The Ecology of Disease and Anthropogenic Stressors in Amphibians

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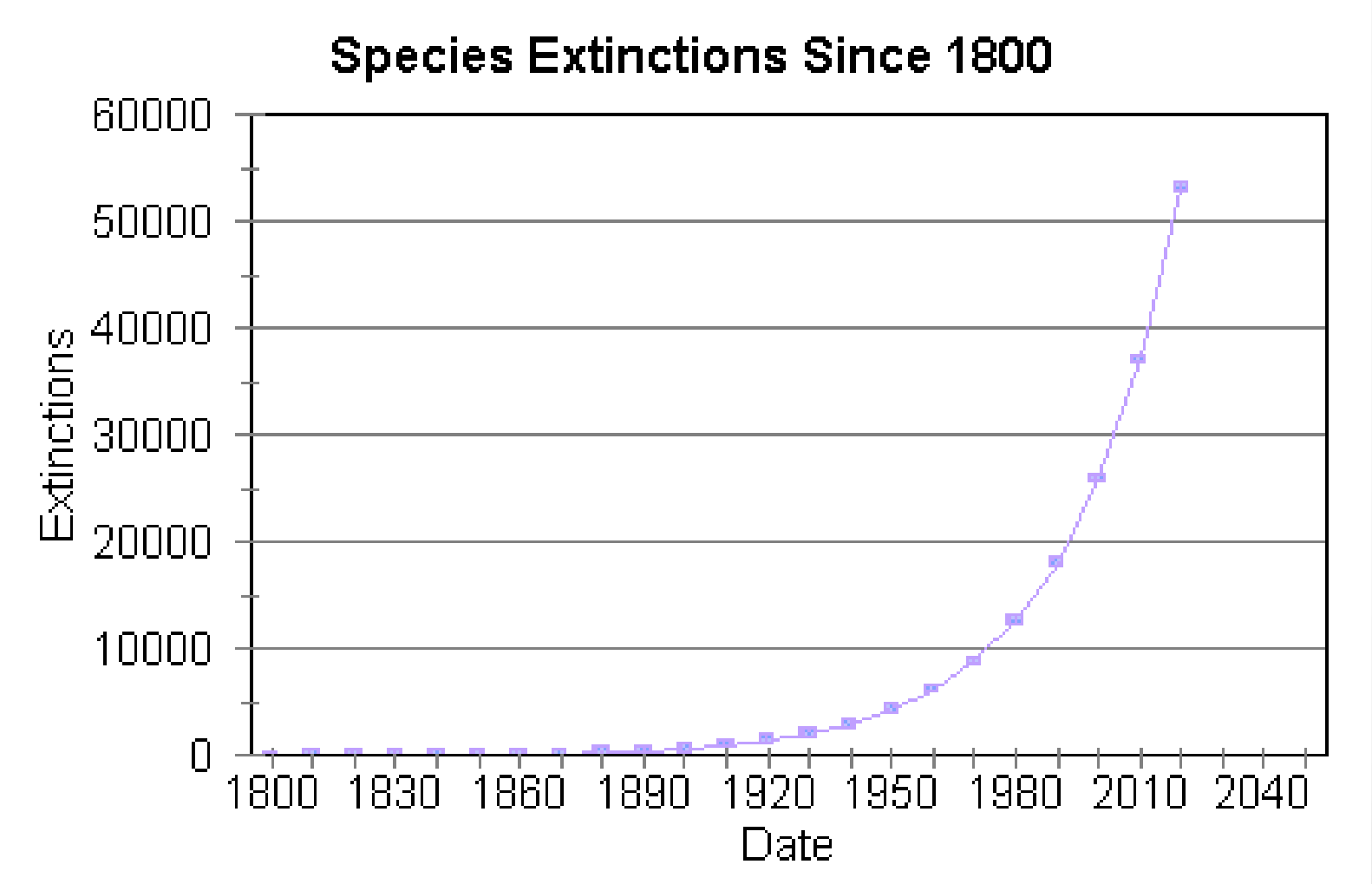
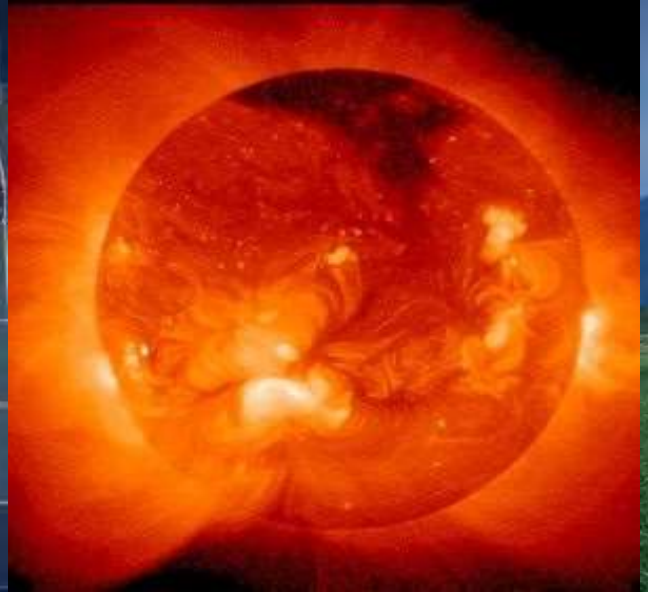
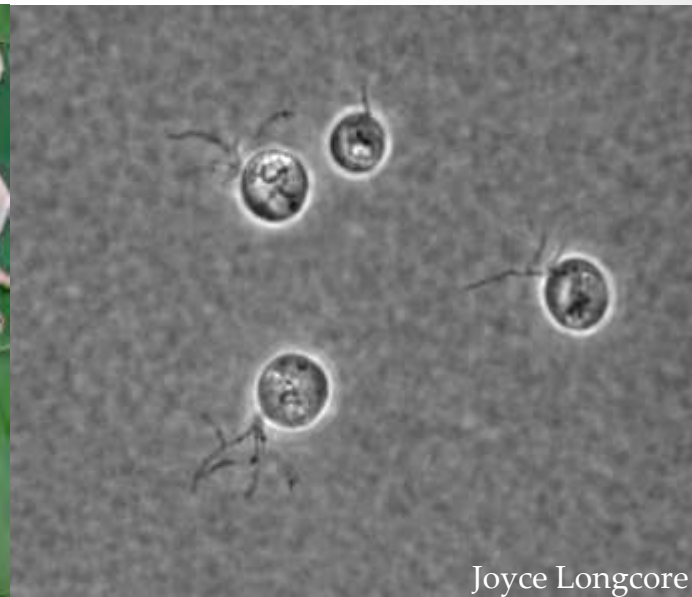
Sixth Mass Extinction?



