

# Emerging and proactive amphibian disease research within the USGS: severe *Perkinsea* parasitism & National scale surveillance for Bsal

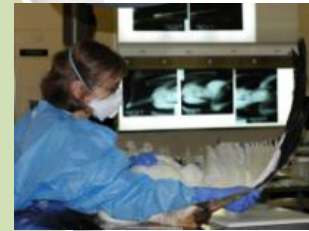
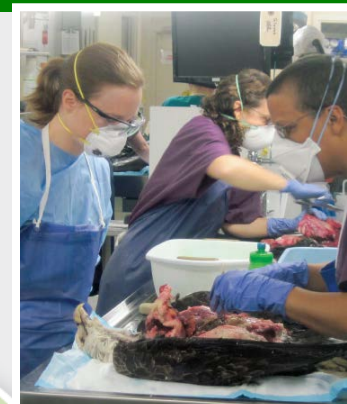
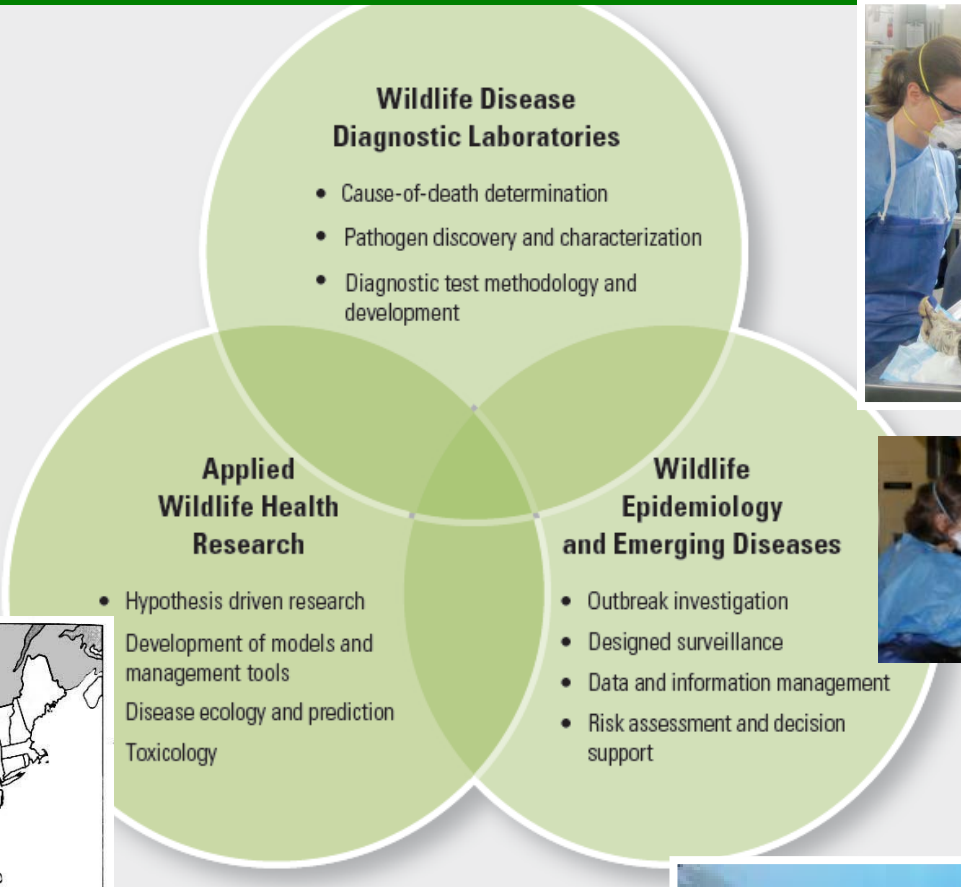
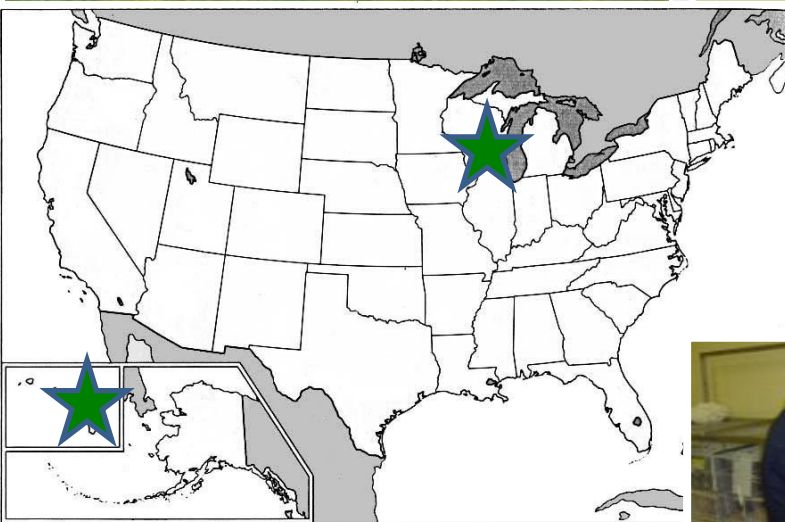


**Daniel A. Grear**

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David E Green, Marcos Isidoro-Ayza, J. Hardin Waddle, Jeffery Lorch, Michael Adams, Neil Baertlein, William J. Barichivich, Daniel Calhoun, Robert N. Fisher, Evan H. Campbell Grant, Brian J. Halstead, Blake Hossack, Patrick Kleeman, Erin Muths, Iga Stasiak, Susan C. Walls, C. LeAnn White and Megan Winzeler

# Diagnostics and patterns of emerging and wildlife disease

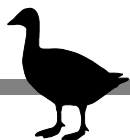


**1970s**

Avian Cholera

Duck Plague

Sea Otter Mortality



**Inclusion Body Disease**

**Newcastle Disease**

**Hawaiian Forest Bird Diseases**

**Avian Botulism**

**1990s**

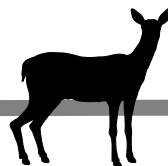
West Nile Virus

Coral reef health

Avian Influenza

Snake fungal disease

**2016+**



**Amphibian Malformations**

Monkeypox

Chronic Wasting Disease

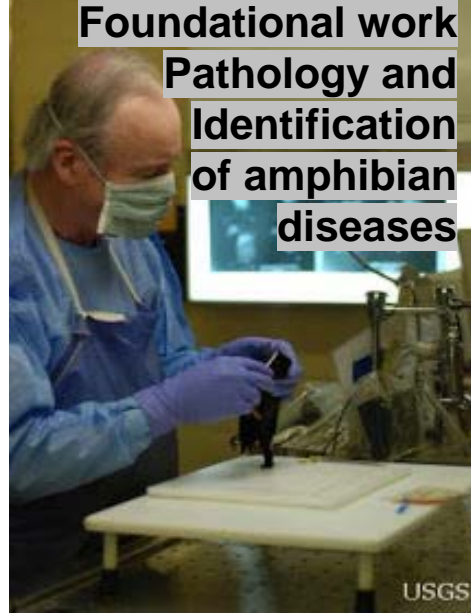
**White-Nose Syndrome**

**Bsal**

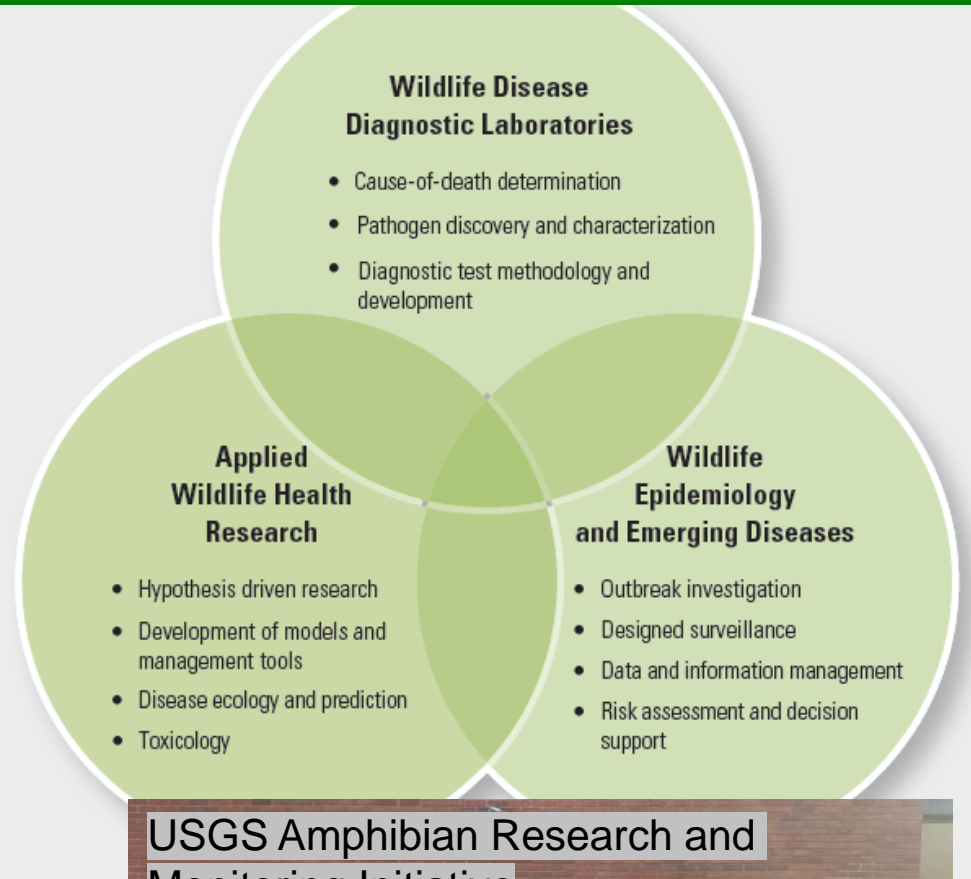
# Diagnostics and patterns of emerging and endemic herp disease 1999-present



