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Community-based population recovery of overexploited Amazonian wildlife

João Vitor Campos-Silva[a,*], Carlos A. Peres[b], André P. Antunes[c], João Valsecchi[d], Juarez Pezzuti[e]

[a] Institute of Biological and Health Sciences, Federal University of Alagoas, Av. Lourival Melo Mota, s/n, Tabuleiro do Martins, Maceió 57072-900, AL, Brazil
[b] Centre for Ecology, Evolution and Conservation, School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich NR47TJ, UK
[c] Wildlife Conservation Society Brasil, Federal University of Amazonas, Av. Rodrigo Otavio, 3000, Manaus 69077-000, Amazonas, Brazil
[d] Mamiraua Sustainable Development Institute (IDSM), Estrada da Bexiga 2584, Fonte Boa, Tefé, AM, Brazil
[e] Centre for Advanced Amazon Studies, Federal University of Para, R. Augusto Correa 01, CEP 66075-110, Belém, PA, Brazil

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ABSTRACT

The Amazon Basin experienced a pervasive process of resource overexploitation during the 20th-century, which induced severe population declines of many iconic vertebrate species. In addition to biodiversity loss and the ecological consequences of defaunation, food security of local communities was relentlessly threatened because wild meat had a historically pivotal role in protein acquisition by local dwellers. Here we discuss the urgent need to regulate subsistence hunting by Amazonian semi-subsistence local communities, which are far removed from the market and information economy. Following positive examples from community-based management of aquatic and terrestrial resources, we advocate that hunting practices, based on modern scientific principles firmly grounded in population ecology, represent a strong window of opportunity to recover viable populations of previously overexploited wildlife.

Introduction

The Amazon basin experienced a dramatic process of 20th-century overexploitation of a wide range of both terrestrial and aquatic species, partly resulting from the international hide trade. Large-bodied vertebrates, such as black caiman (*Melanosuchus niger*), giant otter (*Pteronura brasiliensis*), manatee (*Trichechus inunguis*), giant air-breathing fish (*Arapaima gigas*) and white-lipped peccary (*Tayassu pecari*) succumbed to steep population declines due to overhunting and overfishing (Antunes et al., 2016; Fig. 1). Vertebrate overexploitation can lead to abrupt ecological changes that degrade the resilience and ecosystem services of Amazonian environments (Doughty et al., 2013; Peres et al., 2016). Moreover, population declines and local extirpation of game species can substantially reduce food security for Amazonian forest and floodplain dwellers, given that animal protein is a limiting resource across the Amazon basin (Headland and Bailey, 1991). Strategies to minimize habitat loss and reverse wildlife population declines — to ensure both the critical role of these species in ecosystem functioning and provide a safety net for local communities — represent an urgent conservation priority.

Protected areas worldwide arguably represent the key cornerstone in preventing or mitigating further habitat degradation and biodiversity loss (Bruner et al., 2001; Coetzee et al., 2014). However, tropical countries are typically under sharp financial duress and lack human resources to substantially implement protected area management (e.g. Campos-Silva et al., 2015). For instance, Brazil's ~1.6 million km^2 State of Amazonas, the subnational political unit controlling the largest tropical forest area on Earth, currently counts on only three staff employed to manage all 42 state protected areas, representing only 0.07 employee per reserve, or a mean reserve area of nearly 6.3 Mha per park manager. Novel approaches to both strengthen and diversify biodiversity conservation strategies are therefore critically needed.

In low-governance countries, decentralizing state-controlled natural resource management, including formal alliances with local communities, can substantially strengthen surveillance systems, reduce costs and improve effectiveness (Somanathan et al., 2009). Positive examples from community-based management arrangements have been documented in many natural ecosystems (Gibson and Marks, 1995; Cinner et al., 2012a,b; Somanathan et al., 2009). However, developing a legal regulation framework and robust

* Corresponding author.
E-mail address: jvpiedade@gmail.com (J.V. Campos-Silva).

