Reptile and Amphibian Responses to Large-scale Wildfires in Southern California

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INTRODUCTION

Abstract

In 2003, southern California experienced several large fires which burned thousands of hectares of wildlife habitats and conserved lands. In order to investigate the effects of the fires on reptile and amphibian communities, we compared the results from herpetofauna sampling from several years prior to the fires to results from sampling in the second and third years after the fires among 38 burned and 17 unburned plots. The sampling plots were spread over four vegetation types and four open space areas within San Diego County. Our capture results indicated that burned plots of chaparral and coastal sage scrub lost herpetofaunal species diversity after the fires and displayed significant shifts in overall community structure. Additionally, post-burn herpetofauna community structure was more similar to that found in unburned grassland. We did not find differences in herpetofaunal species diversity or community composition in grasslands or woodland/riparian vegetation after the fires. We foresee that a continued unnatural fire regime for southern California may result in a simplification of the southern California reptile and amphibian communities.

MATERIALS AND METHODS

Study Sites

Four study sites (Figure 1)

- •Elliott Chaparral Reserve (ELL)
- •Little Cedar Ridge (CED)
- •Rancho Jamul Ecological Reserve – Hollenbeck Canyon Wildlife Area (RAJ)
- •Santa Ysabel Open Space Preserve (SYR)

Each site was impacted by 2003 wildfires in part or in whole

Four vegetation types

- •Chaparral (CHAP) •Coastal sage scrub (CSS)
- •Grassland (GRASS) •Woodland/riparian (WR)

All sites were sampled before the fires when vegetation and herpetofauna communities were considered to be senescent

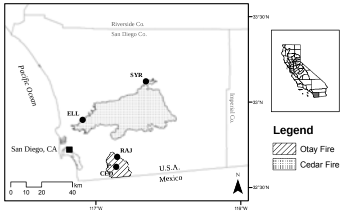

Figure 1. The four study sites in San Diego, CA, were Little Cedar Ridge, Elliott Chaparral Reserve, Rancho Jamul Ecological Reserve, and Santa Ysabel Open Space Preserve.

Trapping Methods

Pitfall trap array (Figure 2)

- •Three 15-m arms of drift fence
- •Seven 19-L pitfall traps
- •Three hardware-cloth funnel traps

Sample schedule

- •Pre-fire sampling varied based on original purpose of study site
- •Post-fire sampling was conducted at four or five week intervals, resulting in 8 to 10 samples per year
- •During sample session, traps were checked daily

Data collection

- •Captured animals were processed, we recorded:
  - •species, sex, age class, weight, and length
- •Marked for identification of recaptures
- •Released at point of capture

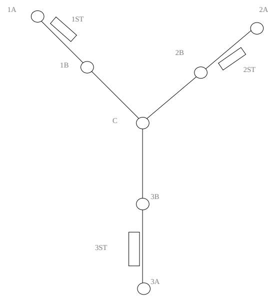

Figure 2. Pitfall trap array with drift fence and funnel traps used to sample reptiles and amphibians.

Analyses

Capture data

- •Averaged at each pitfall trap array into pre-fire and post-fire capture rate

Species Diversity

- •Calculated the Shannon Diversity Index at each array before and after fire.
- •Net change in diversity (ΔSDI) calculated as:
  - (post-fire impact – pre-fire impact) – (post-fire control – pre-fire control)
- •SAS Statistical Software used to test differences in least squares means.

Community Structure

- •Bray-Curtis similarity matrix
- •Analysis of similarity (ANOSIM) to test for differences in community structure
- •Razed samples (post-fire impact) compared against non-razed samples (pre-fire control, pre-fire impact, and post-fire control)
- •PRIMER-E used to analyze community changes

Community Conversion

- •All razed samples averaged into one value per vegetation type
- •All non-razed samples averaged into one value per vegetation type
- •Bray-Curtis similarity matrix
- •ANOSIM used to analyze

sas PRIMER-E

RESULTS AND DISCUSSION

Species Diversity

Both CHAP and CSS exhibited significant losses in herpetofauna diversity after the fire at the post-fire impact plots when adjusted for changes in the control plots. No post-fire changes in diversity were found for GRASS or WR plots (Figure 3).

