

# Invasive Bullfrog Removal in the American Southwest

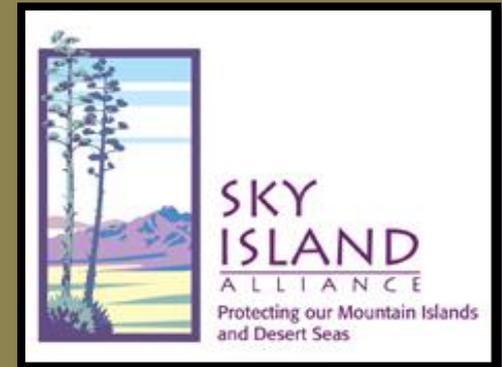
A Case Study from the Pajarito/Atascosa Mountains,  
Arizona

Christina M. Akins and Thomas R. Jones  
Nongame Branch  
Arizona Game and Fish Department



# Acknowledgements

An interagency – multipartner approach



...and a host of  
volunteers

# Invasive Species

The subset of introduced species that persist, proliferate, and cause economic or environmental harm, or harm to human health.

-- Ecological Society of America (2004)

The most effective way to deal with invasive introduced species, short of keeping them out, is to discover them early and attempt to eradicate or at least contain them before they spread.

-- Simberloff (2003)



# Re-evaluating eradication of nuisance species: invasion of the tunicate, *Ciona intestinalis*

Paul K Edwards\* and Brian Leung

*Front Ecol Environ* 2009; 7, doi:10.1890/070218

## Treatment Zone Concept

### Approach

- Define vulnerability window  
= minimum range of susceptible, immature stages
- Determine # of passes necessary for eradication  
Each pass – all individuals in window are removed (no recruitment)
- Existing adults removed directly  
(no reproduction)



**Figure 1.** Socks of blue mussels coated in *Ciona intestinalis*. Inset: close-up of blue mussels with *C. intestinalis* adhering to them.

“We argue that eradication has been prematurely dismissed in practice...”

# Bang for buck: cost-effective control of invasive species with different life histories

Eric R. Buhle<sup>a,1</sup>, Michael Margolis<sup>b</sup>, Jennifer L. Ruesink<sup>a,\*</sup>

Ecological Economics 52 (2005) 355–366

“Effective control should target the weak link in the life cycle”

“removal of egg capsules is more effective at reducing population growth... Because adults...have relatively low survival, their removal does not help much to reduce population growth.”

(J.L. Ruesink <http://depts.washington.edu/jlrlab/oysterdrills.php>)



photo: J.L. Ruesink

# Removal of the American bullfrog *Rana (Lithobates) catesbeiana* from a pond and a lake on Vancouver Island, British Columbia, Canada

*S. A. Orchard*

*BullfrogControl.com Inc., 69A Burnside Road West, Victoria British Columbia, Canada, V9A 1B6.  
<bullfrogcontrol@shaw.ca>.*

## Strategy:

remove all metamorphosed frogs & therefore eliminate reproduction

Disrupt the system, eliminate reproduction  
local extirpation follows

(Edwards & Leung 2009)

- No tadpoles were taken
- Repeat visits at each site
- 2 sites from 2007 – 2009
- Removed ~2400 bullfrogs



photo courtesy of Stan Orchard

Cohen and Howard. 1958. Bullfrog food and growth at the San Joaquin Experimental Range, California. *Copeia* 1958: 223 – 225.



**Fig. 1.** In 1950 thousands of recently metamorphosed bullfrogs lined the shores of one of the earthen reservoirs at the San Joaquin Experimental Range, California. The eggs had been laid only about seven months earlier. This reservoir went completely dry during the late summer of the previous season.

# Project Area

Pajarito and Atacosa mountains, Arizona



# Peña Blanca Lake

- built in 1957
- ~ 20 ha
- excellent bullfrog habitat & source for regional metapopulation



# Peña Blanca Lake

contaminated with mercury



Federal Superfund CERCLA site

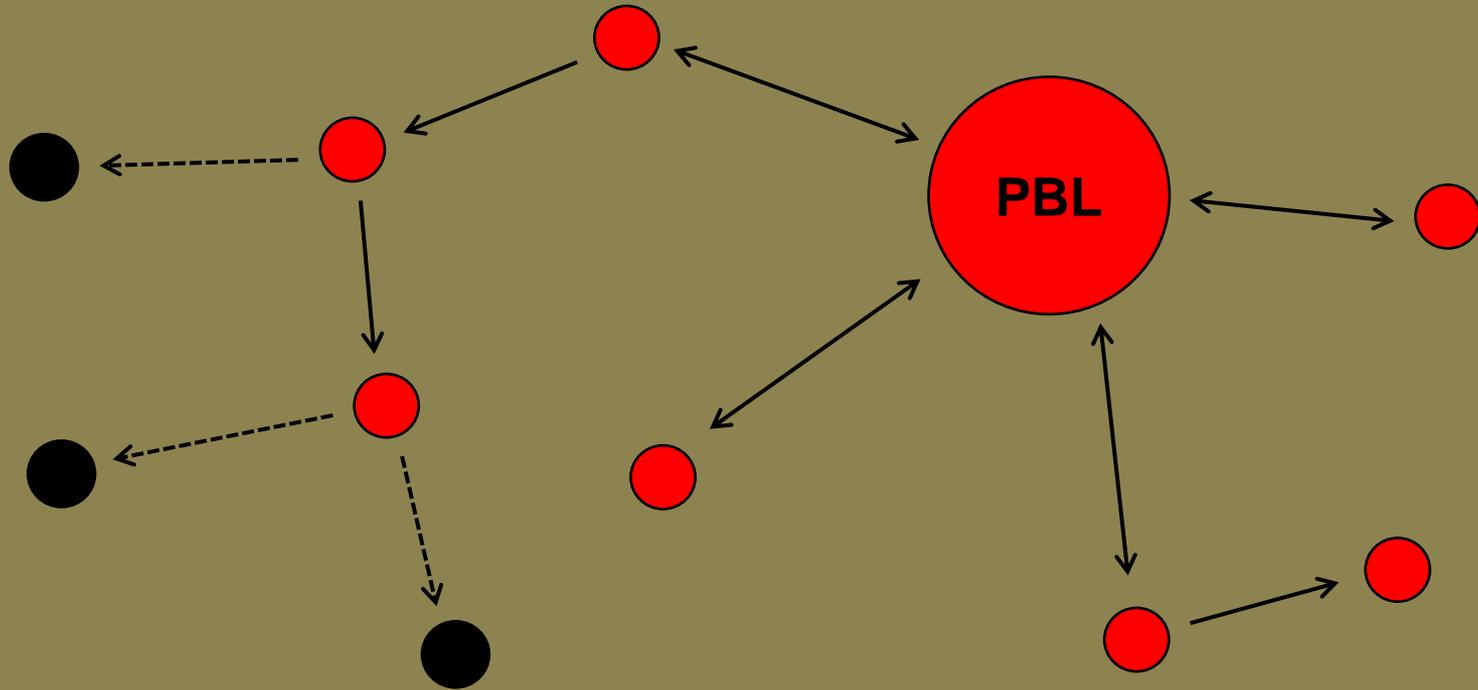
Comprehensive Environmental Response, Compensation and Liability Act

