



# Acoustic Monitoring of Bat Diversity in Northern California

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## Introduction

California is home to 23 species of bats – almost half of all the species in the country – yet there have been few long-term acoustic monitoring programs to study bat diversity, especially in the northern California. Long-term monitoring provides useful information, not just of diversity, but of seasonal activity patterns, impacts of habitat loss and climate change.

This study examines the diversity and activity patterns of bats in different habitat types in Northern California along an 1500m elevation gradient from the central valley to the Sierras. Three study sites have been monitored from August 2014 to present. The objectives of this study are to:

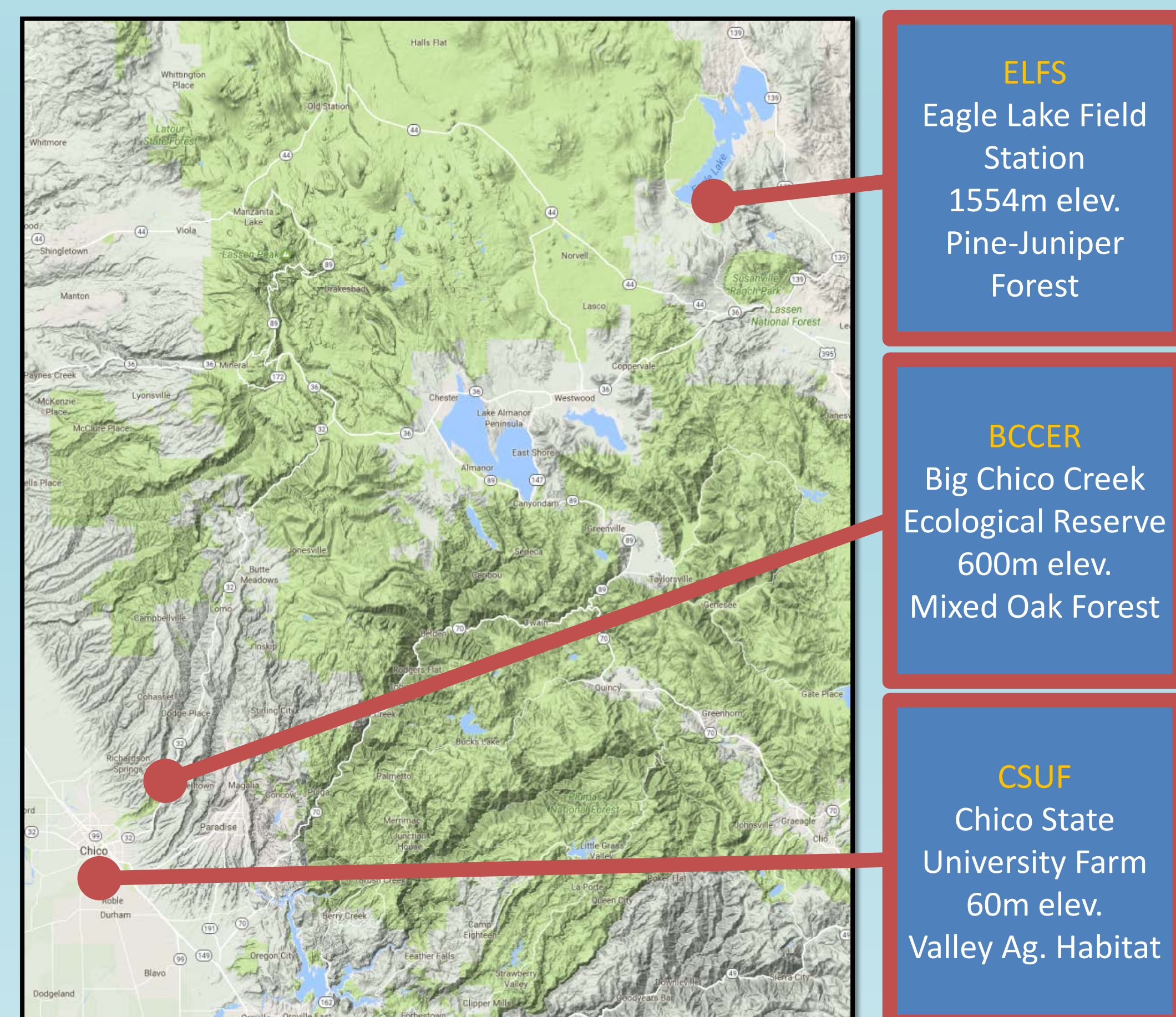
- determine species diversity at the three sites
- examine relative activity levels at each site
- examine seasonal variation in bat activity
- manually authenticate automated ID of bats by software

