Name_____

Changing Planet: Disappearing Lizards

Background

Food chains and food webs give us an overall picture of how an ecosystem works, but usually this picture only includes the organisms, and leaves out the abiotic factors that have a strong influence on the health of an ecosystem. Ecosystem components such as temperature, winds, moisture, light, and other non-living chemical and physical factors in the environment play an important role in the success of an ecosystem since all the organisms living an ecosystem have evolved to survive in particular abiotic conditions. Should those conditions change in any way, extinction may threaten a species. For example, lizards rely on the warmth of the day to raise their body temperatures from the cooler night, and if the temperatures end up being too warm, the lizards will seek shelter, thus limiting the amount of time they have to forage for food or to mate. In this all-too-typical scenario happening around the world, lizard populations cannot survive. In this activity you will explore the innate characteristics of lizards that make them susceptible to extinction on a warming planet.

Lesson Focus Questions

What characteristics of lizards make them susceptible to warming climates? If lizards are removed from a food web, what are the resulting impacts on the ecosystem?

Part I:

Read the AAAS news release entitled "As Global Temperatures Rise, the World's Lizards Are Disappearing" and answer the questions below.

1. What do scientists believe caused 12% of Mexico's lizard population to go extinct?

2. What percentage of the population may go extinct by 2080? _____

3. On what evidence do scientists base their beliefs?

4. Lizards seem to like sunshine and being warm, so what is the issue for lizards if global temperatures rise?

5. Why does the article state that "it does appear that lizards have crossed a threshold for extinctions—and that their sharp decline will continue for decades at least?"

6. Describe the methods used by Dr. Sinervo and his colleagues to create a model that studies the effects of global warming on lizard populations.

7. What is the relationship between the quantity of carbon dioxide in the atmosphere and the rate of lizard extinctions? Even if we reduce the amount of carbon dioxide in the atmosphere, will lizard populations continue to be affected? Explain

8. How did these scientists come to realize that this is a global issue and not a problem in just one country?

9. How did Dr. Sinervo test his model?

10. Describe the effects of warmer temperatures on the behaviors of a lizard. How do they adjust? What are the implications of these compensating behaviors and how does this lead to extinction of the species?

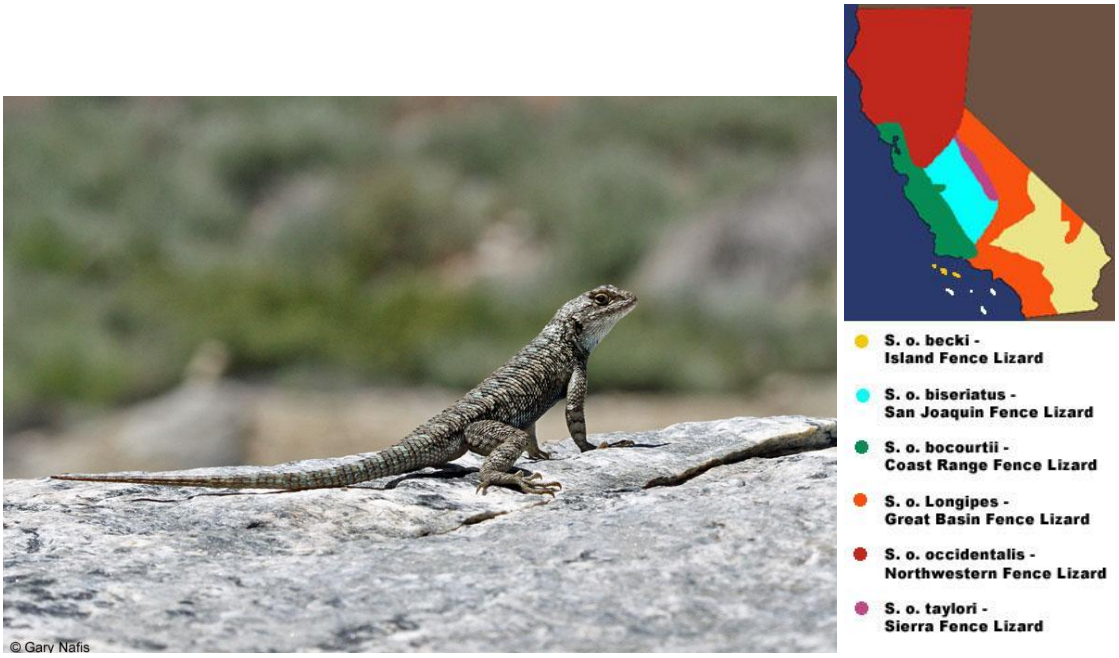

Figure 1: Adult male Sceloporus occidentalis longipes - Great Basin Fence Lizard, and a range map for the Great Basin Fence Lizard (http://www.californiaherps.com/lizards/pages/s.o.longipes.html)