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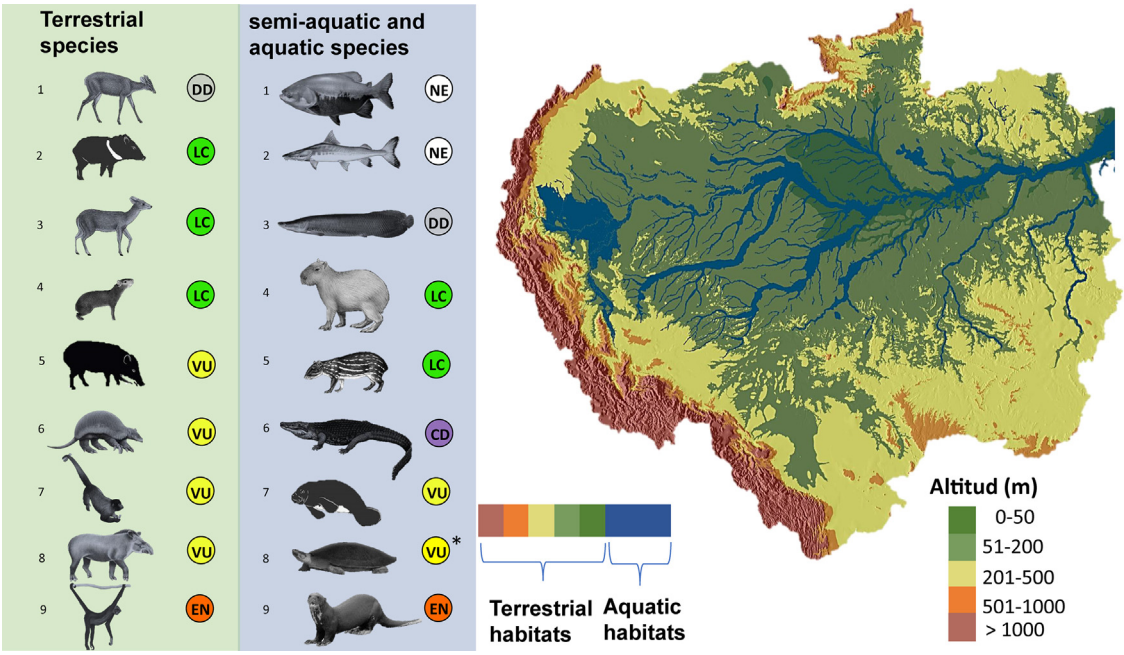

Fig. 1. Main species exploited and their habitats. A profile of key wildlife resources harvested for both subsistence and trade from either terrestrial or aquatic ecosystems across the entire hydrological boundary of the Amazon basin. Exemplar species of terrestrial (including strictly terrestrial and arboreal) and aquatic (including semi-aquatic) vertebrates are shown in the green and blue vertical columns, respectively. Circles denote the current IUCN conservation status of each species according to the latest update (IUCN, 2017). Green (Least Concern) and purple (Conservation Dependent) symbols represent low-risk species; yellow (Vulnerable) and orange (Endangered) symbols represent threatened species; grey symbols represent Data Deficient species and white symbol represent species that were not assessed. The elevational range of Amazonia is shown on the map, including strictly terrestrial and seasonally flooded areas, and permanent water bodies. Numerical codes denote the following species groups: Terrestrial: (1) Grey brocket deer, *Mazama gouazoubira*; (2) Collared peccary; *Pecari tajacu*; (3) Red brocket deer, *Mazama americana*; (4) Black agouti, *Dasyprocta fuliginosa*; (5) White-lipped peccary, *Tayassu pecari*; (6) Giant armadillo, *Priodontes maximus*; (7) Woolly monkey, *Lagothrix* sp.; (8) Lowland tapir, *Tapirus terrestris*; (9) Spider monkey, *Ateles* sp.; Aquatic: (1) Tambaqui, *Colossoma macropomum*; (2) Dourado catfish, *Brachyplatystoma rousseauxii*; (3) Arapaima, *Arapaima gigas*; (4) Capybara, *Hydrochoerus hydrochaeris*; (5) Lowland paca, *Cuniculus paca*; (6) Black caiman, *Melanosuchus niger*; (7) Amazonian manatee, *Trichechus inunguis*; (8) Freshwater turtles, *Podocnemis* spp.; and (9) Giant otter, *Pteronura brasiliensis*. *Three species of freshwater turtles: South American river turtle (*Podocnemis expansa* – Conservation Dependent); Yellow-spotted river turtle (*Podocnemis unifilis* – Vulnerable) and six-tubercled Amazon river turtle (*Podocnemis sexturbeculata* – Vulnerable). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