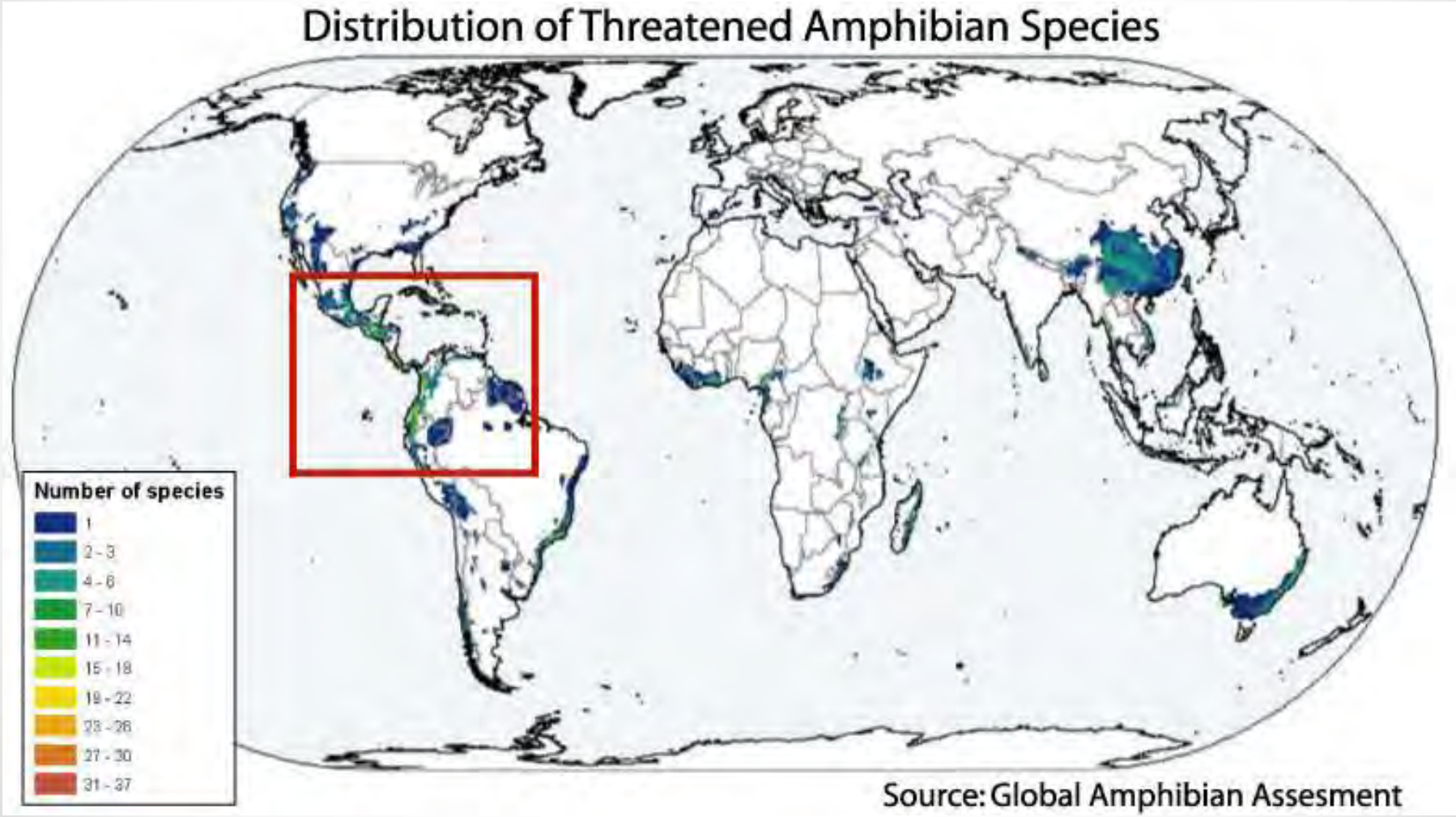

Can interactions between these factors modify their effects?





Joyce Longcore

Amphibian Population Declines



Global amphibian population declines

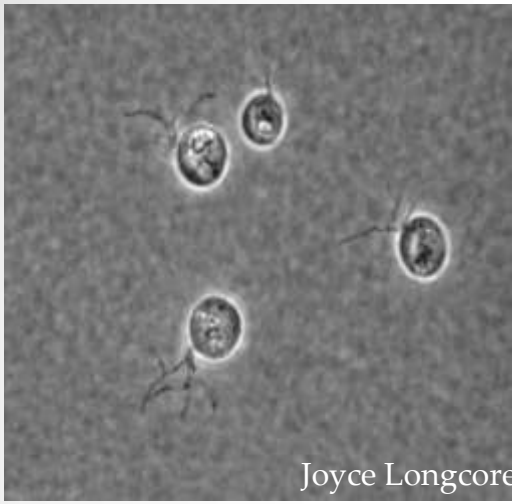
Group	Threatened	Endangered
Mammals	23% (1130)	3.8% (184)
Birds	12% (1211)	1.8% (179)
Amphibians	33% (1856)	7.4% (427)

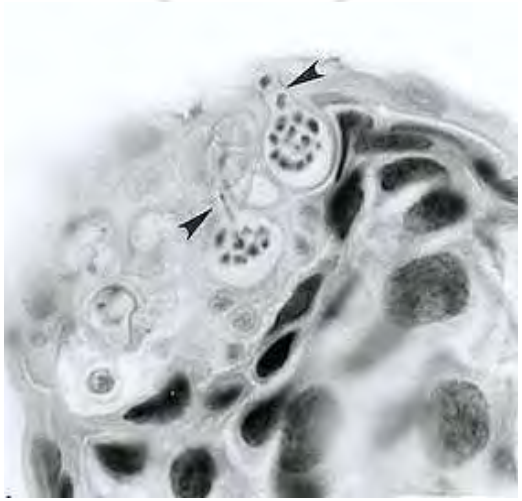
Stuart et al. 2004. **Science**

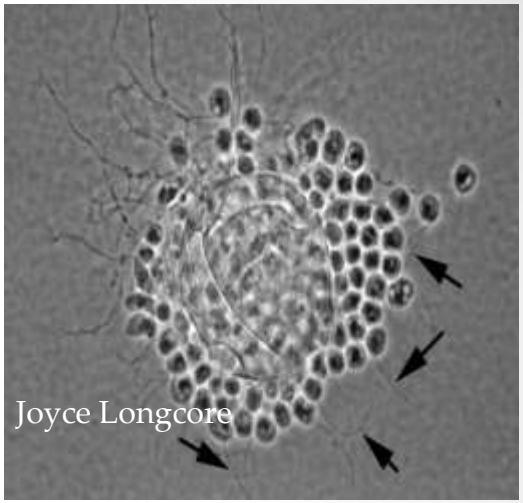
Why study amphibians?

- Offer an ideal system for studying the interaction of contaminants (e.g., pesticides) and pathogens
  - Live in and out of water
    - More susceptible to terrestrial and water-borne stressors
  - Permeable skin and unshelled eggs

Batrachochytrium dendrobatidis (Bd)



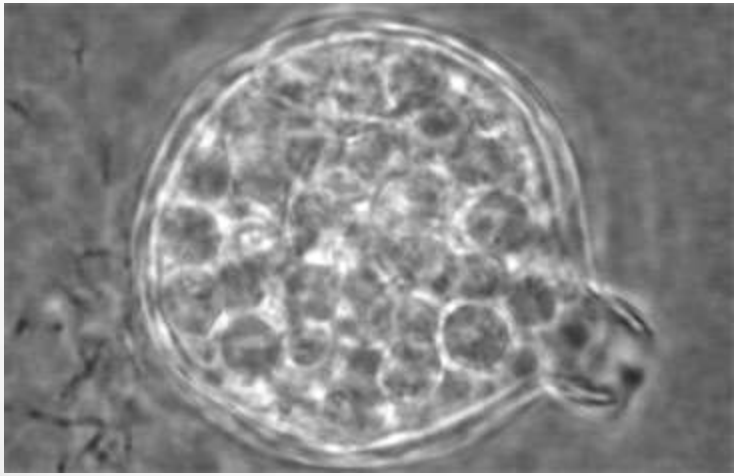




- Implicated in population declines globally
- Fungal pathogen of amphibians
- Causes chytridiomycosis
- Infects keratinized tissue

Our Goal

To examine the separate and combined impacts of pathogens and pesticides on five species of amphibians.



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Hypothesis

Ecologically relevant concentrations of pesticide mixtures will increase susceptibility of metamorphic amphibians to a pathogen (*Bd*).

