EFFECTS OF BURNING ON RELATIVE ABUNDANCES AND MORPHOLOGICAL CHARACTERISTICS OF GREEN TREE FROG (*HYLA CINEREA*) IN TEXAS

An Undergraduate Research Scholars Thesis

by

THANCHIRA SURIYAMONGKOL

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ABSTRACT

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Thanchira Suriyamongkol
Department of Wildlife and Fisheries Science
Texas A&M University

Research Advisor: Dr. Hsiao-Hsuan Wang
Department of Wildlife and Fisheries Science

Wildfires are natural phenomena that can impact native fauna by altering their habitats. In 2011, a large wildfire occurred in 2011 near Bastrop, Texas. Bastrop area is known for its famous Lost Pines region which is a house of many wildlife species including tree frogs. Unfortunately, much of its Lost Pines habitats was destroyed, as a result of wildfire, and will take years to recover. The objective of this study is to compare the relative abundances and morphological characteristics of green tree frogs (*Hyla cinerea*) in burned areas with those in unburned areas near Bastrop to assess the effect of these fires on green tree frog populations in the area. I will analyze unpublished field data on green tree frogs provided by colleagues at Texas State University. I will test the null hypothesis of no difference in abundances of green tree frogs in burned versus unburned habitats; I expect more green tree frogs in unburned areas.

CHAPTER I

INTRODUCTION

Amphibians are important components of ecosystems throughout the temperate and tropical regions of the world (Halliday, 2008). They are considered as both predator and prey, and the cumulative biomass of amphibians suggests that they have key roles in community structure (Francesco Ficetola and De Bernardi, 2004), energy flow (Regester et al., 2006), and nutrient cycling (Beard et al., 2002). However, populations of many amphibian species are declining in various regions of the world (Becker et al., 2007) due to numerous factors such as global climate change, pollution, ultraviolet radiation (Wyman 1990), and habitat loss (Becker et al., 2007).

Wildfires are important in shaping amphibian populations (Hossack and Pilliod 2011). Different amphibian species may react differently to wildfires (Hossack and Pilliod 2011). Fires can trigger reproduction of some species such as tailed frog (*Ascaphus truei*) (Sánchez Alfaro et al., 2015), but cause destruction and loss of another species (Nkwabi et al., 2011). Low-severity fire also helps maintaining suitable habitat conditions for many species (Hossack and Pilliod 2011). Some of the amphibian species benefit from the fragmented area created by wildfires as it mimics an early-successional environment (Semlitsch et al., 2009). Yet, not all of the stages of amphibian life cycle are able to survive this change. For example, adult stage of some species that inhabits trees, such as grey tree frog (*Hyla versicolor*), need a habitat that is far developed into mid- or late- successional stage

(Semlitsch et al., 2009). On the other hand, the larval stage would benefit from post-fire pools that occur in the clear-cut areas (Semlitsch et al., 2009).

Nevertheless, the benefits that the larval stages of some species get from the habitat created by wildfire do not guaranty the survival of the population in the particular areas (Semlitsch et al., 2009). Based on a study of Semlitsch, there are three hypotheses that could be used to explain the possible decline of the amphibian species after disturbances (Semlitsch et al., 2009). Firstly, the mortality hypothesis assumes that the population would decline in the disturbed area due to the lack of food and refuge, desiccation, and inability to move out of the area (Semlitsch et al., 2009). A large portion of the population, especially small juveniles, was found dead in the clear-cut areas (Semlitsch et al., 2009). Secondly, the evacuation hypothesis assumes that the population move to the nearby forests (Semlitsch et al., 2009). Lastly, the retreat hypothesis assumes that the population is still in the disturbed area; however, they move into more suitable underground habitats and will reemerge as the forest goes through successional period (Semlitsch et al., 2009). To predict the effects of wildfire on a species, it is necessary to know the abilities of each species' survival chance in the fires due to their life history characteristics and their history with wildfires (Hossack and Pilliod 2011).