Drained October 2008

Excavated and  
removed sediments



# Peña Blanca Lake metapopulation conceptual plan

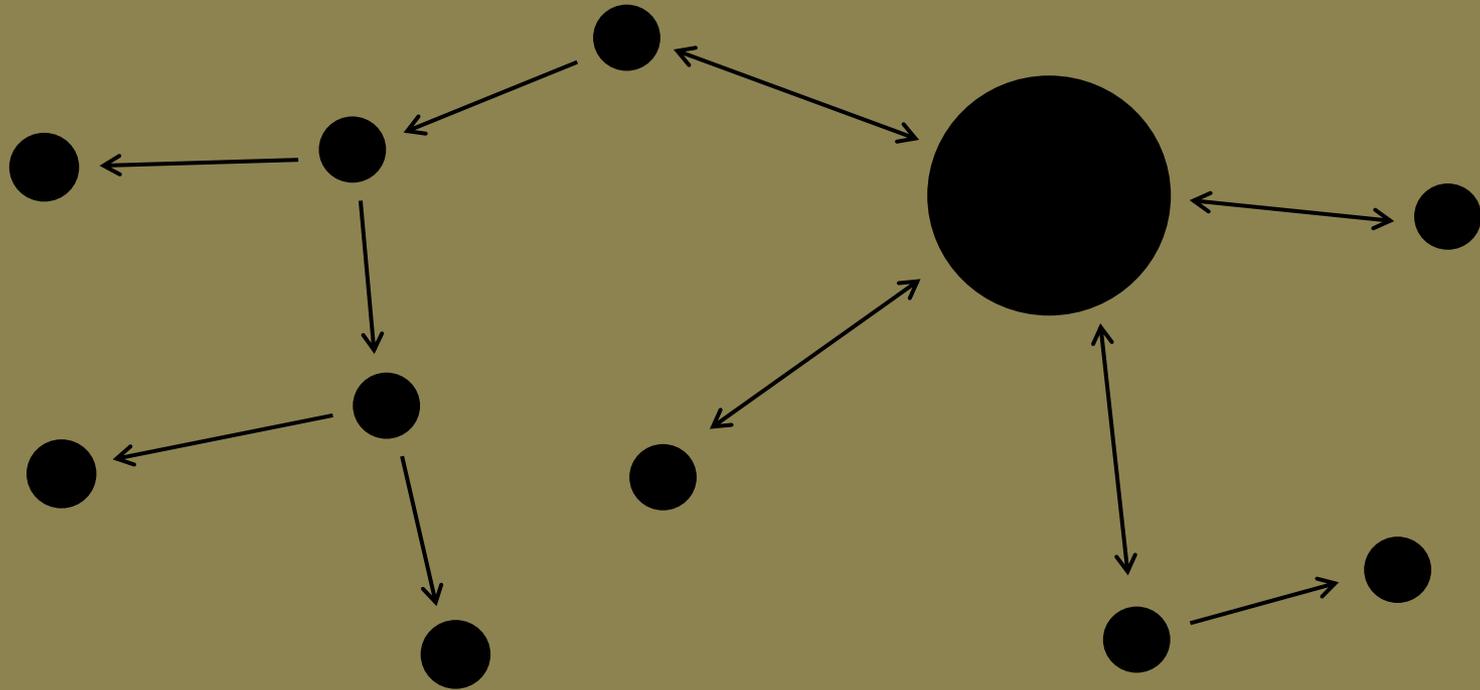


● bullfrog (+)

● bullfrog (-)



# Peña Blanca Lake metapopulation conceptual plan



● bullfrog (+)

● bullfrog (-)

# *Outline a Plan*

- First – define the conservation objectives
- Second – know the landscape
  - thoroughly survey all possible sites, and consider avenues for dispersal
- Third – identify strategies
  - Disrupt the system (eliminate reproduction)
  - Target vulnerable life history stage (reduce recruitment)
  - Maximize efficiency (detectability, likelihood of success)
  - Complete before dispersal
- Fourth – identify techniques

# Define the conservation objectives

Eliminate all bullfrogs from Peña Blanca Lake, stock tanks and other waters in the surrounding mountains

- Monitor results
- Prevent immigration (recolonization of PBL)
- Document changes in native ranid frog distribution