Specifically, exposure to the contaminants in the larval and metamorphic stages will

- increase mortality
- increase pathogen load
- decrease growth

Our Amphibians

Spring peepers
Pseudacris crucifer

Pacific Tree Frogs
Pseudacris regilla

Western Toads
- *Anaxyrus boreas*

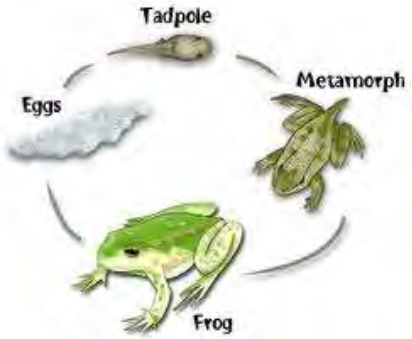
Leopard frogs
Rana pipens

Cascades Frogs
Rana cascadae

Experimental design: 5 x 5 x 2 x 2 factorial

X

X



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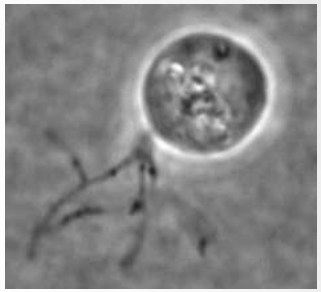


<u>5 Species of Frogs</u>

- Spring Peepers
- Pacific Tree Frogs
- Western Toads
- Leopard Frogs
- Cascades Frogs