## Study Areas

The California State University Chico Farm (CSUF) is an agricultural field station in the valley at 60m elevation that is dominated by orchards, pasture, and two small ponds. The Big Chico Creek Ecological Reserve (BCCER) is canyon and ridge habitat dominated by mixed oak woodland at approximately 600m. The Eagle Lake Field Station (ELFS) is a high-altitude pine-juniper forest at 1554m located on the southeastern edge of Eagle Lake.

## Methodology

A Wildlife Acoustics SM3 Bat Detector was placed in a fixed stationary location at each of the three sites. These detectors have continuously remained in the field, and have been recording bat echolocation call on a nightly basis. The CSUF and BCCER sites have been monitored since August 2014 and the ELFS site since October 2015. This study reports on the first year of data from each site. Recorded echolocation calls were analyzed using SonoBat 4.06 software. Given that there were over 300,000 identified recordings for the year, manually confirming all calls was not possible. Thus the analysis presented here are based on the automated ID results of the SonoBat software. To estimate the reliability of the software in species identification, we manually identified up to 25 randomly chosen calls per species per month for 5 months at the BCCER site.

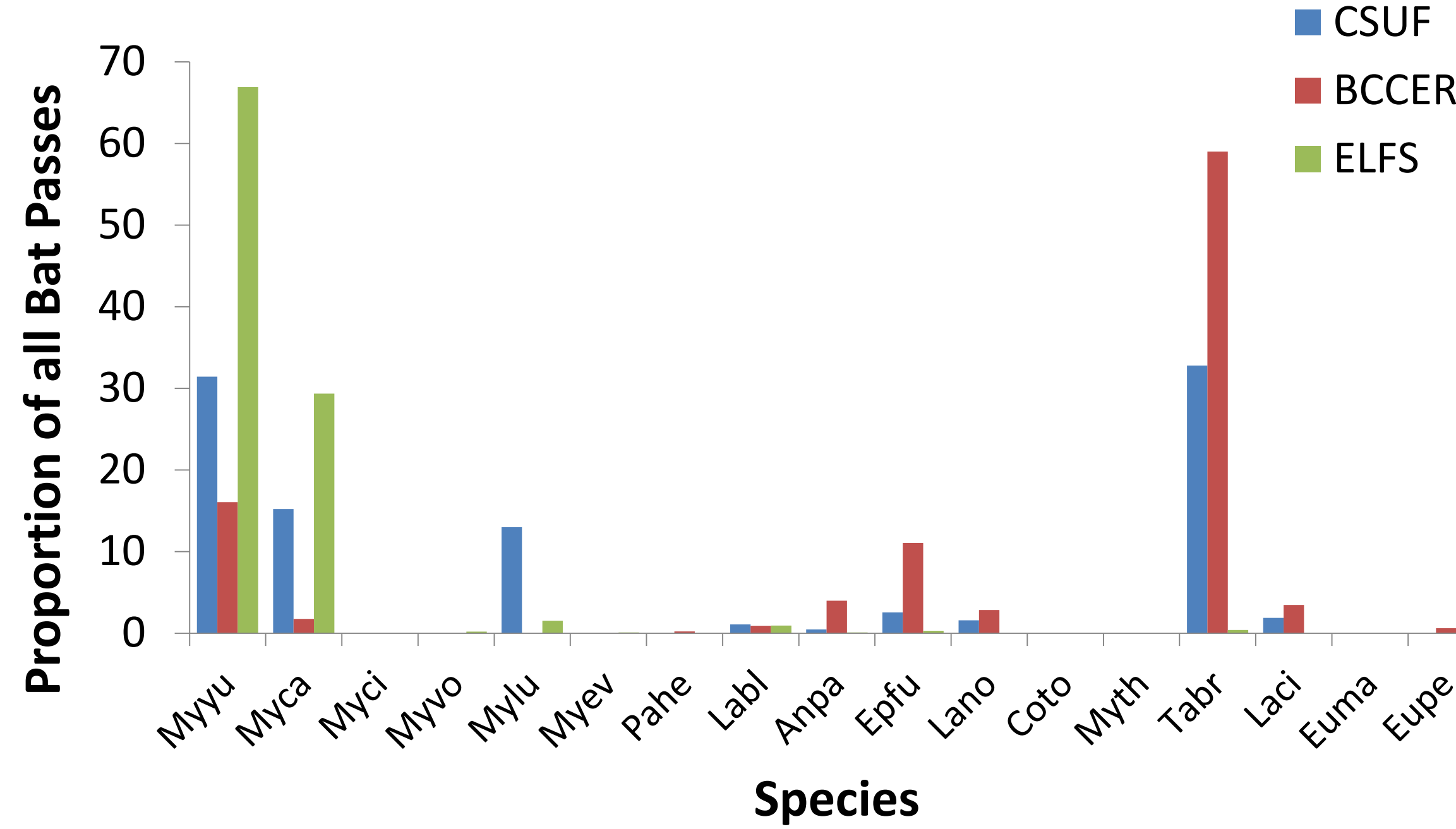


## Results

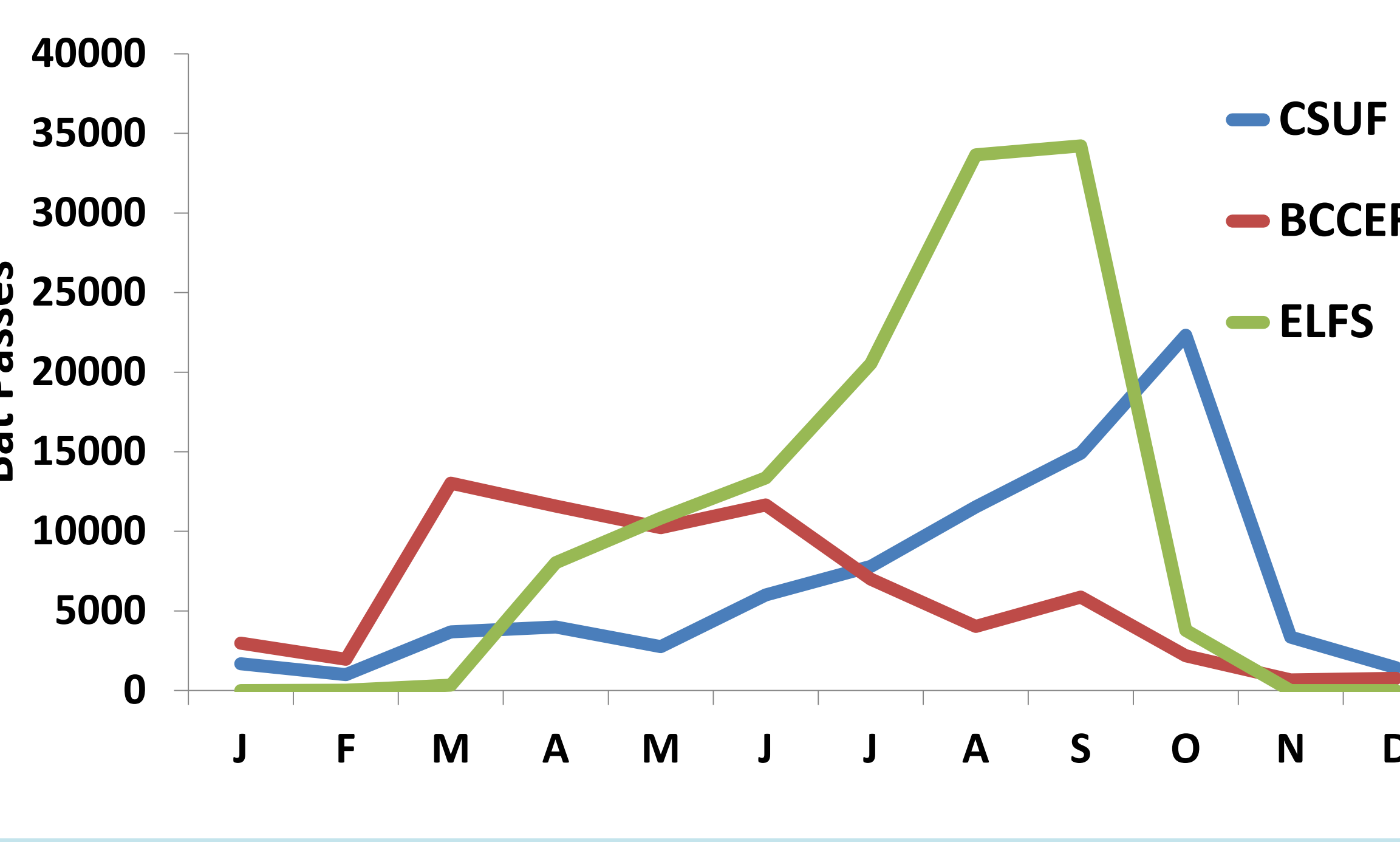
**Table 1.** Species diversity across all three sites. Cells shaded green represent species with 1000s of recorded passes per month, yellow 100s of passes, and pink 10s of passes. White cells denote species absence. Accuracy measures the software auto-ID effectiveness based on 1175 calls from BCCER. An X indicate sample sizes too small for calculation.