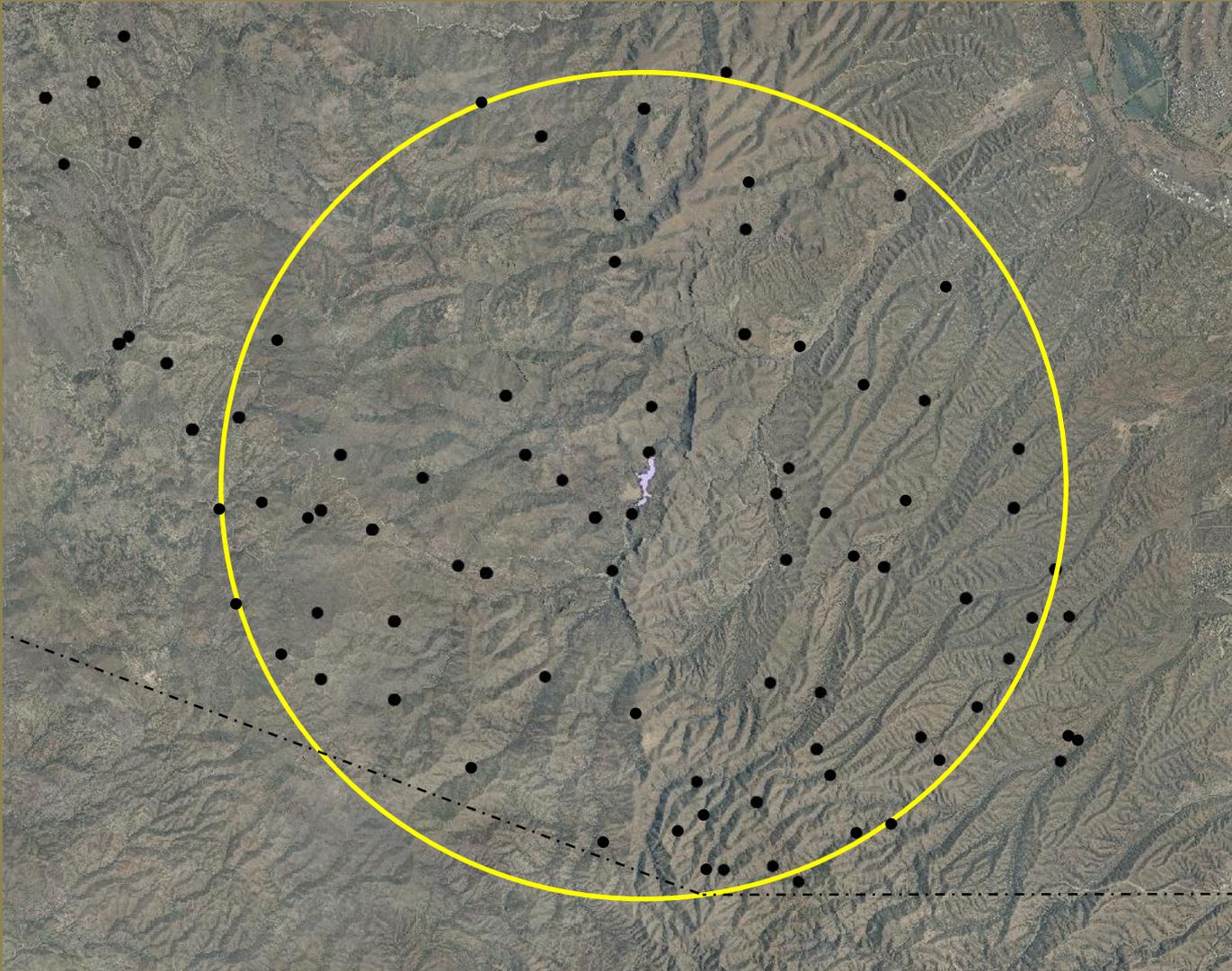


*Lithobates chiricahuensis*



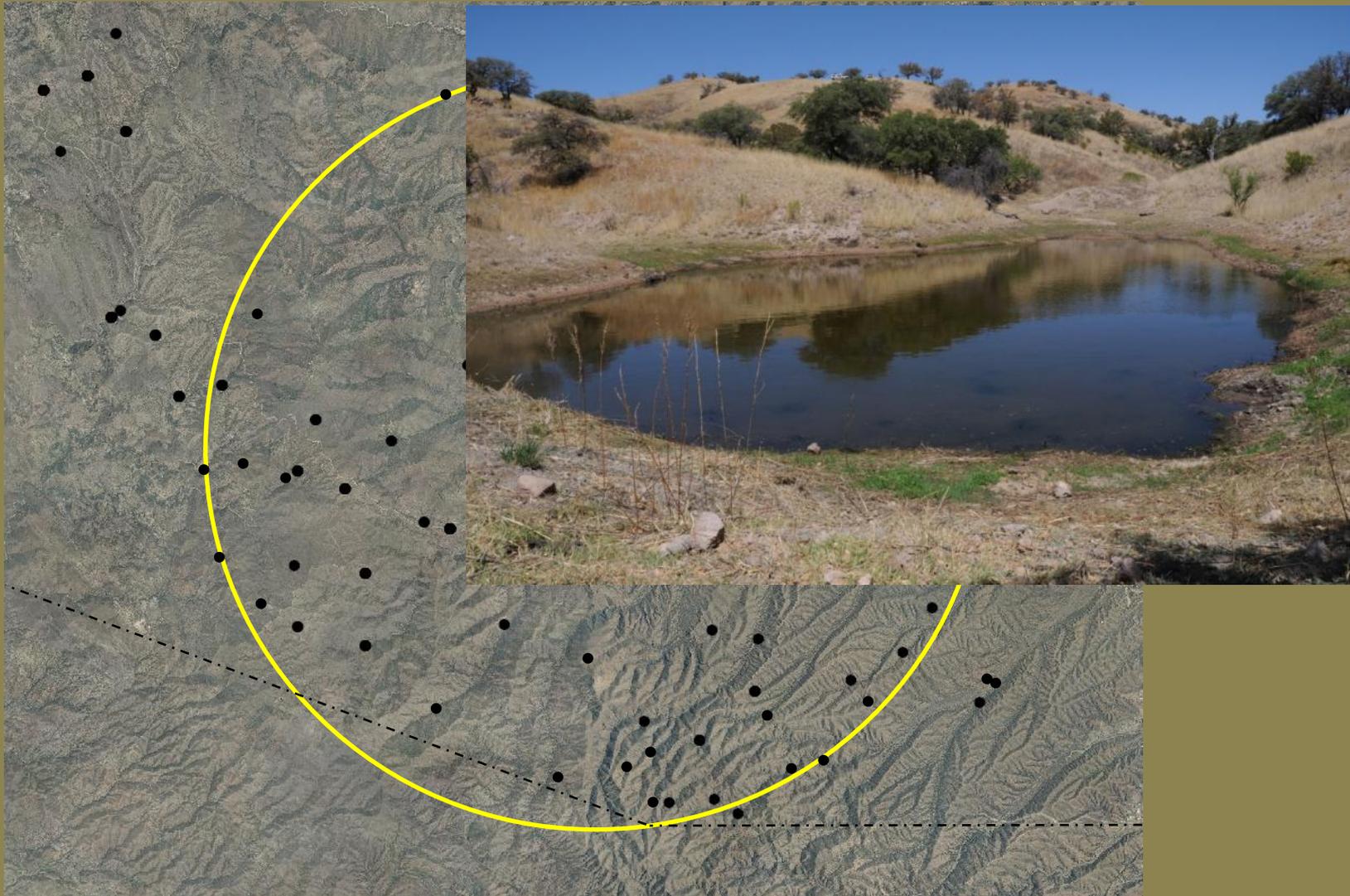
*Lithobates yavapaiensis*

# Know the landscape



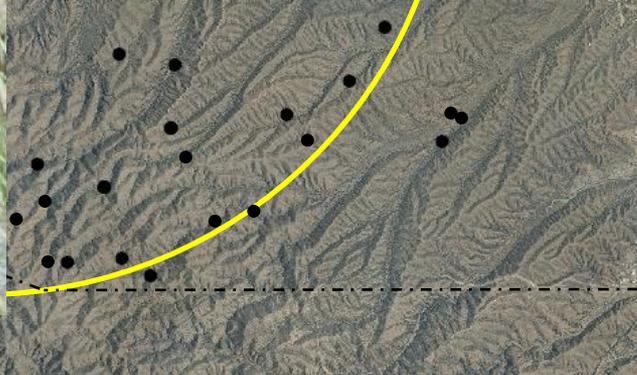
Surveyed 8 km radius around Peña Blanca Lake

# Know the landscape



Surveyed 8 km radius around Peña Blanca Lake

# Know the landscape



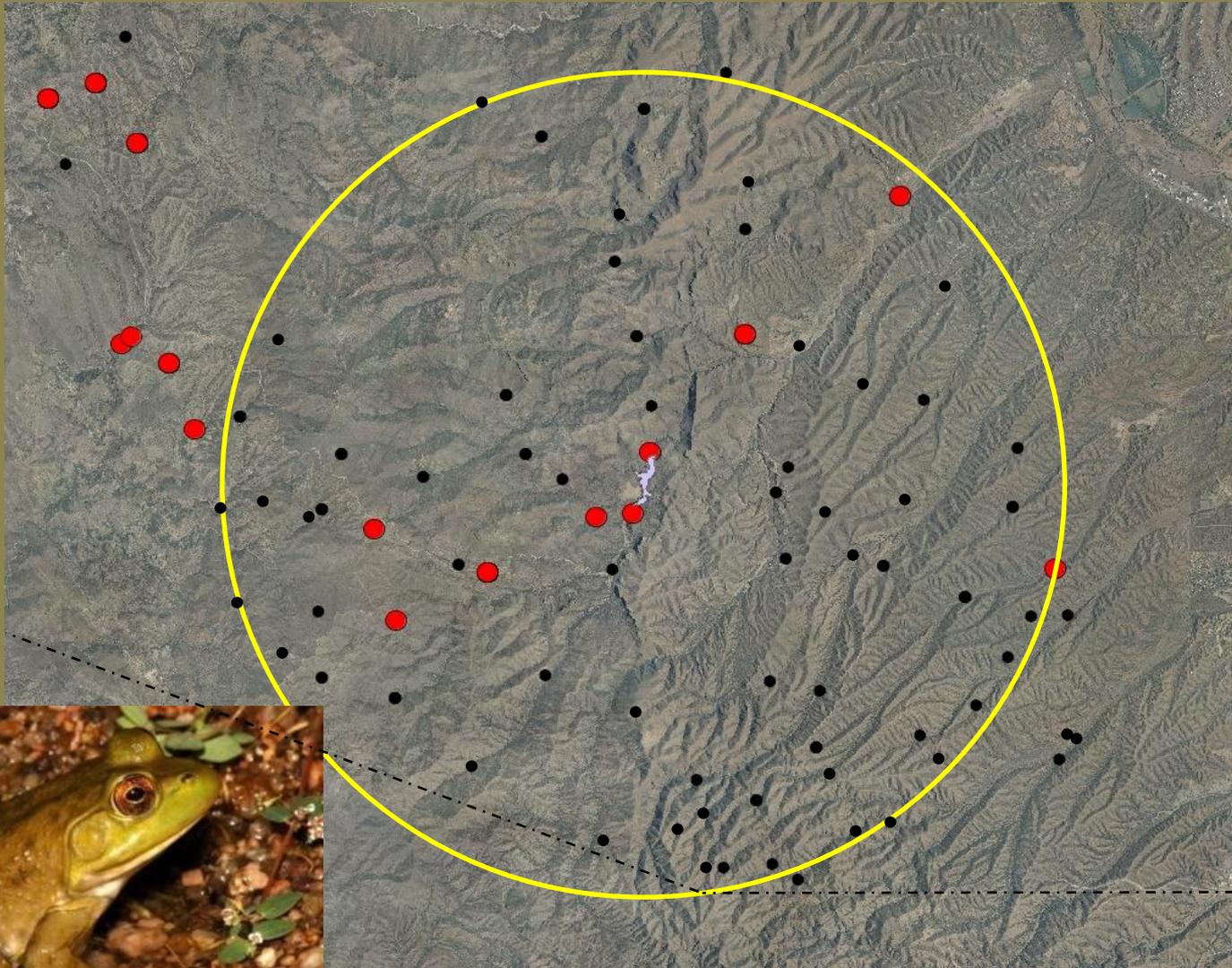
Surveyed 8 km radius around Peña Blanca Lake

