Potential Positive Effects of Fire on Juvenile Amphibians in a Southern USA Pine Forest

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Abstract

Prescribed fire is a common tool used to conserve and manage the integrity of forest ecosystems. We investigated short-term juvenile amphibian capture and body condition changes subsequent to fire (i.e., one prescribed burn and two wildfires) in a southern United States pine forest. We surveyed amphibians and predatory invertebrates before and after fires occurring during summer 2010. We tested for treatment (i.e., control, wildfire, or prescribed burn) and status (i.e., preburn or postburn) differences in 1) genus-level captures, 2) amphibian health (inferred through a body condition index), and 3) predatory invertebrate captures. *Bufo* and *Scaphiopus* captures increased in the prescribed burn treatment; whereas, no differences in *Gastrophryne* captures were observed. We did not detect a burn status effect on amphibian body condition. Predatory invertebrate captures were higher postburn in the control and wildfire treatments. Neither a low-intensity prescribed burn nor high-intensity wildfires negatively impacted short-term juvenile amphibian captures. Further, we speculate that *Bufo* and *Scaphiopus* survivorship may have been higher after the prescribed burn.

Keywords: amphibians; fire; forest; Houston toad; predators

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Introduction

Prescribed fire is becoming a primary tool for conservation and recovery of fire-maintained ecosystems (Agee 1996; Sparks et al. 1998; Kloor 2000; Pyne 2010). Prescribed fire is often used to reduce heavy fuel loads in fire-suppressed forests, helping to prevent catastrophic wildfires, and allowing recovery of understory vegetation (Sweeney and Biswell 1961; Lovaas 1976; Cain et al. 1998; Ryu et al. 2006). Restoring understory vegetation in fire-suppressed forests may promote greater animal diversity and abundance (Moseley et al. 2003; Smucker et al. 2005; Benson et al. 2007). Fire can also stimulate aquatic productivity through increased nutrient loads (Gresswell 1999; Scrimgeour et al. 2001) and has been linked to mitigation of spruce beetle *Dendroctonus rufipennis* outbreaks (Bebi et al. 2003).

Scientific investigations of fire effects on wildlife have progressed slowly from game to nongame species over the last century. Amphibians are possibly the least-studied major vertebrate group in relation to fire research (Russell et al. 1999; Pilliod et al. 2003). The importance of amphibians to terrestrial and aquatic food webs (Burton and Likens 1975; Semlitsch et al. 1996; Walls and Williams 2001; Davic and Welsh 2004) accentuates their potential use as vertebrate bio-indicators (Welsh and Ollivier 1998; Kerby et al. 2010) and inherent ecological value. There is a need to achieve a better understanding of fire effects on amphibian populations.
Historically, amphibians were assumed vulnerable to direct mortality from fire, largely due to limited mobility and direct mortality observations (Babbitt and Babbitt 1951). However, results of the majority of published research found no evidence that fire significantly affects short-term abundance of amphibian species (Ford et al. 1999; Ruthven et al. 2008). Grafe et al. (2002) suggested that surface-aestivating anurans (i.e., frogs and toads) respond to auditory cues of approaching fire by seeking burn-resistant refugia. Longer term responses to fire-induced habitat changes are species- and context-specific (Moseley et al. 2003; Cummer and Painter 2007; Cano and Leynaud 2009; Rochester et al. 2010).

Burning during terrestrial postmetamorphic growth phases could potentially affect juvenile amphibian survivorship and health. Fire could reduce the quantity and quality of refugia through reduction of litter, duff, and coarse woody debris (Tinker and Knight 2000; Matthews et al. 2010). Fire could impact juveniles both negatively and positively through invertebrate mortality. Moretti et al. (2006) and Vasconcelos et al. (2009) reported negative impacts on arthropod communities following fire, while Taber et al. (2008) and Greenberg et al. (2010) found few if any differences. Fire could negatively affect juvenile amphibians through a reduction in their food base, but positively affect them through predator reduction (Toledo 2005). Predation probably plays a major role in survivorship of most amphibians at all life stages (Wells 2007). In addition to removal of predatory invertebrates, fire may also reduce predation by mesopredators. Jones et al. (2004) found raccoons Procyon lotor had higher preference for unburned compared to burned longleaf pine Pinus palustris stands, and Sunquist (1967) found raccoons reducing foraging activity in a Minnesota savannah following a prescribed burn.