<u>5 Pesticide Treatments</u>

- High Herbicide
- Low Herbicide
- High Insecticide
- Low Insecticide
- Control

<u>2 Exposure Stages</u>

- Tadpole Exposed
- Metamorph Exposed

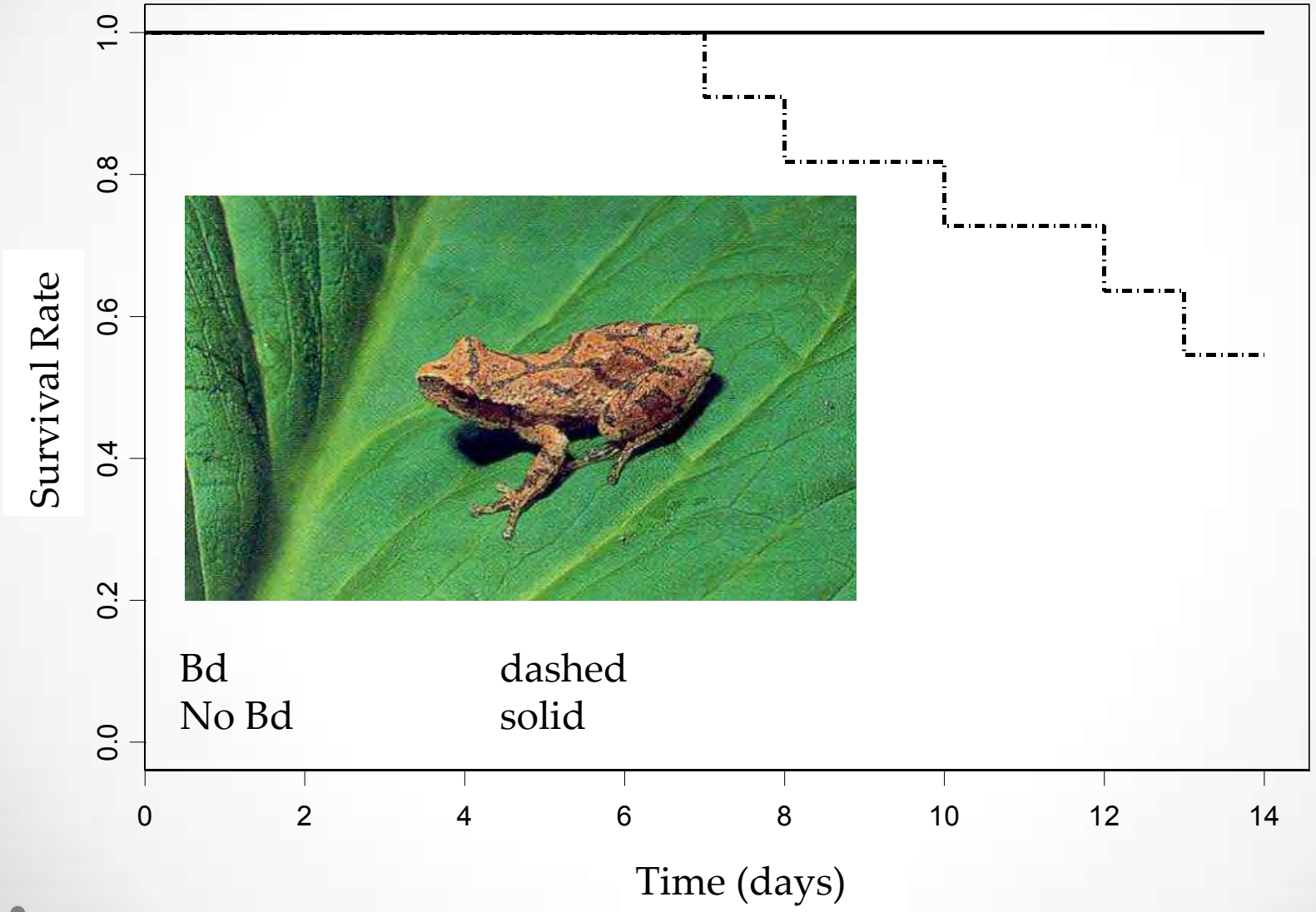
<u>2 Bd Treatments</u>

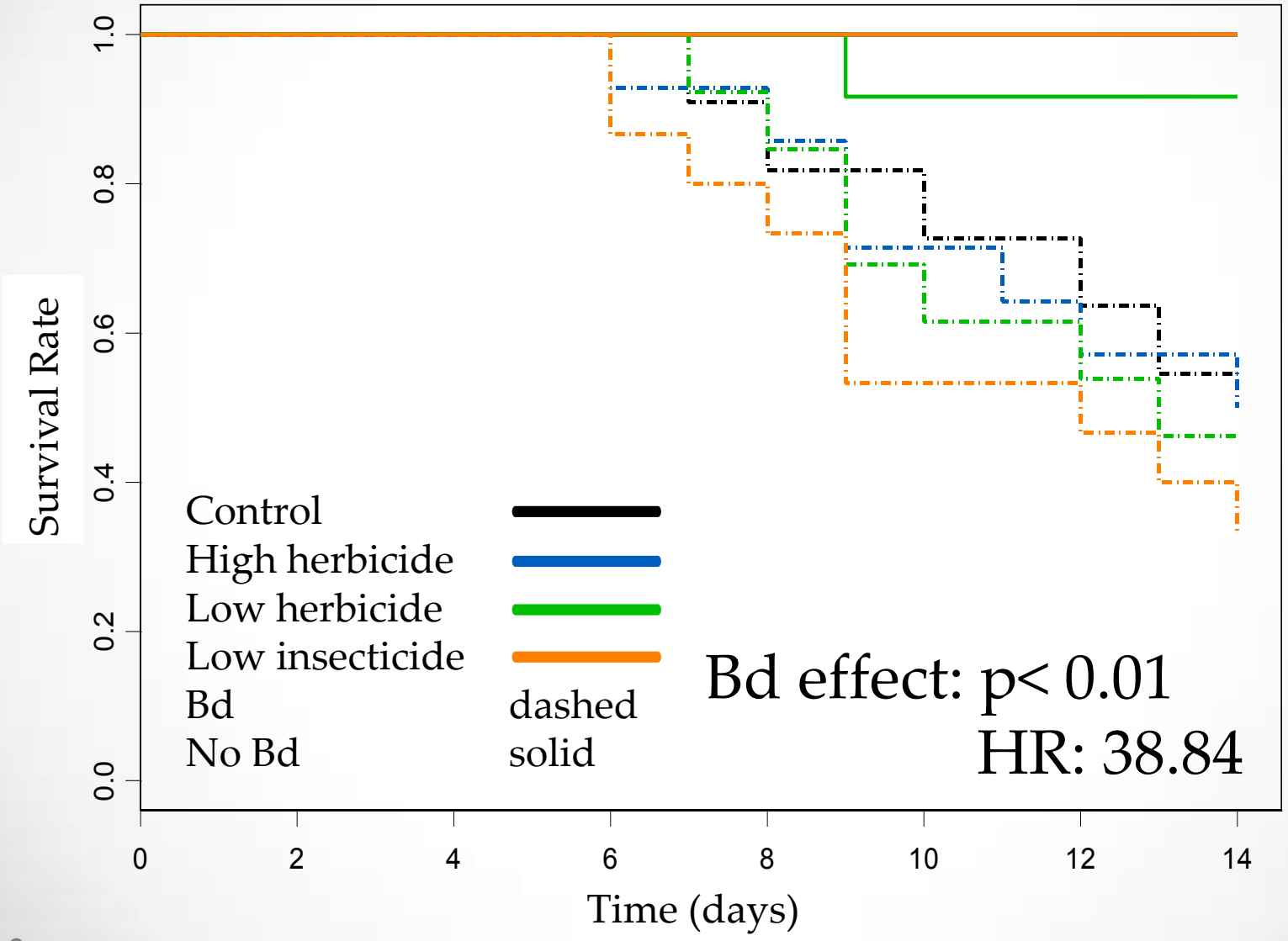
- Present
- Absent


66 C/ET/BD

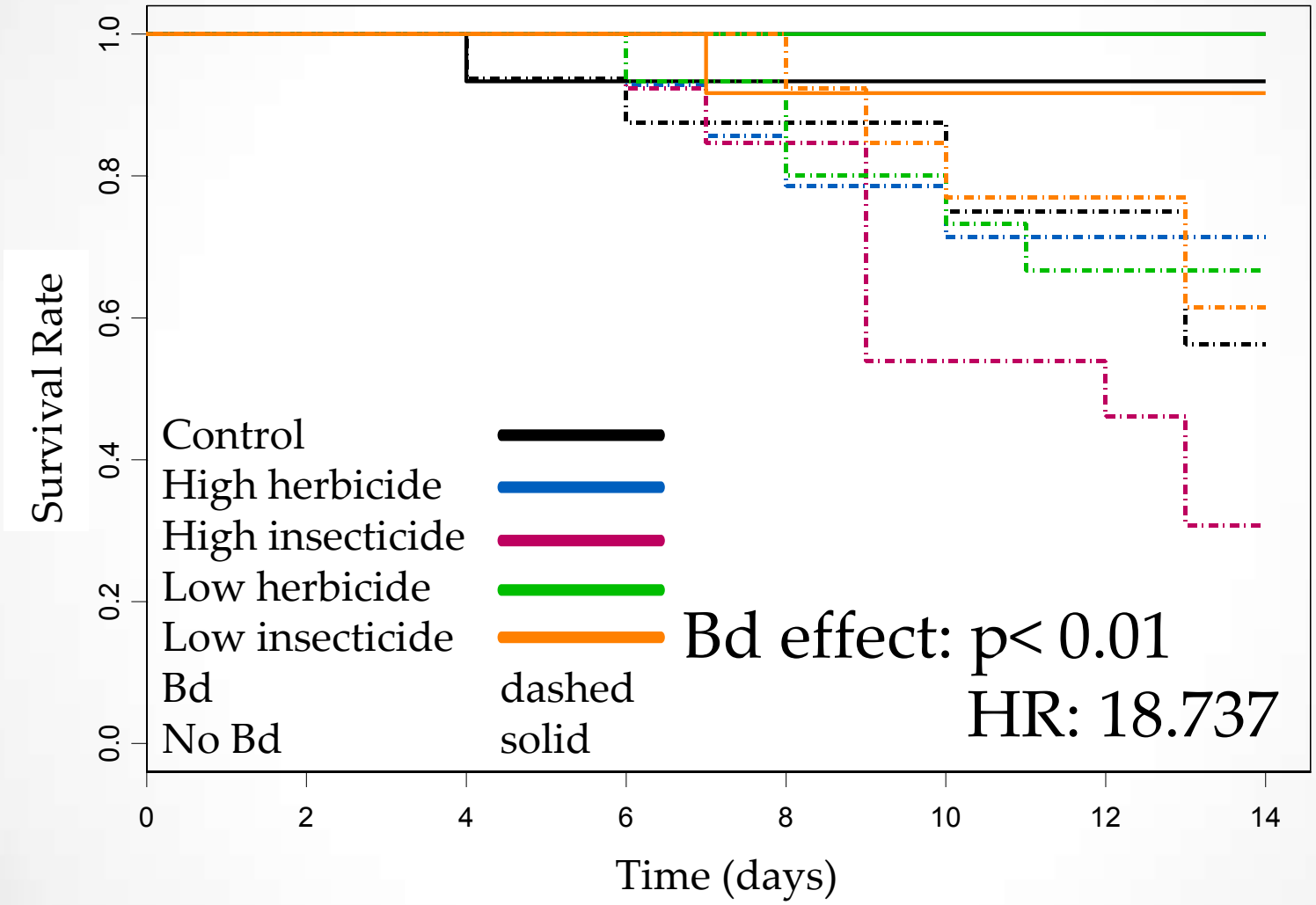
Results

Spring Peepers, tadpole exposure (showing pesticide controls only)

