



Caltrans Division of Research,
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Research

Results

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Project Title:

Landscape Genomics Study on
California Tiger Salamander

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Landscape Genomics Study on California Tiger Salamander

Develop tools that will assess mitigation strategies that support the recovery of California Tiger Salamander (CTS) and minimize the spread of Barred Tiger Salamander (BTS) and CTS/BTS hybrids.

WHAT WAS THE NEED?

The California Tiger Salamander – *Ambystoma californiense* (CTS) is endemic to California. The Sonoma County distinct population segments (DPS) and Santa Barbara County DPS are federally listed as Endangered, while the Central California DPS is federally listed as Threatened. CTS is listed as Threatened under the California Endangered Species Act. Caltrans is required to consult with regulatory agencies about the impacts of transportation projects. A major conservation issue for CTS is the ongoing hybridization with the introduced non-native barred tiger salamander - *Ambystoma mavortium* (BTS). The two species hybridized in the areas where they came into contact creating admixed populations around the introduction sites and generating hybrid swarms. Thus, CTS recovery, in part, depends on preventing the geographical spread of introgression. For Caltrans the issue is to understand how roadways as barriers can modulate dispersal and gene flow to help prevent the spread of introgression.

WHAT WAS OUR GOAL?

The immediate outcome of this research was to inform Caltrans on the extent to which roads can be used as barriers to the movement of non-native genes. The project provided specific recommendations on the positive and negative effects of roads in different regions, including the measurable effects of roads on the movement of pure CTS genes where salamander undercrossing are useful to promote the movement of native genes, and areas where such crossings should not be installed to inhibit the spread of non-native BTS genes.



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WHAT DID WE DO?

Landscape genomics is at the leading edge of new genetic tools that provide fine scale, spatially-explicit data allowing researchers and managers to achieve a deeper understanding of how different habitat types impede or enhance the resistance to movement of organisms on landscapes. For species like the CTS, which are extremely cryptic and very difficult to track with standard ecological approaches, landscape genomics is frequently the only way to assess habitat connectivity and movement. This work constituted the first such genomic data set explicitly designed to quantify the effects of roads on gene movement in an endangered species. The data and approach of this project served as a model for similar research in other parts of California on CTS, and on other species that maybe be impacted by roads.

This research tackled the landscape genomics of the Central and Santa Barbara DPSs of CTS, quantifying habitat resistance across the range of the species. The work focused on landscape genomics of both native and non-native genes in areas of Monterey County and Santa Barbara County where they are both represented in hybrid swarms, and in comparable pure CTS regions in Contra Costa County. This task was completed in two years with field work conducted between March-June 2018 and a final sampling in March-April 2019. Laboratory and GIS work took place continuously for the duration of the project.

WHAT AS THE OUTCOME?

The most fundamental result showed that, as originally predicted, roads appear to have a larger measurable effect on the movement of hybrid salamanders than on pure natives. Several possible mechanisms, detailed fully in the final report, may be responsible for this pattern, and we cannot

disentangle them without explicit experiments that are beyond the scope of this project. However, it does appear that roads are a potent barrier to the movement of hybrid salamanders, and as such should be considered when planning for the movement of non-native genes in the future.

WHAT IS THE BENEFIT?

CTS is listed as either endangered or threatened under both the state and federal regulations. Therefore, understanding how human modifications and other landscape features like highway, rail, or transit corridors enhance or hinder the movements of these salamanders is critical to prevent further introgression and to support CTS recovery actions and decision making. Additionally, because Caltrans may enhance or restore seasonal wetland habitat as mitigation for CTS as a result of regulatory permit conditions, it is important to understand what attributes of mitigation sites will favor development and recovery of CTS populations while impeding the development of hybrid salamanders.

IMAGE



Image 1: California Tiger Salamander on the left and Bared Tiger Salamander on the right
(Credit: Jarrett Johnson)