The Pleistocene extinctions altered energy use in modern large mammal communities across the globe

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Calculating community energy flow

- 241 global camera trap inventories from the Ecological Register
- Samples consist of native, wild species >1 kg from six main terrestrial ecological groups (Fig. 1)
- Basal metabolic rate (BMR) obtained from the primary literature for 141 of 441 species total
- Rates for remaining species were predicted based on body mass (Fig. 2)

Extinctions and energy use

- Current rates of extinction are over a hundred times higher than the typical background rate (Ceballos et al. 2015)
- Large mammals are particularly susceptible to extinction, yet also have disproportionate effects on ecosystems
- Losses can lead to severe consequences, including dramatic reductions in heterotrophic biomass and energy use (Enquist et al. 2020)

Community energy use varies geographically

Figure 1. Examples of species from the six ecological groups included in the analysis. From left to right: tiger (carnivore), eastern grey kangaroo (other large mammal), white-tailed jukarabiti (other small mammal), gorilla (primate), beaver (rodent), and wildebeest (ungulate). Images are CC BY-SA.

Figure 2. The relationship between log10 basal metabolic rate (BMR) and log10 body mass (g) for the 141 species whose BMR was obtained directly from the literature. This relationship was used to predict the BMR of the remaining species. Slope = 0.783, \( R^2 = 0.2146 \).

EF\( \text{com} \) = \( \sum_{i=1}^{n} (N_i \times M_i) \)/[kJ trap\(^{-1}\) day\(^{-2}\)]

\( n \) = number of species in a sample, \( N_i \) = abundance of species \( i \), \( M_i \) = metabolic rate of species \( i \)

- Energy use is significantly lower in South America and Australia than in Africa and Eurasia (Fig. 3)
- The pattern strongly reflects the spatial distribution of megafaunal extinction intensity during the Late Pleistocene

2. Rates of energy flow can recover to an extent of pre-extinction levels provided there are adequate conservation programs

- Rates are not reduced in North America (Fig. 3), a severely impacted region, due to the effective conservation of certain large mammal species (Fig. 4)

3. Energy use patterns can vary within regions most impacted by extinctions due to ecological differences between constituent species

- Further energetic differences are seen between the most impacted regions
- Per-gram rates of energy flow are significantly lower in Australia than in South America (Fig. 5)
- Due to fundamental differences in species abundances between realms

References


Key implications

Extinctions fundamentally alter rates of community energy use
The conservation of large mammals is essential to preserving community energy use around the globe