In September 2011, a large wildfire occurred near Bastrop in the Lost Pines area, located in central Texas (Brown, Swannack et al. 2011). This area is composed of sandy soils with many drought-resistant species of plants, notably loblolly pine (*Pinus taeda*) (Rissel and Ridenour, 2013). It also contains variety of herpetofaunal species including five species of lizards, three species of turtles, 15 species of snakes, 12 species of amphibians, and Houston toad (*Bufo houstonensis*), the endangered species (Brown, Swannack et al. 2011). The fire started during a drought year and was fanned by strong winds from Tropical Storm Lee (Justice, 2014). It destroyed 39% of the 34,400 ha of the Lost Pines forests and 96% of the area within Bastrop State Park (Brown et al., 2014). The original environmental setting of Bastrop forest was disturbed after the fire. Hence, I have chosen green tree frogs as my focal species to access the impacts of the wildfire in the Bastrop area.

Green tree frogs (*Hyla cinerea*) are an arboreal species commonly found in natural and suburban areas (Pham et al., 2007). They reside in shrubby vegetation, breed in permanent ponds and marshes, and do not disperse far from water (Pham et al., 2007). According to The Virginia Herpetological Society, Green Tree Frog possesses limitation in their habitat types (n.d.). This species needs habitats with well water supplies and high density of shrubs and it prefers floating and emergent vegetation ("Reptiles and Amphibians of Virginia", n.d.). Green tree frog prefers open area of the forest. According to a study on abundance of green tree frog in artificial canopy gaps, 88% of green tree frogs were found in the area of open canopy (Horn et al, 2004). Green tree frogs are not a keystone species; however, they play a role in controlling populations of mosquitoes and other insects in the ecosystem (Ritchie and Montague, 1995). Even though this species does not show a range-wide decline, previous studies have shown that green tree frog populations have disappeared or declined where wetland and associated upland habitat loss has occurred (Lu et al., 2015). Therefore, green tree frogs present an optimal model species for testing the effects of wildfire on local amphibian populations.

CHAPTER II

METHODS

Study area

Our study area is located at the Griffith League Ranch (GLR), Bastrop, Texas, which is located in the range of Bastrop wildlife in 2011 (see figure 2). The ranch is approximately 1948 ha; however, as a result of 2011 wildfire, 50.7% of the GLR was burned in September and another 4.1% was burned in October (Brown et al., 2014) (see figure 3). GLR is considered a typical Lost Pines forest which composed of loblolly pine (*Pinus taeda*) and mixed with open grassland and deciduous woodland (Forstner, 2004). The overstory is dominated by Loblolly Pine (Pinus taeda), Eastern Red Cedar (Juniperus virginiana), and Post Oak (Quercus stellata), and an understory is dominated by Yaupon Holly (Ilex vomitoria), American Beautyberry (Callicarpa americana), and Farkleberry (Vaccinium arboreum) (Brown et al., 2014). My colleagues at Texas State University conducted surveys at 4 different ponds within the GLR. Pond1 and Pond5 were in the unburned area of the ranch and Pond13 and Pond14 were in the burned area (See figure.1). According to the past surveys on size of the ponds by my colleagues at Texas State University, Pond 1 is the largest pond, then Pond 5, Pond 13, and Pond14, respectively (See table1). During the surveys, they also measured weather conditions including temperature, relative humidity, and wind speed. Based solely on our observation at the time of surveys, temperatures from June to August were in the same range then the temperature dropped as September was approaching (see figure 4), relative humidity was decreasing from June to October (see figure 5), and wind speed varied depending on the day of surveying (see figure 6).

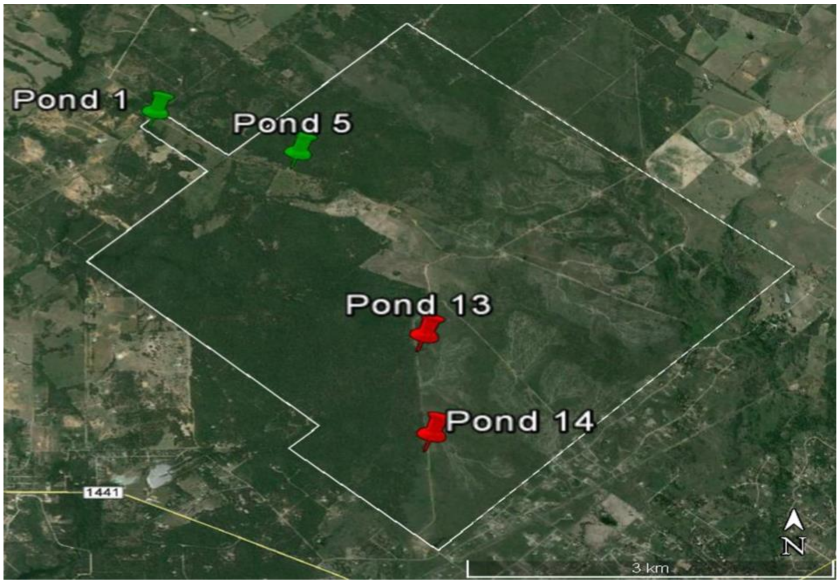

Figure 1. Locations of the study sites on Griffith League Ranch. Pond 1 and Pond 5 are located in an unburned area. Pond 13 and Pond 14 are located in the burned area.