| Code | Species                          | CSUF<br>12 | BCCER<br>17 | ELFS<br>15 | Accuracy<br>(%) |
|------|----------------------------------|------------|-------------|------------|-----------------|
| Myyu | <i>Myotis yumanensis</i>         | Green      | Green       | Green      | 97              |
| Myca | <i>Myotis californicus</i>       | Green      | Green       | Green      | 94              |
| Myci | <i>Myotis ciliolabrum</i>        | White      | White       | White      | X               |
| Myvo | <i>Myotis volans</i>             | White      | White       | White      | X               |
| Mylu | <i>Myotis lucifugus</i>          | Green      | White       | Yellow     | 88              |
| Myev | <i>Myotis evotis</i>             | White      | White       | White      | X               |
| Pahe | <i>Parastrellus hesperus</i>     | White      | White       | White      | 94              |
| Labl | <i>Lasiurus blossevillii</i>     | Yellow     | White       | White      | 62              |
| Anpa | <i>Antrozous pallidus</i>        | White      | Green       | White      | 76              |
| Epfu | <i>Eptesicus fuscus</i>          | Yellow     | White       | White      | 91              |
| Lano | <i>Lasionycteris noctivagans</i> | Yellow     | White       | White      | 83              |
| Coto | <i>Corynorhinus townsendii</i>   | White      | White       | White      | 70              |
| Myth | <i>Myotis thysanodes</i>         | White      | White       | White      | 100             |
| Tabr | <i>Tadarida brasiliensis</i>     | Green      | Green       | White      | 87              |
| Laci | <i>Lasiurus cinereus</i>         | Yellow     | Green       | White      | 32              |
| Euma | <i>Euderma maculatum</i>         | White      | White       | White      | X               |
| Eupe | <i>Eumops perotis</i>            | White      | Yellow      | White      | 76              |