CHAP: ΔSDI = -0.527, SE = 0.263, t_{55} = -2.00, p = 0.05
CSS: ΔSDI = -0.491, SE = 0.182, t_{55} = -2.70, p = 0.01
GRASS: ΔSDI = -0.154, SE = 0.211, t_{55} = -0.73, p = 0.47
WR: ΔSDI = -0.284, SE = 0.234, t_{55} = -1.21, p = 0.23

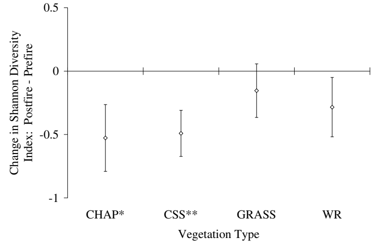

Figure 3. The net change, pre-fire to post-fire, in the Shannon Diversity Index with standard error bars. Levels of significance are indicated as * ($p \le 0.05$) and ** ($p \le 0.01$).

Community Structure

Analysis of pre-fire samples showed that both site (ANOSIM: R = 0.537, p < 0.001) and vegetation type (ANOSIM: R = 0.292, p < 0.001) were significant factors influencing herpetofaunal community similarity among study samples. Therefore, all subsequent multivariate analysis controlled for site to examine differences by vegetation type. Reptile and amphibian communities within CHAP and CSS were significantly different in razed versus the non-razed samples (ANOSIM: CHAP: R = 0.580, p < 0.001; CSS: R = 0.316, p < 0.002). Reptile and amphibian communities within GRASS and WR samples showed no significant differences between the razed versus non-razed samples, (GRASS: R = -0.175, p = 0.927; WR: R = 0.083, p = 0.270).

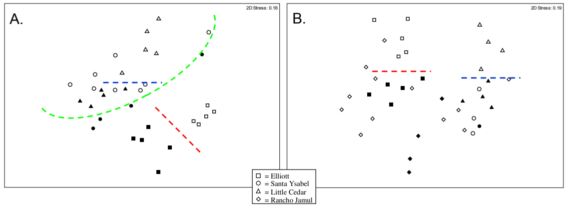

Figure 4. Non-metric multi-dimensional scaling plots (MDS) for A) chaparral and B) coastal sage scrub. These MDS plots are based on Bray-Curtis similarity matrix using square root transformed capture data averaged across all plots within each vegetation type. Open symbols represent non-razed samples and closed symbols represent razed samples.

Community Conversion

The capture results, averaged across vegetation type and burn condition, showed that the reptile and amphibian communities within razed samples were different from those in the non-razed samples. Razed CHAP and CSS samples were more like non-razed GRASS, with a shared similarity of 75% or higher (Figure 5). All combinations of vegetation type and burn condition had a 50% similarity level based on the species documented and the level of detection.

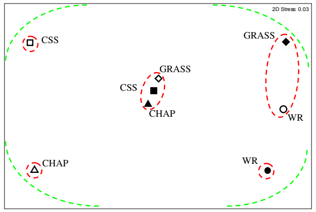

Figure 5. Razed samples have shifted away from the communities detected in the non-razed samples. Open symbols represent non-razed samples and closed symbols represent razed samples.

CONCLUSION

The southern California wildfires of 2003 impacted the herpetofaunal species diversity and community structure in chaparral and coastal sage scrub study plots.

We detected significant shifts in species diversity and community composition in these vegetation types. No changes in diversity or community composition were measured in grasslands or woodland/riparian plots where vegetative structure was not substantially affected from the fires.

Most importantly, the herpetofauna communities in burned CSS and chaparral were more similar to those of unburned grasslands. We will continue to monitor these communities to document the longer term effects in light of the more frequent fire regime in southern California.

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