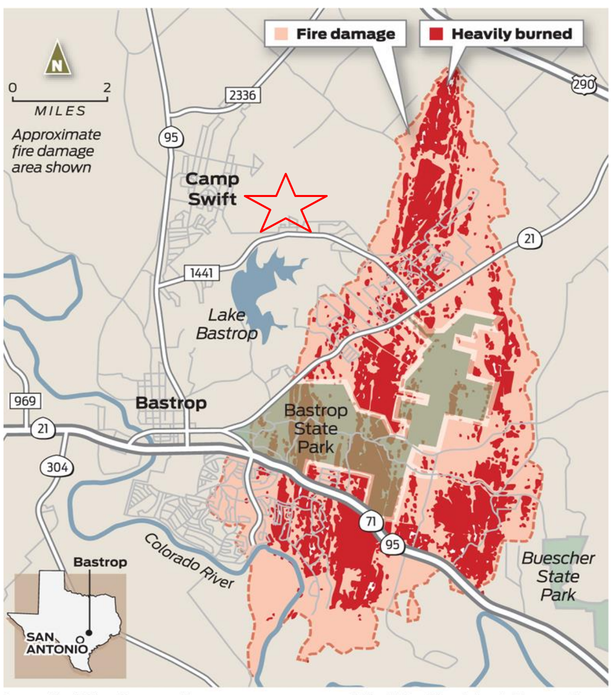

Figure 2. The range of wildlife fire in Bastrop area in 2011 from Mike Fisher, *San Antonio Express-News*;. Red star marks the location of the study site (The Griffith League Ranch).

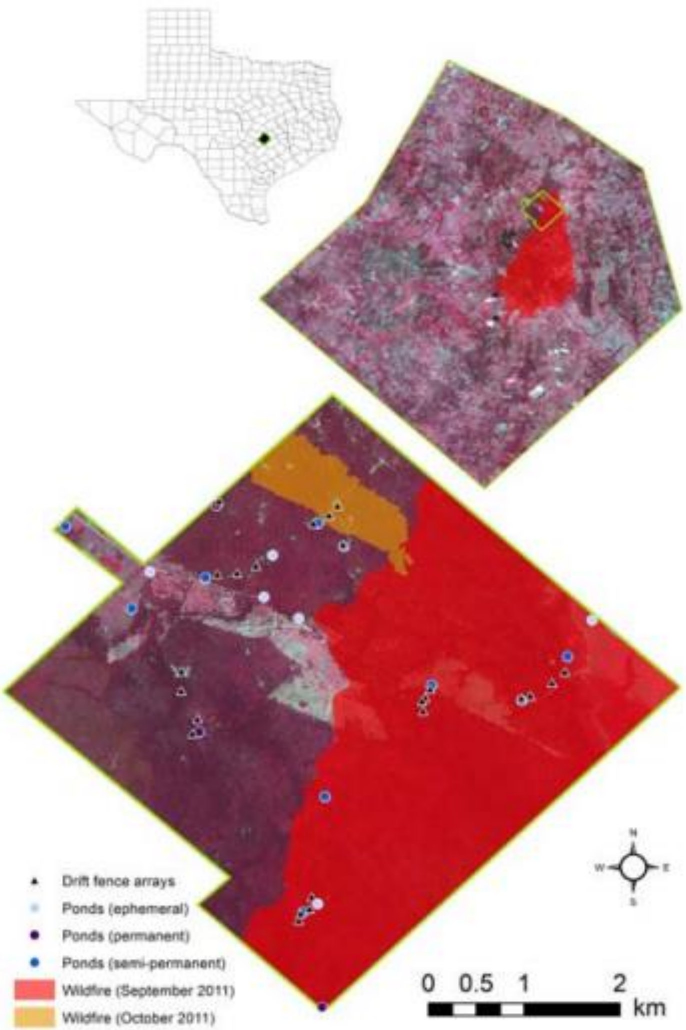

Figure 3. Griffith League Ranch during the wildfire of 2011. The orange area indicates the burned area due to the fire in October 2011. The red area indicates the burned area due to the fire in September 2011 (Brown et al., 2014)

Table 1. Mean and range (in parentheses) of pond characteristics of the two burned ponds and two unburned ponds sampled for *Hyla cinerea*.