Part II:

Important Terminology

Use reference books or scholarly websites on the Internet to define these terms related to lizards and ecology:

Term	Definition
Viviparous lizards	
Oviparous lizards	
Heliotherm lizards	
Thermoconform lizards	
Behavioral plasticity & Physiological plasticity	
Thermal Limit	
Adaptation	
Competitive Exclusion	

Lizard Lifestyles: Lizard extinctions occur more rapidly in certain species. Working with a partner and using the definitions from above, choose one of the 2 traits of a lizard that you think makes lizards more susceptible to extinction caused by global warming, explain why, and decide what evidence you need to support your claim. Place all your responses in the table below.

Trait Choice	Of the 2 traits, the more susceptible trait that would lead a lizard species to extinction because of global warming is….	I think this trait makes a lizard more susceptible to extinction caused by global warming because…	The evidence I need to support my claim is…. or A possible research study I could do is….
Viviparous or Oviparous?			
Heliotherms or Thermal conformers?			
Lives in a Low Latitude or High Latitude?			
Lives at a Low elevation or High elevation?			

Part III:

Now we will investigate additional characteristics of lizards that place them at the brink of extinction on a warming planet. Read and summarize the content of the following excerpt from Dr. Sinervo and colleagues' paper (2010):

> "Although *Sceloporus* lizards are heliotherms that bask and require solar radiation to attain physiologically active body temperatures (T_b), activity in hot weather may result in T_b exceeding CTmax, the critical thermal maximum, leading to death. Lizards retreat to cool refuges rather than risk death by overheating. However, hours of restriction (h_r) in thermal refuges limit foraging, constraining costly metabolic functions like growth, maintenance, and reproduction, there by undermining population growth rates and raising extinction risk. Lizards could evolve higher T_b, but this brings them closer to CTmax, which increases risk of overheating. Extinction risk may increase because of other thermal adaptations. For example, viviparity, which is posited to be a thermal adaptation to cold climates, may elevate extinction risk because high T_b can compromise embryonic development in utero." (Sinervo, et al, 2010)

Use the information in above paragraph to analyze the following images:

