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Multi-Trophic Level Feeding Interactions Among Two Native and Two Non-Native Species: Implications for the Endangered Reticulated Flatwoods Salamander (*Ambystoma bishopi*)

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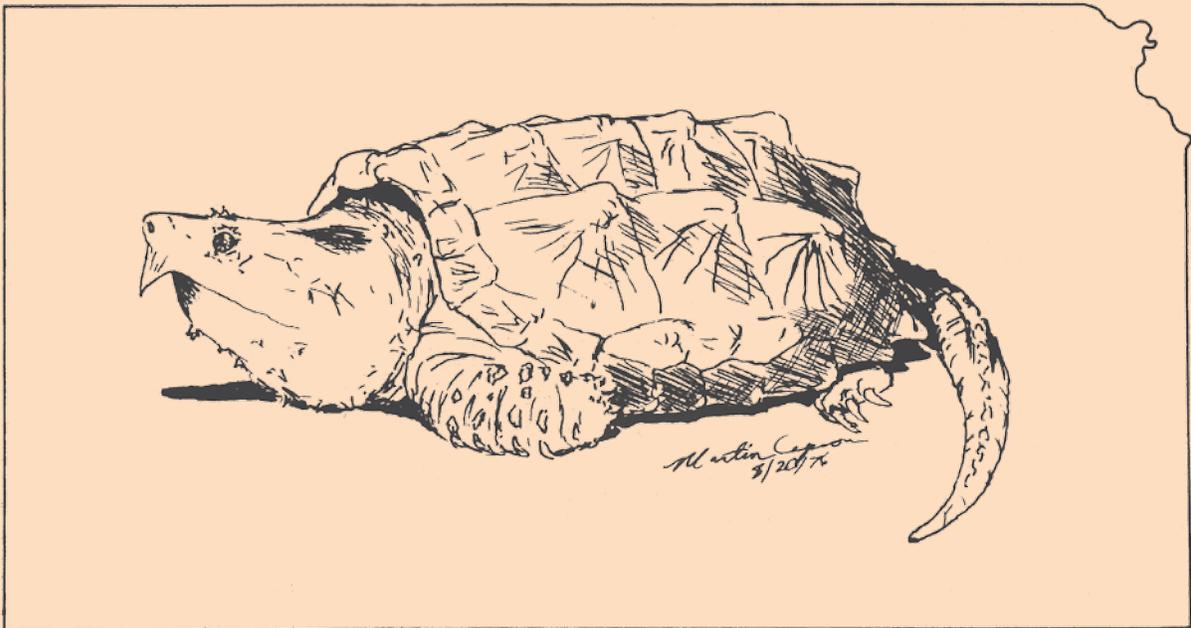
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Multi-Trophic Level Feeding Interactions Among Two Native and Two Non-Native Species: Implications for the Endangered Reticulated Flatwoods Salamander (*Ambystoma bishopi*)

Eglin Air Force Base (Eglin) in Florida is one of few remaining public lands where the Reticulated Flatwoods Salamander (*Ambystoma bishopi*) occurs, and it represents the only remaining location within the entire range of this endangered species to have two populations that both occur in wetland complexes with >2 occupied wetlands (Gorman et al., 2009). The decline of the species has been rapid and few remaining breeding locations for this species remain. It was listed as federally endangered in 2009 (USFWS, 2009). Flatwoods salamanders depend on complex herbaceous vegetation for all aspects of their life history and while in wetlands they use this habitat for egg laying (Gorman et al., 2014), larval cover (Sekerak et al., 1996; Gorman et al., 2009), and metamorphs and adults are frequently observed climbing in the herbaceous vegetation (Jones et al., 2012). Feral Swine (*Sus scrofa*) damage and degrade wetlands (and other habitats) on Eglin (Engeman et al., 2007; Brown, 2014), and represent an emerging threat to Reticulated Flatwoods Salamanders and their breeding wetlands on Eglin. Thus, assessing the impacts of swine on flatwoods salamanders is a critical need.

On 27 May 2014, while evaluating the extent of damage from swine rooting in the wiregrass-dominated ecotone of one of the last remaining occupied breeding wetlands of the salamander, we observed a multi-trophic level interaction among two native and two non-native species. First, we observed the partial remains of an apparently

swine-predated Eastern Glass Lizard (*Ophisaurus ventralis*), a native species, in one of the freshly rooted patches of vegetation. While examining the carcass, we observed several Red Imported Fire Ants (*Solenopsis invicta*) visiting and apparently scavenging the glass lizard remains. Subsequently, we observed an adult Eastern Narrow-mouthed Toad (*Gastrophryne carolinensis*), another native species, within 2 cm of one of the two small uneaten fragments of glass lizard. The Eastern Narrow-mouthed Toad was making quick movements in the direction of the glass lizard remains, which after closer inspection revealed that the toad was consuming fire ants attracted to the remains. The native anuran had found a concentrated food source in the scavenging invasive fire ants, which in turn had also found a food source in what was left from the non-native swine's foraging event on the native Eastern Glass Lizard. The consumption of *O. ventralis* by *S. scrofa* has been documented previously (Wood and Roark, 1980), as has the consumption of *S. invicta* by *G. carolinensis* (see Deyrup et al., 2013), but the multi-level predation and scavenging that involved the invasive exotics *S. Scrofa* and *S. invicta*, and the native *O. ventralis* and *G. carolinensis* demonstrates a novel multi-trophic level interaction among two native and two invasive species. Of particular concern is that this event took place in one of the few remaining breeding sites of the Reticulated Flatwoods Salamander and occurred while newly metamorphosed flatwoods salamanders were emigrating from the breeding wetland for the first time

in 4 years (we had documented almost daily movement of metamorphs in the vicinity of the hog damage from 12 April - 31 May (Gorman and Haas, unpubl. data). Furthermore, we have observed flatwoods salamanders in high densities undergoing metamorphosis under damp litter and at the bases of herbaceous vegetation near the water's edge in this same site (K. Jones, pers. obs.), which makes this a vulnerable life history stage to rooting animals such as feral swine. Thus, the native glass lizard depredated by swine could have been an endangered salamander instead. Moreover, the rooting in the breeding wetland may indirectly impact the reproductive potential of the salamander, because complex herbaceous vegetation is critical and recovers slowly following this type of negative disturbance (Brown, 2014).

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