An Evaluation of Movement Patterns of California Tiger Salamanders (*Ambystoma californiense*) Using Individual Identification based on Spot Patterns

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Study Question

Do male California tiger salamanders (CTS) show regional or random movement patterns relative to specific upland habitat surrounding a pool during breeding migration?

Background

- The California Tiger Salamander, *Ambystoma californiense*, is an endangered species endemic to regions of California that depend on seasonal vernal ponds to breed.
- Alton Preserve in Santa Rosa, CA contains vernal pools with known breeding CTS populations.
- CTS have unique spot patterns that allow for identification of specific individuals.
- Combining recorded data of recaptured individuals we used I^{3}S analysis software to identify individual males captured multiple times in a pit trap array.

Methods

- Pitfall traps were set up around pool 1 at the Alton Preserve, trapping CTS on their way in or out of Alton Pond 1 to breed.
- Traps were checked daily during the 2018-2019 breeding season from November through March.
- Digital photo images of all captured CTS were taken using cell phones.
- These images were digitally straightened, and annotated by digitally selecting individual spot locations.
- I^{3}S uses a matching algorithm to create a score to compare spot patterns among annotated images.
- Combined with general data collected, individual male identifications were then verified by eye by two researchers.

Fig 1. Adult CTS captured in pit fall trap

Results

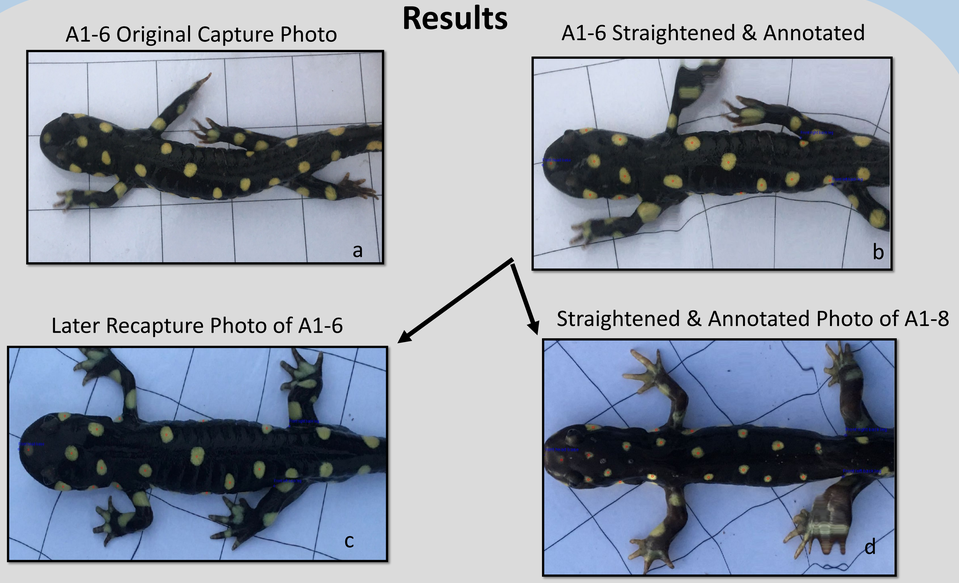

Figure 2. a) Original capture photo of A1-6 before straightening, b) Original capture photo of A1-6 straightened and with spot patterns annotated, c) Photo from later recapture of A1-6 straightened and annotated, d) Photo of a different individual A1-8, straightened and annotated, e) Spot position comparison between A1-6 original and recapture (score=3.72), e) Spot position comparison between A1-6 original and individual A1-8 (score=23.10).

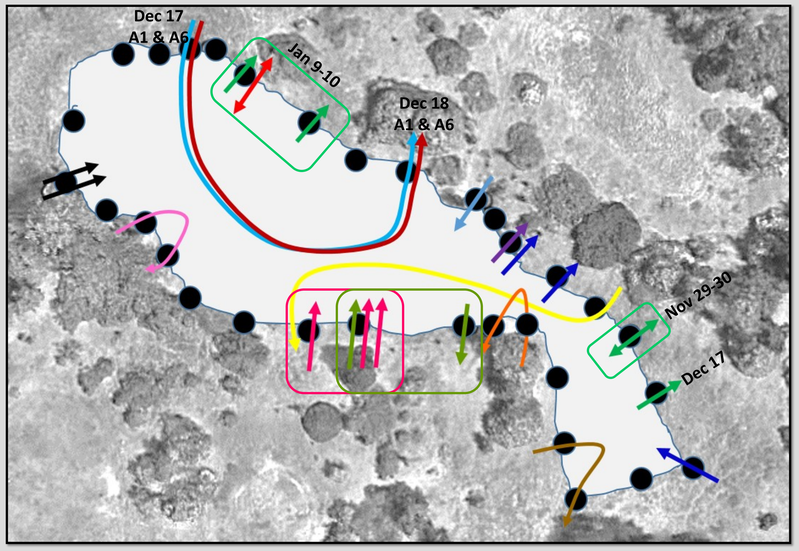

Fig 3: Movement patterns of individual identified males (indicated by color) showed a generally consistent regional use of pool 1 at the Alton Preserve in Santa Rosa.

Discussion

- I_3S aided extensively in allowing individual male CTS to be identified from recapture events based on individual spot patterns.
- Use of I_3S scores were consistent with double verified individual identification by a combination of visual verification, and consistency among measurements of date, sex, snout to vent length.
- Individual males showed that, in many cases, they visit the pool multiple times over the course of the breeding season.
- Individual male CTS appear to typically show localized movement patterns associated with specific regions of adjacent upland habitat, particularly for ingress and egress during short widows of time.

Ongoing Analyses

- Analysis of matrices of pairwise distances among pitfall traps and pairwise comparisons of number of individuals trapped, will be used to determine if there is a statistically significant signal of regional upland habitat use indicated by localized capture patterns.
- A heat map of overall direction of migration of all males and females using this breeding pond will be generated to determine if some upland regions surrounding the pool are accessed more than others

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References

1. Van Tienhovem, A.M., Den Hartog, J.E. Reijns, R.A., Peddemors, V.M., "A computer aided program for pattern-matching natural marks on the spotted raggedtooth shark Carcharias taurus (Rafinesque, 1810)" 2007 Journal of Applied Ecology 44, 273-280.
2. Loredo, Ivette, et al. "Habitat use and migration behavior of the California tiger salamander." *Journal of Herpetology*, vol. 30, no. 2, June 1996, pp. 282-85.