Global Ecology and Conservation 12 (2017) 9–20

Contents lists available at ScienceDirect

Global Ecology and Conservation

journal homepage: http://www.elsevier.com/locate/gecco

Review Paper

How are garbage dumps impacting vertebrate demography, health, and conservation?

Pablo I. Plaza*, Sergio A. Lambertucci

Grupo de investigaciones en Biología de la Conservación, Laboratorio Ecotono, INIBIOMA (Universidad Nacional del Comahue – CONICET), Quintral 1250 (R8400FRF), San Carlos de Bariloche, Argentina

ARTICLE INFO

Article history:
Received 16 March 2017
Received in revised form 3 August 2017
Accepted 3 August 2017
Available online 22 August 2017

Keywords:
Rubbish dumps
Organic waste
Landfills
Introduced species
Endangered species
Vertebrates

ABSTRACT

Organic waste can be considered a food subsidy which represents an important source of energy for different species that exploit it. However, it could produce contrasting impacts, both positive and negative. We reviewed which species of terrestrial vertebrates (birds, mammals, reptiles and amphibians) exploit rubbish dumps, and the impacts that waste produces on them. We analysed 159 articles including 98 species that are present in rubbish dumps. Studies come from all over the world (including Antarctica), but mainly from Europe, North America and Africa. Impacts reported on vertebrates were manly considered positive (72.6%) but around a quarter showed negative impacts. Rubbish dumps provide food resources that may improve body condition, enhance reproductive performance and abundance, improve survival rate, alter movements, and they can be an important sustenance for some endangered species. However, these places increase the risk of pathogen infections and poisoning, can be responsible for the spread of introduced-invasive species and favour conflicts between humans and animals that use them. Moreover, species that take advantage of these sites can produce negative impacts on others that do not use them. Worldwide increase in waste production makes this novel ecosystem important on shaping ecological communities. Therefore, the spatial and temporal effects of rubbish dumps on wildlife should be evaluated more deeply at a worldwide scale considering current differences in waste production from developing to developed countries.

1. Introduction

Humans have altered the ecosystem voluntary and involuntary through the activities performed at global scale (Foley et al., 2005; McKinney and Lockwood, 1999). One of the most important current drivers of ecosystem alteration is the predictable anthropogenic food subsidies -food remains produced by humans and exploited by other species-, especially those derived from rubbish dumps (Oro et al., 2013). Solid waste generation is mostly an urban phenomenon and, as urbanization increases, this problem also increases (Hoornweg et al., 2013). Indeed, waste volumes are growing faster than urbanization rates and its generation rates will be more than double in the next twenty years, especially in lower income countries (Hoornweg and Bhada-Tata, 2012). Every day people discard 3 million tonnes of waste around the world, by 2025 the waste

* Corresponding author.
E-mail address: plazapablo22@gmail.com (P.I. Plaza).

http://dx.doi.org/10.1016/j.gecco.2017.08.002

generated is expected to be 6 million tonnes per day and by 2100 it will exceed 11 million (Hoornweg and Bhada-Tata, 2012; Hoornweg et al., 2013). Therefore, a peak of waste is expected in the early coming century (Hoornweg et al., 2013). In this complex context of waste overproduction, it is expectable that this problem may enhance the ecosystem alteration and lead to a novel ecosystem where changes in biodiversity may occur (Hobbs et al., 2009).

Food subsidies derived from rubbish dumps have both positive and negative attributes. On the one hand, they are worldwide distributed, abundant, spatially and temporally predictable, daily renewed and represent a potential valuable food source (Oro et al., 2013). Since they are composed of parts of meat, fish, chicken, fresh fruit, meals and eggs (Parfitt et al., 2010) they can be exploited by different species along the food chain and can be used as part of their caloric requirements (Oro et al., 2013). On the other hand, however, with these anthropogenic organic items there are also glasses, metals, wire, plastic, paints, different toxics and dangerous pathogens, which can alter individuals' health and abundances (Flores-Tena et al., 2007; Houston et al., 2007; Matejczyk et al., 2011). Therefore, taking advantage of these food subsidies could produce contrasting impacts on vertebrate populations that need to be studied in detail.