The purposes of our study were to determine whether 1) fire affected juvenile amphibian captures per unit effort, and thus, potentially, juvenile amphibian survivorship, 2) whether fire affected health (i.e., body condition) of individuals, and 3) whether fire affected captures per unit effort of potentially predatory invertebrates. To our knowledge, this is the first quantitative study specifically addressing the short-term effects of different intensity fires on terrestrial juvenile amphibians.

**Study Site**

We conducted this study on the 1,948-ha Griffith League Ranch (GLR) in Bastrop County, Texas, USA. The GLR is located in the Lost Pines ecoregion, a 34,400-ha remnant patch of pine-dominated forest isolated from the East Texas Piney Woods ecoregion during the Pleistocene (Bryant 1977; Al-Rabab’ah and Williams 2004). The GLR is primarily a forested ranch with an overstory dominated by loblolly pine Pinus taeda, post oak Quercus stellata, blackjack oak Q. marilandica, and eastern red cedar Juniperus virginiana, and an understory dominated by yaupon holly Ilex vomitoria, American beautyberry Callicarpa americana, and farkleberry Vaccinium arboreum. The GLR contains 17 ponds, with hydropodorus ranging from highly ephemeral (n = 2) to permanent (n = 3). Prior to 2009, the study area had been fire suppressed for at least 60 y.

We have documented 12 amphibian species on the GLR, 5 of which were included in this investigation (Figure 1): the gulf coast toad Bufo (Inclilius) nebulifer, the endangered Houston toad B. (Anaxyrus) houstonensis (Gottschalk 1970), the Hurter’s spadefoot toad Scaphio- pus hurterii, the eastern narrowmouth toad Gastrophryne carolinensis, and the Great Plains narrowmouth toad G. olivacea. These species typically breed in the spring and early summer in this region, beginning in February for the Houston toad, and late March or early April for the remaining species (Forstner and Swannack 2004; Supplemental Material, Reference S1; http://dx.doi.org/10.3996/062011-JFWM-037.S1; Saenz et al. 2006; Brown et al., in press).

Metamorphosis usually occurs between 15 and 50 d after eggs hatch, with shorter time to metamorphosis for Scaphiopus and longer time to metamorphosis for Bufo (Wright and Wright 1949; Hillis et al. 1984). Pond-breeding anurans typically aggregate near pond edges for several weeks to months after metamorphosis and then disperse into the surrounding terrestrial landscape (Arnold and Wassersug 1978; Greuter 2004). Studies have shown directional preferences in initial movement away from ponds (deMaynadier and Hunter 1999; Vasconcelos and Calhoun 2004), after which point movement appears to be essentially random outside of the microhabitat scale (Semlitsch 2008). Juvenile movement and foraging activity occurs throughout the summer months, with daily activity patterns likely heavily influenced by weather conditions (Roe and Grayson 2008; Child et al. 2009).

**Methods**

The primary goal of the GLR prescribed-fire management policy is to reduce the depth of litter and duff layers accumulated over the past half-century. This reduces the probability of a catastrophic wildfire and mimics the type of prescribed burns conducted throughout the Lost Pines ecoregion. We conducted a low-intensity prescribed burn on a 262-ha burn unit on 7 August 2010. Two medium to high-intensity wildfires occurred on the GLR on 21 August 2010, burning 153 ha and 36 ha, respectively. Burn breaks were installed during the wildfires due to the intensity of the burns and the risk of the fires spreading beyond the boundaries of the GLR.

We assessed initial burn effects on habitat using vegetation plots (20 × 50 m) established in 2008 using random placement within forested habitat. We surveyed vegetation plots between 10 and 29 d following the burns using National Park Service (2003) fire-monitoring guidelines. Four vegetation plots were burned during the prescribed burn and one vegetation plot was burned during the wildfire. We assessed burn severity to substrate and vegetation within each plot using four 15-m transect lines, each consisting of four points spaced...
We assigned points a burn severity ranking from 1 (heavily burned) to 4 (scorched) using a qualitative visual assessment (National Park Service 2003). In addition, we estimated char height and recorded status (i.e., alive or dead) for all overstory trees (i.e., diameter at breast height > 15 cm) within vegetation plots.