**David Green (retired)**  
**Foundational work**  
**Pathology and**  
**Identification**  
**of amphibian**  
**diseases**



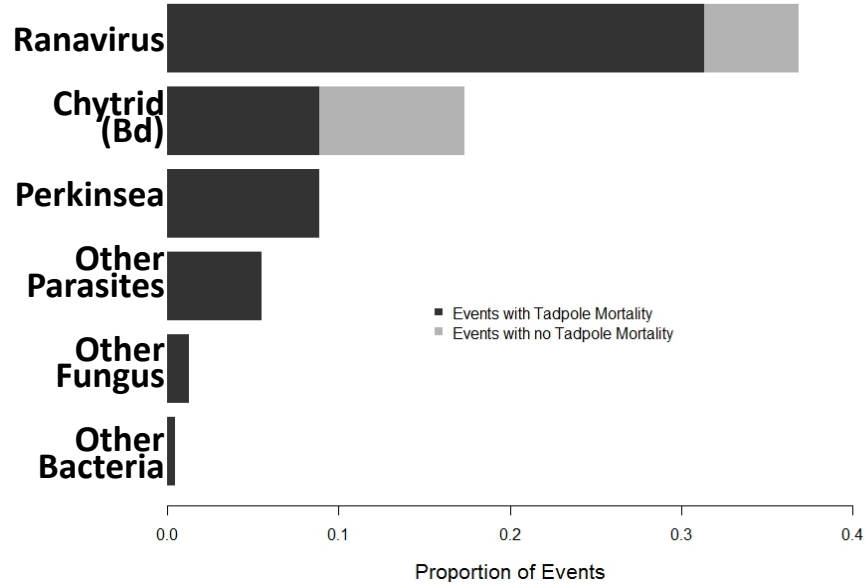
USGS



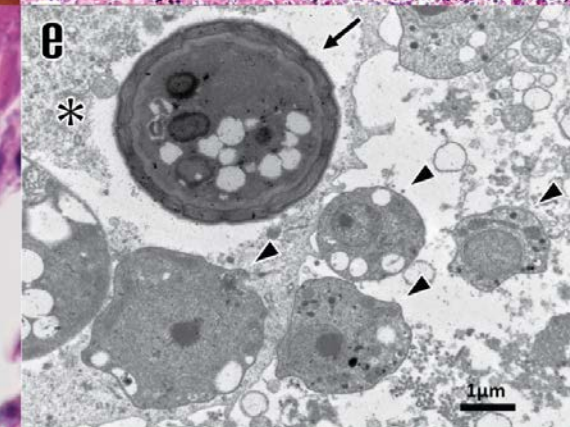
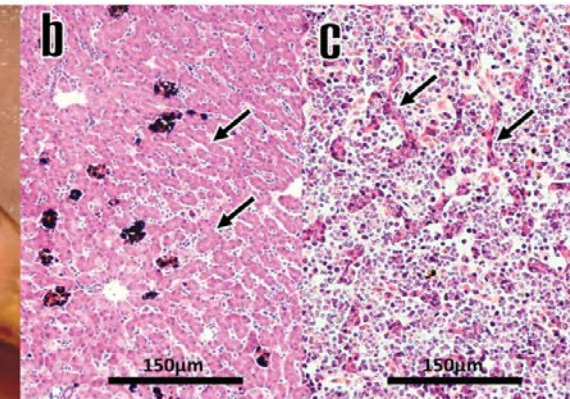
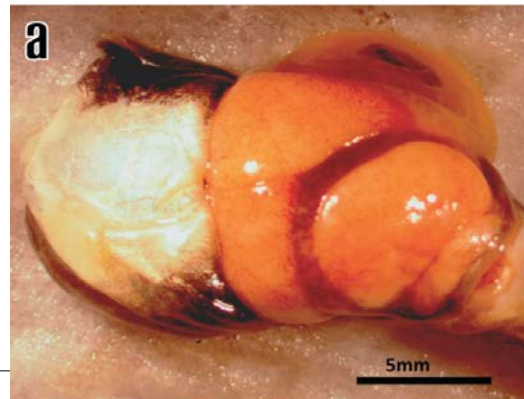
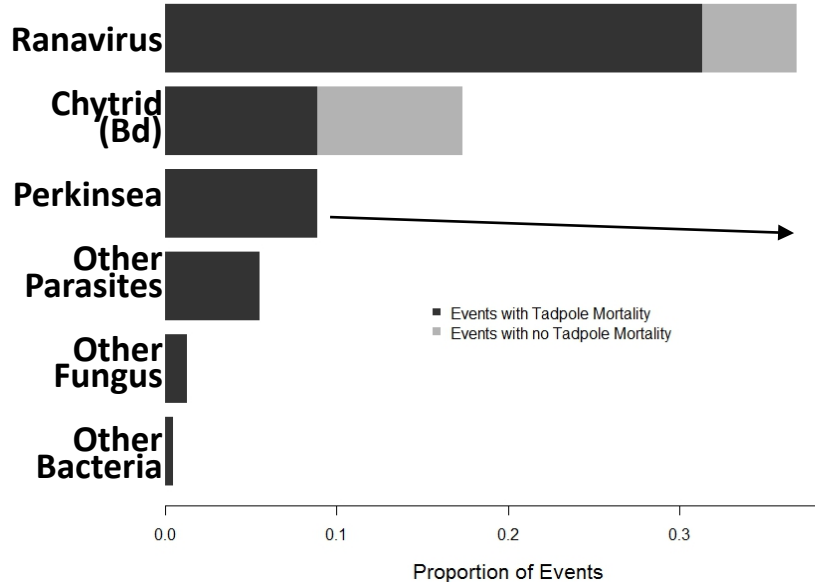
**USGS Amphibian Research and Monitoring Initiative**



Summary of amphibian mortality investigated at NWHC 1999-2015 (167 mass mortalities)



