of Polynesian and black rats on forest composition in Hawaiian rain forests are unknown at present, but the great abundance of these small mammals suggests that vegetation changes have resulted from their activities.

Alien Birds

Introduced birds can be an important means of distributing introduced and native plants, sometimes over long distances. Since 1850, more than 52 species of nongame birds (species not hunted or classified as game birds) and 78 species of game birds have been released in the Islands, of which probably 15 species of game and 30 nongame birds remain. Game birds are known to disperse native and alien plants (Burr 1984). For example, alien ring-necked pheasants (*Phasianus calchinus*) and chukars (*Alectaris chukar*) ingested fruits of available native shrubs (*Vaccinium reticulatum, Styphelia tameiameiae, Coprosma* spp., and *Geranium cuneatum*) in high-elevation shrubland in Haleakala National Park and thereby enhanced germination and probably distribution (Cole et al. 1986b). Lewin and Lewin (1984) noted that the alien banana poka (*Passiflora mollissima*) is the main food of the alien kalij pheasant (*Lophura leucomelana*) on the island of Hawai'i, although many other native and alien plants are also eaten. They noted that many seeds appeared unharmed in the large intestine and feces of this bird. Lewin and Lewin (1984) stated that kalij pheasants "apparently have the ability to enhance the establishment of exotic plant pests."

Alien nongame birds can also spread alien and native plants over considerable distances. The rapid spread of the alien shrub *Lantana camara* through lowland Hawai'i has been attributed to the abundant alien spotted dove (*Streptopelia chinensis*) and common myna (*Acridotheres tristis*) (Perkins and Swezy 1924; Fisher 1948). Similarly, Japanese white-eyes (*Zosterops japonica*), house finches *(Carpodaceus mexicanus)*, and other species have likely increased dispersal and intensification of the invasive alien firetree (*Myrica faya*), often found under *'ōhi'a* trees (*Metrosideros polymorpha*) in which these birds have perched. Van Riper (1980) speculated that the expansion of the native *naio (Myoporum sandwicense)* on Mauna Kea may be partly the result of alien species such as the red-billed leiothrix *(Leiothrix lutea)*, house finch, and turkey *(Meleagris gallopavo)*.

Introduced birds are known to irrupt to very high population levels, especially during establishment. For example, populations of the red-billed leiothrix and the common myna were once much higher, and these species were found in different areas in Hawai'i (lowlands and dense forests) than at present (Scott et al. 1986). During peak populations, irruptive alien birds may especially affect the arthropod pollinators of native Hawaiian plants.

Management of introduced game birds includes techniques for "habitat improvement," such as planting alien species of herbs and grasses for bird food and cover and opening of forest and shrublands by bulldozing (Culliney 1988). If native vegetation is subjected to such management, invasion of alien plants and animals will be encouraged and the integrity of native plant communities compromised. Habitat improvement of State and private lands for game birds still occurs (Hawaii State Department of Land and Natural Resources 1980, 1987), but on State lands at least, the scale is reduced and areas of disturbance are confined to alien vegetation (T. Lum, pers. comm. 1989).