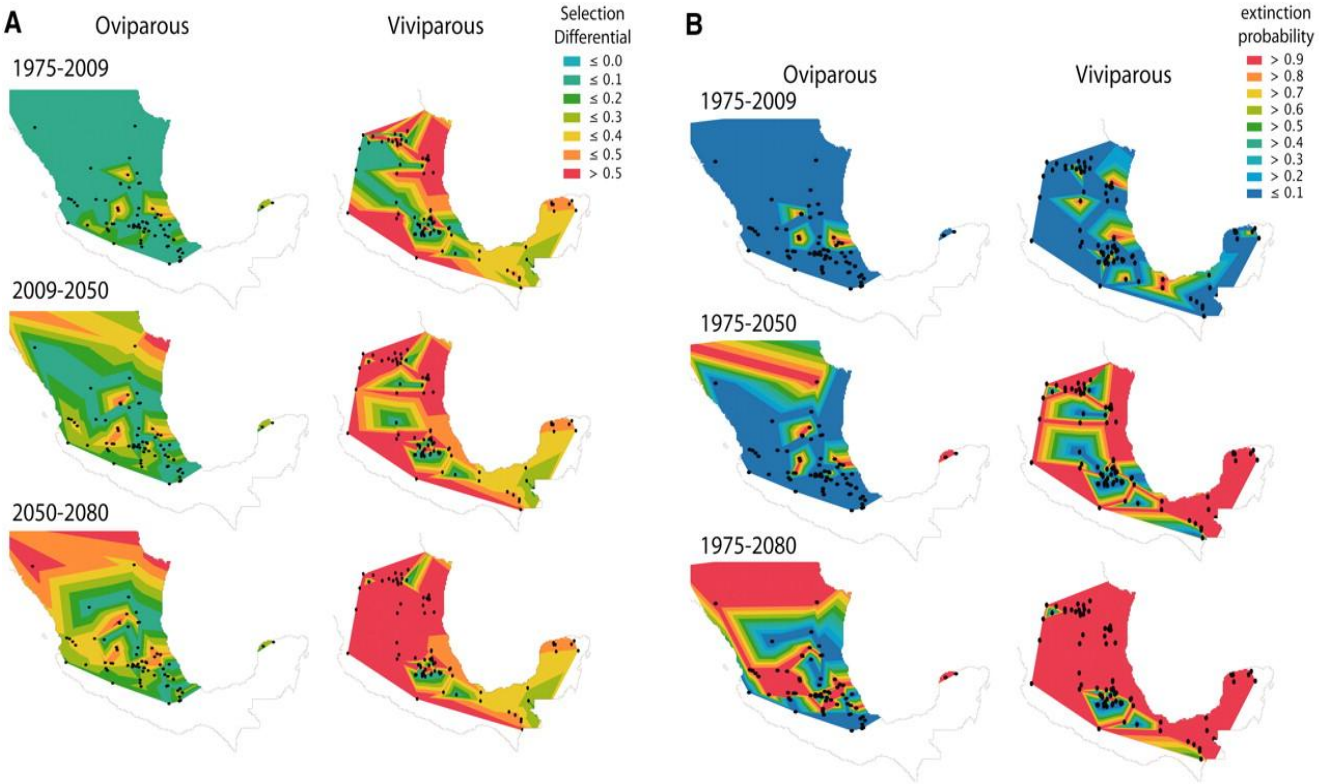

Figure 2: A. Sustained selection differentials per year required for T_b to keep pace with global warming. B. Extinctions of Mexican Sceloporus lizards (1975 to 2009, 2009 to 2050, 2050 to 2080). (from Sinervo, et al, 2010)

1. From Figure 2.A., which lizards, oviparous or viviparous, have a more difficult time genetically adjusting to warming climates in Mexico?

2. Refer to a physiographic map of Mexico along with Figure 2.A. and combine elevation with your explanation to the above question.

3. What is the relationship between selection differential and extinction probability? What does this suggest about the effectiveness of natural selection in preventing the *Sceloporus* species from going extinct?