# Know the landscape



Surveyed 8 km radius around Peña Blanca Lake

*L. catesbeianus*  
pre-removal



# Disrupt the system

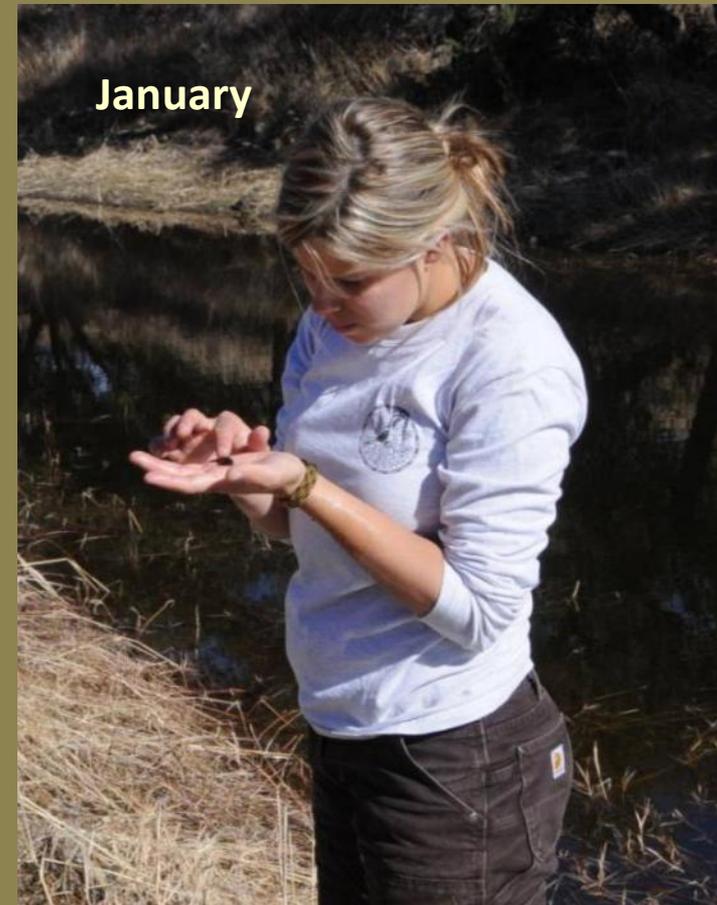


Eliminate reproduction



# Target vulnerable life history stage

- Winter seining reduced tadpole #s
- Tadpoles are small, and easier to remove large numbers
- Ultimately reduced numbers of frogs to remove later



# Maximize efficiency



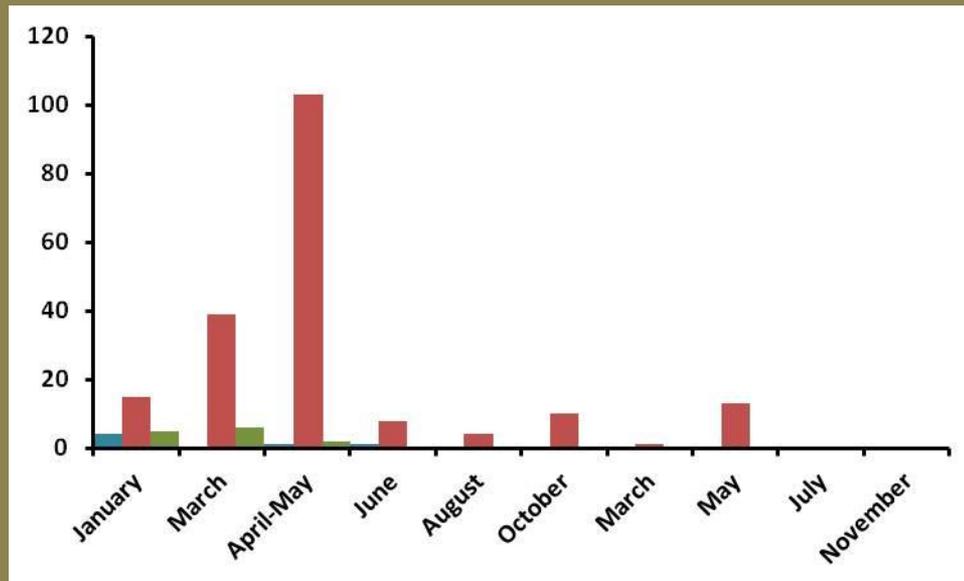
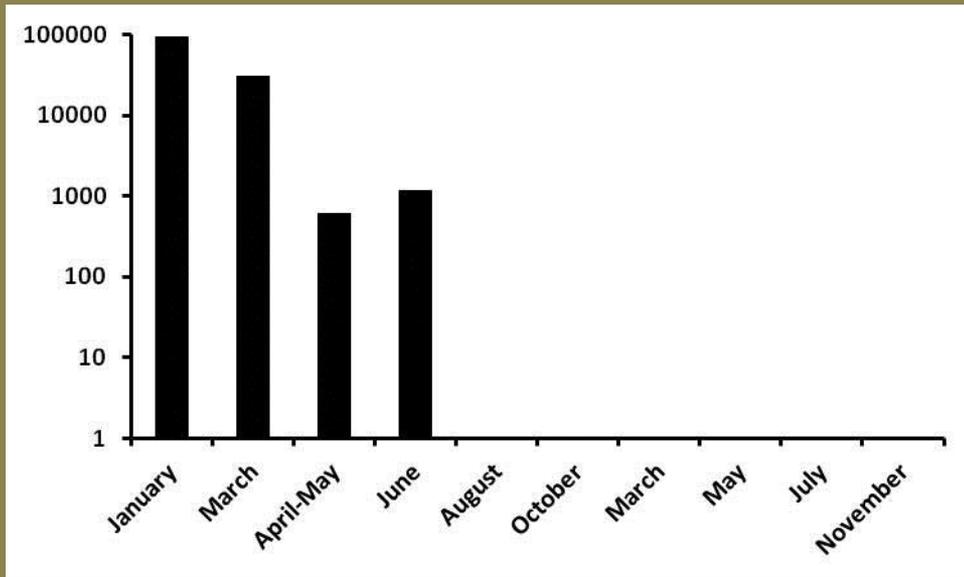
**Time activities to increase likelihood of success**

# Maximize efficiency

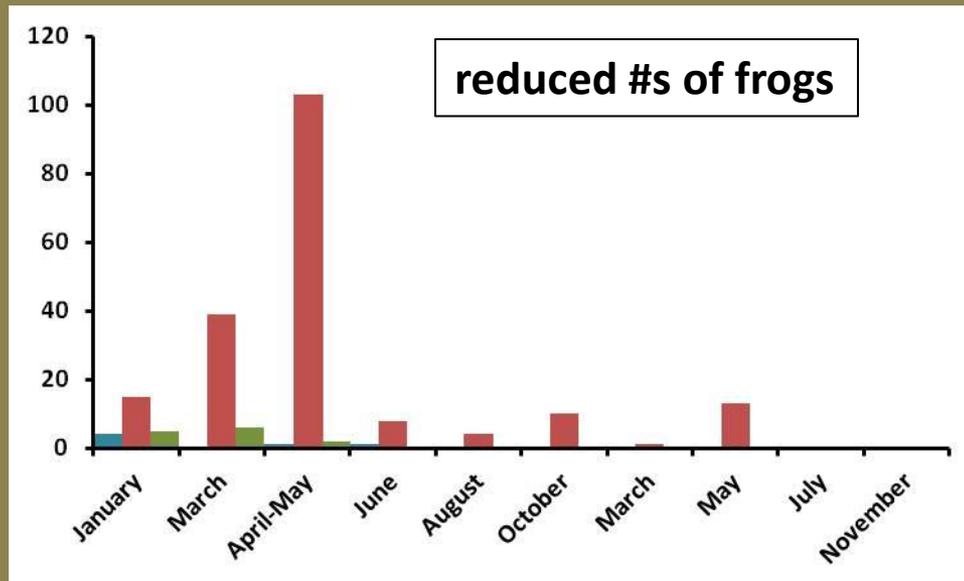
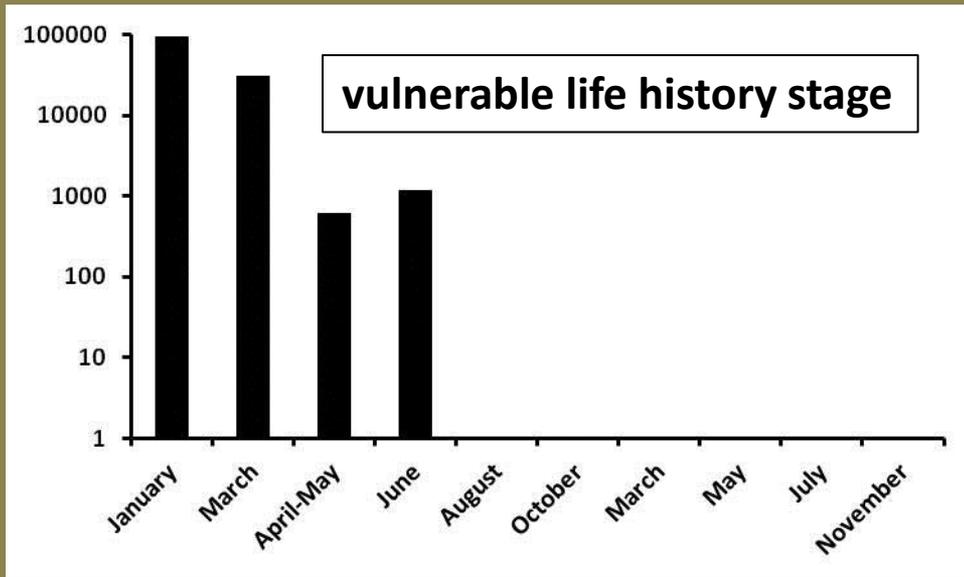