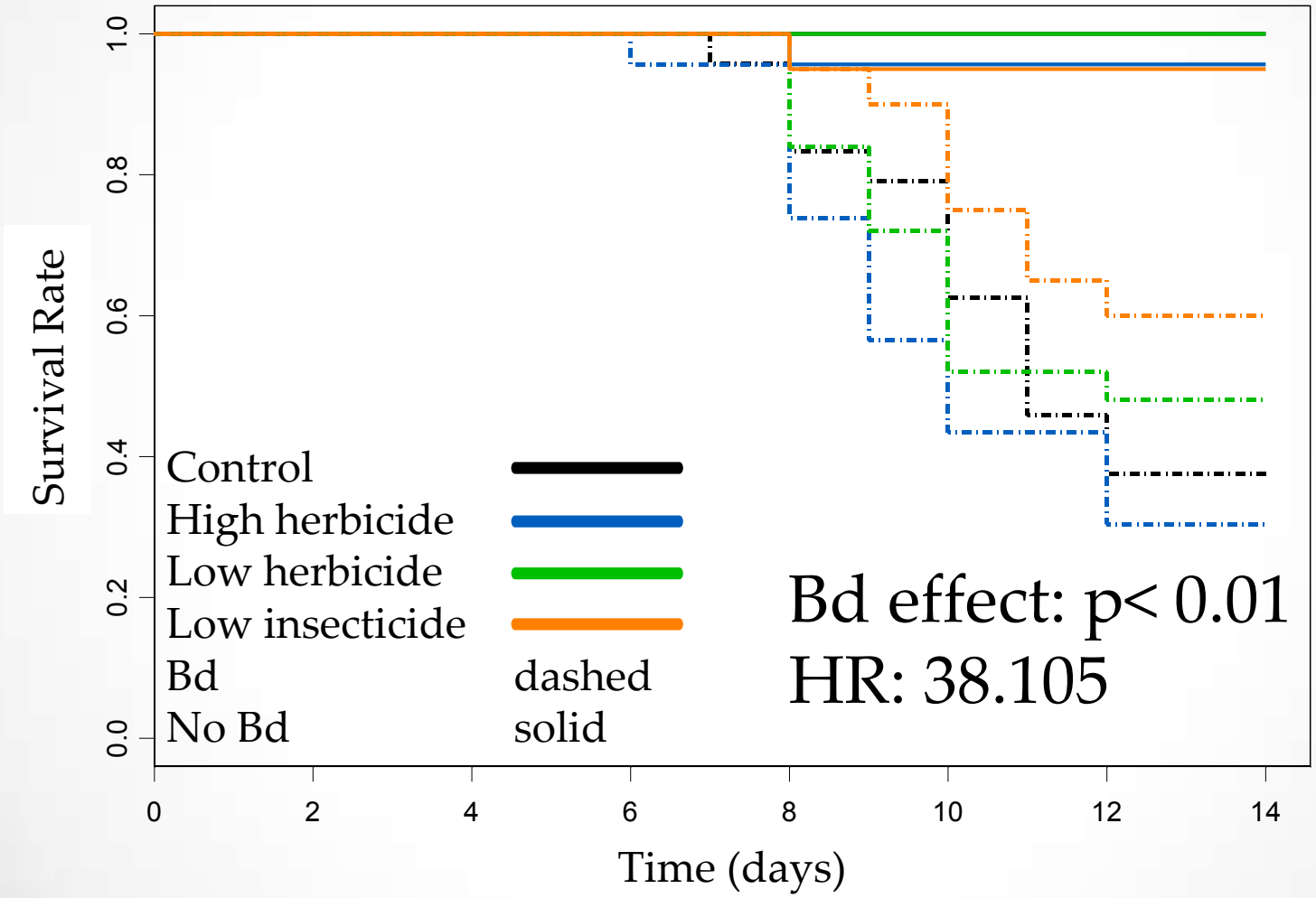



Spring Peepers (tadpole exposure)
Survival Rate
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
Time (days)
Control
High herbicide
Low herbicide
Low insecticide
Bd
No Bd
dashed
solid
Bd effect: p< 0.01
HR: 38.84

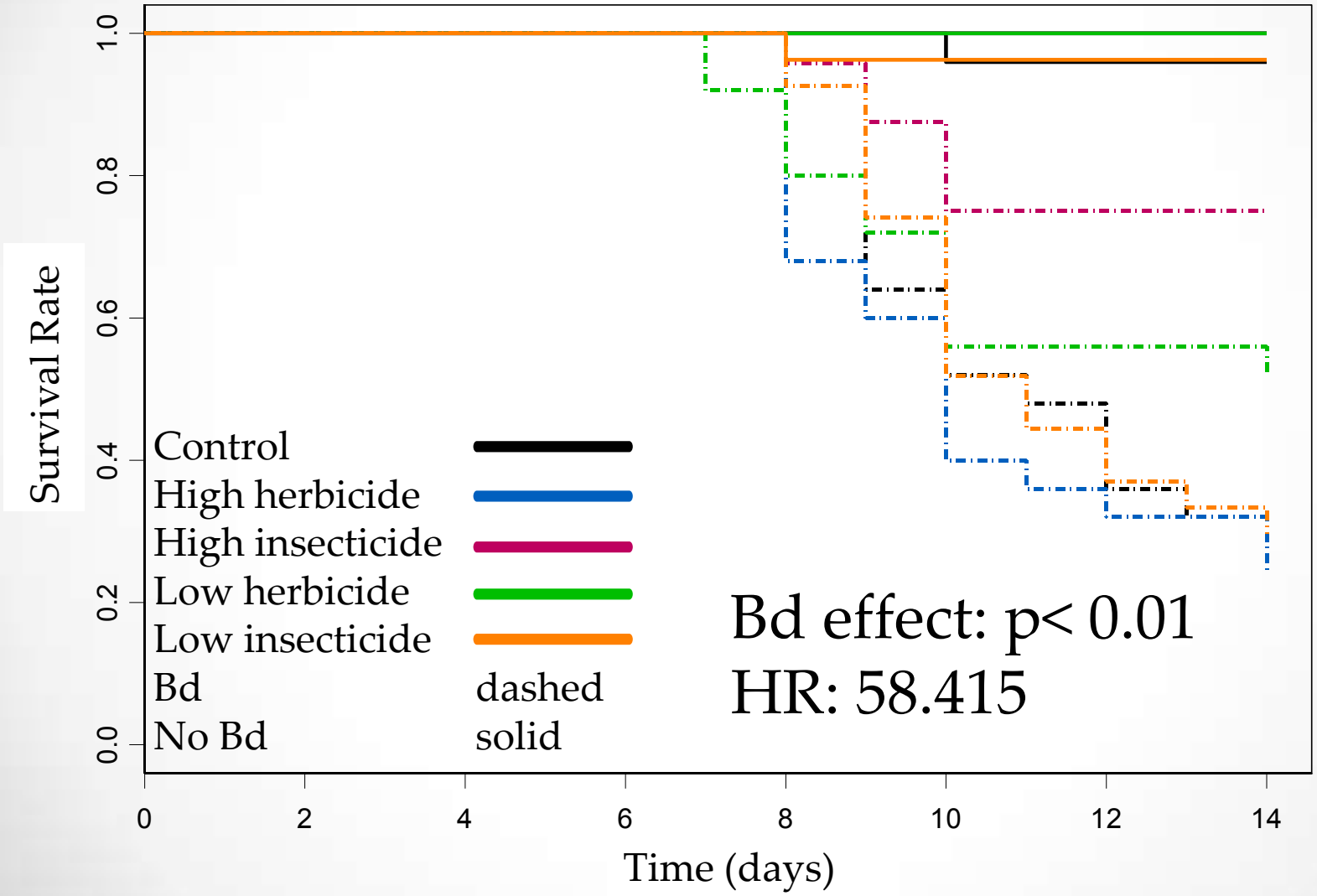
Spring Peepers (metamorph exposure)