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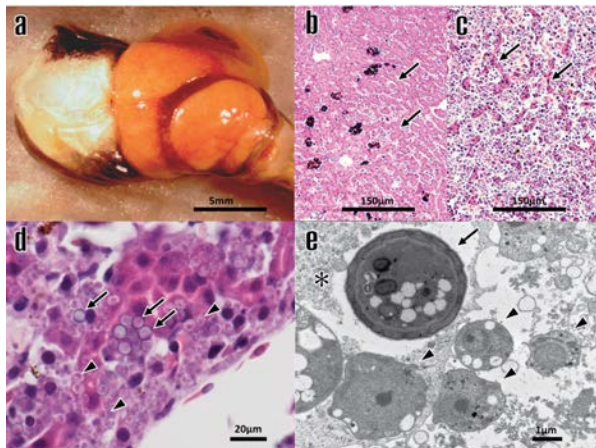
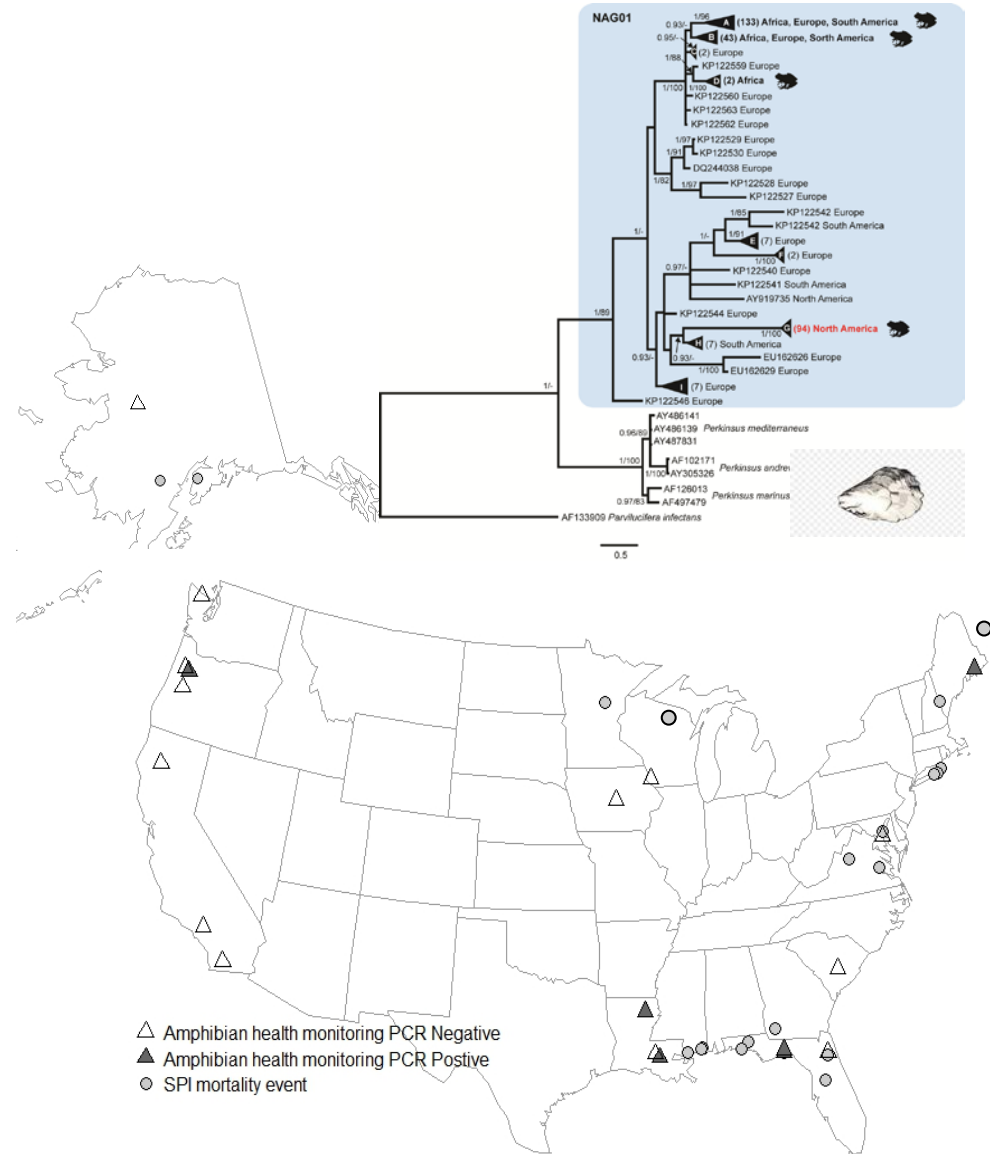
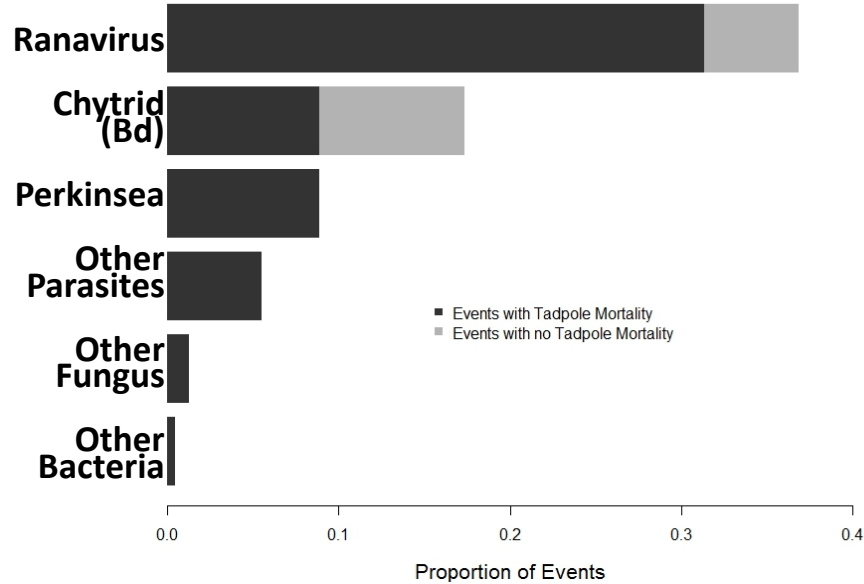


## Sever Perkinsea Infections

- Rapid death in immature anurans
- Massive liver, spleen, kidney, pancreas enlargement
- “Replacement” of host cells with parasite

# Is Severe *Perkinsea* Infection an emerging disease?

Summary of amphibian mortality investigated at NWHC 1999-2015 (167 mass mortalities)



## What are we doing about Bsal threat in the US

- (1) Risk assessment
- (2) Risk-based surveillance
- (3) Re-evaluate risk

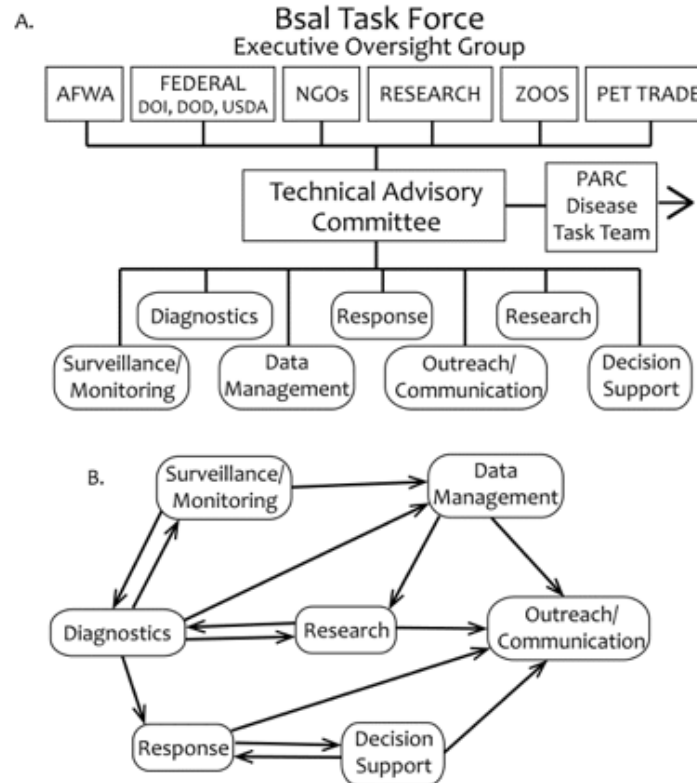
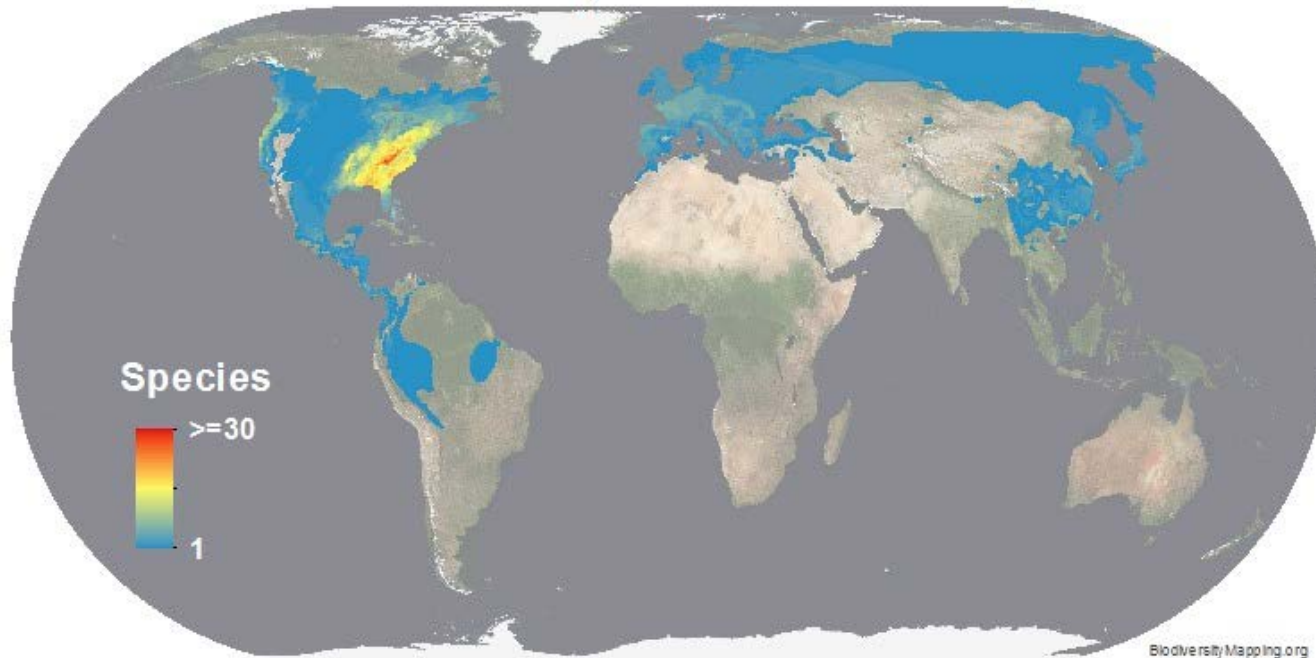


Fig. 1. Bsal Task Force organizational structure (A) and main Working Group interactions (B).