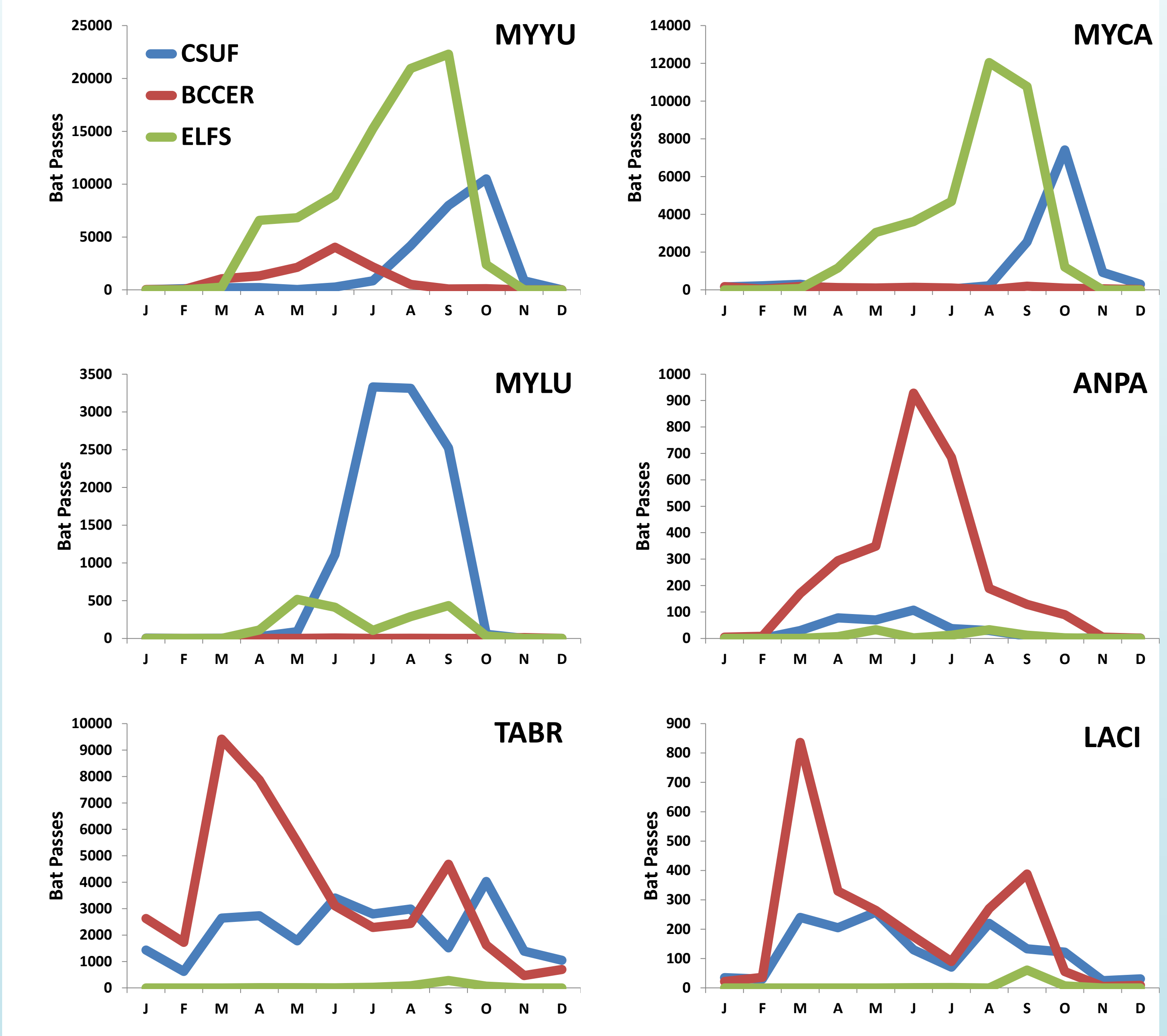
**Figure 1.** Relative Proportion of Bat Species



**Figure 2.** Seasonal Variation in Bat Activity



**Figure 3.** Seasonal Variation in Bat Activity of Six Select Species



## Discussion

These three sites exhibited considerable diversity with BCCER having 17 of the 23 California species. The CSUF agricultural area (12 species) in the valley was notably missing *Parastrellus*, *Corynorhinus*, *Euderma* and two *Myotis* species, while the higher elevation ELFS site (15 species) did not have *Euderma* or *Eumops*. Eleven species were found at all three sites. Based on acoustic activity levels three species stand out as being prevalent. *Myotis yumanensis* dominated the ELFS site and was also quite active at the other two locations. *Tadarida brasiliensis* was the most common species at BCCER and was also significant in activity levels at CSUF. *Myotis californicus* was notable at CSUF and ELFS.

All three sites showed seasonal patterns of activity but each peaked at a different time in the year. The BCCER site in the foothills had an early Spring peak and tapered off through the rest of the year. ELFS had substantial activity during the late summer and CSUF peaked during late Fall. *Myotis lucifugus* was found predominantly during the summer months at CSUF as was *Antrozous pallidus*, but mostly at BCCER. *Tadarida brasiliensis* and *Lasiurus cinereus* were present throughout most of the year at the lower elevation sites but both showed a unique sharp increase in numbers in February at BCCER. This may be due to migratory events in early Spring.

The accuracy of the SonoBat auto-id feature was generally high, averaging 81% across all species. The only species that were not properly classified most of the time were Lasiurids, especially LACI. Many of these calls involved noise or distortion and we are examining these further to determine why this species is problematic.

In the future we plan on exploring this data further to look for relationships between activity levels and temperature, species-specific daily activity patterns, as well as mist-netting bats to confirm their presence.

## Acknowledgements

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