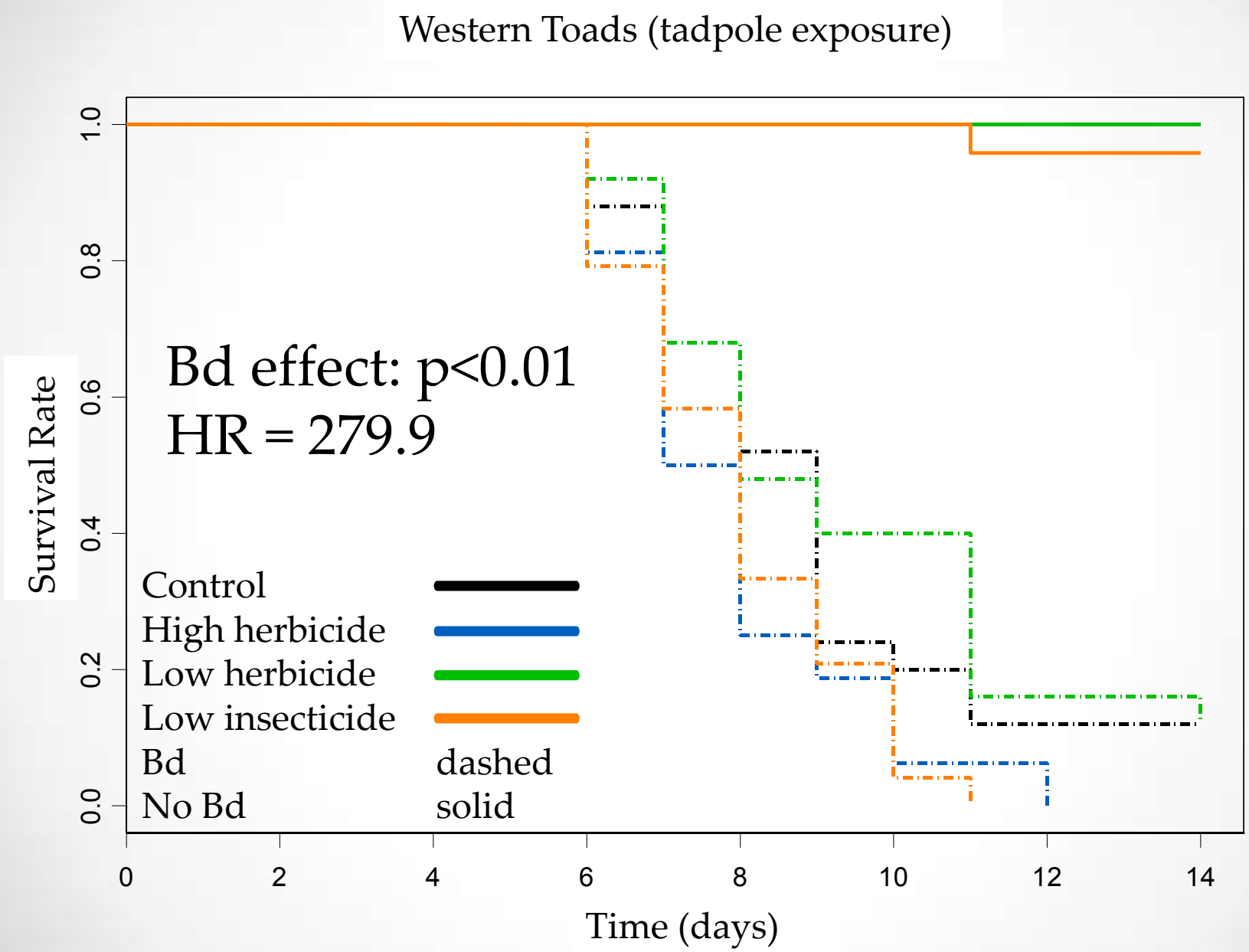


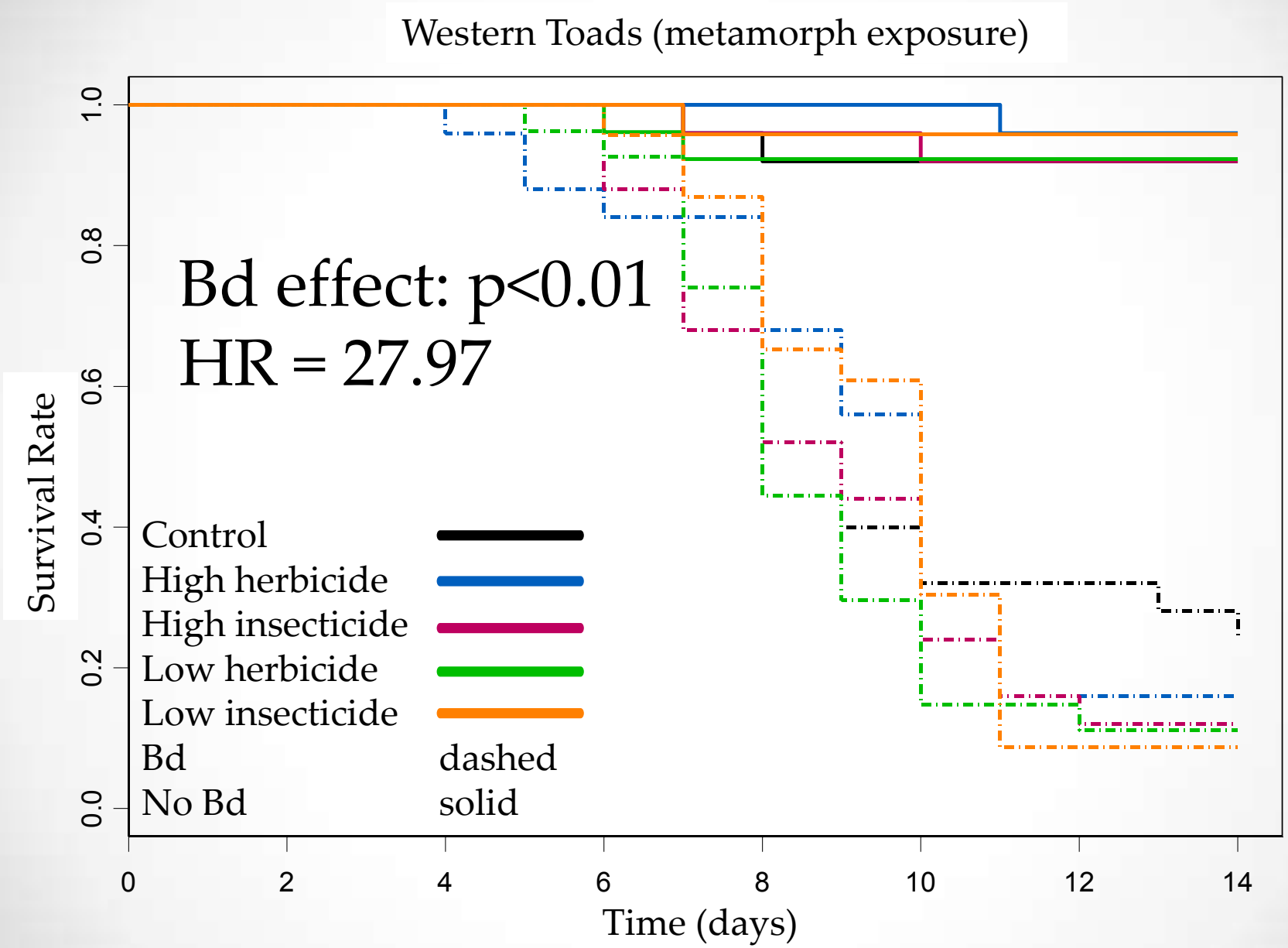
Pacific Tree Frogs (tadpole exposure)