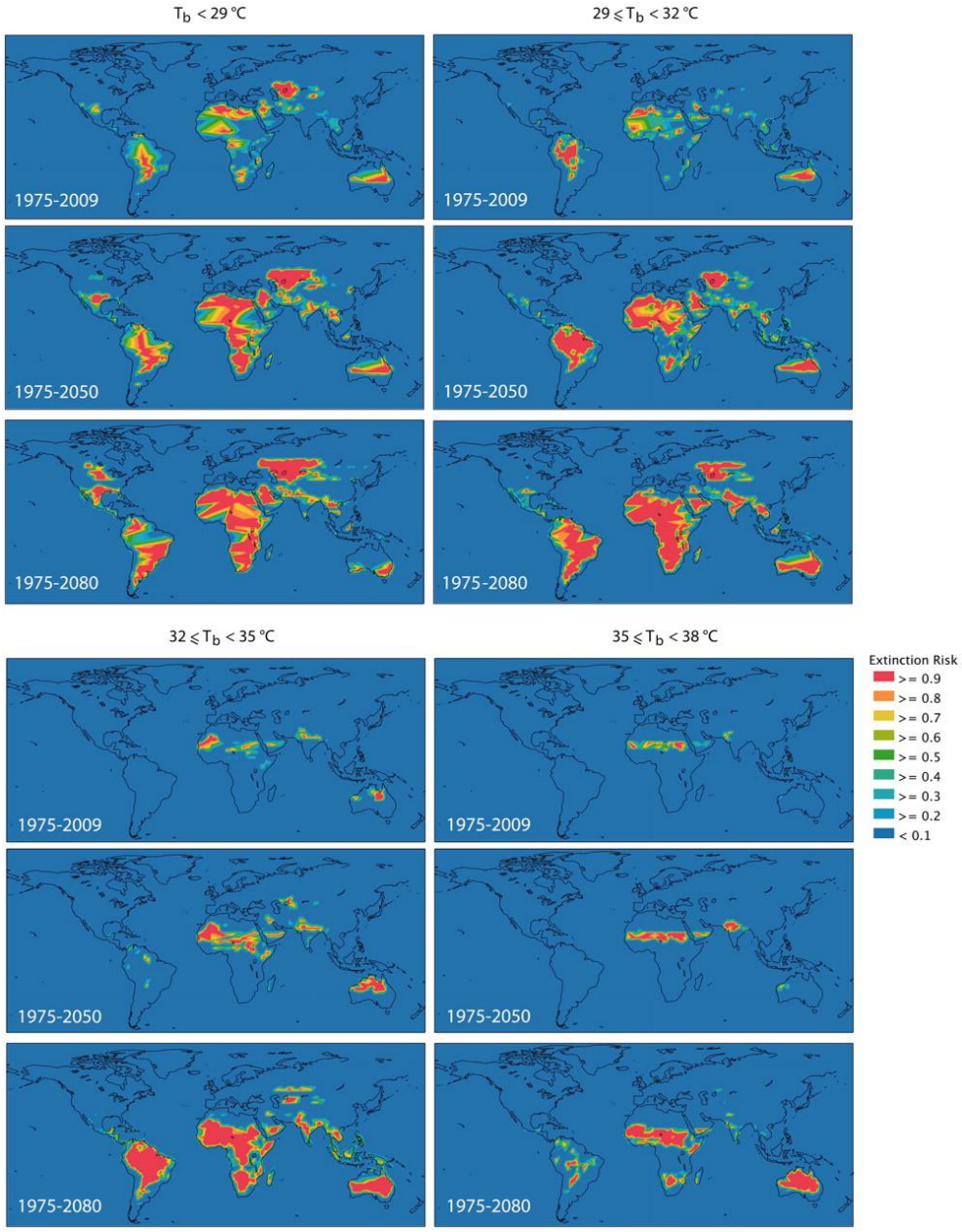

Figure 3: Contour plots of global levels of local extinction for heliothermic lizards (1975 to 2009, 1975 to 2050, 1975 to 2080), assuming $h_r = 4.55$ and various T_b values. (from Sinervo, et al, 2010)

4. Figure 3 refers to heliothermic lizards and assumes hours of restriction to be 4.55 which is greater than the ideal maximum hours of restriction of less than 3.85 (Sinervo, et al, 2010). Which physiologically active body temperatures (T_b) is at a higher risk of extinction?

5. Dr. Sinervo describes the extinction of lizards as "canaries in a coal mine" when discussing global warming. What does he mean by this statement?

6. Dr. Sinervo and his colleagues link the extinction rate and global warming to rising carbon dioxide levels in the atmosphere. Refer back to the press release and describe the impacts of reducing atmospheric carbon dioxide on the extinction rates of lizards.

Part IV:
Lizards play a vital role in the local food webs in which they live. Select a California or Mexican lizard species and use the space below to create a before and after extinction food web for the location in which the lizard lives.

Before Picture:

After Picture:

Conclusion:
With the exception of Alaska, ecosystems in every U.S. state have native lizard species playing a role in their local food webs. Use the Internet and state resources to research one species that lives in your state. Describe the ideal habitat for the lizard (include biotic and abiotic components), and project what would happen to the species and the local food web should global temperatures rise as predicted.

One lizard species living in my state: _____

Ideal habitat:

Food Web role:

Implications of global warming on the lizard species and the local food web:

Reference:
Barry Sinervo, Fausto Méndez-de-la-Cruz, Donald B. Miles, Benoit Heulin, Elizabeth Bastiaans, Maricela Villagrán-Santa Cruz, Rafael Lara-Resendiz, Norberto Martínez-Méndez, Martha Lucía Calderón-Espinosa, Rubi Nelsi Meza-Lázaro, Héctor Gadsden, Luciano Javier Avila, Mariana Morando, Ignacio J. De la Riva, Pedro Victoriano Sepulveda, Carlos Frederico Duarte Rocha, Nora Ibargüengoytía, César Aguilar Puntriano, Manuel Massot, Virginie Lepetz, Tuula A. Oksanen, David G. Chapple, Aaron M. Bauer, William R. Branch, Jean Clobert, and Jack W. Sites, Jr. Erosion of Lizard Diversity by Climate Change and Altered Thermal Niches**.** *Science*, 2010; 328 (5980): 894-899