**Sampling design**

We used 18 Y-shaped and 8 linear arrays for trapping amphibians and invertebrates. Y-shaped arrays consisted of three 15-m arms with a 19-L center bucket and a 19-L bucket at each arm terminus. Seven linear arrays consisted of a 15-m arm with a 19-L bucket at each end, and a double-throated funnel trap in the center of the array on each side of the flashing. One linear array consisted of a 121-m arm with a 19-L bucket at each end and a 19-L bucket near the center of the trap. We equipped pitfall traps with flotation devices to mitigate mortality during bucket flooding, and both pitfall and funnel traps with wet sponges to provide a moist environment for amphibians. We also equipped pitfall traps with predator exclusion devices (Ferguson and Forstner 2006).

The sampling design consisted of six sets of arrays, with each set containing three Y-shaped arrays spread along drainages and between ponds, and one linear array adjacent to, and parallel with, a pond. The two remaining linear arrays were used to monitor amphibian movement between forest and grassland habitat, and activity at an additional pond, respectively. We did not create this sampling design explicitly for this experiment, but rather as part of long-term investigations into amphibian activity, movement, treatment response (e.g., prescribed fire), and habitat use (Swannack et al. 2009). To determine whether the sampling design was suitable for detecting juvenile amphibians (arrays were located up to 618 m from breeding ponds) we regressed numbers of juvenile captures of three genera (*Bufo*, *Gastrophryne*, *Scaphiopus*) against array distance from breeding pond (Supplemental Material, Table S1, http://dx.doi.org/10.3996/062011-JFWM-037.S2). These analyses showed that captures for all 3 genera spanned the distribution of array distance from source ponds; captures were positively associated with distances from breeding pond, and slopes were similar between sampling periods. Therefore, we included all 26 arrays in this study.

We trapped amphibians and invertebrates for 7 d between 17 July 2010 and 24 July 2010 (i.e., 21–27 d prior to the prescribed burn), and 7 d between 5 September 2010 and 12 September 2010 (i.e., 29–35 d after the prescribed burn, and 15–21 d after the wildfires). The September sampling period was unusually wet due to a heavy rain event caused by Tropical Storm Hermine. We checked traps and processed amphibians daily. We toe-clipped amphibians using an individual numbering system (Martof 1953), recorded snout–vent length (SVL) and head width to the nearest 0.1 mm using digital calipers (Control Company, Friendswood, TX), and weight to the nearest 0.1 g using spring scales (Pesola, Baar, Switzerland). We collected invertebrates from all pitfall traps on the last day of each sampling period (i.e., we allowed pitfall traps to accumulate invertebrates for 7 d) and euthanized them by freezing. Handling permits were provided by Texas Parks and Wildlife Department (SPR-0102-191) and U.S. Fish and Wildlife Service (TE 039544-0). Trapping and handling methods were approved by the...

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**Figure 1.** Genera included in our investigation on short-term impacts of fire on juvenile amphibians on the Griffith League Ranch, Bastrop County, Texas, USA in summer 2010: *Bufo* (A), *Scaphiopus* (B), and *Gastrophryne* (C). Individuals shown are the Houston toad *B. houstonensis*, Hurter’s spadefoot toad *S. hurterii*, and the Great Plains narrowmouth toad *G. olivacea*, respectively.
Texas State University-San Marcos Institutional Animal Care and Use Committee (Protocol No. 0810_0208_11).

A 1-m fire break was cleared around arrays in the prescribed burn unit and we ensured that the burn carried to those breaks and spread throughout the adjacent habitat. Thus, the prescribed fire treatment included all four arrays within the treatment area. The wildfires occurred adjacent to two of the array sets. The distance from wildfire perimeters to these arrays ranged from 0 to 280 m, with a mean distance of 94 m. Terrestrial juvenile anuran movement patterns are not well-studied (Wells 2007) and, thus, it is difficult to define the appropriate cut-off distance for wildfire influence on array captures during our study period. Smith and Green (2006) reported that most recaptured juvenile and adult Fowler’s toads *Bufo* (Anaxyrus) fowleri (*n* = 1,326) were within 100 m of the location of initial capture over the course of 2-mo sampling periods. Semlitsch (2008) suggested that long-distance dispersal of most amphibian species is probably broken up into discrete events over multiple years due to low stamina in juveniles and a positive relationship between body size and locomotor capacity.

