



## Anthropogenic impacts on frugivory and seed dispersal (part II)

**Thema proposed by** [Norbert Cordeiro](#) (Roosevelt University) and [Daniel Garcia](#) (Universidad de Oviedo).

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Anthropogenic impacts of over-hunting and habitat fragmentation and/or degradation causes biodiversity decay worldwide. While frugivore extinctions, especially of large-bodied species, form an important component of this biodiversity loss, declines in frugivores may also lead to a concomitant seed dispersal collapse of dependent plant species in tropical and temperate ecosystems alike. Mechanisms leading to seed dispersal disruption are multiple and complex, and operate at multiple spatial and temporal scales. Apart from over-hunting, habitat loss and fragmentation may also disrupt seed dispersal even much before the extinction of dispersers. This may manifest by modifying the spatial patterns of foraging and movement of frugivorous animals. The effects of defaunation from over-hunting and habitat fragmentation may, however, emerge at smaller scales involving habitat fine structural features (e.g. the presence of individual fruiting trees), to larger scales involving species geographic ranges. The ultimate consequences of anthropogenic impact on seed dispersal also emerge at different levels of biological complexity, from the demographic responses of individual plant species, to the changes in the composition and structure of plant communities, and across the evolutionary change of plant populations.

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species composition in tropical forests

### Human frugivory and seed dispersal in Neotropical forests

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In Neotropical forests, indigenous people gather wild fruits and travel from hundreds of meters to tens of kilometers per day. Thus, they disperse seeds over a wide range of distances. Seeds may be spit out along trails (e.g., *Inga* spp.), discarded on rubbish heaps (e.g., *Oenocarpus* spp.), or purposefully planted (e.g., *Pourouma* spp.). Groups with the least frugivory might consume only a few species of wild fruits, while others, such as the Joti, in Venezuela, consider 222 species of wild tree fruits edible, and regularly consume fruits of two dozen species. Despite these facts, documented primarily by ethnobiologists, ecologists who study distributions of tropical trees almost uniformly ignore the human dimension of seed dispersal, even though historical effects of seed dispersal by humans may persist for centuries. For example, groves of *Ecclinusa guianensis* are apparently maintained and visited regularly by the Joti. Not solely as hunters of frugivorous vertebrates should humans be considered part of the seed dispersal equation, and the effectiveness of seed dispersal by humans should be measured. Human hunting, frugivory and seed dispersal coupled with activities of non-human frugivores, seed dispersers, and seed-eating animals might together impact select tree populations. We will discuss data on human movement patterns, their potential for very long distance dispersal of large seeds, and the known scope of frugivory among different indigenous groups in Neotropical forests.

### Vanishing endemic frugivorous birds and endangered plants in the islands of Eastern Polynesia (South Pacific): an extinction cascade?

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Islands are known to be extinction hotspots for endemic birds, including many frugivorous species. Their role as dispersers of native and endemic plants is critical for island colonization, plant succession, and forest regeneration. On the remote oceanic islands of Eastern Polynesia (South Pacific), human colonization by Polynesians around 1,000 years ago triggered a wave of avian extinctions, which have continued with the arrival of Europeans in the 18<sup>th</sup> century and into the present. Palaeo-archeological and historical records reveal that half of the ca. 50 known frugivorous species (fruit doves *Ptilinopus*, pigeons *Ducula*, starlings *Aplonis* and cuckoo-doves *Macroptylgia*) from 29 islands have been lost. All frugivorous species have disappeared on at least seven islands, and more than 50% on four other islands. We assessed the conservation status of large-fruited (> 1 cm in diam.) endemic woody plant taxa, including large trees (*Nesoluma* and *Planchonella*, Sapotaceae, *Hernandia*, Hernandiaceae), small trees (*Santalum*, Santalaceae, and *Ochrosia*, Apocynaceae), shrubs (*Ixora* and *Psychotria*, Rubiaceae, *Cyrtandra*, Gesneriaceae) and palms (*Pritchardia*,



Arecaceae) in these islands, based on IUCN Red Lists and recent botanical surveys. Results show that a high proportion of endangered and presumed extinct plants occur on islands that have lost frugivorous birds, suggesting a cascading extinction effect. Other important factors contributing to the increased vulnerability of the endemic flora are habitat destruction and fragmentation, seed predation by rats and plant invasions.

### **Different ecological patterns in the seed dispersal systems of two endemic junipers (*Juniperus cedrus* and *J. brevifolia*) in the Macaronesian archipelagos**

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Representative populations of the two endemic endangered junipers that occur in the Macaronesian islands (*Juniperus cedrus* from Canary Islands and Madeira, and *J. brevifolia* from the Azores) were selected to study their respective seed dispersal systems. Droppings and pellets from the potential frugivores were collected and analysed, subjecting undamaged seeds to germination experiments. Results indicate that the wintering *Turdus torquatus* and the native *T. merula* were the main seed dispersers for *J. cedrus* and *J. brevifolia*, respectively. The endemic lizard *Gallotia galloti* was quantitatively outstanding as seed disperser of *J. cedrus*, although its qualitative effect does not appear to be beneficial. A seasonal replacement pattern of the main seed disperser agents allows *J. cedrus* seeds to be dispersed throughout the year. Nevertheless, the introduced rabbit *O. cuniculus* acts as a disruptor in the natural seed dispersal systems of both junipers, as inferred from the high percentage of damaged seeds found in their droppings. *Juniperus cedrus* and *J. brevifolia* are primarily adapted to ornithochory processes, *T. torquatus* and *T. merula* being legitimate seed dispersers and probably playing a key role in the connectivity of fragmented populations. However, the dependence of *J. cedrus* on a migrant bird for the long distance dispersal of its seeds implies a notable fragility of the system, conservation of *T. torquatus* being the key to the persistence of this endangered juniper.

