



Quantifying the Impacts of Invasive Species on Federally Listed Animal Species in the US

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Introduction

The biological invasion of non-native species that cause environmental harm (hereafter, invasive species) is one of the most common causes of global species extinctions (Bellard et al., 2017, Clavero and Garcí'a-Berthou 2005). The spread of invasive species is occurring more rapidly today than at any point in documented human history (Early et.al., 2016). In the United States (US), invasive species are one of the leading and fastest growing threats causing species to require federal protection under the US Endangered Species Act (ESA) (Leu et al. 2019 and Wilcove et al., 1998). The objectives of this project were to identify the 'who' and 'how' in invasive species that negatively influenced Threatened and Endangered (T&E) animals listed under the ESA.



Source: <https://ocean.reviverstore.org/threats/solutions/marine-threats/islands/>

Table 1. An overview of both direct and indirect ways that invasive species negatively impact T&E species within biological communities in the US.

Interaction	Definition
Predation	Any type of feeding-on or consumption of another individual (Ricklefs & Relyea, 2014)
Secondary predation	Predation on a species in which the imperiled species depends, such as a host, pollinator, or disperser, for non-consumptive resources (Polis, Myers, & Holt, 1989)
Competition	Depriving the imperiled species of resources necessary for survival (e.g., space displacement, prey, nutrients, water, light) (Ricklefs & Relyea, 2014)
Secondary competition	Competition with a species upon which the imperiled species depends, such as a prey species, pollinator, or disperser (Kerfoot, 1987)
Secondary herbivory	Herbivory on a host plant in which the imperiled species depends or relies to fulfill a survival need (Kerfoot, 1987)
Disease/Parasitism/Vect or (DPV)	Diseases or parasites of native T&E species or nonnative vectors of diseases or parasites (Roberts & Janovy, 1996)
Hybridization	Interspecies breeding that alters the gene pool (Hickman et. al, 2014)
Adverse habitat modification (AHM)	Species impacts the environment in a negative way that is non-consumptive (Tylianakis et al., 2008)
Invasive Carrier	Species facilitates the spread of another harmful invasive species (Shiels, 2010)

Methods

We reviewed federal register final rule listing documents for all T&E animals from 1975 through 2020 available on the U.S. Fish and Wildlife Service Environmental conservation online system (2020). We treated distinct population segments as species in our analysis. When provided, we documented the diversity of invasive taxa that threatened T&E animals and summarized the potential mechanisms of how invasive taxa negatively influenced these species. We define these mechanisms in Table 1.