Because our preliminary regression analyses did not indicate that we were capturing juveniles actively dispersing from breeding ponds in the first sampling period (i.e., slopes were similar between sampling periods), we assumed that most individuals remained in the vicinity of their initial capture for the duration of the study. We considered captures at arrays >100 m from wildfire perimeters unlikely to be significantly affected by the wildfires, and we included these arrays as controls. The wildfire treatment included seven arrays, and the mean distance from wildfire perimeters to wildfire treatment arrays was 52 m (Figure 2). The prescribed fire treatment contained four arrays, with distance to unburned habitat ranging from 96 to 209 m. The control treatment included 15 arrays, with distance to burned habitat ranging from 190 to 1,295 m.

### Statistical analyses

To increase sample sizes for amphibian capture comparisons, we grouped captures by genus using a traditional classification system (Dixon 2000): *Bufo* (*B. nebulifer* and *B. houstonensis*), *Scaphiopus* (*S. hurterii*), and *Gastrophryne* (*G. carolinensis* and *G. olivacea*). We did not analyze the other genera present in our study area, *Acris, Ambystoma, Hyla*, and *Rana* (*Lithobates*), due to low total captures (i.e., <15 individuals per genus) of these taxa. Based on SVL values reported in Wright and Wright (1949), we captured 55 adults and removed these individuals from the data set.

For the three genera investigated, we used the total numbers of unique juveniles captured at each array within each sampling period as the response variable. We analyzed these data using mixed-effects models, which allow for unbalanced designs (Zuur et al. 2009). We designated treatment (i.e., control, wildfire, or prescribed fire) and status (i.e., preburn or postburn) as fixed effects and array as a random effect. We assessed assumptions of normality and homoscedasticity using residual plots. When we found significant differences, we determined which means were different using contrast comparisons (Maindonald and Braun 2003). We performed these analyses with the program R (R Version 2.10.1, www.r-project.org) using the nlme (Pinheiro et al. 2009) and contrast (Kuhn et al. 2010) packages.

We used body condition indices (BCI) to determine whether health of individuals was affected by fire (Reading and Clarke 1995). For each genus within each sampling period, we regressed body length (SVL) on weight and used residuals as our response variable (Schulte-Hostedde et al. 2005). Positive and negative residuals indicate above- and below-average body condition, respectively. We removed 33 individuals from the data set because SVL or mass was not recorded, as well as recaptures within sampling periods. We linearized data for all three genera using the log_{10} transformation (Fowler et al. 1998). We analyzed these data using generalized least squares (gls) models, with treatment and status as predictors (Zuur et al. 2009). When we found significant differences, we determined which means were different using contrast comparisons (Maindonald and Braun 2003). We performed these analyses with the program R (R Version 2.10.1, www.r-project.org) using the nlme (Pinheiro et al. 2009) and contrast (Kuhn et al. 2010) packages.

Several larger invertebrates in our study system are likely to exert substantial predation pressure on terrestrial juvenile amphibians, including members of the class Arachnida (orders Scorpiones [i.e., scorpions] and Araneae [i.e., spiders]), and beetles in the family Carabidae (Toledo 2005). Although ants are also known to prey upon juvenile amphibians, we did not include ant captures because they can crawl into and out of pitfall traps and, thus, we could not accurately detect their captures with this sampling design. However, individuals are probably most vulnerable to ant predation when they first leave the water (Freed and Neitman 1988; Toledo 2005). Thus, for the predatory invertebrate analysis we used the total number of scorpions (*Centruroides vittatus*; Taber and Fleenor 2003), ground-dwelling spiders (primarily wolf spiders), and carabid beetles captured at each array within each sampling period as the response variable. We analyzed these data using identical statistical methods as for amphibian captures.

