The Journal of Wildlife Management 85(4):615–616; 2021; DOI: 10.1002/jwmg.22039

EDITOR'S MESSAGE

Special Section: Gopher Tortoise Demographic Variables Estimated from Long-Term Mark-Recapture Data

The gopher tortoise (*Gopherus polyphemus*) is a burrowing tortoise endemic to the sandy uplands of the southeastern United States Coastal Plain, and its range spans from eastern Louisiana to southwestern South Carolina to southern Florida. It occurs in a variety of forest types, but perhaps no ecosystem has a closer biological and cultural association with the species than the longleaf pine (*Pinus palustris*)—wiregrass (*Aristida* spp.) ecosystem. The ecosystem evolved with frequent ground fire, which maintained relatively open forest canopy conditions and abundant light on the forest floor to meet the tortoise's foraging and thermoregulatory needs. The gopher tortoise was once widespread and common, but with reduction of the longleaf pine forest following European settlement, active fire suppression, and unsustainable harvesting of adult tortoises, the gopher tortoise population sharply declined to the point that it is currently under assessment for listing under the United States Endangered Species Act.

The tortoise is a charismatic species whose presence within a landscape is often given away by its conspicuous burrows and bright sand aprons. Tortoises have characteristics that have made them a historically appealing subject for capture and marking. Tortoises are relatively easy to catch (with sufficient patience) and handle, their longevity and high site fidelity produce a good chance of later re-encounter, and tortoise carapaces can be marked inexpensively and durably. The first known use of marked tortoises for scientific study was that of Goin and Goff (1941), who reported 1-year growth increments of tortoises in central Florida.

Awareness of an emerging conservation plight for the species led to population studies starting in the late 1970s and early 1980s. Studies in southwest Georgia (McRae et al. 1981) and northcentral Florida (Diemer 1992) demonstrated the utility of mark-recapture methods for understanding tortoise movements and population age structure; more mark-recapture studies followed by other researchers at other sites. At about the same time, an acceleration in Florida of large-scale translocations of groups of tortoises from sites slated for development resulted in the release of permanently marked animals into recipient sites (Ashton and Burke 2007, Cozad et al. 2020). Thus, the number of sites hosting populations of marked tortoises—including living individuals marked decades ago—has steadily increased even as habitats capable of supporting tortoise populations continue to decline in area (Berry and Aresco 2014).

The papers in this special section all feature inferences about gopher tortoise populations derived from mark and recapture studies spanning 8–30 years. As the papers will make clear, long-term studies provide invaluable insights about population dynamics and environmental associations that are unrecoverable or unreliable from shorter-term studies, especially for this long-lived species. Unmanipulated tortoise populations are the focus of 2 of the studies, and translocated populations are the focus of 2 others. All the studies occur in the northern, non-Florida range of the species where population demographics have not been as closely studied and are less understood.

The studies share common analytical features found in contemporary applications. They all make use of Cormack-Jolly-Seber or Jolly-Seber-based study designs to estimate survival. Where the mark-recapture sample includes non-adult size classes, the studies incorporate multi-state mechanisms to explicitly estimate the probabilistic transitions among size classes (i.e., growth) and size-class-specific survival. All the studies use Bayesian methods, which facilitate the handling of missing data, simplify the interpretation of estimated quantities, and enable the direct modeling of informative quantities such as population persistence probability and random effects.

In the paper by Folt et al. (2021), the authors conducted a follow-on study to that of Goessling et al. (2021), extending the earlier investigation to compare 3 apparently stable and 3 apparently declining sites over 30 years in the Conecuh National Forest, Alabama. Within their models, the authors estimated risk of extinction for each population, and they identified demographic characteristics that distinguished stable from declining populations. This study reveals the importance of site-specific demographic information for estimating the probability of population persistence.

Tuberville et al. (2021) followed an original study (Tuberville et al. 2008) of a tortoise population translocated to St. Catherine's Island, a coastal barrier island in Georgia. In the current study that spanned 8 years, the authors estimated apparent survival of immature (hatchling, juvenile, and subadult stages) tortoises. They also compared survival rate among 3 types of introduction to the population: hatchling direct release, head-starting, and wild recruitment. Hatchlings had the same survival rates among all 3 treatments, which provides evidence that translocation has produced a population capable of sustaining itself.

In McKee et al. (2021), the authors estimated apparent survival rates of waif tortoises (tortoises displaced by human collection) translocated to the Aiken Gopher Tortoise Heritage Preserve, South Carolina, at the extreme northern extent of the range. Over the 13-year study period, the authors found no evidence that annual apparent survival of tortoises translocated as waifs differed from that of unmanipulated populations, indicating that waif tortoises could be used to augment declining, isolated populations.

Hunter and Rostal (2021) analyzed 27 years of mark-recapture data collected at Fort Stewart, Georgia. Their models permitted estimation of *per capita* population inflow, emigration, and adult abundance. Yearly data collection allowed the authors to connect demographic rates to prescribed burning regimes, and the authors found differing responses to burning that depended on habitat context. Tortoises primarily responded to burning through movement, indicating that tortoise populations are spatially dynamic when habitat area is large and unrestricted.

The insights gathered from these studies on the long-term persistence of populations and the effects of management actions like translocation and prescribed burning would not have been possible without long-term mark-recapture studies. As these and other studies continue to track marked gopher tortoise populations, additional valuable demographic information will contribute to the conservation and management of this keystone species.

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