Pond Size (m^2)

Burned		Unburned	
Pond13	Pond14	Pond1	Pond5
53.14 (0-310.65)	3.96 (0-46.4)	476.17 (46.03-1221.65)	337.13 (0-855)

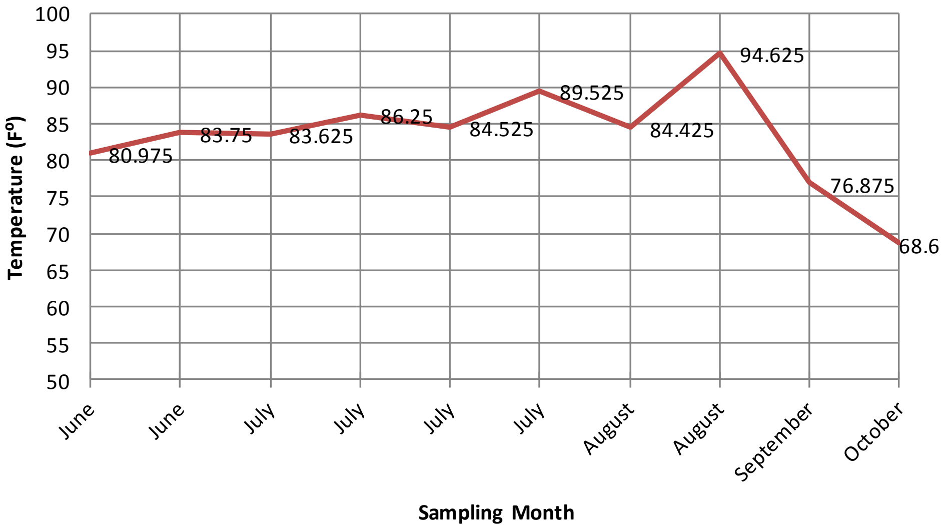

Figure 4. Average temperature (F^0) measured during samplings from June to October

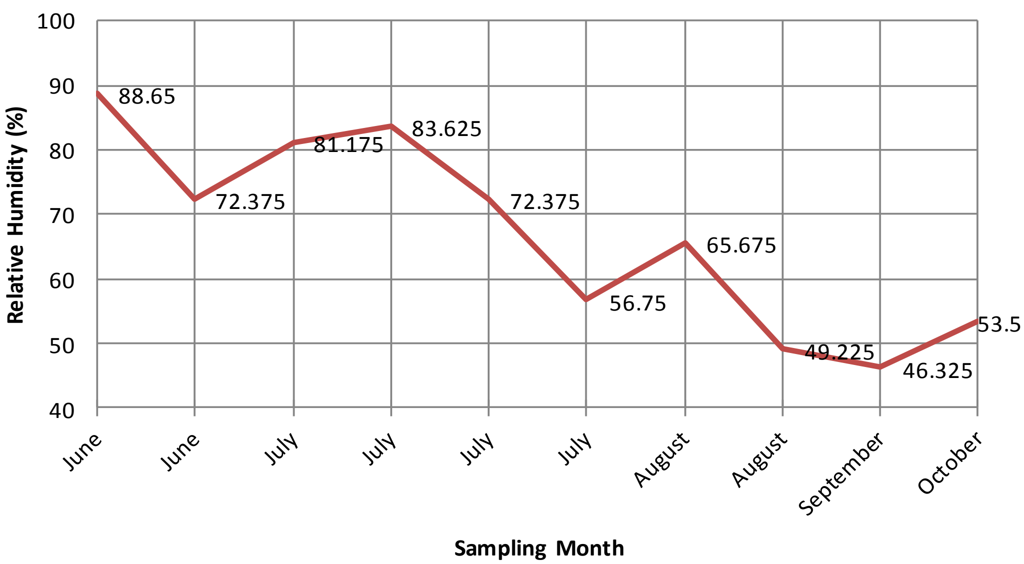

Figure 5. Average relative humidity (%) measured during samplings from June to October

