans

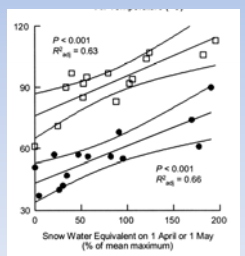
(Gibbs & Breisch 2001)

Phenology

Date of Snow Melt is critical for temperate montane species



Bufo boreas

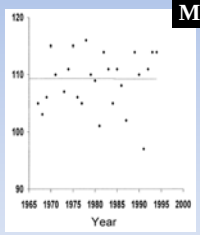


(Corn 2003)

Phenology

Location!

Michigan



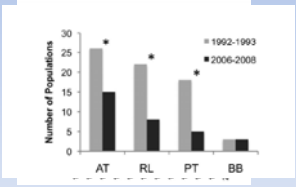
Pseudacris crucifer

(Blaustein et al. 2001)

Decrease Hydroperiod

Yellowstone National Park

• 4x number of permanently dry ponds



1992 – 93%
2006 – 60%

Rana luteiventris

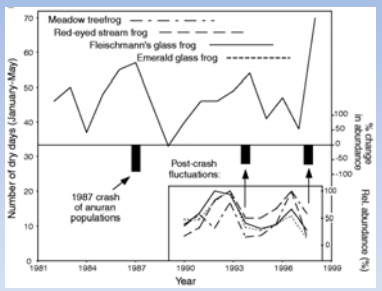
(McMenamin et al. 2008)

Decrease Hydroperiod

(Patla et al. 2009)
- Detection ?

(McMenamin et al. 2009)

Decreased Hydroperiod



(Pounds et al. 1999)

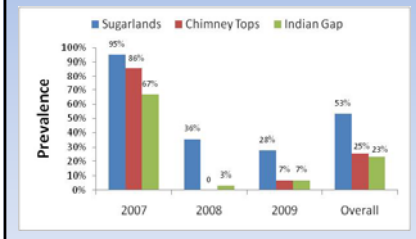
Potential Indirect Impacts on Amphibians

- **Physiological Stress**
  - **Pathogens**
  - **Pesticides**
  - **UV**
  - **Hybridizations**
  - **Habitat loss**

(Noyes et al. 2009)

Pathogens

Ranavirus

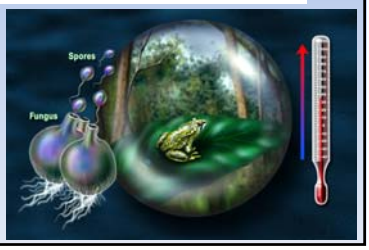


2007 Drought -30 cm

(Gray et al. 2009)

Pathogens

"Disease is the bullet killing frogs, but climate change is pulling the trigger"



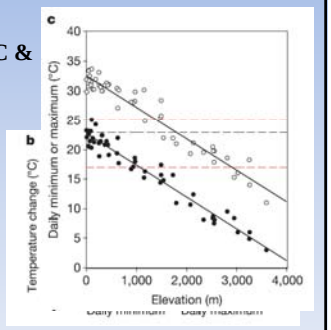
(Morelle 2006)

Pathogens

Chytrid-Thermal-Optimum

17 – 25 °C Optimal
Growth stops at 28 °C & death at 30 °C

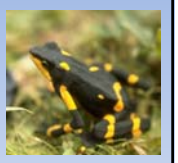
Cloudiness decreases temperature below 30 °C

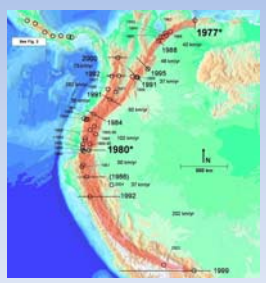


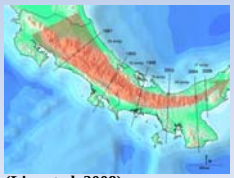
(Pounds et al. 2006)

Pathogens

Multiple introductions not climate!







(Lips et al. 2008)

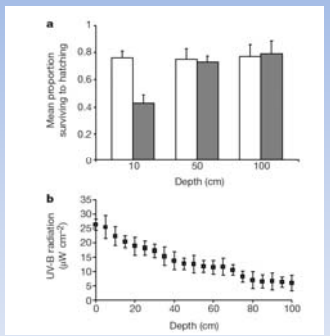
Pathogens

- **Fluctuating asymmetry began 1.5 years before declines**
- **Correlates to year preceding the decline due to Bd**

Litoria nannotis

(Laurence 2008)

Pathogens

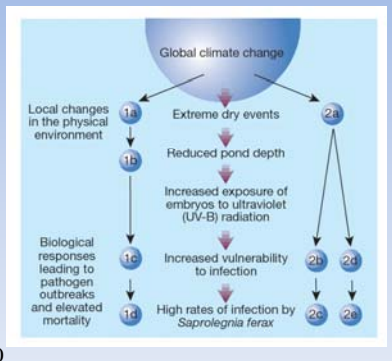


Saprolegnia ferax

El Nino/Southern Oscillation (ENSO) cycles

Bufo boreas

Pathogens



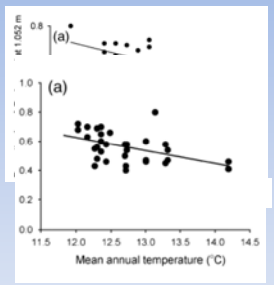
(Pounds 2001)

Hybridizations

Plethodon shermani

Steve Tilley

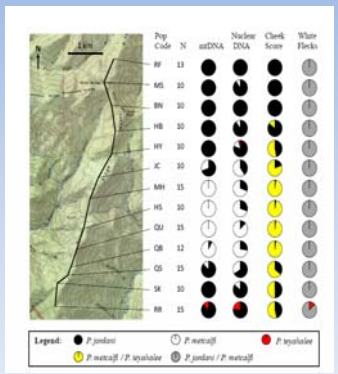
Plethodon teyahalee



(Walls 2009)

Hybridizations

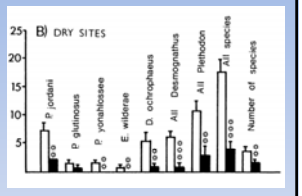
Plethodon jordani



(Chatfield 2009)

Habitat Loss

Thermal Limits
Desiccation



14 million salamanders lost per year in W. NC

(Petranka et al. 1993)

Synergistic

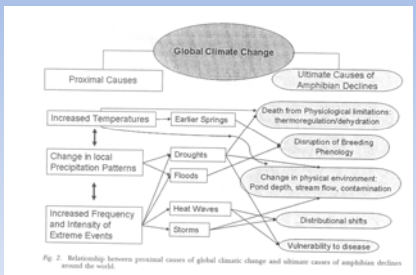


Fig. 2. Relationship between proximal causes of global climatic change and ultimate causes of amphibian declines around the world.

(Burrowes 2009)