### Results

Fire passed through 27 of the 64 substrate burn severity points during the prescribed burn, 13 of which contained vegetation. The mean intensity ranking for substrate and vegetation was 3.5 and 3.7, respectively. Of the 164 overstory trees, 73 were charred, with a mean char height of 0.4 m. Four of the 141 overstory trees that were alive prior to the burn were killed. Fire passed through all 16 substrate burn severity points during the wildfires, 10 of which contained vegetation. The mean intensity ranking for substrate and vegetation was 2.5 and 2.2, respectively. Of the 37 overstory trees, 33 were charred, with a mean char height of 2.8 m. Ten of the 30 overstory trees that were alive prior to the burn were killed (Supplemental Material, Table S2, http://dx.doi.org/10.3996/062011-JFWM-037.S3).
We captured 210 Bufo, Scaphiopus, and Gastrophryne preburn, and 217 Bufo, Scaphiopus, and Gastrophryne postburn (Supplemental Material, Table S3, http://dx.doi.org/10.3996/062011-JFWM-037.S4). Individual species results are shown in Table 1. We recaptured two individuals in both sampling periods, and recaptured nine individuals within sampling periods. We found a significant treatment and treatment–status interaction effect for Bufo, and a treatment–status interaction effect for Scaphiopus (Table 2). Contrast comparisons showed that preburn and postburn captures differed in the prescribed fire treatment for Bufo ($t_{44} = -3.03, P = 0.004$) and Scaphiopus ($t_{44} = -3.87, P < 0.001$), with no differences detected for the control or wildfire treatments (Figure 3).

For body condition comparisons, we found a treatment effect for Bufo, and no significant differences for Scaphiopus or Gastrophryne (Table 3; Supplemental Material, Table S4, http://dx.doi.org/10.3996/062011-JFWM-037.S5). For Bufo, the contrast comparisons showed body condition in the prescribed burn treatment differed from both the control ($t_{212} = -2.98, P = 0.003$) and wildfire ($t_{212} = -3.59, P < 0.001$) treatments. In both preburn
and postburn samples, *Bufo* in the control and wildfire treatments had a greater than average mean BCI score, and *Bufo* in the prescribed burn treatment had a lower than average mean BCI score.

We captured 123 predatory invertebrates preburn, and 182 predatory invertebrates postburn. We found a status effect for predatory invertebrate captures (\( F_{1,23} = 6.91, P = 0.015 \)). Treatment (\( F_{2,23} = 0.18, P = 0.836 \)) and treatment–status interaction (\( F_{2,23} = 0.86, P = 0.438 \)) effects were not significant.

**Discussion**

We found that neither a low-intensity summer prescribed fire, nor high-intensity summer wildfires, negatively impacted juvenile captures or body condition for the three amphibian genera investigated. Indeed, *Bufo* and *Scaphiopus* captures were higher postburn in the prescribed fire treatment. The fact that we captured substantially more *Bufo* and *Scaphiopus* postburn in the prescribed fire unit warrants the following potential explanations: 1) the statistical increase in individuals was purely a function of weather-influenced activity; 2) new individuals entered the prescribed fire unit after the first sampling period, either through tadpole metamorphosis or dispersal into the unit; 3) capture rates were higher in the prescribed fire unit after the burn (presumably as a function of increased mobility and, hence, pitfall encounters by these species); or 4) survivorship was higher in the prescribed fire unit.

We address evidence for each of these potential explanations in sequential order. Weather is often strongly tied to amphibian population trends and activity patterns (Hillis et al. 1984; Pechmann and Wilbur 1994; Wells 2007) and undoubtedly influenced the number of captures within each sampling period. Here Tropical Storm Hermine resulted in substantial rains (8.1 cm) across the study area during the September sampling period. However, if weather were the only explanatory factor, we would expect to see the fire treatment results mirrored in the control treatment results. This appeared to be the case for *Gastrophryne* but not for *Bufo* or *Scaphiopus* with respect to the prescribed fire treatment. Thus, it appears additional factors influenced numbers of postburn captures for at least the two latter species.