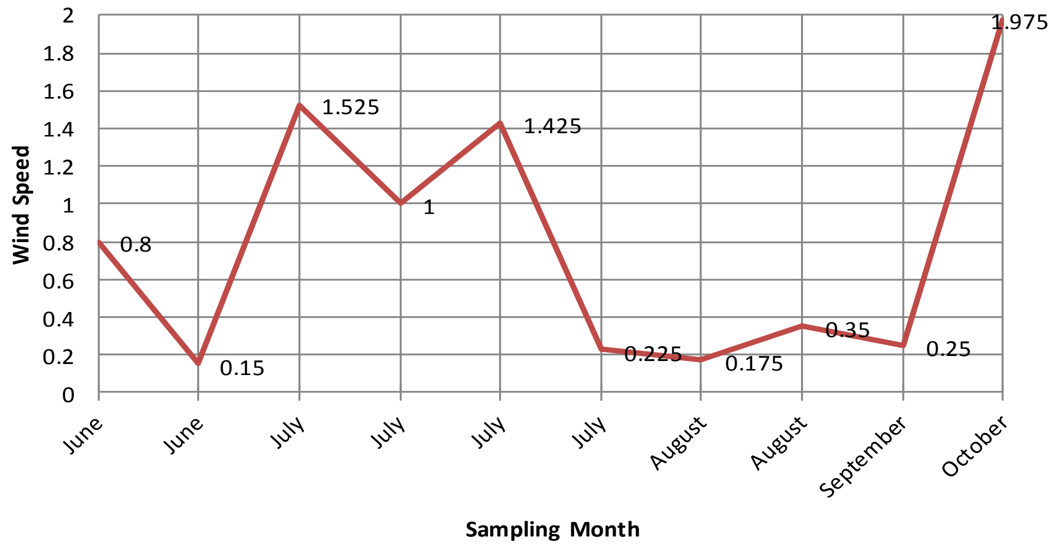

Figure 6. Average wind speed measured during samplings from June to October.

Statistical analysis

I analyzed unpublished field data on green tree frogs provided by colleagues at Texas State University. The data came from four ponds at the Griffith League Ranch; two ponds in the burned forest and two ponds in the unburned forest was collected once a week from June through August of 2015, which encompassed the main breeding period of the green tree frog. As the weather got colder and the end of breeding period was approaching, the data was collected once a month in September and October of 2015, altogether there is a total of 13 sampling events in 2015 (see table2). Frogs were collected using 5 ft. long PVC pipes of two different sizes: 1.5-inch diameter and 2-inch diameter. Ten of each pipe size were set up at each pond. Adult frogs, size above 37mm(Boughton, Staiger et al. 2000) snout to urostyle length (SUL) were measured, marked, and released. Juvenile frogs, size less than 37 mm SUL (Boughton, Staiger et al. 2000) were considered juvenile and were not marked. The data, that we collected, included sex, age (juvenile or adult), mass, head width, and snout to urostyle length.

I used t-tests to determine if there was a statistically significant difference in relative abundance of green tree frogs between the burned versus unburned areas and analyses of variance to determine if there was a statistically significant difference in mass, head width, or snout to urostyle length between frogs from the burned versus unburned areas. I set the level of significance of all statistical tests at $\alpha = 0.05$.

Table 2 Dates of the sampling events from June through October of 2015.

Sampling Event	Date
1	6/21/2015
2	6/28/2015
3	7/3/2015
4	7/12/2015
5	7/20/2015
6	7/27/2015
7	8/2/2015
8	8/9/2015
9	8/16/2015
10	8/23/2015
11	8/29/2015
12	9/13/2015
13	10/4/2015