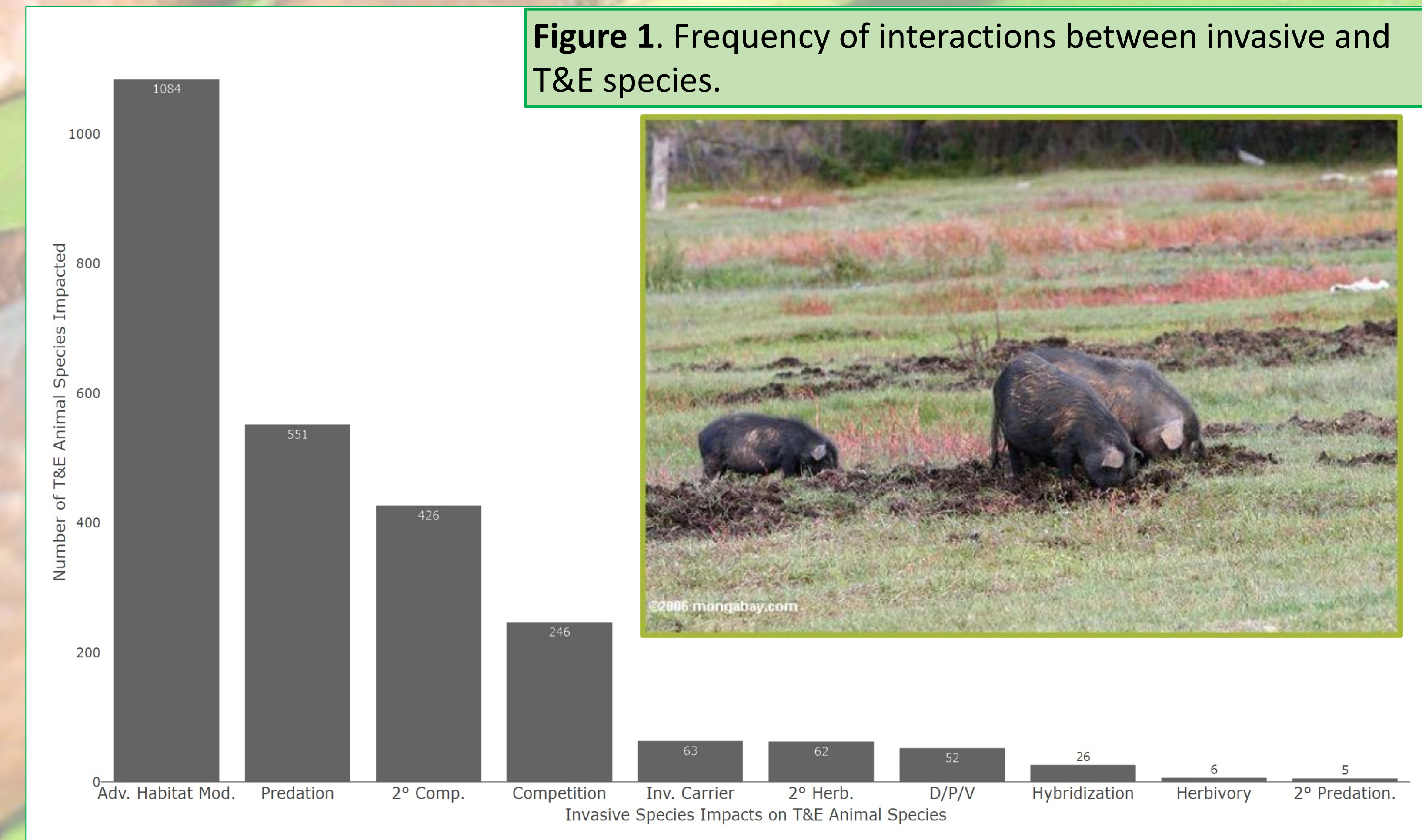


Figure 1. Frequency of interactions between invasive and T&E species.

Results

We reviewed final listing documents for 615 T&E animal species and found that nearly half (43%; n=269) were negatively influenced by invasive species. Percentage of T&E taxa influenced by invasive species varied; birds= 66%, reptiles = 61%, fish = 52%, amphibians = 40%, mammals = 29% and invertebrates = 45%. Many T&E animal species were influenced by more than one invasive species and a couple had more than one negative interaction per invasive species. We identified a total of 297 invasive species (258 genera) that negatively influenced T&E animals. We list the most mentioned invasive taxa in Table 2. Invasive species mainly influenced T&E through predation, habitat modification and secondary competition (Figure 1). The proportion of T&E animals influenced by these interactions varied by taxa (Figure 2).

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Table 2. The most widely occurring and detrimental genera that negatively interact with T&E vertebrate species.

Invasive Taxa	Frequency
<i>Rattus spp.</i>	104
<i>Sus spp.</i>	59
<i>Capra spp.</i>	37
<i>Cenchrus spp.</i>	37
<i>Solenopsis spp.</i>	37
<i>Stachytarpheta spp.</i>	32
<i>Psidium spp.</i>	31
<i>Lantana spp.</i>	31
<i>Malinis spp.</i>	29
<i>Micropterus spp.</i>	27
<i>Felis spp.</i>	27
<i>Lepomis spp.</i>	27
<i>Passiflora spp.</i>	27

