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Publication Brief

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Survival of Adult Female Giant Gartersnakes in the Sacramento Valley

Understanding the survival curves of organisms and the variables that affect risk of mortality provide valuable information for conservation. However, many radio telemetry studies of survival, especially those for rare or cryptic species, are plagued by small sample sizes.

A study in *Animal Conservation* by USGS biologists demonstrates the use of "Bayesian shared frailty models" to solve this problem. The method combines inference across studies to estimate region-wide survival curves, and increases the precision with which survival probabilities and risk of mortality are estimated. Researchers applied the method to evaluate the survival probabilities of adult female giant gartersnakes (*Thamnophis gigas*), a federally listed threatened species limited to a few marshes and rice fields and associated canals in the Sacramento Valley.

The model successfully incorporated data from a number of studies with relatively small sample sizes (1 to 31 radio-marked individuals). The mean annual survival probability was calculated at 0.61, and survival probabilities were greatest in restored marsh habitat.

Where restored marshes are present, mortality risk was higher in canals than restored marshes. But within agricultural sites, mortality risk was lower in canals than in rice fields and other farm habitat. Overall, mortality risk was greater in aquatic than in terrestrial habitats, but this is likely related to the gartersnake's heavy use of aquatic habitats for foraging, where any absence of vegetative cover can expose them to predators.

Patterns in survival probabilities and risk of mortality can inform management decisions. Marsh restoration decreased risk of mortality, suggesting that for giant gartersnakes, creation of marsh habitats or maintenance of emergent aquatic vegetation in agricultural waterways could be effective conservation tools.

Management Implications

- Bayesian shared frailty models allow large-scale inferences to be drawn from multiple site-specific radio telemetry studies, increasing the value of such studies beyond the sites at which they were conducted.
- Site-specific studies, even those with small sample sizes, can still provide valuable information relevant for the conservation of rare or cryptic species at larger spatial scales, using the model.
- Applied to giant gartersnake telemetry data, the analyses suggest that maintaining emergent aquatic vegetation on the canal margins and terrestrial vegetation on canal banks could help improve snake survival rates in canals. Additionally, marsh construction and restoration could be valuable management tools for gartersnake recovery.

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Halstead, BJ, GD Wylie, PS Coates, P Valcarcel, ML Casazza. Bayesian shared frailty models for regional inference about wildlife survival. Animal Conservation 15(2): 117-124. doi: 10.1111/j.1469-1795.2011.00495.x

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Assessing survival rates of rare or cryptic species is often challenging, but Bayesian shared frailty models allows the use of small samples to make useful inferences.