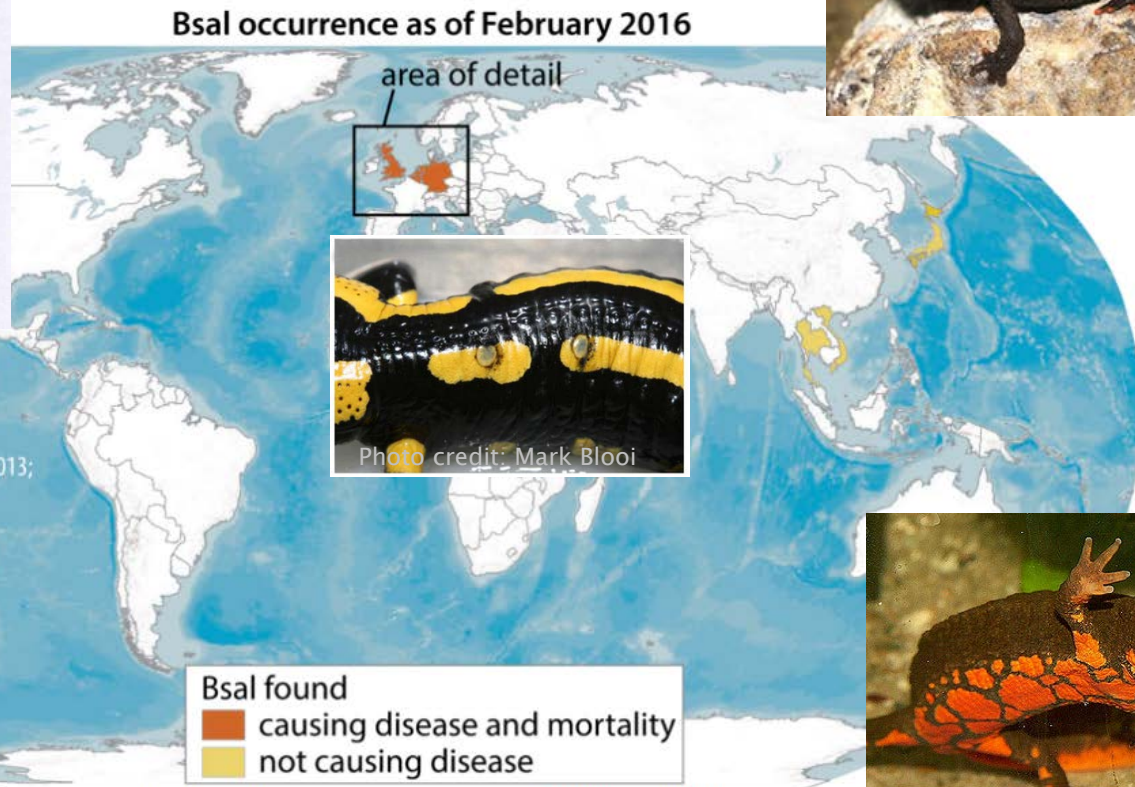
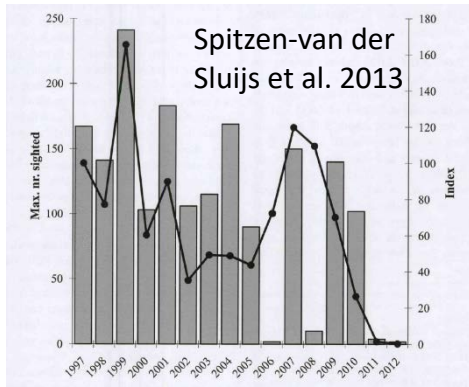


# Threat to North American Salamanders is High

## Caudata (Salamanders)



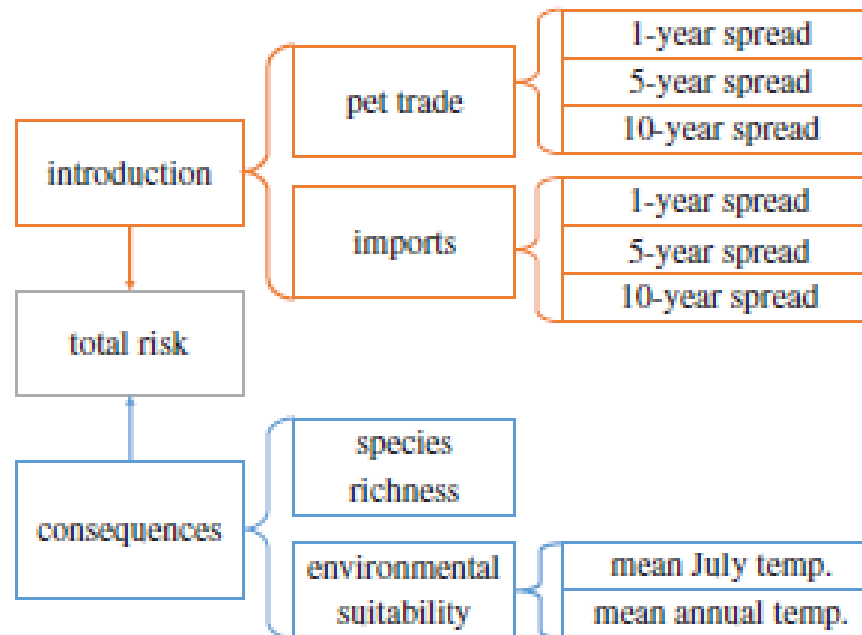
## Europe: Fire salamander population crash Introduction via pet trade



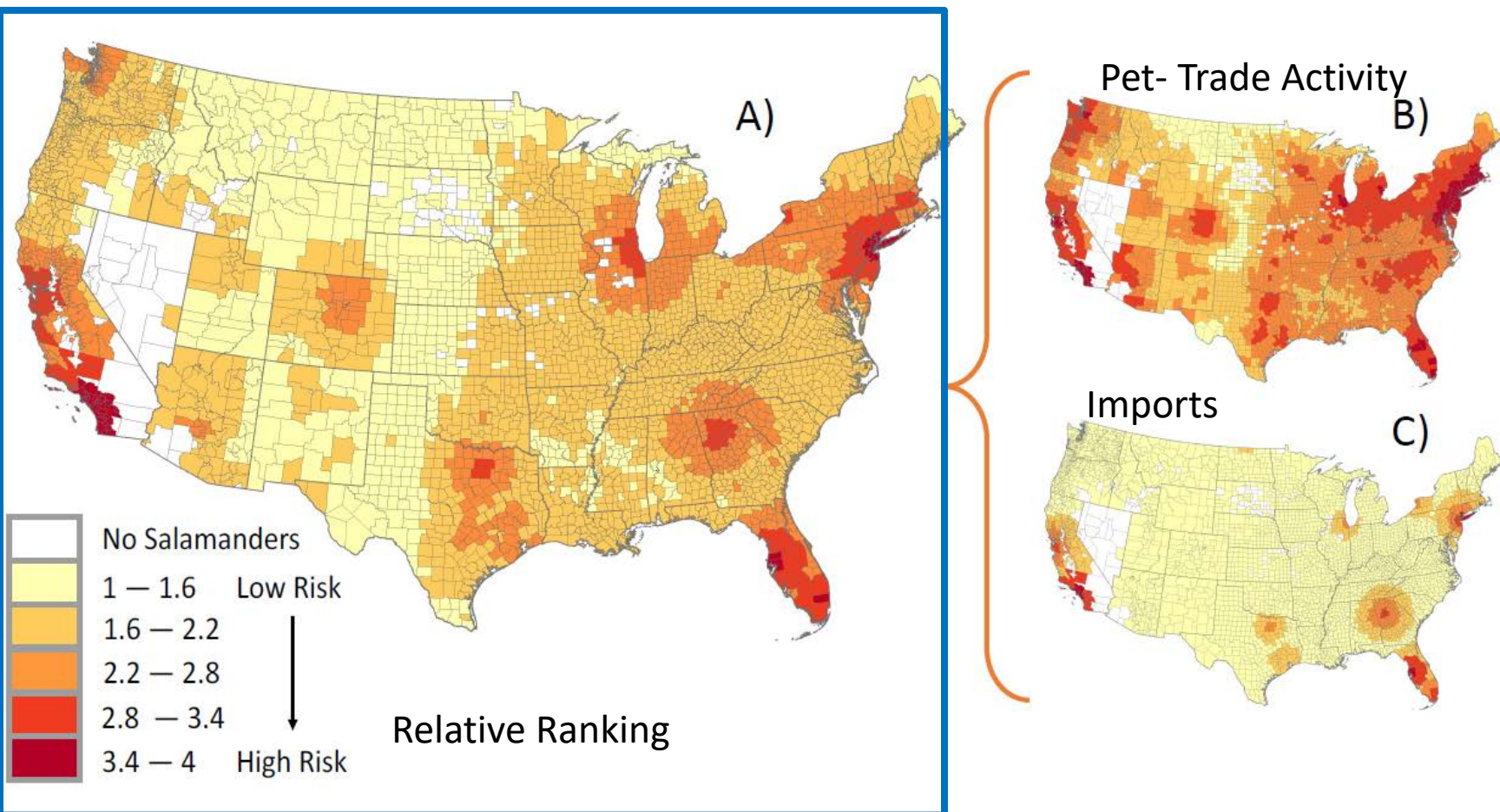
Contact person for European data: An Martel (An.Martel@ugent.be)