Another potential explanation is that the numbers of individuals increased in the prescribed fire unit after the first sampling period, either through recruitment (i.e., tadpole metamorphosis) or dispersal into the unit. If recruitment were a major factor, we would expect SVL to

<table>
<thead>
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<th>Genus</th>
<th>Source of variation</th>
<th>df</th>
<th>F</th>
<th>P</th>
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</thead>
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<td>Treatment</td>
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<td>Status</td>
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<td></td>
<td>Treatment × status</td>
<td>2,23</td>
<td>0.42</td>
<td>0.662</td>
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</table>

### Table 1.

Number of preburn (trapped 17 July 2010 to 24 July 2010) and postburn (trapped 5 September 2010 to 12 September 2010) captures in three treatments: control, wildfire, and prescribed fire, for juvenile amphibians on the Griffith League Ranch, Bastrop County, Texas, USA.

<table>
<thead>
<tr>
<th>Species</th>
<th>Control</th>
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<th>Wildfire</th>
<th></th>
<th>Prescribed fire</th>
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<tr>
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<td>Postburn</td>
<td>Preburn</td>
<td>Postburn</td>
<td>Preburn</td>
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<tr>
<td><em>Bufo houstonensis</em></td>
<td>3</td>
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<td>1</td>
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<td><em>Bufo nebulifer</em></td>
<td>57</td>
<td>51</td>
<td>7</td>
<td>20</td>
<td>13</td>
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<tr>
<td><em>Bufo spp.</em></td>
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<td>5</td>
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<td>0</td>
<td>9</td>
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<td>0</td>
<td>2</td>
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<tr>
<td><em>Gastrophryne olivacea</em></td>
<td>27</td>
<td>17</td>
<td>12</td>
<td>9</td>
<td>4</td>
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<td><em>Scaphiopus hurterii</em></td>
<td>38</td>
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<td>4</td>
<td>8</td>
<td>2</td>
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</table>

* Control treatment captures included 15 arrays.
* Wildfire treatment captures included 7 arrays.
* Prescribed-fire treatment captures included 4 arrays.
* Young individuals lacked interspecific morphological trait differences.

### Table 2.

Results from a mixed-effects model analysis with treatment (i.e., control, wildfire, or prescribed fire) and status (i.e., preburn or postburn) as fixed effects and array as a random effect, used to determine whether number of captures differed among treatments and sampling periods for three amphibian genera on the Griffith League Ranch, Bastrop County, Texas, USA in summer 2010.
be similar in the second sampling period (i.e., a mix of new small juveniles plus larger juveniles present during the first sampling period). Based on mean (±1 SD) SVL between sampling periods in the prescribed fire unit (Bufo preburn: 20.26 mm ± 8.16, Bufo postburn: 38.11 mm ± 6.40; Scaphiopus preburn: 20.30 mm ± 1.41, Scaphiopus postburn: 29.91 mm ± 4.67), it is unlikely that recruitment can explain the results.

Although we cannot rule out the possible influence of dispersal into the prescribed fire unit, the nearest potential source pond outside of the sampling area was 900 m away. Further, only 1 of the 11 recaptures was found at a trap different from where it was first captured. Two individuals were captured in both sampling periods, and both of them were recaptured at the same trap. Finally, the mean BCI score in the prescribed fire treatment

**Figure 3.** Number of preburn (trapped 17 July 2010 to 24 July 2010) and postburn (trapped 5 September 2010 to 12 September 2010) captures at arrays in three treatments: control (n = 15), prescribed fire (n = 4), and wildfire (n = 7), for three amphibian genera: *Bufo* (A), *Scaphiopus* (B), and *Gastrophryne* (C), and predatory invertebrates (D) on the Griffith League Ranch, Bastrop County, Texas, USA. Boxes enclose the range, diamonds show the mean, and horizontal bars delineate the median number of captures at arrays within each treatment and sampling period.

**Table 3.** Results from a generalized least-squares analysis with treatment (i.e., control, wildfire, or prescribed fire) and status (i.e., preburn or postburn) as factors, used to determine whether body condition differed between treatments and sampling periods for three amphibian genera on the Griffith League Ranch, Bastrop County, Texas, USA in summer 2010.
was significantly lower than control and wildfire treatments, but similar between sampling periods (Bufo preburn: −0.03 ± 0.07, Bufo postburn: −0.01 ± 0.03; Scaphiopus preburn: 0.01 ± 0.06, Scaphiopus postburn: 0.00 ± 0.04). These data, coupled with the regression analyses, indicate that long-distance dispersal was not prevalent during our study period.