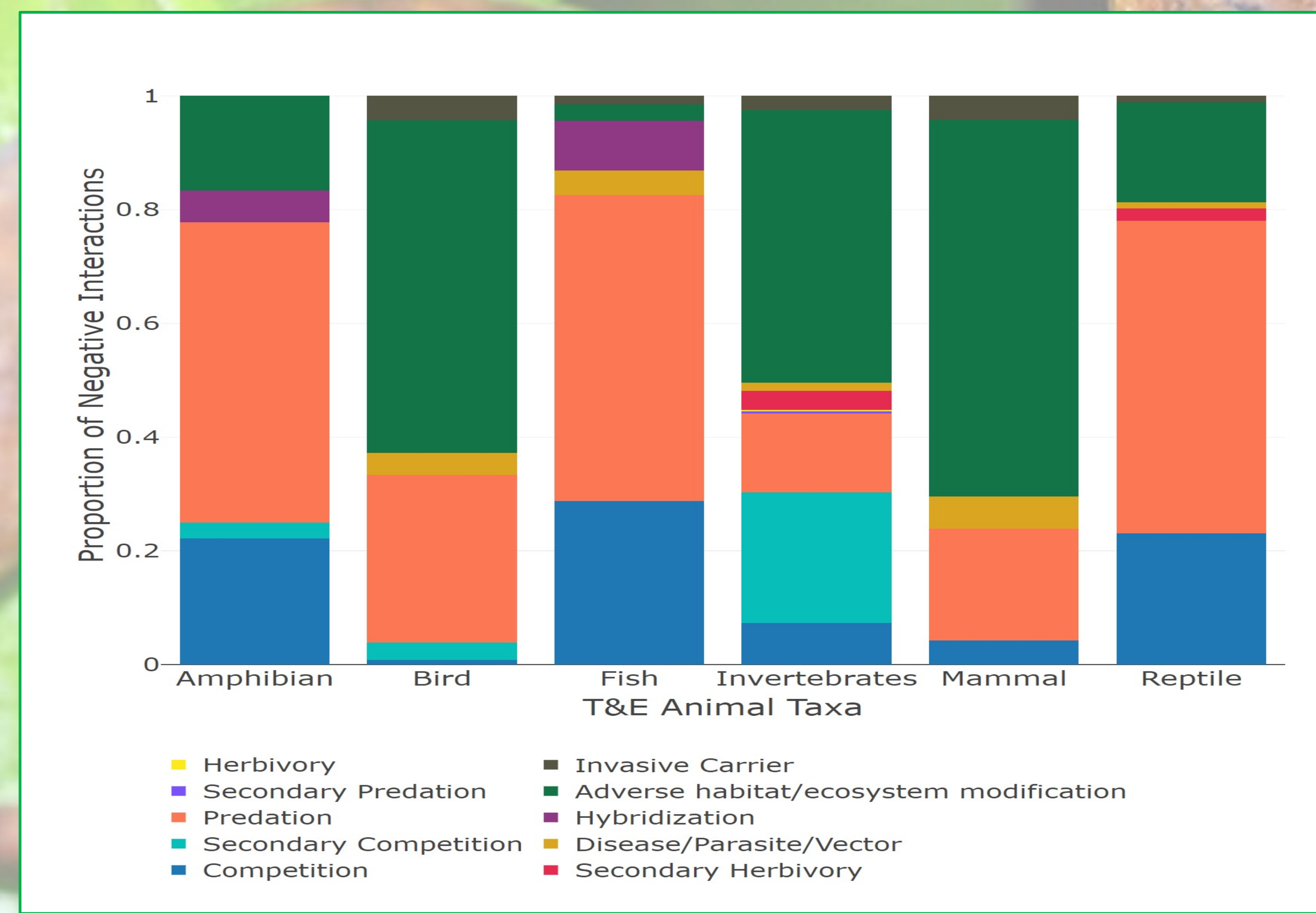


Figure 2. The most frequently occurring interactions between invasive and T&E species broken down by taxa. Amphibian, fish and reptile have predation as the top threat while birds, invertebrates and mammals' top threat is adverse habitat/ecosystem modification.

Discussion

Invasive species not only cause a great loss to native biodiversity, they also incur a great cost to local economies. The cost of invasive species control and damage exceeds \$110 billion annually in the US (Pimental et al. 2005). Feral pigs (*Sus scrofa*) alone can inflict \$1 billion annually of economic damage to agricultural production, as well as degrade habitat through rooting and transfer of pathogens to endangered species like the Akekee (*Loxops caeruleirostris*) and other imperiled Hawaiian birds (Bevins et al. 2014). Feral goats (*Capra hircus*) and rats (*Rattus spp.*) disrupt ecosystems by extirpating native species and modifying biological communities, causing local extinctions (Chynoweth et al. 2013 and Shiels et al. 2014). Recently, the Department of the Interior (DOI) released a draft strategic plan to decrease the spread of invasive species. We hope our continued analysis of invasive species influences on T&E species can help raise awareness, provide opportunities to consolidate and improve data collection efforts and improve coordination of invasive species control to benefit wildlife conservation. We are continuing our research efforts by quantifying the impacts of invasive species on T&E plants.