CHAPTER III

RESULTS

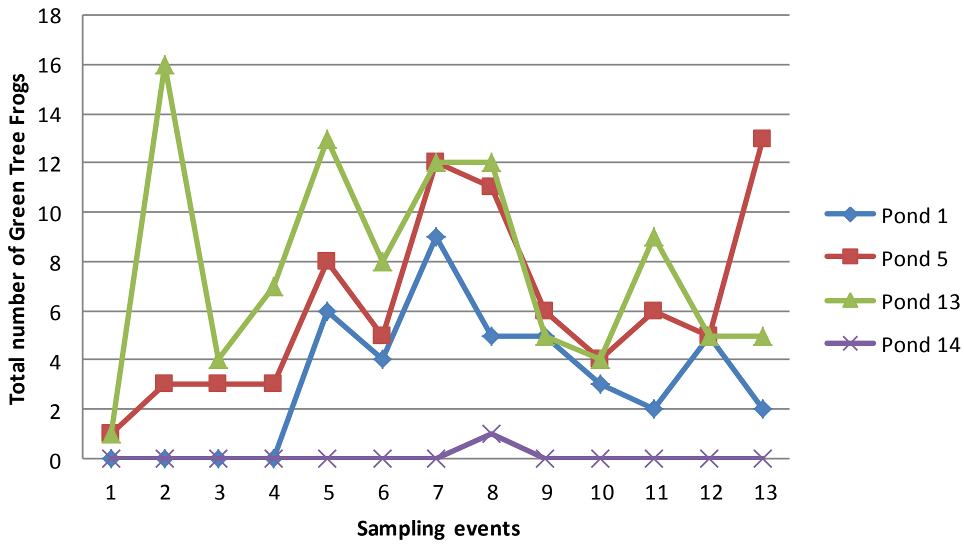

Figure 7. Total number of green tree frogs in unburned and burned areas collected at each sampling events from June through October of 2015.

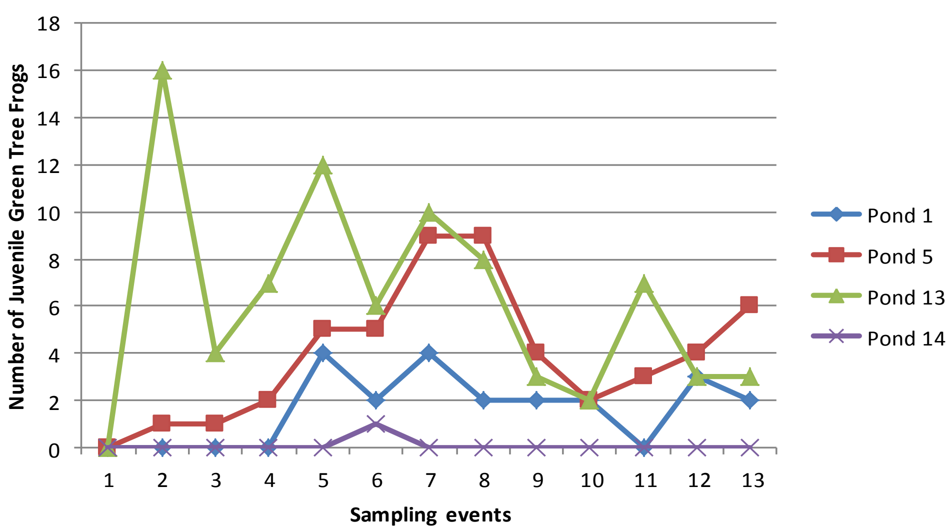

Figure 8. Number of Juvenile green tree frogs in unburned and burned areas collected at each sampling events from June through October of 2015.

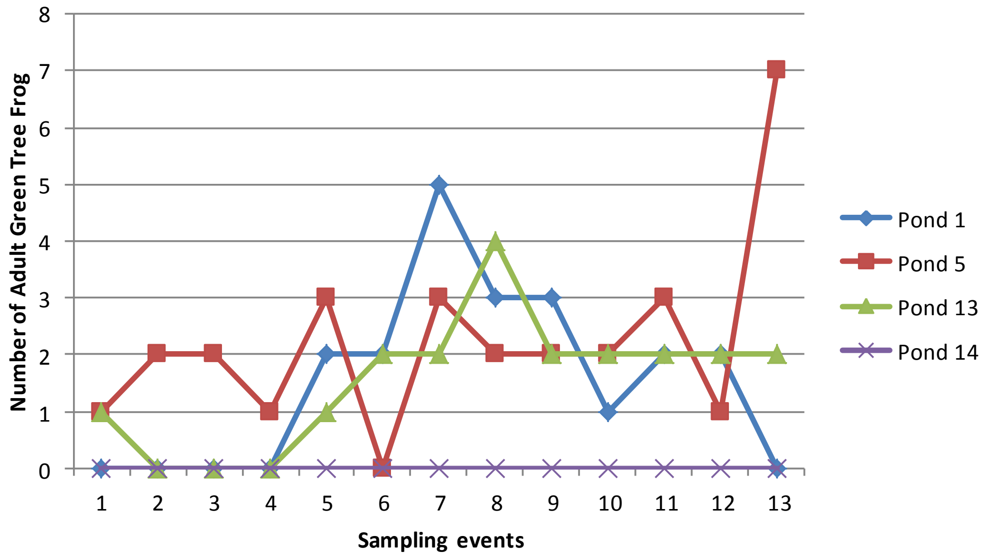

Figure 9. Number of adult green tree frogs in unburned and burned areas collected at each sampling events from June through October of 2015