management tools are critical to empower and consolidate these arrangements. Here, we discuss pragmatic approaches to effectively achieve the conservation of viable populations of Amazonian wildlife through community-based management initiatives.

Lessons from aquatic resources

Impressive cases of sustainable use and population recovery of aquatic vertebrates have been shown in Brazilian Amazonia. *A. gigas*, the world's largest scaled freshwater fish, was historically decimated at most sites across entire Amazonian floodplains (Veríssimo, 1895), but community-based fishery management have led to a gradual recovery of wild populations (Castello et al., 2009; Petersen et al., 2016; Campos-Silva and Peres, 2016). Local communities, under strict collaborative arrangements with government agencies, NGOs and academia, have co-designed a number of spatially-explicit fisheries zones accommodating the interests of multiple stakeholders, resulting in locally protected and subsistence lakes used by small-scale fisherfolk, and lakes used by commercial fishing boats. Protected lakes can safeguard arapaima populations 30-times larger than similar-sized unprotected lakes (Campos-Silva and Peres, 2016). This ensures annual sustainable harvest quotas (up to 30% of total adults counted by the local managers in the previous year) commercialized locally, which protect not only this target species but several overexploited taxa, such as freshwater turtles, caimans and other high-value fish species, all of which have increased at managed sites (Miorando et al., 2013; Arantes and Freitas, 2016; Campos-Silva and Peres, 2016). Beyond marked demographic outcomes, community-based management provides unprecedented socioeconomic welfare for rural floodplain communities, enhancing their direct income, standards of living, and social organization (Campos-Silva and Peres, 2016).

Another pertinent example is the community-based protection of fluvial sand beaches, focusing on the conservation of freshwater *Podocnemis* turtles (*P. expansa*, *P. unifilis* and *P. sexturbeculata*). This was spearheaded by the Amazon Chelonian Program, a governmental initiative launched in the early 1970s, based on mapping of remaining large breeding populations of *P. expansa*, which in many cases had already been protected by local communities. This strategy consists of protecting beaches and breeding females along major rivers during the turtle reproductive season, thereby deterring poachers from raiding both eggs and adult females (Andrade, 2015; Campos-Silva, 2016; Pezzuti et al., 2017). *Podocnemis* turtles have gradually recovered across many areas of lowland Amazon (Cantarelli et al., 2014; Andrade, 2015; Camillo et al., 2012). Although population outcomes are impressive, the social benefits are still timid due to the absence of tangible socioeconomic gains delivered to local beach guards, although this embryonic program is on a positive trajectory (Projeto Médio Juruá, unpubl. data; Pezzuti et al., 2017).

Terrestrial game hunting: a management imperative?

We recognize different types of hunting, including commercial, recreational, trophy and population culls, but given our collective experience, we will largely focus on the issue of subsistence hunting, unavoidably with a strong Amazonian bias. This encompasses traditional livelihoods in Amazonian countries, for whom subsistence hunting is a daily necessity to meet animal protein needs, including indigenous groups, *caboclos*, *ribeireños*, *quilombolas*,

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