Spitzen-van der Sluijs et al. 2016 EID;  
<http://www.salamanderfungus.org/resources/maps/>

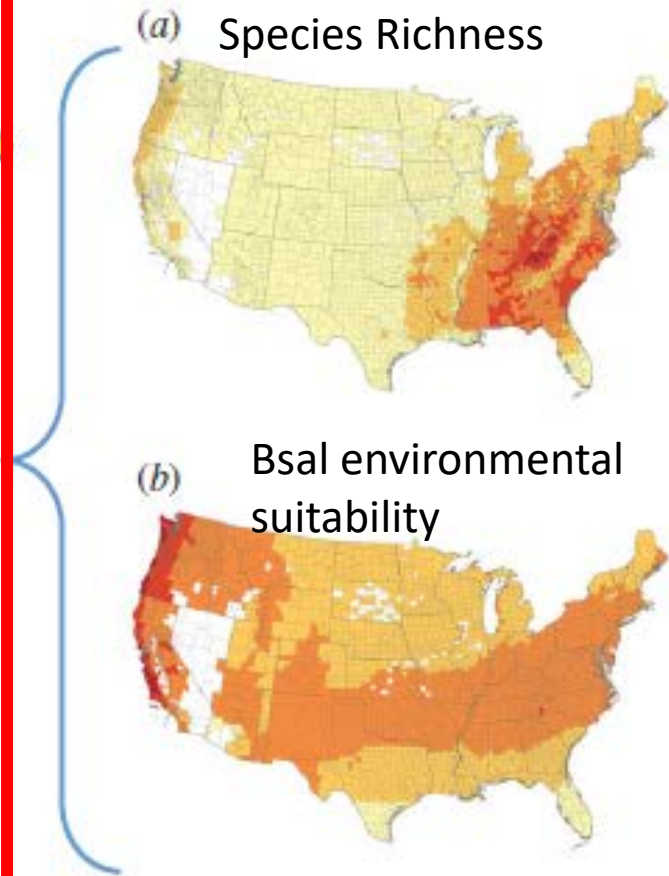
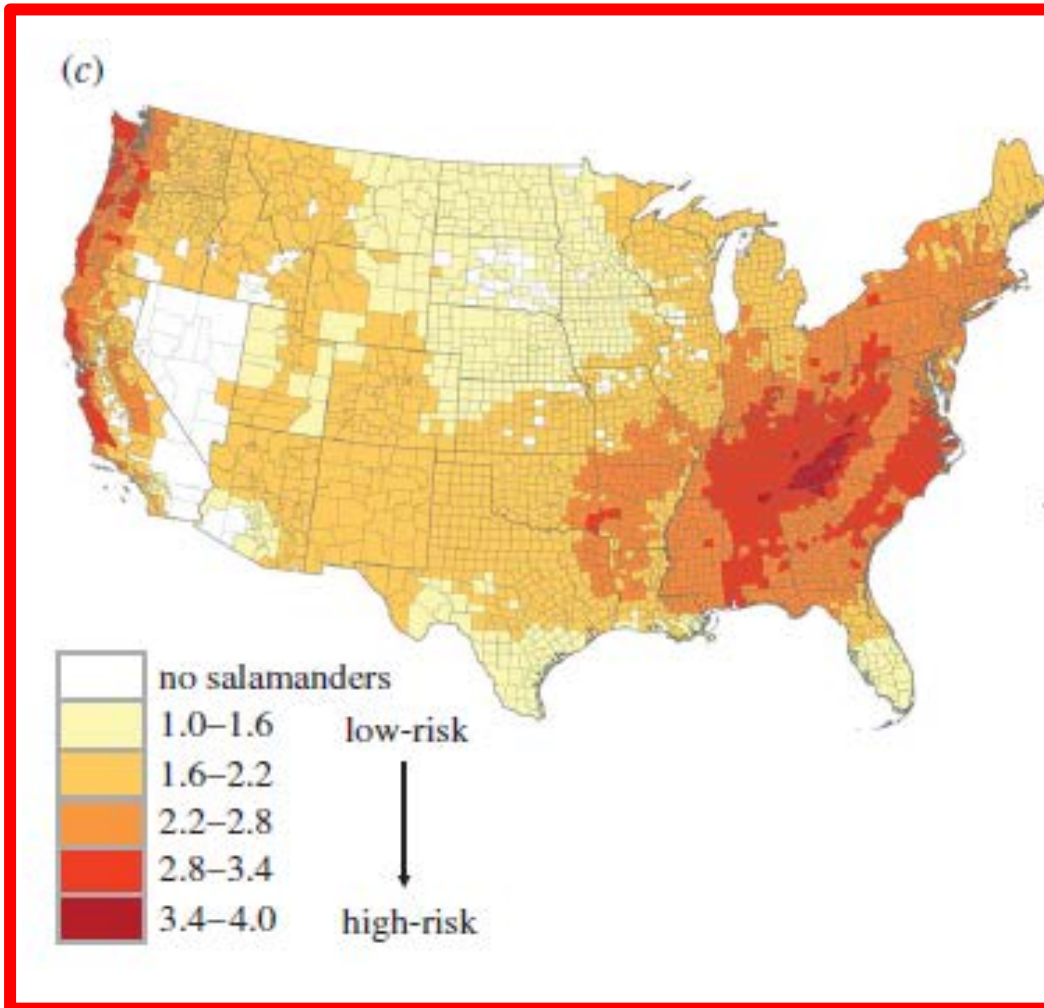
Risk = probability of incurring unmitigated consequences



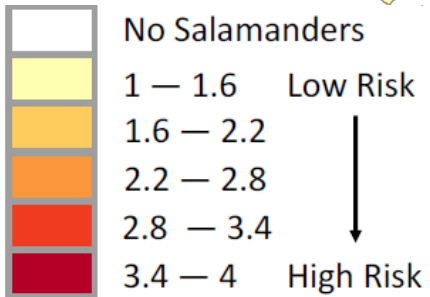
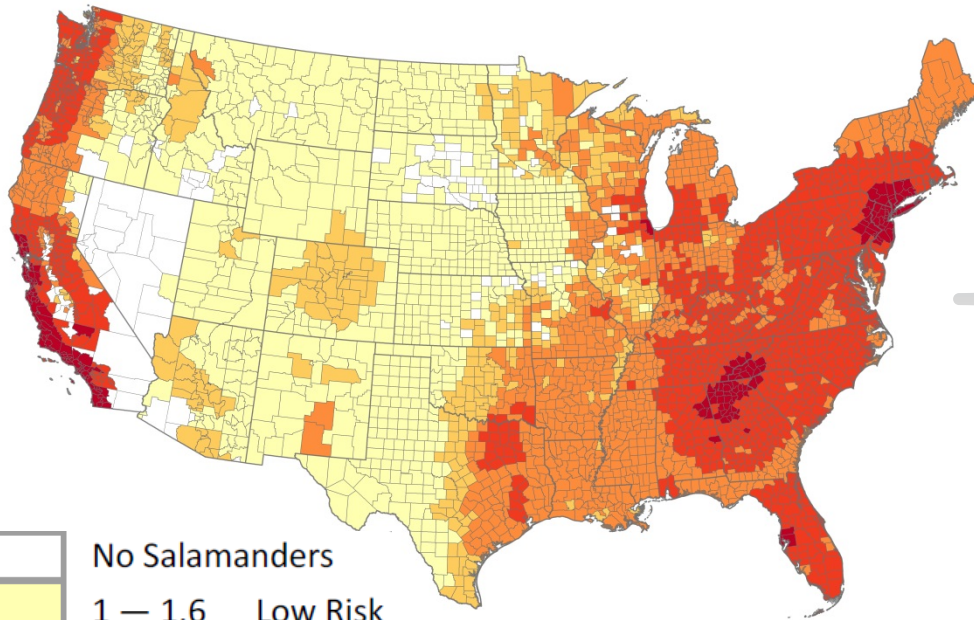
# Introduction Assessment



