



Release:

February 2012

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Narrowheaded Gartersnake Species Complex Comprised of Three Divergent Lineages

Unraveling and accurately describing the genetic diversity and phylogenetic relationships of closely related species can provide a valuable framework for resource managers to evaluate options for conservation.

This is especially the case for the narrowheaded gartersnake species complex (*Thamnophis rufipunctatus*) inhabiting the Mexican highlands of the Sierra Madre Occidental and nearby montane regions in Arizona and New Mexico. Recent surveys indicate that these snakes have been extirpated from more than 60% of their historic range in the United States, with remaining populations becoming increasingly more isolated and/or experiencing local extirpations.

In a *Molecular Ecology* article, researchers from USGS, UBIPRO, and Arizona State University analyzed the genetics of the narrowheaded gartersnake species complex (*Thamnophis rufipunctatus*) using both mitochondrial and nuclear DNA markers to assess whether the three montane isolates across the species' range each comprise divergent genetic lineages, and to identify historical processes responsible for generating the recovered gene lineages.

Genetic analyses provided evidence that diversification within the *T. rufipunctatus* species complex developed as a result of glacial-interglacial climate cycles of the Pleistocene, and that isolation was likely enhanced in the disjunct U.S. and southern Mexico populations throughout the warming periods of the late Pleistocene (i.e. the last 700,000 years).

The multi-locus genetic analyses suggested that *T. rufipunctatus* populations consist of three distinct genetic lineages, confirming previously recognized taxonomic divisions among the geographically isolated montane groups: *rufipunctatus*, *unilabialis*, and *nigronuchalis*.

Management Implications

- *T. rufipunctatus* species complex consists of three distinct genetic lineages (*rufipunctatus*, *unilabialis*, and *nigronuchalis*) confirming previously recognized taxonomic divisions that correspond with present-day geographic isolates.
- In particular, DNA evidence indicates that the *rufipunctatus* lineage along the Mogollon Rim in Arizona and New Mexico are evolving independently from the *unilabialis* lineage to the south in the Sierra Madre Occidental.
- Extant populations in the U.S. (*rufipunctatus* lineage) exhibited low levels of genetic diversity compared to populations in Mexico. Use of more variable nuclear DNA markers (e.g. microsatellites) may better discern fine-scale diversity patterns in these populations and may be useful for designing reintroduction strategies that are consistent with natural patterns of genetic diversity.

THIS BRIEF REFERS TO:

Wood, D.A., A.G. Vandergast, J.A. Lemos Espinal, R.N. Fisher, A.T. Holycross. 2011. Refugial Isolation and Divergence in the Narrowheaded Gartersnake Species Complex (*Thamnophis rufipunctatus*) as Revealed by Multilocus DNA Sequence Data. *Molecular Ecology*. doi: 10.1111/j.1365-294X.2011.05211.x

<http://www.werc.usgs.gov/sandiego>

<http://www.werc.usgs.gov/ProductDetails.aspx?ID=4634>



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The narrowheaded gartersnake is adapted to montane coldwater habitats, and its speciation appears to have been driven by Pleistocene climate fluctuations.

Multi-locus genetic analyses also affirm that the *rufipunctatus* clade, which are found in the Mogollon Rim of Arizona and New Mexico, are evolving independently from the *unilabialis* clade in the Sierra Madre Occidental, providing resolution to one of the central management concerns for these declining U.S. populations, that is, whether these disjunct Mogollon Rim populations correspond to a distinct genetic group.

Finally, genetic structure recovered throughout the range of the *T. rufipunctatus* species complex was largely congruent with contemporary drainage patterns, indicating that river drainages appear to be an important component in population subdivision. Also, markedly lower genetic diversity was measured in U.S. populations than in populations in Mexico.

While the primary causes of population declines in the U.S. are attributed to the introduction of non-native species and habitat alterations, low genetic variability coupled with small population size and isolation also may hinder the ability of remaining U.S. populations to adapt to ecological and environmental stressors.



A narrowheaded gartersnake in Temósachic, Chihuahua, México. Courtesy of Jim Rorabaugh