### **The importance of piling wood debris on bird-dependent seed dispersal in Mediterranean burned forests**

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Salvage logging is the most frequent management practice in recently burned pine forest in the Mediterranean region, and has important impacts on bird communities. Therefore, it is likely to affect bird dependent seed dispersal as well. Different microhabitats appear as a result of logging and postfire succession: cleared areas, unlogged patches, snag perches, regenerated shrubland, etc. Non-commercially profitable wood debris can be spread on the ground or piled, as erosion barriers in steep slopes or as small piles. We investigated the effect of these microhabitats on frugivorous disperser birds' occurrence, seed rain and distribution of



dispersed plant species, in Mediterranean lowland pine forests. We found that birds select wood debris piles above other microhabitats, which is likely to be the cause of the greater seed density found under those piles. Some of the dispersed seeds came from unburned areas, which involves a colonization of bird-dispersed plants to burned areas in the short time after fire, possibly affecting vegetation recovery. Furthermore, wood debris piles also have a longer term effect on the spatial distribution of some dispersed plant species, which are more abundant in piles than out of them, especially in driest areas. Therefore, it is highly recommendable to build wood piles in burned and salvage logged pine forests, since they have an important role in the conservation of the seed dispersal process by frugivorous birds in such areas.

### **Seed dispersal by animals in a shaded coffee agroecosystem in Mexico: How prevalent is it, and how is it perceived by people?**

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Shaded plantations are recognized worldwide for their potential use as ecologically-friendly matrices that might be compatible with long-term conservation goals in anthropogenic landscapes. Most of these plantations occur in rainforest areas, where many native plant species depend on animals for seed dispersal. In this study we quantified the number of tree and shrub species maintained in shaded coffee plantations and assessed the prevalence of zoochory. We also interviewed farmers and high-school students to determine their knowledge and perception regarding seed dispersal by animals. We found that shade-coffee plantations have a high richness (86) of trees and shrubs, and that 81% of these species are dispersed by animals. However, about half of the plant species present as adults, were not recorded as juveniles. In terms of the knowledge and perception of people, all farmers perceived seed dispersal as important, while only 63% of students did. Regarding knowledge, most farmers were able to explain, to some degree, why seed dispersal is important. Almost all farmers mentioned birds as seed dispersers, while only 25% indicated non-flying mammals, and only one mentioned bats. Results on knowledge were similar for students. If animals and their roles in plant regeneration are understood, and perceived as being important, by the local people responsible for managing these agroecosystems, then their potential for conservation purposes will be enhanced.

### **Impact of gold mining on seed dispersal and extractive resources in a Papua New Guinea rainforest**

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Papua New Guinea is among the planet's five High Biodiversity Wilderness Areas. Enga Province (12,800 km<sup>2</sup>) comprises more rainforest than any other province of Papua New Guinea, but has received the lowest biological survey effort in the country. This biodiverse province has also sustained extreme anthropogenic impacts related to the development of one



of the world's largest gold mines (Porgera). Our understanding of the impact of the Porgera mine on the relationships among plants, their seed dispersers, and human use of forest resources is virtually non-existent. Here, we present preliminary data on the distribution, richness, abundance, and extractive resources of zoochorous tree species. Data were collected in Enga Province 1998 – 2006; methods include participant observation and interviewing of local Ipili and Engan speaking inhabitants, GIS analysis, and plant/animal survey. In addition, transects (50 x 10 m) were established and all trees >10cm DBH were classified with regard to their utility for extractive resources. Seven species (3 families) of frugivorous mammals were identified in the study area, including terrestrial, arboreal, and volant forms. Of 104 bird species, 21 were identified as frugivorous seed dispersers. 200 tree species were identified by local inhabitants, many of which are both zoochorous and yield extractive resources. The implications of these preliminary data for plant-animal-human interactions in a rapidly changing habitat will be discussed.

### **The consequences of hunting for frugivores, seed dispersal and plant species composition in tropical forests**

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Hunters reduce frugivore abundances and the dispersal of frugivore-dispersed seeds in tropical forests. This can have far reaching effects on the structure, dynamics and species composition of tropical forests by favoring woody climbers or lianas. The seeds of > 60% of tropical liana species are dispersed by wind while the seeds of > 80% of tropical tree species are dispersed by frugivores. In central Panama, lianas are 100% more abundant in the seedling layer at heavily hunted sites than at protected sites even though both types of sites have similar canopy tree species compositions. Lianas replace the leaves of their host trees on a one-to-one mass basis, reduce host tree growth rates and increase host tree mortality rates. Thus, hunters and reductions in frugivores might contribute to many of the long-term changes that have been documented for the structure and dynamics of tropical forest tree communities.