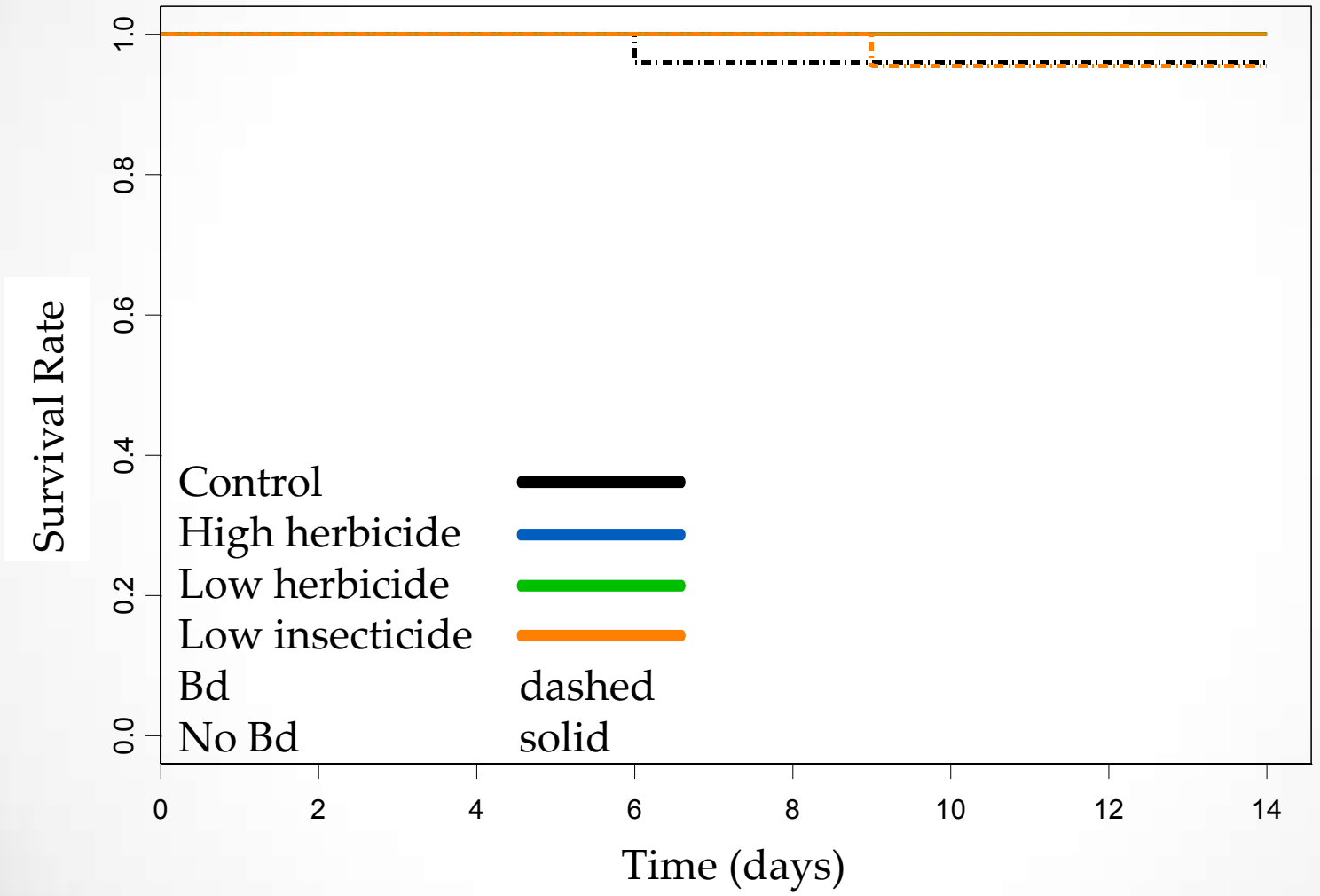
Pacific Tree Frogs (metamorph exposure)



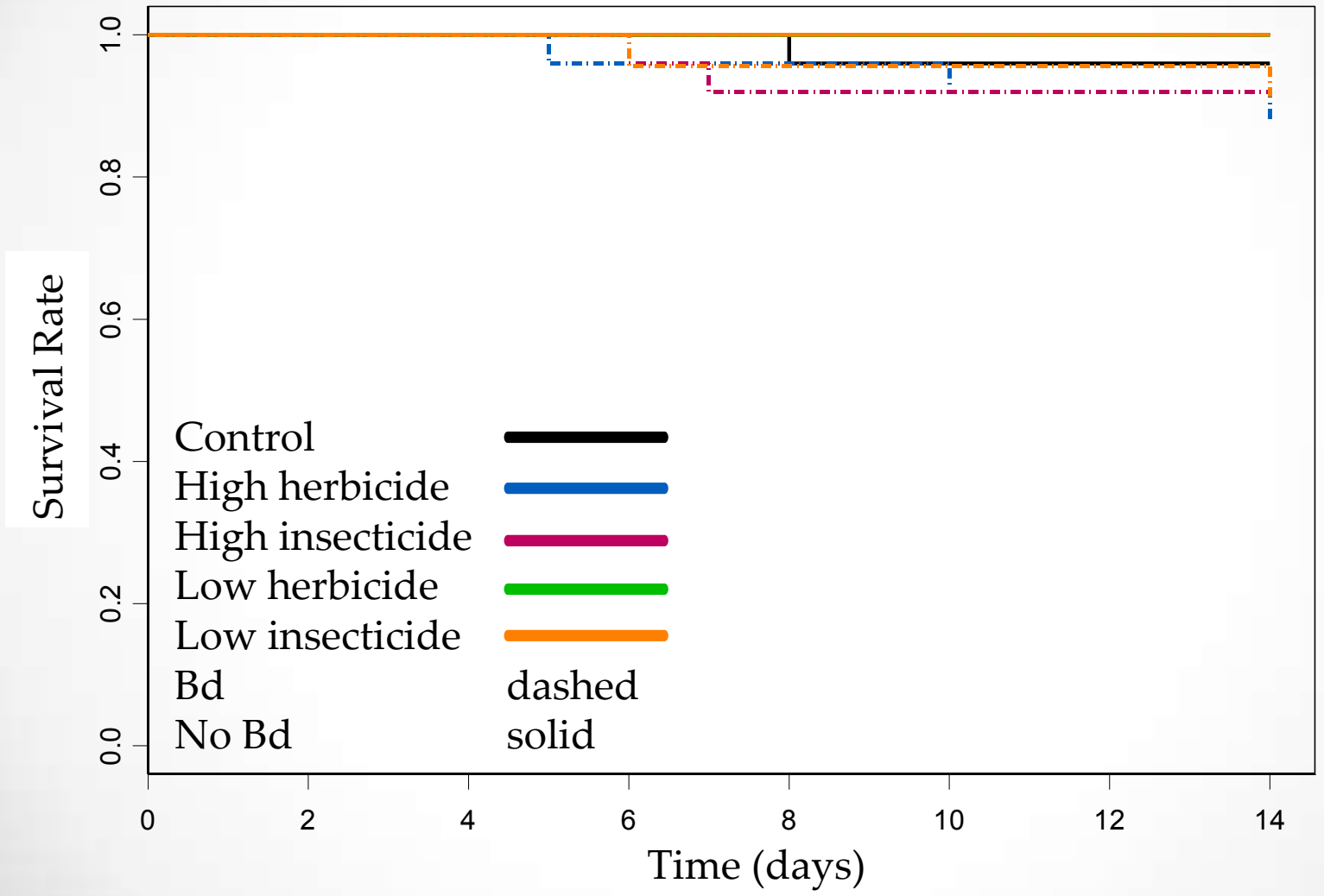

Western Toads (tadpole exposure)
Survival Rate
1.0
0.8
0.6
0.4
0.2
0.0
Bd effect: p<0.01
HR = 279.9
Control
High herbicide
Low herbicide
Low insecticide
Bd
dashed
No Bd
solid
0
2
4
6
8
10
12
14
Time (days)


Western Toads (metamorph exposure)
Bd effect: p<0.01
HR = 27.97
Survival Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14
Time (days)
Control
High herbicide
High insecticide
Low herbicide
Low insecticide
Bd
dashed
No Bd
solid