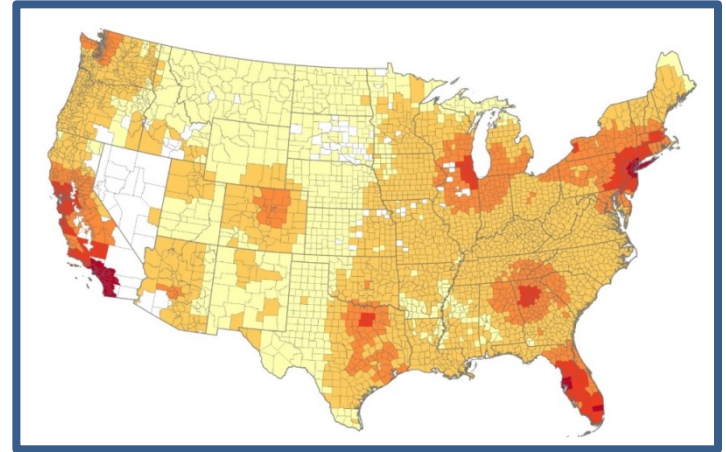
# Consequences Assessment



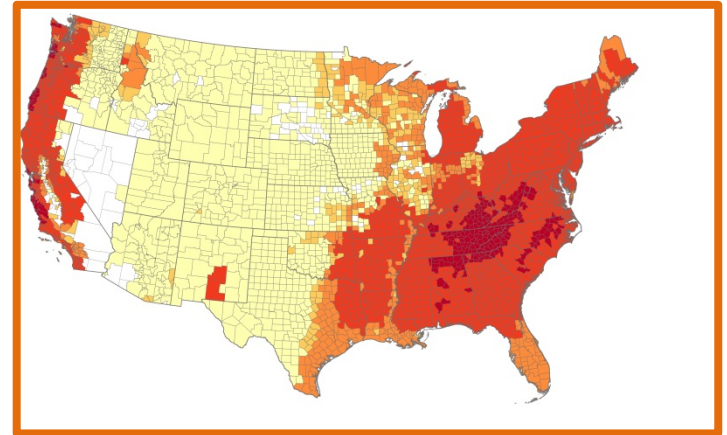
# Total Risk



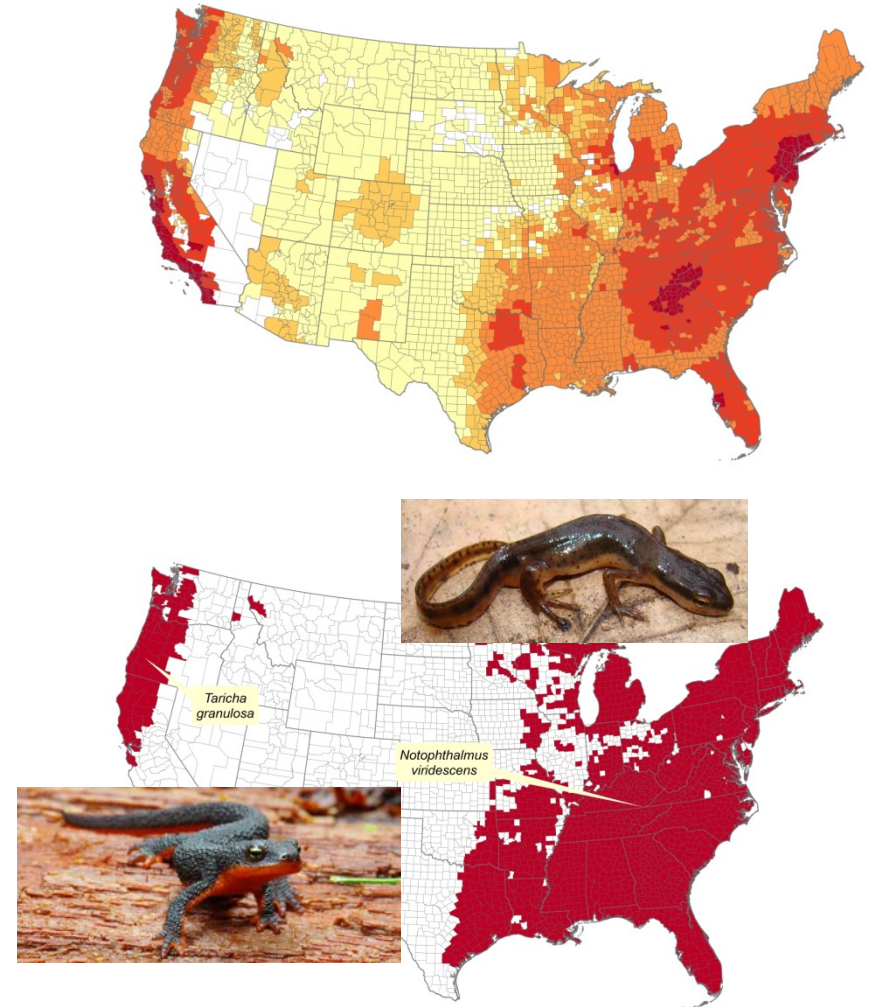
Introduction



Consequences



- Introduction - likely
  - >100,000 potential carriers imported/year prior to 2016
- Consequences – severe
  - Extreme: global biodiversity
  - At least 2 widespread species expected to decline



# Risk-Based Surveillance 2016-2017

**Objective:** detect Bsal if it is present at 10% prevalence at as many sites as possible- focusing on high-risk areas

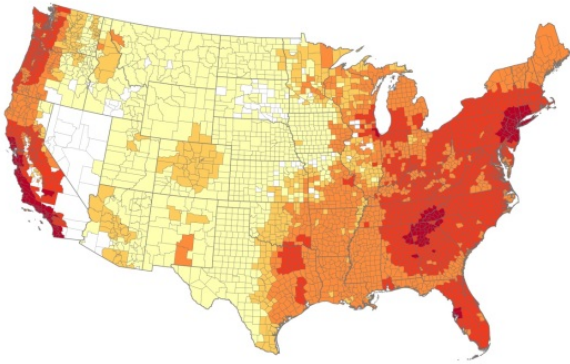
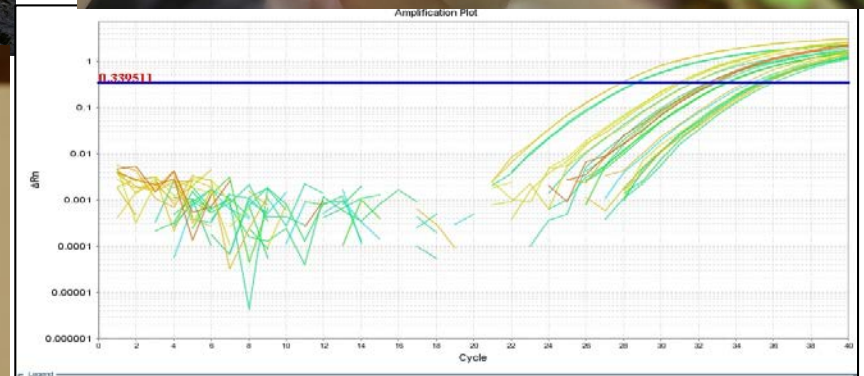