**Time activities to increase likelihood of success**

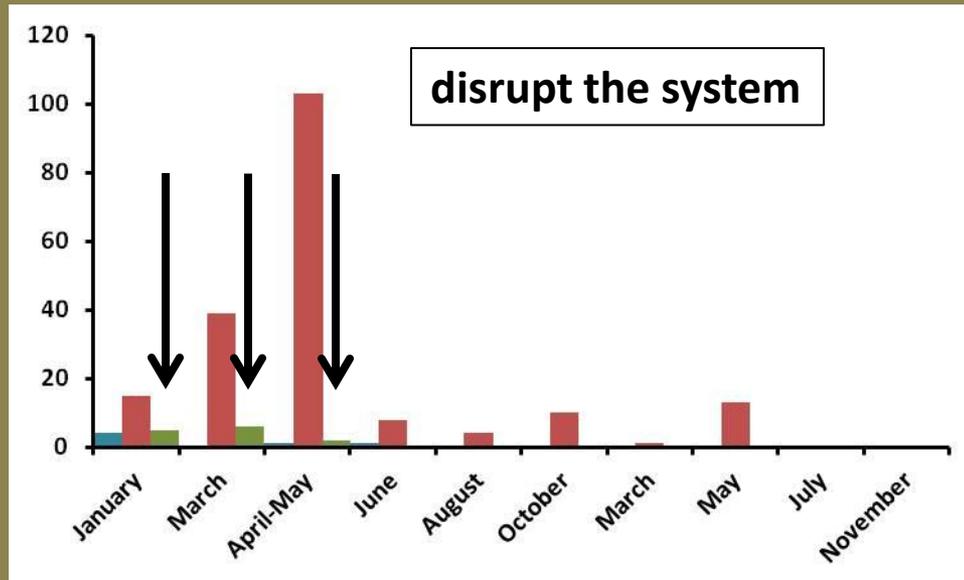
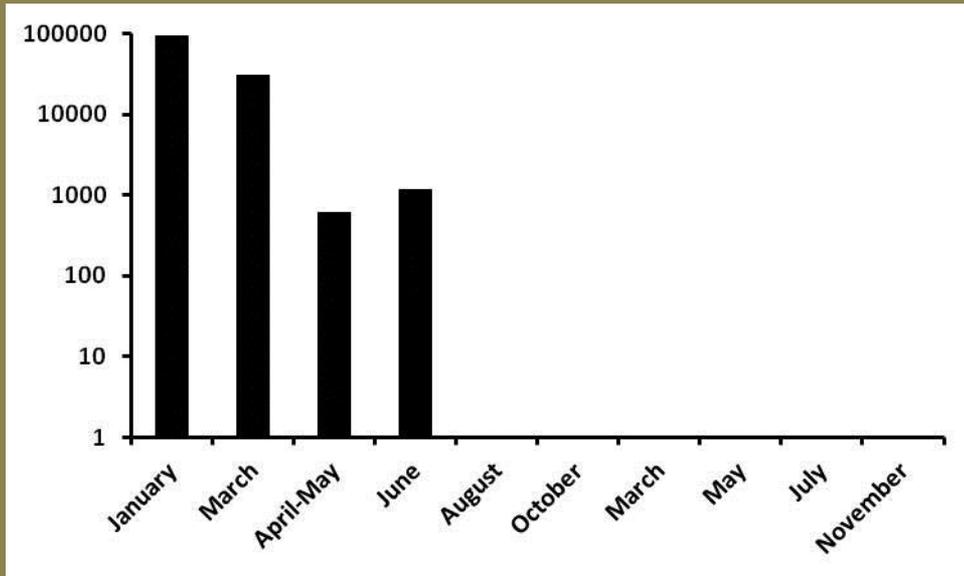
# Frog Tank 2009 - 2010



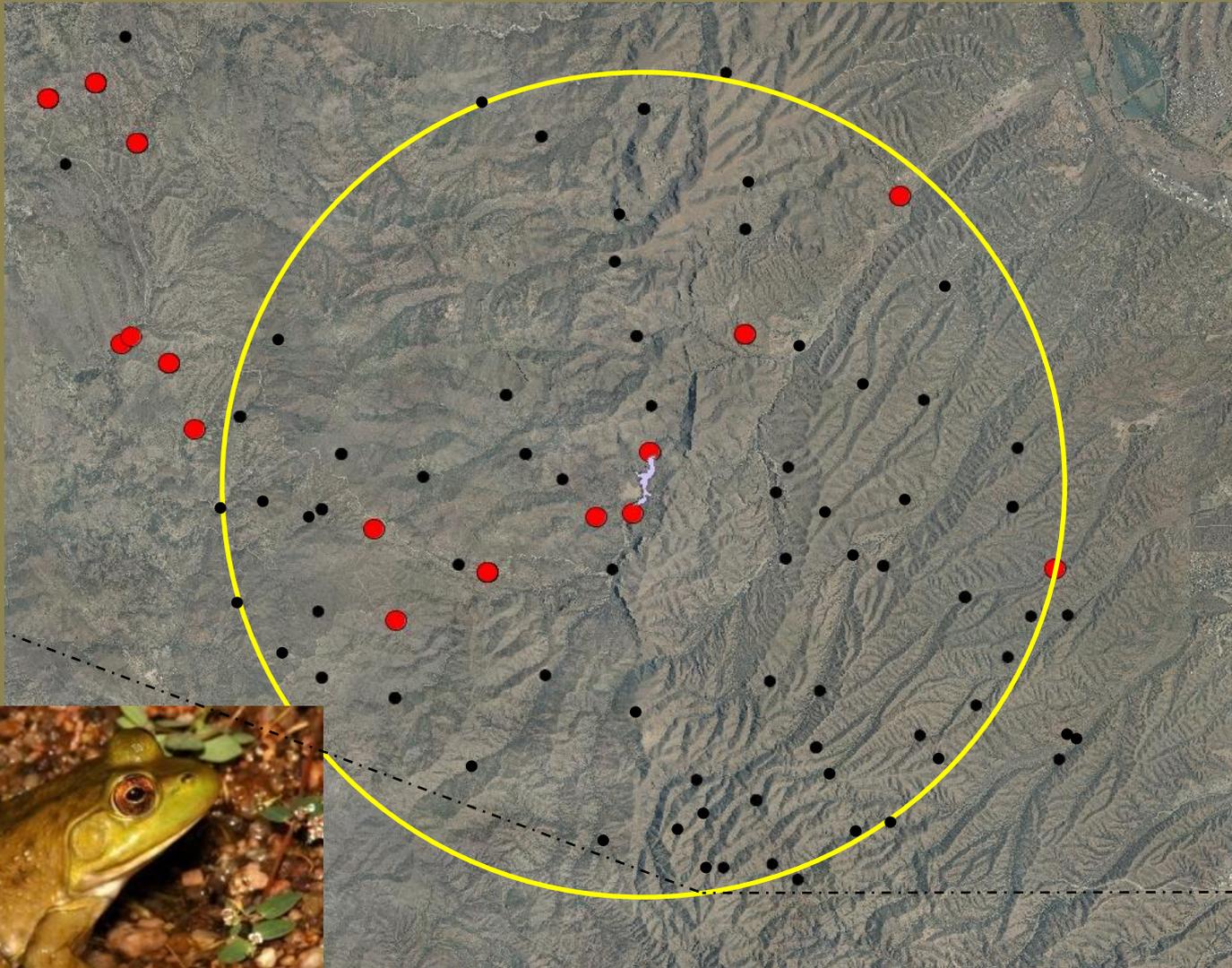
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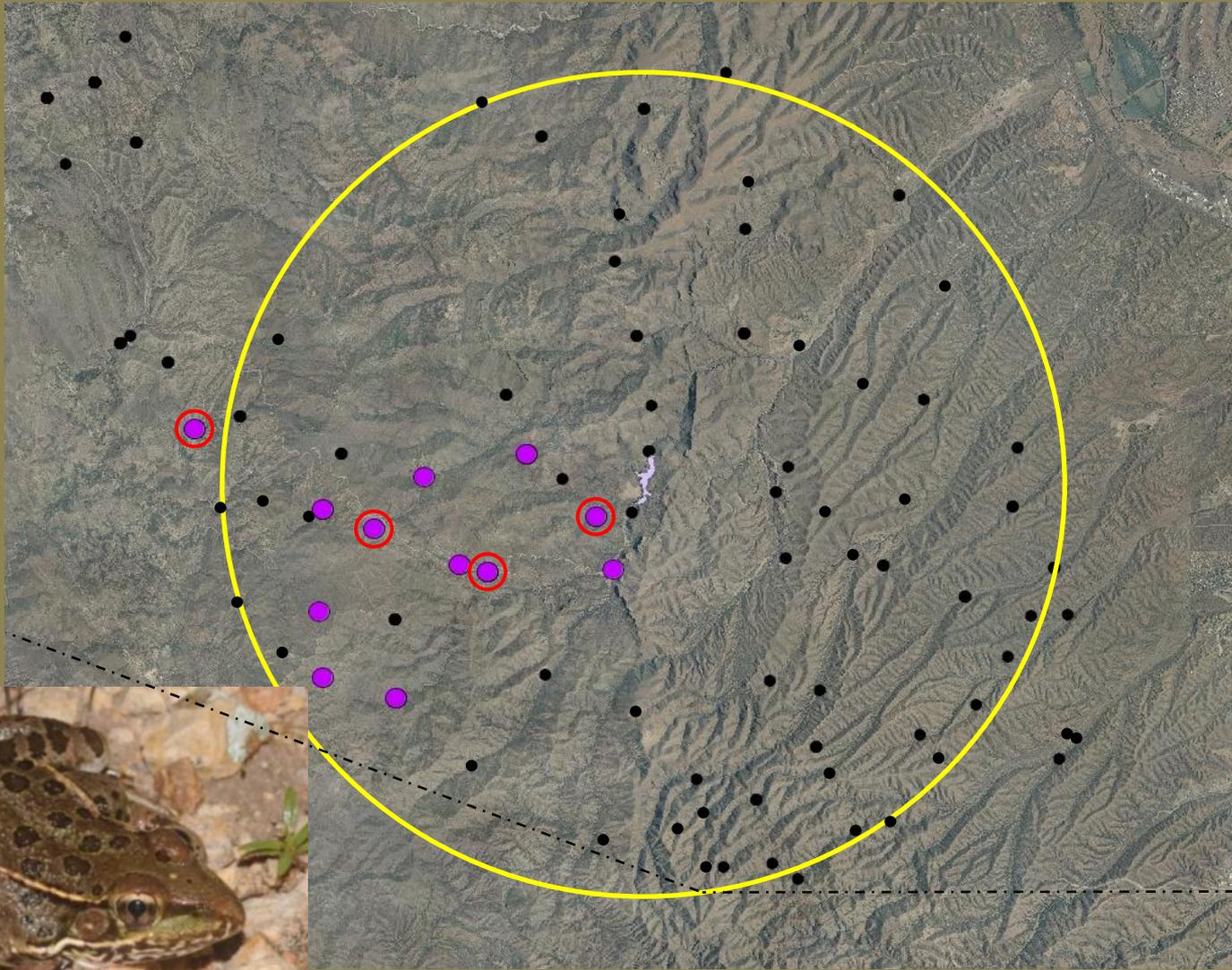
*L. catesbeianus*  
pre-removal



