Spatiotemporal Partitioning of Two Invasive Ungulates in Guam

(Abstract)

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ABSTRACT: Interspecific interactions are crucial in shaping ecosystem dynamics (Connell 1983, Tilman 1987, Barbosa and Castellanos 2005). Non-native ungulates have been introduced across the globe (Ferretti and Lovari 2014, Volery et al. 2021) and in environments where multiple invasives thrive, these co-occurring sympatric species may shift spatiotemporal patterns to minimize interspecific competition (Schoener 1974, Chesson 2000). Spatiotemporal shifts can lead to cascading effects to the native flora and fauna (Simberloff and Von Holle 1999). Given the potential negative impacts, understanding these interactions is vital for effective management of these ecosystems.

Two invasive ungulates, the wild pig (*Sus scrofa*) and the Philippine deer (*Rusa marianna*), have inhabited much of Guam since their introduction in the 1600s and 1700s (Intoh 1986, Wiles et al. 1999) and both have been associated with significant ecological damage throughout the island (Conroy 1989). Despite sharing similar invasive roles, they seemingly coexist throughout areas of Guam. Subsequently, efforts are increasingly put forth to remove both species from partitioned areas at one time.

To aid these efforts and understand invasive species interactions, we studied the seasonal spatiotemporal patterns of wild pigs and Philippine deer during February 2021-March 2022. Specifically, we used GPS collars from 39 wild pigs and 22 deer to examine spatial and temporal partitioning and assess dynamic spatiotemporal interactions between interspecific dyads at seasonal scales. We investigated spatial partitioning of wild pigs and deer by estimating the spatial overlap between home ranges and core areas of interspecific neighboring dyads. We estimated temporal overlap in diel activity to evaluate temporal partitioning between the species. Lastly, we examined dynamic spatiotemporal interactions, those that occur simultaneously in space and time, by estimating movement interactions between neighboring interspecific dyads to understand attraction and avoidance.

We found spatial overlap between the species decreased significantly in core areas compared to home ranges in both seasons. Within home ranges, deer were approximately 3 times more likely to be within pig ranges than vice versa. This effect diminished at core areas such that deer were only 1.3× more likely to be within pig core ranges than vice versa. Temporal overlap of activity between wild pigs and deer was very high during dry and wet seasons, with overlapping activity peaks during crepuscular hours. At a critical distance threshold of 50m, we estimated 77 movement interactions from 58 dyad pairs over 3 seasons and found that only 2 (2.6%) and 4 (5.2%) movement interactions were considered avoidant and attractive, respectively, and the remaining 71 interactions (92.2%) were neutral.

Our results showed that, while not extensive, spatial overlap between wild pigs and deer occurred between home ranges. More exclusive use of core areas suggests that spatial partitioning of these smaller space use areas might serve as one mechanism facilitating coexistence between wild pigs and Philippine deer. Additionally, we did not see any evidence of temporal partitioning or avoidance between wild pigs and deer. Using this knowledge, managers can maximize efficiency of managing invasive ungulates by combining efforts during crepuscular hours when both species are most active. Management activities to remove these species simultaneously may be most effective in areas of known spatial overlap (i.e., home range overlap) and, if that is unknown, managers should default to removal efforts within deer ranges as the odds of encountering both species is higher than in pig's home ranges.

KEY WORDS: interspecific interactions, Philippine deer, *Rusa marianna*, spatiotemporal, spatial partitioning, *Sus scrofa,* temporal partitioning, ungulate management, wild pig

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