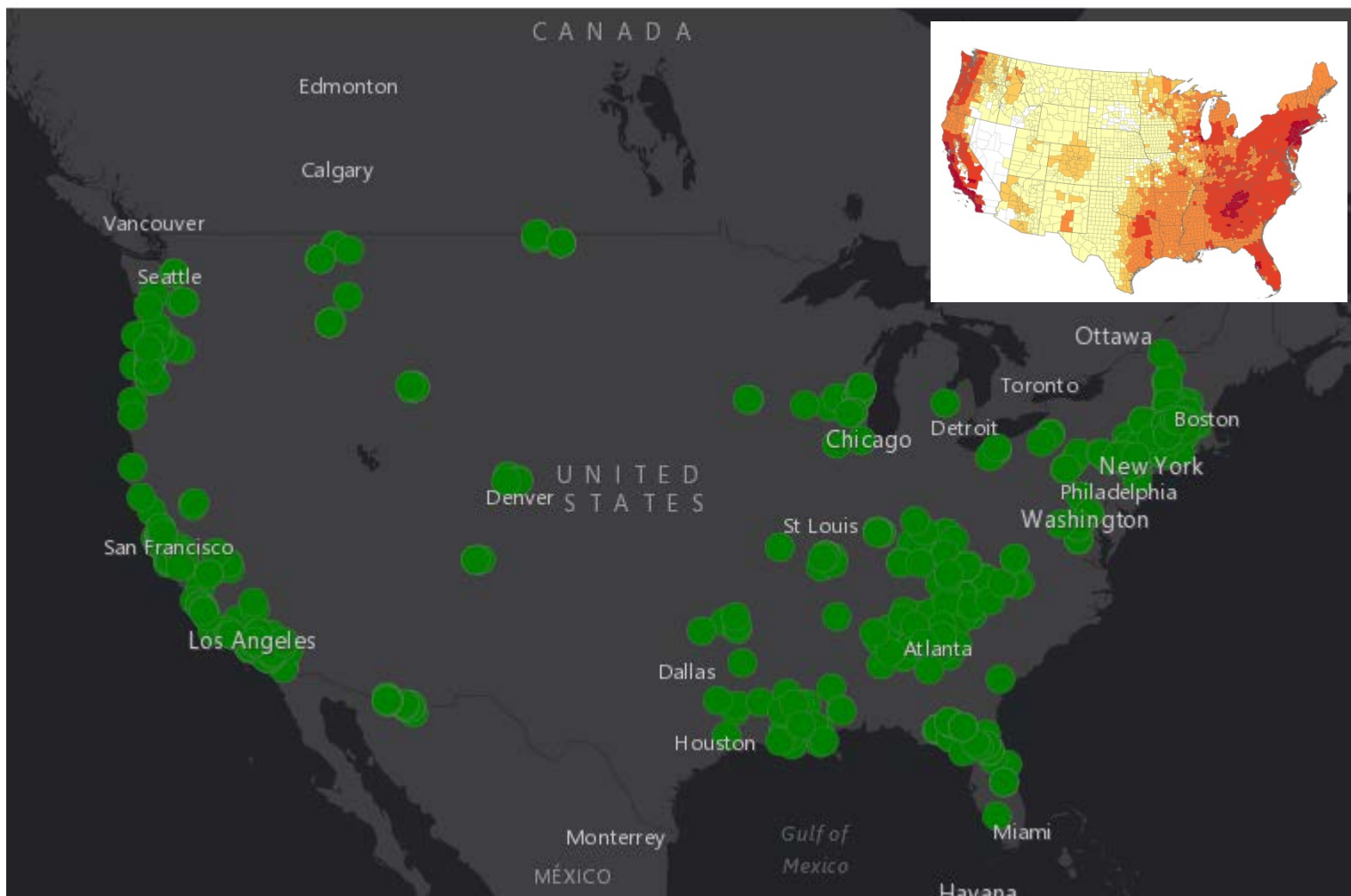
Photo: Kentucky Department of Fish and Wildlife Resources





**11,000+**  
Bsal tests  
600+ sites  
35 States

**No Bsal**



We are Bsal free... right?

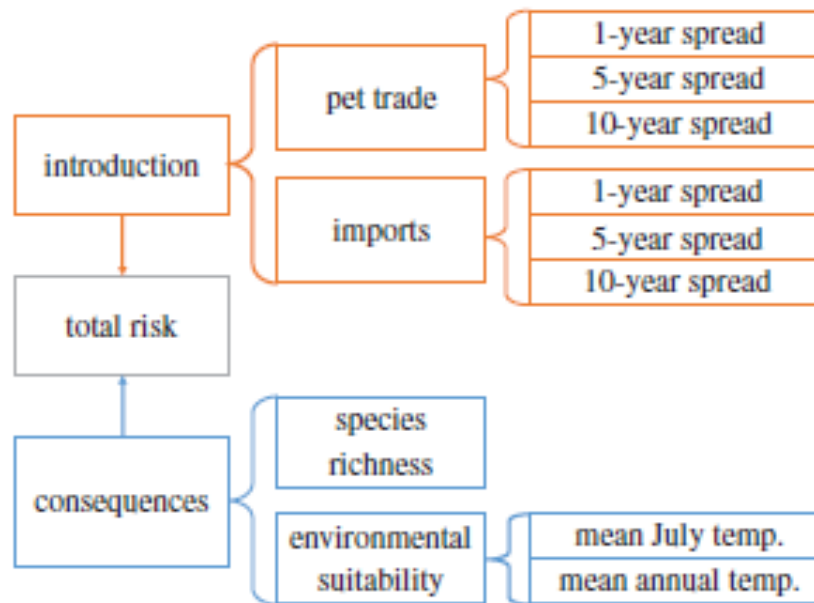
- *Extremely* difficult to prove absence

We are Bsal free... right?

- *Extremely* difficult to prove absence

Risk = likelihood of incurring unmitigated consequences

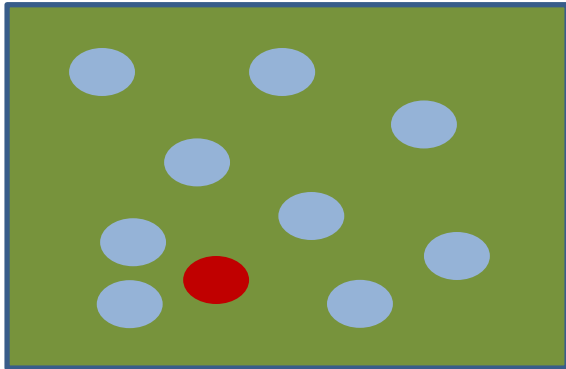
Surveillance =  
Is it here?



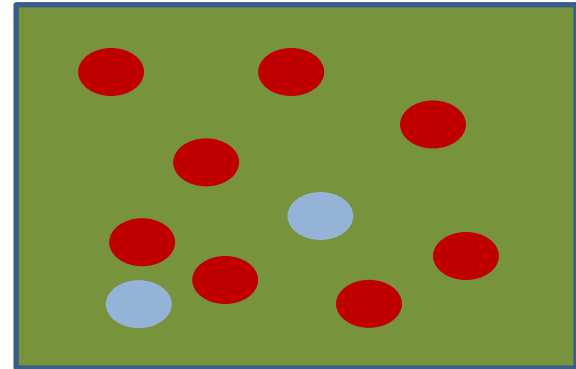
We are Bsal free... right?

- *Extremely* difficult to prove absence
- Also depends on expectations about invasion

Early Invasion,  $\varphi = 0.1$



Late invasion,  $\varphi = 0.8$



0

Occurrence,  $\varphi$

1

Conditional on our expectations about occurrence and prevalence,

What is the probability that Bsal was present at any of our sampled sites?

$$\bar{y}_i = 1 - \Pr(\text{neg}_{n,i} | Z_i = 1, \varphi, \pi, N, i_n, Se) = 1 - \prod_n^N \frac{\varphi * ((1-\pi) + (1-Se)^k)^{i_n}}{(\varphi * ((1-\pi) + (1-Se)^k)^{i_n} + (1-\varphi))}$$