Many studies around the world document the use of rubbish dumps by different species (Newsome et al., 2015; Oro et al., 2013). However, there is not much information on the conservation status and population tendencies of species using them. Moreover, there is little information about the health impacts associated to this foraging strategy, survival rates in these sites and the impacts that species using rubbish dumps produce on other species that do not use them. Oro et al. (2013) made a great advance onto this subject, but with a broader focus on different types of food subsidies including food intentionally provided to wildlife. Therefore, a review specifically addressing this topic, focusing in detail on rubbish dumps as food sources, direct and indirect impacts of rubbish dumps on wildlife, and consequences at ecosystem level is timely and necessary. The aim of this study is to review which species of terrestrial vertebrates (birds, mammals, reptiles and amphibians) exploit rubbish dumps, and the impacts that waste produces at individual, population and ecosystem levels. We also study the consequences of the presence of species favoured by these food sources on other species that do not use them, and on the potential conflicts with humans. This information is relevant to make better policies about waste management, and to perform better conservation policies, particularly for endangered or invasive species that exploit these sites.

2. Materials and methods

We performed an intensive bibliographic search of articles related to vertebrate presence or use of rubbish dumps-landfills through Google Scholar and Scopus search engines, without restriction on year or geographic localization. We performed 5 different searches with different relevant terms combinations. The first was performed with the following terms 'landfills', 'garbage' or 'rubbish dumps' coupled with 'animals', and the other searches were performed with the following terms: 'landfills', 'garbage' or 'rubbish dumps' coupled with 'birds', 'mammals', 'reptiles' and 'amphibians'. We then reviewed the first 1000 returns of each one in the case of Google Scholar and all the returns in the case of Scopus, to include only articles that assess the presence or use of rubbish dumps by birds, mammals, reptiles and amphibians. Finally, we performed a search in the literature cited in the articles we reviewed.

With the selected articles, we first determined the species of vertebrates present in these sites. Then we extracted information about direct impacts of these food subsidies on the studied species, particularly on body condition, reproductive performance, population survival, population abundance, pattern of movement, pathogen infection risk, toxic exposure risk and foreign body ingestion. We also reviewed the impacts of rubbish dumps on the presence of introduced-invasive species and threatened species. After that, we reviewed information on indirect impacts of rubbish dumps as the conflicts produced between animals using these sites and humans, and the impacts that species using these places can produce on others that do not use them. Finally, we reviewed the consequences produced by these food subsidies at ecosystem level.

3. Results

We found 159 articles studying 98 vertebrate species that are present in rubbish dumps: 54 species of birds, 34 species of mammals, 5 species of amphibians and 5 species of reptiles (Supplementary Material Table S1). Most studies (72.6%) showed positive impacts of rubbish dumps on individuals and populations, a little more than a quarter (25.8%) showed negative impacts and the rest do not assess impacts. We found studies performed all over the globe including Antarctica, but the 61.7% came from Europe and North America, and a third from Africa, South America and Asia (Fig. 1). Most articles, (96%, 153/159), showed that the species use rubbish dumps as food resource. Regarding birds that do this, we found a predominance of studies on carnivores, both predators and scavengers, with *Larus* as the most represented genus with almost half (46%, 45/98) of the studies. Regarding mammals, most studies were focused on predators (76%, 35/46), including domestic species as cats (*Felis catus*) and dogs (*Canis lupus familiaris*), and the rest of the studies were focused mainly on rodents, primates and livestock. Most studies found on reptiles were performed on species of the genus *Varanus*, and there was no study that showed organic waste use as food source by amphibians (Supplementary Material, Table S2).

Some studies addressing dumps as food resources (6.3%, 10/159), showed a positive relationship between body mass - body condition and organic waste use as food resource. There were 13.2%, (21/159) of the studies that addressed the influence that organic waste produce in the reproductive performance of different species, and 81% (17/21) of them agreed that exploiting these food subsidies produces an improvement in reproductive parameters such as clutch size, egg volume, and egg size-hatching mass. However, 19% (4/21) of the studies showed negatives impacts of organic waste use on reproductive