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Eradication of exotic species

In their recent *TREE* review, Myers *et al.*[1] thoroughly discuss the pros and cons of eradication programs of invasive exotic species. Although these authors acknowledge the importance of evaluating possible ecological side effects when implementing such eradication programs, they do not explicitly consider the situation in which certain invasive exotic species become keystones for the survival of local endemics.

This is well illustrated by two proposed plant eradication programs in island archipelagos in the northern Atlantic, such as the Azores and Madeira. Most of the native and endemic laurel–juniper forest vegetation on these islands has been replaced or severely altered by several introduced exotic plants (the area of origin is shown in parentheses), such as *Clethra arborea* (Europe), *Cryptomeria japonica* (Japan), *Hedychium gardneranum* (Himalayas), *Hydrangea macrophylla* (Japan) and *Pittosporum undulatum* (Australia). Therefore, the restoration of the native vegetation would require the eradication of these exotics and, in particular, of the extremely fast-growing rhizomatous perennial herb *H. gardneranum*[2–4]. However, some of these exotic plants provide a good micro-ecological environment (e.g. water-balance and hiding places) for several unique endemic land snail species, such as *Actinella*, *Columella*, *Drouetia*, *Hydrocena*, *Leptaxis*, '*Napaeus*' (this genus is currently under revision, thus we use this name provisionally) and *Insulivitrina*. Today, many of these endemic snails more commonly live in association with the introduced exotic plants than with the native (endemic) vegetation[5–10]. Hence, the eradication of the exotic plants would inevitably provoke severe population bottlenecks, if not (local) extinction, for several of the endemic snails. Also, on the island of Mauritius in the Indian Ocean, experimental studies showed that the weeding of exotic plants was detrimental to most native species of land snails[11].

Similarly, the eradication of *C. arborea* in the Azores would be detrimental for the endemic bullfinch (*Pyrrhula murian*) because *C. arborea* provides the best food source during winter[3]. Hence, eradicating exotic plants (and the concomitant re-establishment of the original vegetation) might be detrimental for local endemics, particularly if these endemics have established beneficial relationships with the alien species. Therefore, we believe that this issue should not be overlooked when implementing eradication programs in areas with high endemicity.

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Reply from J. Myers, D. Simberloff, A. Kuris and J. Carey

Van Riel *et al.*[1] provide several examples of exotic plant species apparently becoming 'keystone species' in island archipelagos, and providing habitats for snails and birds after displacing native plants. We could easily have provided other examples. The federally endangered giant kangaroo rat (*Dipodomys ingens*) in California depends on exotic Mediterranean annuals for its continued existence[2]. The well publicized, invasive, exotic saltcedars, *Tamarix ramosissima* and *Tamarix parviflora*, are the source of a major controversy in western USA (Refs 3,4). In riparian areas, dense stands of these species displace native plants and their associated animals, reduce the water table causing increased salination of the soil, dry up ponds, and narrow waterways. Saltcedars have been associated with the decline of 41 threatened or endangered species, especially birds and fish. However, because the endangered southwestern subspecies of the willow flycatcher (*Empidonax traillii extimus*) nests in saltcedars, the initial biological control proposal was rejected.

Successful biological control reduces the density of the target weed over several years, thus providing the potential for native species to re-establish. In addition, revegetation programs could facilitate the recovery of native species. Reconsideration of saltcedar impacts and the potential of native plant species to re-establish have led to a re-evaluation of the biological control proposal.

The decision to manage an exotic species must be made before holding discussions regarding the costs and the likelihood of success of any control technology, including eradication. We did not attempt to deal with this issue in our 'revisitation of eradication'[5] – our goal was to elucidate when eradication is a promising control technique, not when to attempt control. As pointed out in our review, eradication is one of several responses to introduced organisms and one that is likely to be successful in rather limited circumstances. Eradication would probably be neither successful nor appropriate in the situations described by Van Riel *et al.*[1], but biological control might be used to reduce the density of exotics to allow some recovery of native plant species. Biological control is one approach to exotics and, if successful (as it is in only