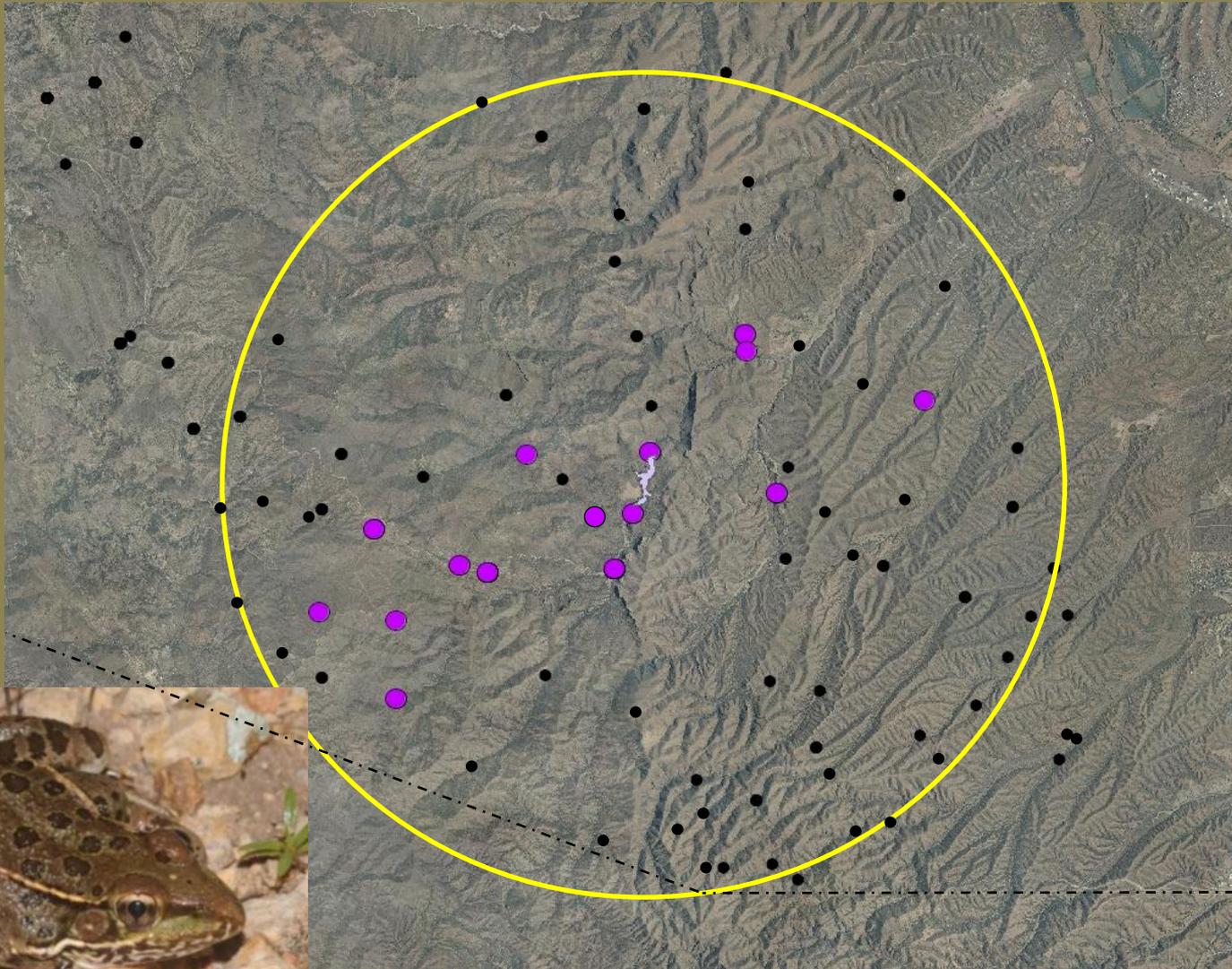
*L. catesbeianus*  
post-removal



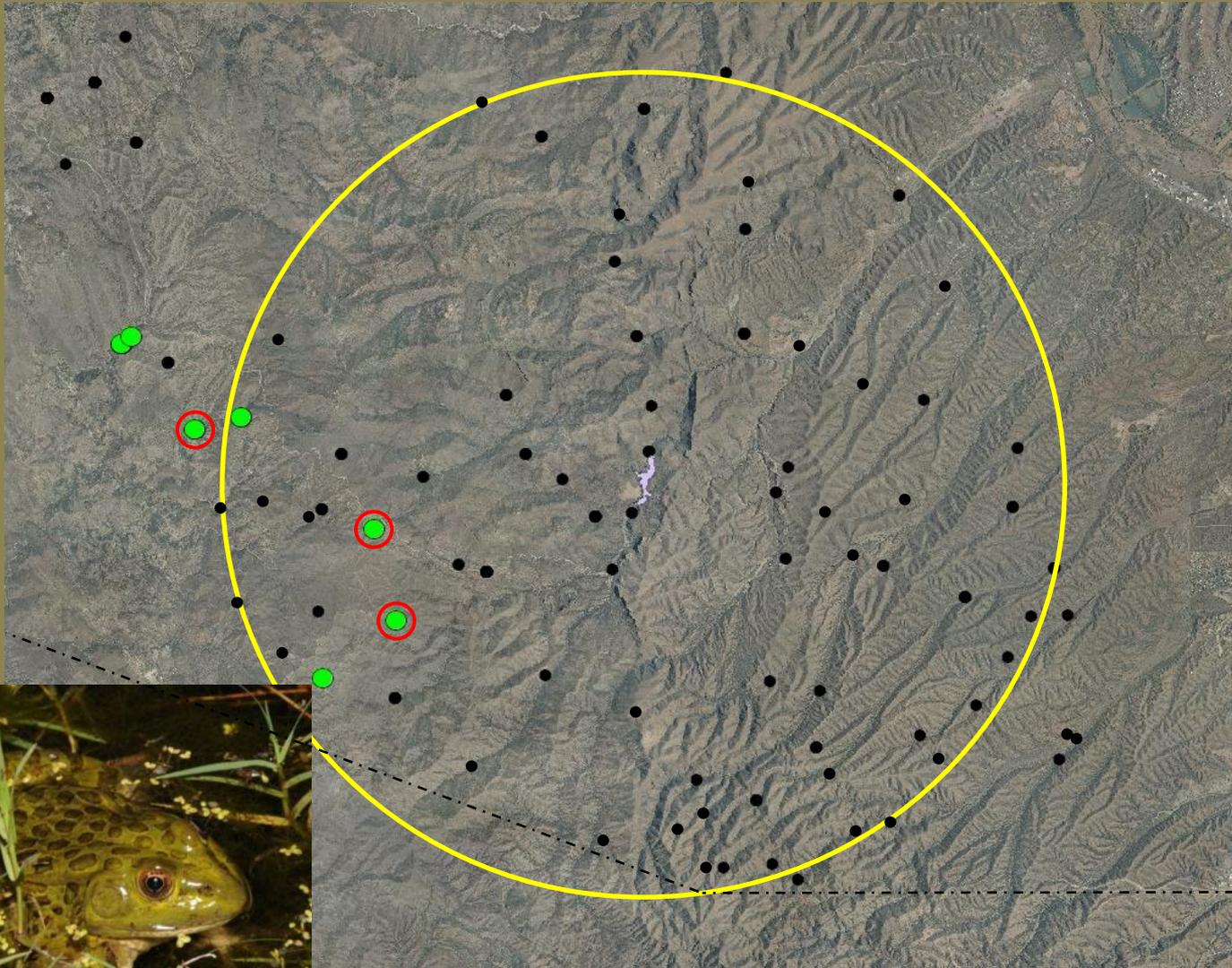
*L. yavapaiensis*  
pre-removal



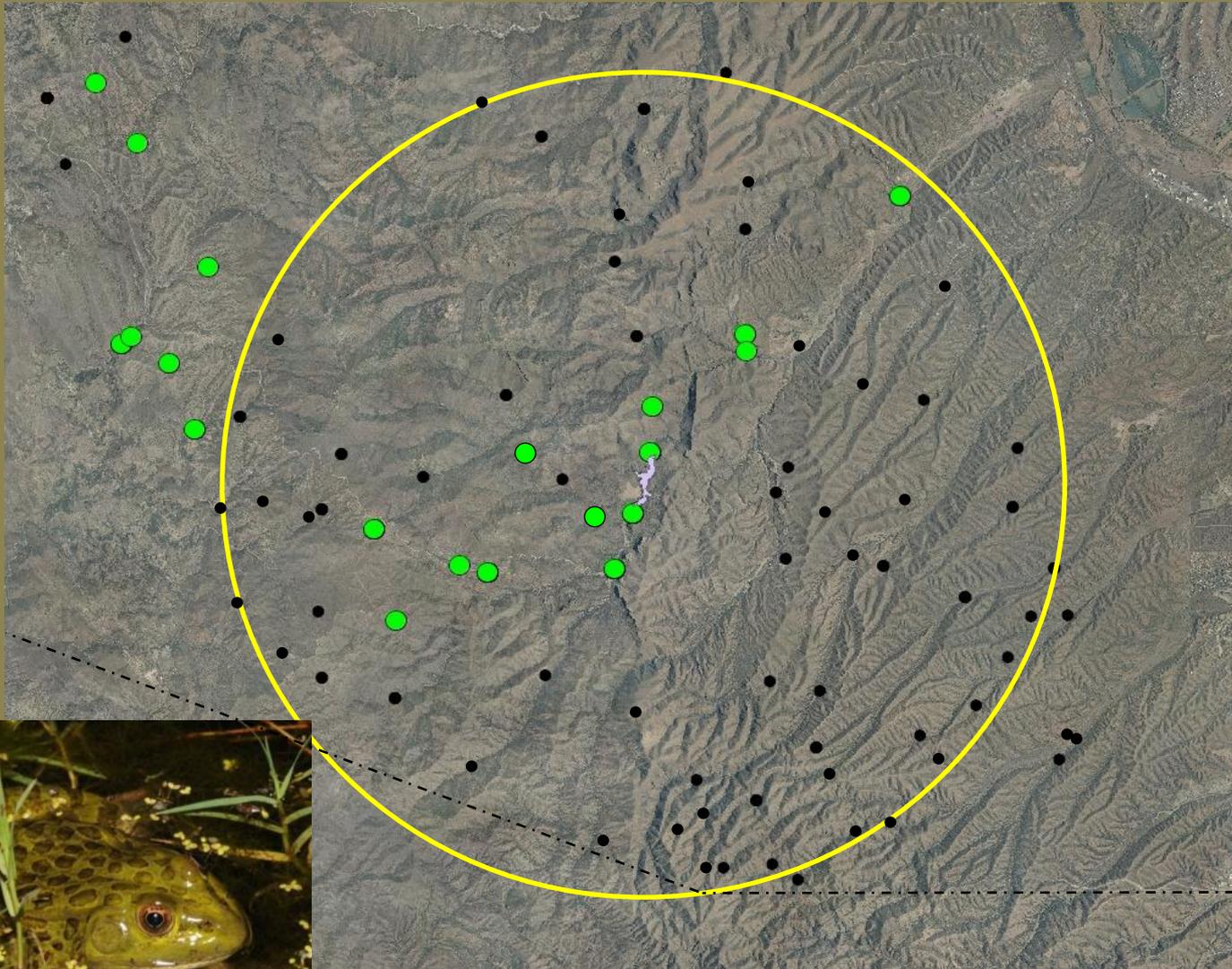
*L. yavapaiensis*  
post-removal



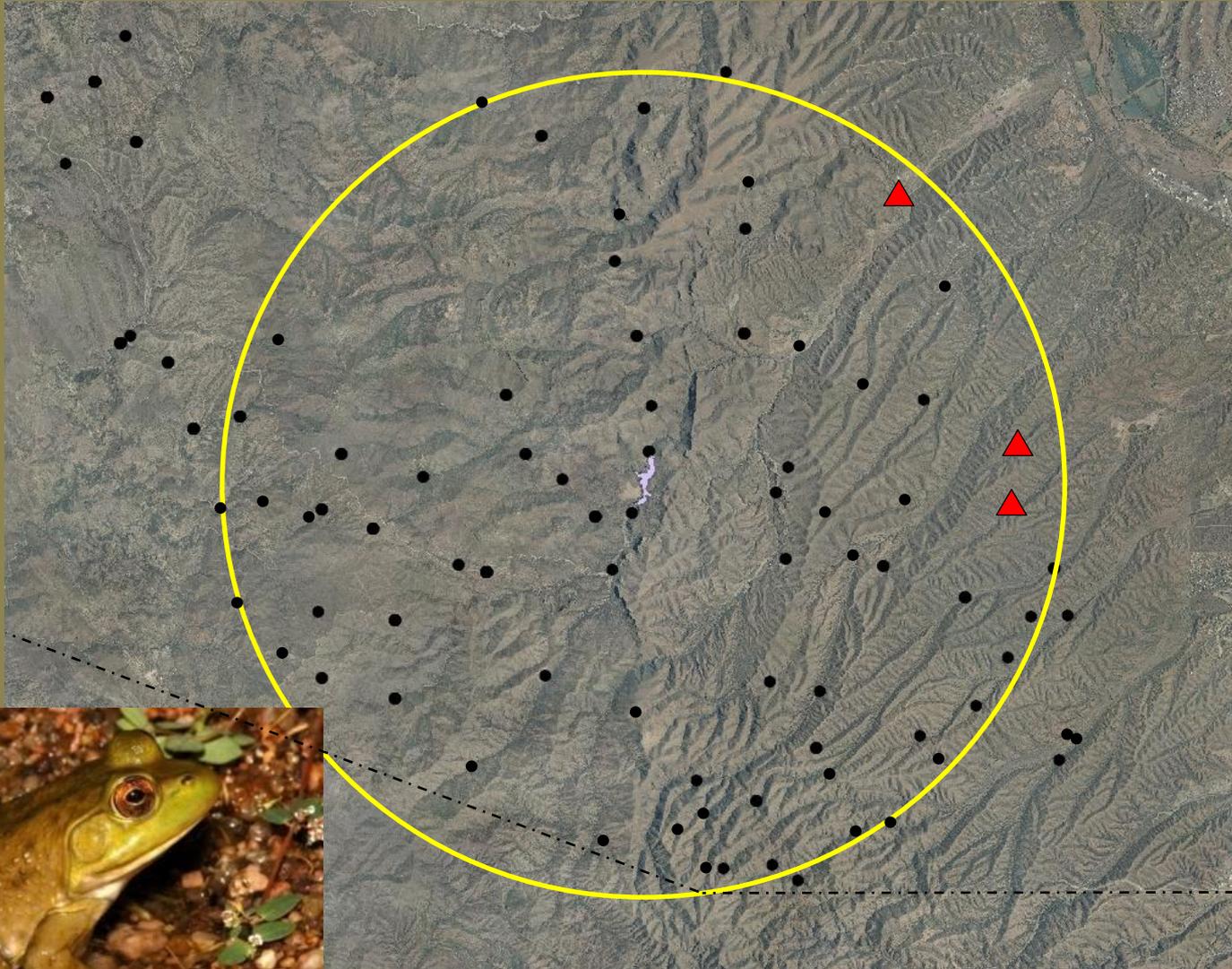
# *L. chiricahuensis* pre-removal



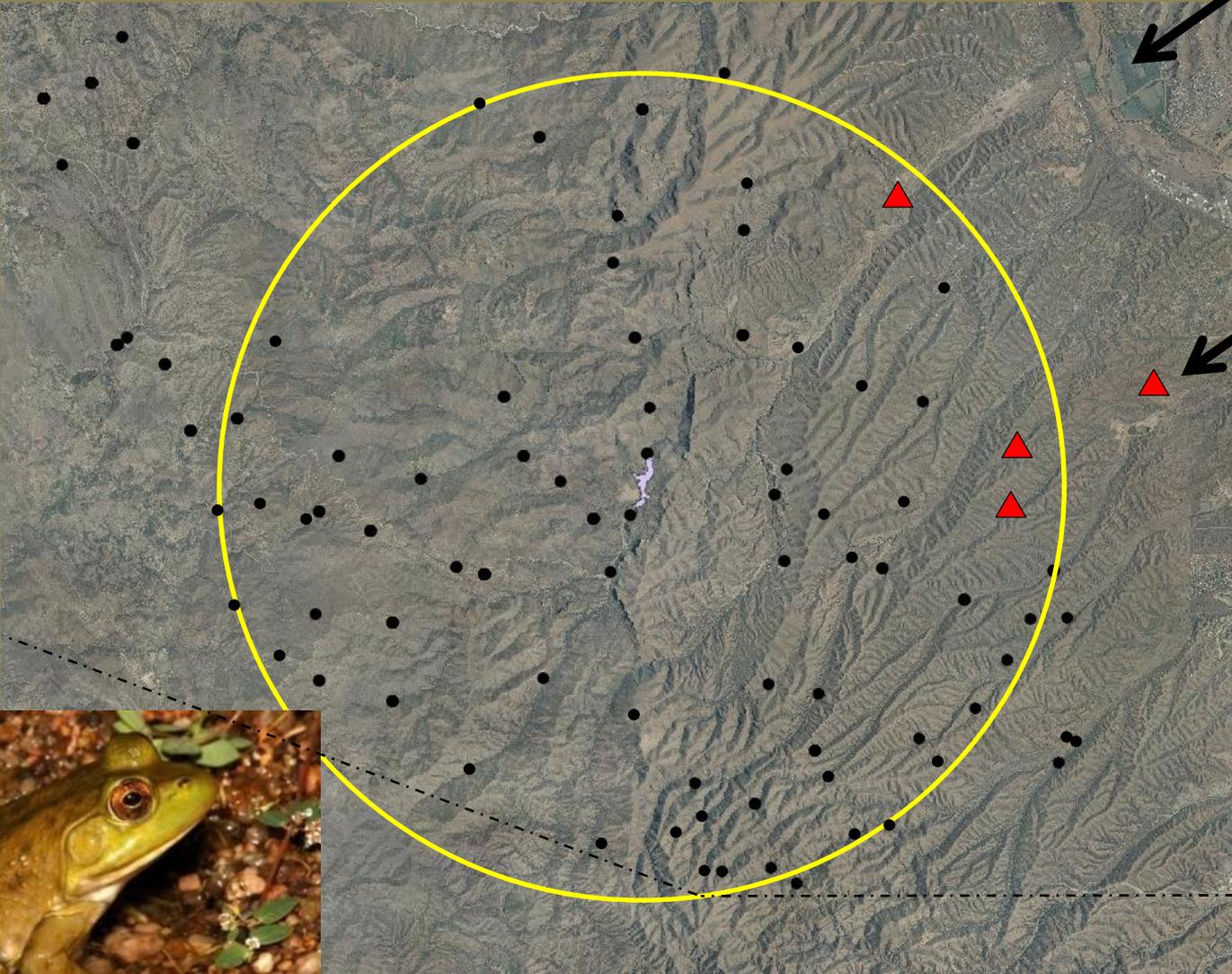
*L. chiricahuensis*  
post-removal



*L. catesbeianus*  
post-removal monitoring



*L. catesbeianus*  
post-removal monitoring