The data shows that in 2015, a similar number of frogs in unburned (pond 1 and 5) and burned area (pond 13) is not significantly different (p= 0.3945) (see figure 7). However, during the sampling periods of this study, only 1 juvenile frog was present at pond 14. Therefore, Pond 14 is accounted as an outlier and will not be calculated in the statistical analysis. From the result, the number of adult green tree frogs is not statistically different in pond 13 comparing to pond 1 (p= 1.00) (see figure 9). Conversely, the number of juvenile frogs is higher in pond13 than in pond 5 (p=0.0025) (see figure. 8). Pond 13 and pond 1 show no difference in total number of green tree frogs, number of adults green tree frogs, and number of juvenile green tree frogs (p=0.2356, p=0.2108, and p=0.1307, respectively) (see figure 8 and 9).

CHAPTER IV

CONCLUSION

The Bastrop Wildfire of 2011 may have negative effects both directly and indirectly on many species (Pilliod, Bury et al. 2003). However, *Hyla cinerea* may not be one of those species. Direct effect is a direct mortality of animals from fire (Pilliod, Bury et al. 2003). In this study, I cannot prove the direct effect of the wildfire on *H. cinerea* in the early time after the fire. Still, the indirect effect of the fire can be observed in this study. Indirect effects of fires are including alteration in soil moisture and temperature, reduction of vegetation, destruction of habitat, erosion, depletion of nutrient availability, and decrease in hydro-period level (Schurbon and Fauth 2003). Both pond hydro-period and rainfall hydro-period are considered an important factor of variety in amphibian community and they are corresponded to level of rainfall, which also has a strong impact on the amphibian breeding period (Schurbon and Fauth 2003). From the previous study on Griffith League ranch on the effect of wildfire of 2011 on herpetofauna, the results showed that there was no evidence for negative short term impacts of the fire on herpetofauna in the study area (Brown et al., 2014). The mortality rates of anuran species were not higher in the burned area (Brown et al., 2014). Moreover, there was high anurans species richness in the burned areas; this showed that the anuran species also used the habitats for reproduction (Brown et al., 2014). Hence, the habitats after the wildfire did not pose threats to inhabited anuran species (Brown et al., 2014). From the study, the fire greatly affected the loss of overstory trees (Brown et al., 2014). Nevertheless, there was still no evidence that amphibians and reptiles were harmed by such an intense fire (Brown et al., 2014). Other study also supports that amphibian species are unlikely killed directly by fire (Schurbon and Fauth 2003). Most of the surviving species escape underground during the fire (Brown et al., 2014). Tree frogs can also escape fire into unburned areas such as under bark and tree crowns (Schurbon and Fauth 2003). On the other hand, wildfires may increase habitat diversity, which can result in higher diversity of herpetofauna species in a long term (Brown et al., 2014). This supports the use of fire as a strategy in managing the amphibians and reptiles communities. For my study, the results suggest that the population density of *H. cinerea* in burned pond (pond 1 and 5) and unburned area (pond 13) are not significantly different. Conversely, juvenile frogs appeared to be as twice as abundant in pond 13, the burned area. Because the number of population was obtained based solely on the number frogs that were captured using the PVC pipes method, therefore I have to take into account that the PVC pipe method might have an impact on the results. I can also assume that the pipes might alternate the habitat and distribution of the green tree frog, which leads to bias in data sets. Furthermore, by the time of the surveys, the habitat condition of the study site (Pond 13) is nearly recovered from the fire. However, I can say that the weather variability was unlikely to affect the results because the data was collected under the same general area and on the same sampling periods. Assuming that, I cannot draw a conclusion on what factors influenced our observations. Further study on the effect of PVS pipe as a trapping method and microhabitat conditions at each study site is necessary for obtaining a more precise vision of current observations.

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