The reduction in vegetative cover and litter depth in the prescribed fire treatment could have increased juvenile amphibian movement rates and, thus, capture rates. Chelgren et al. (2011) found that detection probability for terrestrial salamanders was higher in burned than unburned plots. However, their sampling design consisted of randomized searching under substrates (i.e., active sampling) and, thus, did not address movement rates. The low intensity of the prescribed burn left much of the live vegetation unconsumed, and although the upper litter layer was consumed, there were no obvious changes that would have greatly increased mobility potential.

We speculate the most likely explanation for increased Bufo and Scaphiopus captures following the prescribed burn was increased survivorship coupled with increased activity levels as a consequence of Tropical Storm Hermine. Further, based on the BCI results, if this hypothesis is correct, it was more likely due to reduced predation pressure following the burn, relative to the other treatments, rather than an increase in food resources. Although we did not find statistical support for a treatment difference in predatory invertebrate captures, the significant postburn increase was driven by increased captures in the control and wildfire treatments (see Figure 3). Further, mesopredators may have dispersed out of the prescribed-burn unit during or following the burn. Jones et al. (2004) found that raccoons selected for nonburned longleaf pine forest, presumably because fire inhibited production of soft mast. However, we did not monitor vertebrate predators and, thus, have no hard evidence to support or refute this scenario.

The results of our study agree with observations by Means and Campbell (1982) and Grafe et al. (2002) that amphibians do not appear to be particularly vulnerable to direct mortality from fire. In contrast to Bufo and Scaphiopus, there were no noticeable treatment differences for Gastrophryne. However, species and genera-specific results are common in the amphibian fire literature (cf. Moseley et al. 2003; Hosack and Corn 2007). With these trend-based data, it is not possible to discern whether fire had no short-term influence on Gastrophryne captures or a balance between negative (e.g., direct mortality) and positive (e.g., above hypotheses) capture influences.

In conclusion, the most important finding of our study was that fire did not appear to negatively impact short-term terrestrial juvenile amphibian survivorship or health. Further, we found intriguing evidence that, in some cases, fire might benefit amphibians not only through longer term habitat changes (Means and Moler 1979; Supplemental Material, Reference S2; http://dx.doi.org/10.3996/062011-JFWM-037.S2; Hosack and Corn 2007), but also through short-term changes such as reduction in predator pressure, increased mobility potential, and increased food resources. However, we note that our interpretations were based on the assumption that 7-d sampling periods were sufficient to accurately reflect differences among arrays for captures and body condition of amphibians. Further, we were unable to conduct multiple prescribed burns during the study period and, thus, our ability to infer causation is limited. We encourage future research examining effects of fire on amphibian predators and predator–prey interactions. In addition to increasing causative understanding, this knowledge would help to elucidate the influence of burn season on amphibians and their community-level interactions, which influence both short-term and long-term outcomes of habitat restoration efforts.

**Supplemental Material**

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**Table S1.** Number of preburn and postburn juvenile amphibian captures at arrays, and distance of arrays from breeding ponds on the Griffith League Ranch, Bastrop County, Texas, USA in summer 2010. Found at DOI: http://dx.doi.org/10.3996/062011-JFWM-037.S2 (19.38 KB XLSX).

**Table S2.** Substrate, understory vegetation, and overstory tree burn-severity data for a prescribed fire and wildfires on the Griffith League Ranch, Bastrop County, Texas, USA in summer 2010. Found at DOI: http://dx.doi.org/10.3996/062011-JFWM-037.S3 (26.21 KB XLSX).

**Table S3.** Number of preburn and postburn juvenile captures for three amphibian genera, Bufo, Gastrophryne, and Scaphiopus on the Griffith League Ranch, Bastrop County, Texas, USA in summer 2010. Found at DOI: http://dx.doi.org/10.3996/062011-JFWM-037.S4 (11.14 KB XLSX).

**Table S4.** Body condition scores for three amphibian genera, Bufo, Gastrophryne, and Scaphiopus on the Griffith League Ranch, Bastrop County, Texas, USA in summer 2010. Found at DOI: http://dx.doi.org/10.3996/062011-JFWM-037.S5 (20.48 KB XLSX).


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