Productivity, Inequality, and biodiversity loss in human-dominated ecosystems

Shochat E, Lobo J, Anderies JM, Redman C, Warren PS, Faeth SH, Nilon CH

INTRODUCTION

Loss of diversity in human-dominated ecosystems is an established global pattern. The process that leads to this pattern remains unclear.

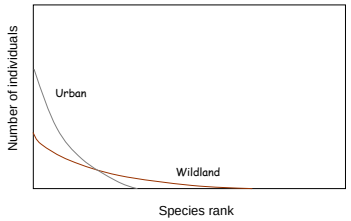
Habitat destruction (or fragmentation) normally serves as the explanation for this phenomenon in the literature.

because in urbanization a new habitat is being created, habitat fragmentation theory does not predict reduction in biodiversity. Thus, we believe that the 'habitat loss' theory *per se* is insufficient to explain diversity loss.

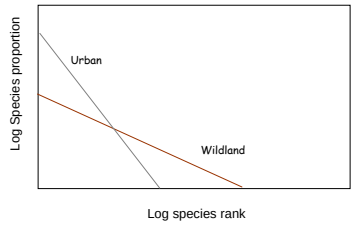
We suggest competitive exclusion of native species by human-commensal invasive species as a framework for the loss of diversity in human-dominated ecosystems:

- In human-dominated environments food resource densities are higher and predation pressure is probably lower than in wildlands.
- Populations grow, but unequally. Invasive species with high foraging efficiencies that normally do poorly in wildlands become highly dominant.
- These species out-compete and exclude many native species.

We predict that, sorted from most to least common, species rank distributions will look as follows:



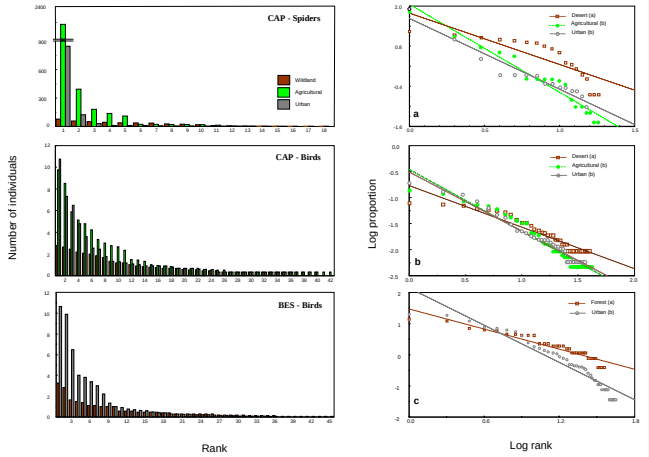
Log-transformation tends to linearize the curves, allowing statistical comparison. Urban habitats are predicted to have steeper negative slopes than wildlands:



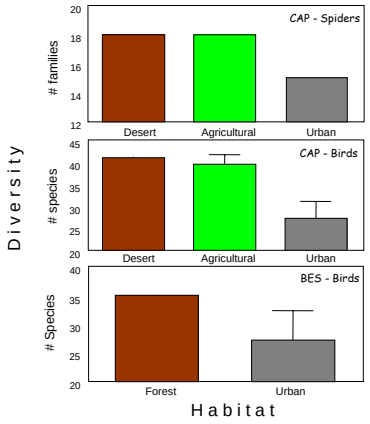
SPECIES DISTRIBUTION RANK

We compared urban and wildland community profiles from CAP-LTER (Spider families and bird species), and From Baltimore (Birds). In CAP, we also used data from agricultural fields. Statistical comparisons were performed using ANCOVA on the log transformed curves (a & b in fig. legends represent statistical differences).

- In all three cases inequality among species or families was higher in urban than in wildlands.
- In CAP, Agricultural field community profiles resembled those in the urban habitat.
- Spiders: Lycosidae (wolf spiders) increase from position 8 with 8% in Sonoran desert to 79% of the whole community in mesic urban yards.
- Birds: In Cap, House Sparrow moves from position 15 in Sonoran desert, through 5 in Agricultural, to 1 in the urban habitat. In Baltimore the Chimney swift is the most common urban species. It is absent from the nearby forest.



SPECIES DIVERSITY



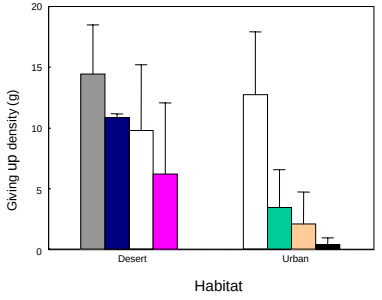
- In all three cases, biodiversity in the urban habitat was lower than in the wildland.
- Agricultural habitats appear to retain biodiversity that is as high as in wildlands.
- Error bars are given where we used rarefaction to control for bias in sample size.

MECHANISMS OF COEXISTENCE

Are urban species more efficient foragers than wildland species? We measured the Giving-Up densities (GUDs) of species on artificial food patches. We mixed 20 g millet seeds in 3 Kilo of sand. Birds experience "diminishing returns" when foraging and quit when the costs of foraging equals the benefit.

Lower GUDs are indicative of higher foraging efficiency.

- Urban species had lower GUDs than desert species.
- The House finch, the only species found on trays in both habitats, had lower GUDs in the desert. This species acts as a 'cream-skimmer', covering long distances and only feeding from the surface of the trays.
- A common mechanism of coexistence is when subordinate species are more efficient foragers than dominant ones. They can deplete food patches after the dominant species quit. The results suggest that this mechanism cannot work in urban settings.



CONCLUSIONS

- Human-dominated environments promote inequality in animal communities, regardless of taxa or region.
- This appears to lead to an increase in population densities of human-commensal species, which, in turn out-compete native species. The overall result is a global loss of biodiversity.
- The driver of this phenomenon may be selection for dominant species that are more efficient foragers than subordinate species.
- Thus, future conservation programs in agricultural and urban settings should focus on controls of top-down and bottom-up drivers of population densities, in addition to habitat and landscape management.