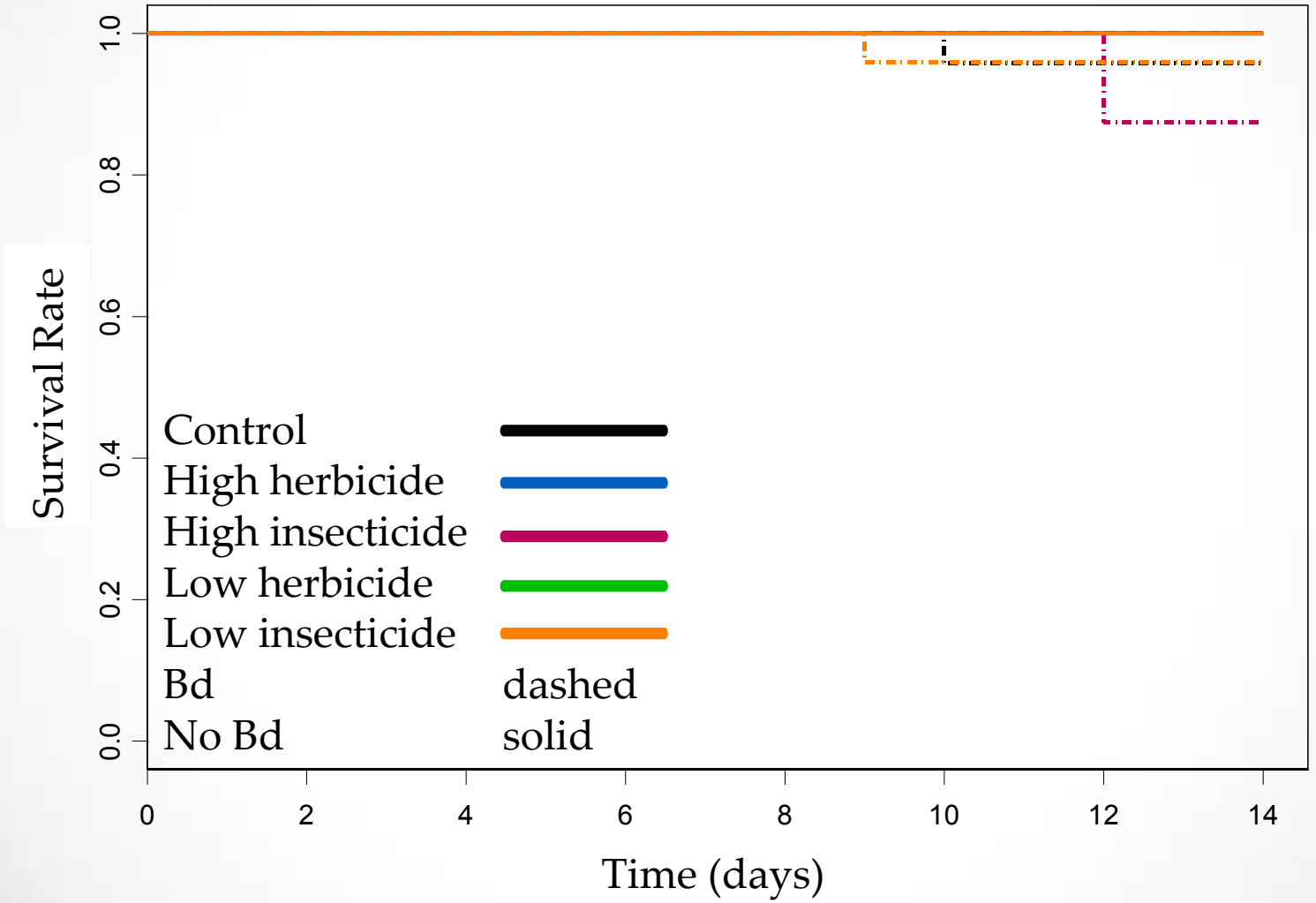
Leopard Frogs (tadpole exposure)

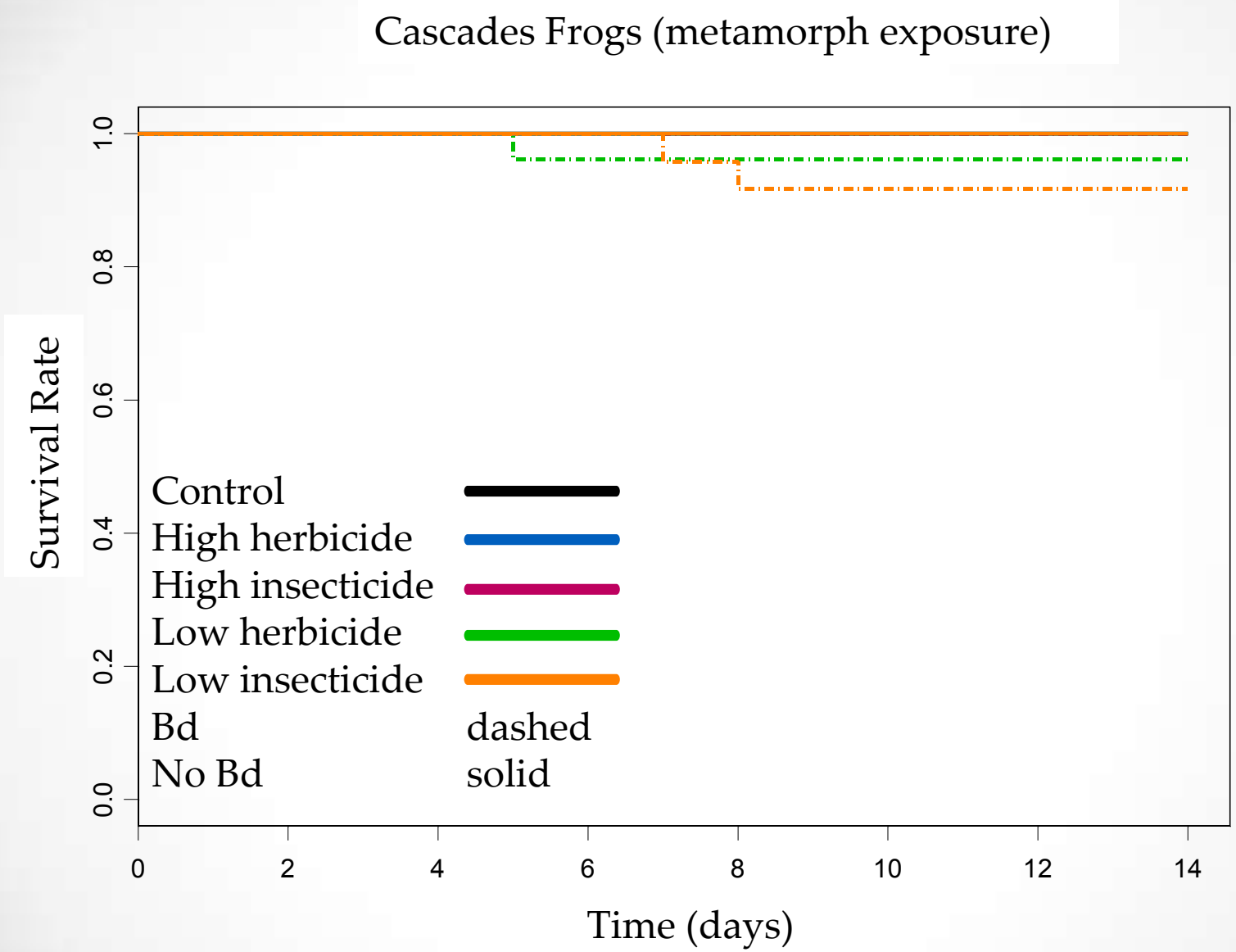


Leopard Frogs (metamorph exposure)



Cascades Frogs (tadpole exposure)




Cascades Frogs (metamorph exposure)
Survival Rate
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
Time (days)
Control
High herbicide
High insecticide
Low herbicide
Low insecticide
Bd
dashed
No Bd
solid

Summary of Results

- 3 of 5 species showed significant mortality
- Similarities between tree frogs
  - Showed Bd effect with significant p-value
- Toads showed increased susceptibility (High HR)
- True frogs had no significant effects
  - Very little mortality

Summary of Results

- Other interesting effects:
  - Pesticide effect in metamorph exposed Pacific Tree Frogs
    - High insecticide: p=0.0023, HR=0.239
  - SVL effect in metamorph exposed Leopard Frogs
    - p=0.000048, HR = 0.44

What's next?

- Mass & SVL after death
- qPCR

Benefits to Society

- Disappearing amphibians may affect whole ecosystems
- The potential to offer new insights into the spread of infectious disease
  - All organisms, including humans are exposed to pesticides and pathogens.

Acknowledgements

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