source ?

source



How do we estimate “cost” of bullfrogs??  
...cost of removal vs. cost of status quo

**An ounce of prevention or a pound of cure:  
bioeconomic risk analysis of invasive species**

Brian Leung<sup>1\*</sup>, David M. Lodge<sup>1</sup>, David Finnoff<sup>2</sup>, Jason F. Shogren<sup>3</sup>,  
Mark A. Lewis<sup>4</sup> and Gary Lamberti<sup>1</sup>

*Proc. R. Soc. Lond. B* (2002) 269, 2407 - 2413

“...bioeconomic cost–benefit analysis of non-indigenous species can strengthen the rationale for actions that achieve environmental goals...”



“Part of the problem is that...sometimes we’ll make mistakes as conservation biologists... but...to take no action, to be afraid of the risk and to take no action is worse and is actually kind of cowardly. It’s safer...but it’s cowardly.”

Harry Greene  
The Natural Histories Project

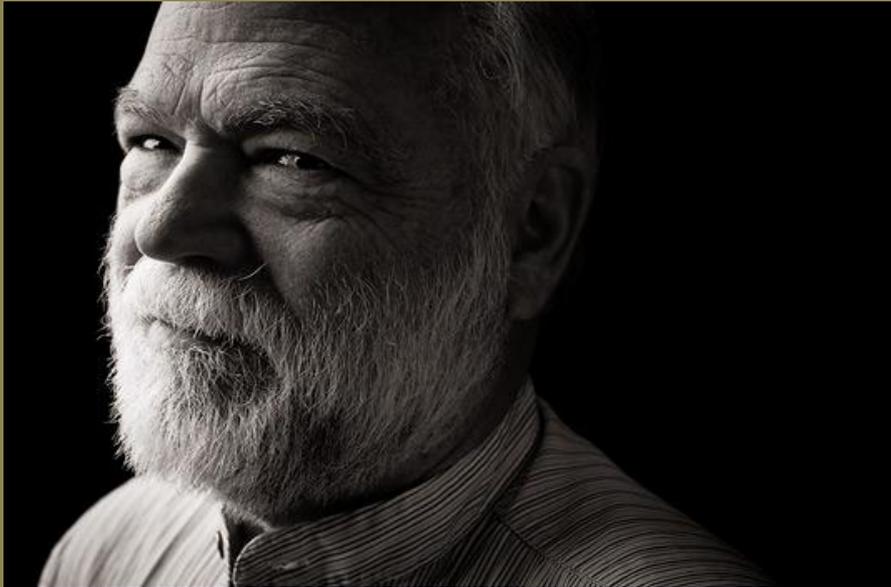


photo: The Natural Histories Project