Expectations

$\varphi = [0.05, 0.95]$

$\pi = [0.05, 0.95]$

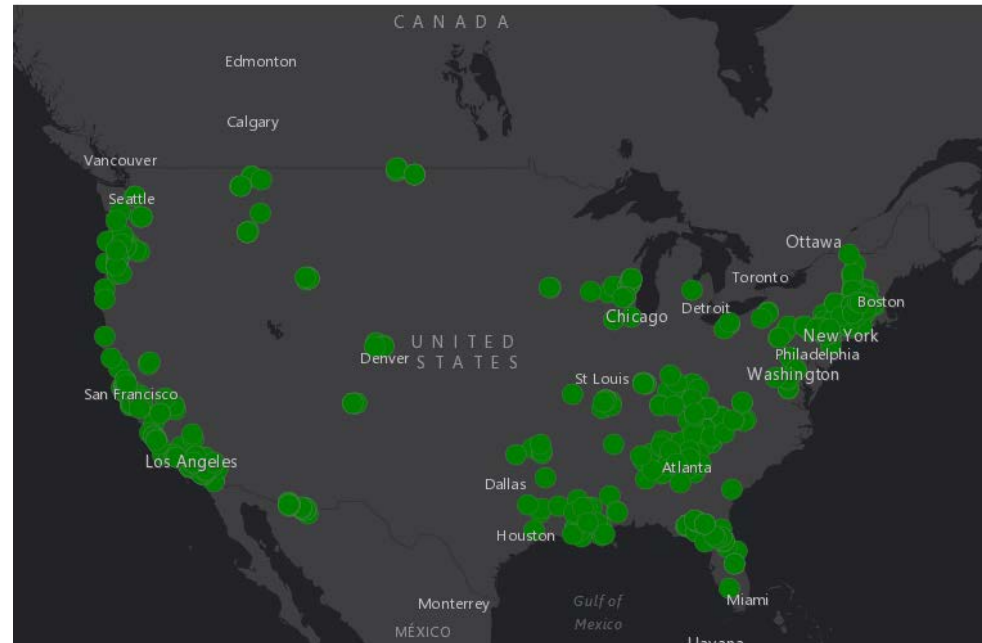
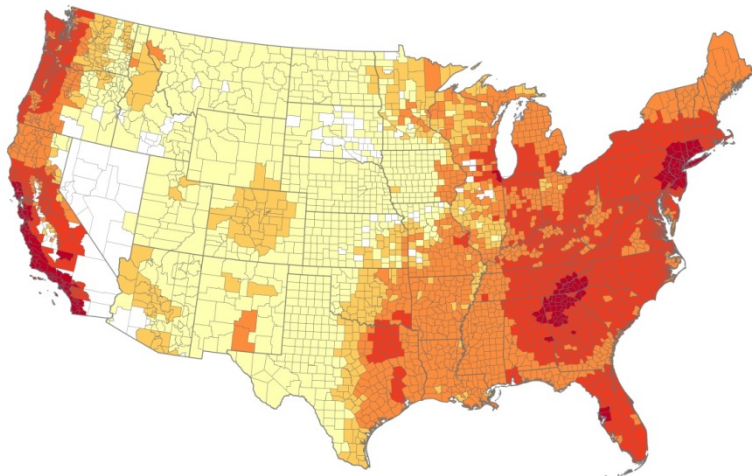
$Se = 0.75$

Data

$i$  counties

$Z_i$  sites in  $i$

$i_N$  samples in  $Z$



Many Scenarios high confidence of detection if present

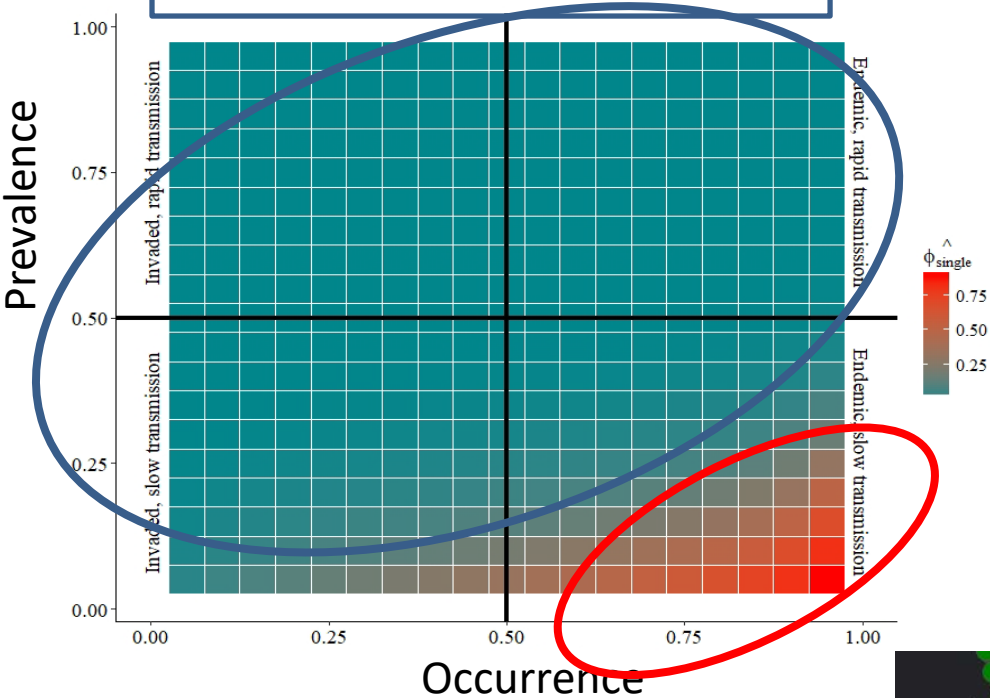
$$\bar{y}_i = 1 - \Pr(\text{neg}_{n,i} | Z_i = 1, \varphi, \pi, N, i_n, Se) = 1 - \prod_n^N \frac{\varphi * ((1-\pi) + (1-Se)^k)^{i_n}}{(\varphi * ((1-\pi) + (1-Se)^k)^{i_n} + (1-\varphi))}$$

### Expectations

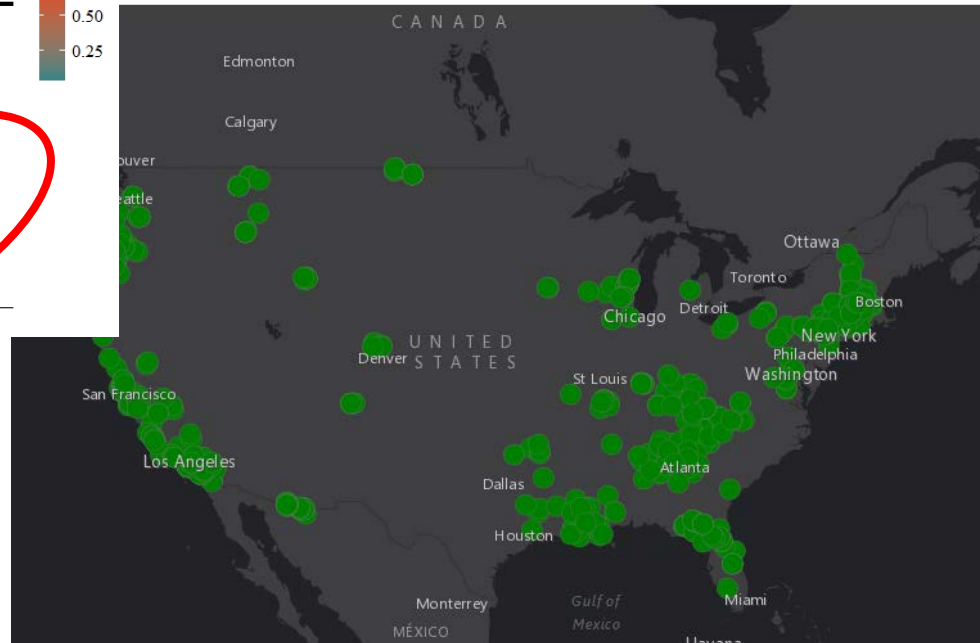
$\varphi = [0.05, 0.95]$   
 $\pi = [0.05, 0.95]$   
 $Se = 0.75$

### Data

$i$  counties  
 $Z_i$  sites in  $i$   
 $i_N$  samples in  $Z$



Widespread and low prevalence = not as confident



# Conclusions

**When we started**

**Total Risk = High**

Introduction: >100,000

suspected carriers

imported/year pre 2016

Consequences: severe

20 – 40% US species

predicted to have lethal

response

# Conclusions

## Total Risk = High

Introduction: >100,000  
suspected carriers  
imported/year pre 2016

Consequences: severe  
20 – 40% US species  
predicted to have lethal  
response

## Challenge: translate into action

- **FWS emergency Import rule on 200 species in pet trade**
- **We did not find Bsal**
- **Local attention to high risk areas**
- **Reduce uncertainties**
  - **Species susceptibility**
  - **Presence in US captive amphibians**



## State and University Swabbers

Iga Stasiak, Kentucky Dept. Fish & Wildlife

Jon Davenport, Southeast Missouri State

Sarabeth Klueh-Mundy, Indiana DNR

Kristine Grayson, University of Richmond

M. Hayes, Washington Dept. Fish and Wildlife

Wil Dillman, South Carolina DNR

Jen Lamb, University of Southern Mississippi

Gregory Watkins-Colwell, Yale Peabody Museum of Natural History

Allison Sacerdote-Velat, Peggy Notebart Nature Museum, Chicago

Tim Krynak, Cleveland Metroparks

## USGS Amphibian Research and Monitoring Initiative

