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Biodiversity conservation: The key is reducing meat consumption

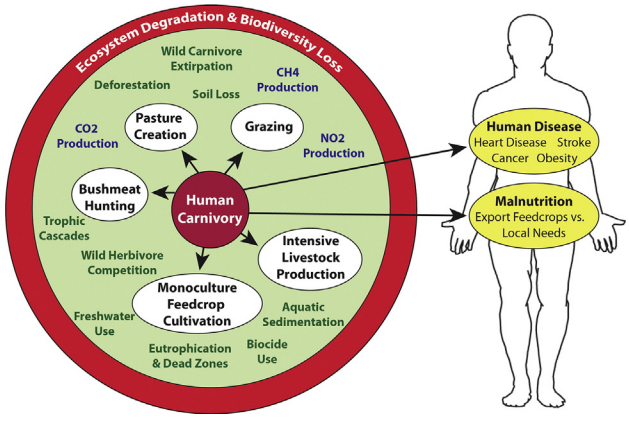
Brian Machovina [a,b,*], Kenneth J. Feeley [a,b], William J. Ripple [c]

[a] Florida International University, Miami, FL 33199, USA
[b] Fairchild Tropical Botanic Garden, Coral Gables FL 33156, USA
[c] Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR 97331, USA

HIGHLIGHTS

- Patterns of meat consumption in tropical Americas, Africa, and Asia are examined.
- Rates of meat production of tropical megadiverse countries are increasing.
- Some countries may require 30–50% increases in land for meat production in 2050.
- Livestock consumption in China and bushmeat in Africa are of special concern.
- Solutions include reduction, replacement, and reintegration of livestock production.

GRAPHICAL ABSTRACT



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ABSTRACT

The consumption of animal-sourced food products by humans is one of the most powerful negative forces affecting the conservation of terrestrial ecosystems and biological diversity. Livestock production is the single largest driver of habitat loss, and both livestock and feedstock production are increasing in developing tropical countries where the majority of biological diversity resides. Bushmeat consumption in Africa and southeastern Asia, as well as the high growth-rate of per capita livestock consumption in China are of special concern. The projected land base required by 2050 to support livestock production in several megadiverse countries exceeds 30–50% of their current agricultural areas. Livestock production is also a leading cause of climate change, soil loss, water and nutrient pollution, and decreases of apex predators and wild herbivores, compounding pressures on ecosystems and biodiversity. It is possible to greatly reduce the impacts of animal product consumption by humans on natural ecosystems and biodiversity while meeting nutritional needs of people, including the projected 2–3 billion people to be added to human population. We suggest that impacts can be remediated through several solutions: (1) reducing demand for animal-based food products and increasing proportions of plant-based foods in diets, the latter ideally to a global average of 90% of food consumed; (2) replacing ecologically-inefficient ruminants (e.g. cattle, goats, sheep) and bushmeat with monogastrics (e.g. poultry, pigs), integrated aquaculture, and other more-efficient protein sources; and (3) reintegrating livestock production away from single-product, intensive, fossil-fuel based systems into diverse, coupled systems designed more closely around the

* Corresponding author.
E-mail address: brianmachovina@gmail.com (B. Machovina).

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structure and functions of ecosystems that conserve energy and nutrients. Such efforts would also impart positive impacts on human health through reduction of diseases of nutritional extravagance.

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1. Introduction

Livestock production is the predominant driver of natural habitat loss worldwide. Over the 300 years ending in 1990, the extent of global cropland area increased more than five-fold and pasture areas increased more than six-fold, the latter encompassing an area 3.5 times larger than the United States (Goldewijk, 2001). A direct cost of land being converted to food production was the loss of nearly one-half of all natural grasslands and the loss of nearly one-third of all natural forests worldwide (Goldewijk, 2001). Although much of habitat lost to agriculture in the 1800s was temperate forests and grasslands, the second half of the 1900s saw rapid agricultural expansion in tropical countries, predominantly at the expense of biodiverse tropical forests (Gibbs et al., 2010). Agricultural expansion is, by far, the leading cause of tropical deforestation (Geist and Lambin, 2002). Although some agricultural expansion is driven by farmers growing crops for direct human consumption, livestock production, including feed production, accounts for approximately three-quarters of all agricultural land and nearly one-third of the ice-free land surface of the planet, making it the single largest anthropogenic land use type (Steinfeld et al., 2006a). Livestock comprise one-fifth of the total terrestrial biomass, and consume over half of directly-used human-appropriated biomass (Krausmann et al., 2008) and one-third of global cereal production (Foley et al., 2011; Alexandratos and Bruinsma, 2012). Though difficult to quantify, animal product consumption by humans (human carnivory) is likely the leading cause of modern species extinctions, since it is not only the major driver of deforestation but also a principle driver of land degradation, pollution, climate change, overfishing, sedimentation of coastal areas, facilitation of invasions by alien species, (Steinfeld et al., 2006a) and loss of wild carnivores (Ripple et al., 2014a) and wild herbivores (Ripple et al., 2015). Global trade is an underlying and powerful driver of threats to biodiversity (Lenzen et al., 2012), and international trade of feedcrops and animal products is growing rapidly (Keyzer et al., 2005b; Godfray et al., 2010). Current global rates of extinction are about 1000 times the estimated background rate of extinction, (Pimm et al., 2014) and the number of species in decline are much higher in the tropics — even after accounting for the greater species diversity of the tropics (Dirzo et al., 2014). Here we present an overview of the connection between animal product consumption and current and likely future patterns of ecosystem degradation and biodiversity loss, the important influence of China in this relationship, the interwoven role of climate change, as well as the direct linkages with human health. In addition, we propose solutions for potentially reducing the negative effects of animal product consumption on ecosystems, biodiversity, and human health.

2. Patterns of biodiversity loss driven by meat consumption in the tropics

2.1. Trends and projections

Animal product consumption is ubiquitous, but consumption levels, types and levels of livestock production, and future projected growth vary among Earth's tropical regions. The Amazon is the planet's largest continuous tropical forest and is a primary example of biodiversity loss being driven by livestock production. Never before has so much old-growth and primary forest been converted to human land uses so quickly as in the Amazon region (Walker et al., 2009). Over three-quarters of all deforested lands in the region have been converted to livestock pasture and feedcrop production for domestic and international markets (Nepstad et al., 2006; Nepstad et al., 2008; Walker et al., 2009). Rising worldwide demands for meat, feedcrops, and biofuel are driving rapid agro-industrial expansion into Amazon forest regions (Nepstad et al., 2008). Although there have been some recent brief periods (2006–2010) when deforestation rates slowed in the Amazon as feedcrop (soy) production expanded more into pasture (Macedo et al., 2012), or were offset by clearing of native vegetation in the adjacent Cerrado region (Gibbs et al., 2015), rates have recently increased. The deforestation accumulated during the period from August 2014 to April 2015, corresponding to the first nine months of the calendar for measuring deforestation, reached 1898 km^2, a 187% increase in deforestation in relation to the previous period (August 2013 to April 2014) when it reached 662 km^2 (Fonseca et al., 2015). Feedcrop production as well as pasture is projected to continue expanding in the Amazon (Masuda and Goldsmith, 2009). Eventually, cleared land that is suitable for feedstock soy production will become scarce and remaining forests outside of protected areas in the Brazilian Amazon will be at risk of conversion to soy (Nepstad et al., 2014). The woodland–savannah