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INFLUENCE OF RESTORED KOA IN SUPPORTING BIRD COMMUNITIES

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Extended Abstract

Deforestation of Hawaiian forests has adversely impacted native wildlife, including forest birds, bats and arthropods. Restoration activities have included reforestation with the native koa (Acacia koa), a dominant canopy tree species that is easy to propagate, has high survivorship, and has fast growth rates. We review recent research describing the ecological benefits of koa restoration on wildlife colonization/use, plant dispersal, and native plant recruitment. In general, planting monotypic koa stands can provide forest habitats for species that need them but does not automatically lead to natural regeneration of a diverse forest species assemblage and may require additional restoration activities such as outplanting of other native plants and alien grass control to achieve more natural forest systems. Although early signs of forest and wildlife recovery have been encouraging, the goals of restoration for wildlife conservation versus commercial grade harvesting require different restoration methods.

The flora of Hawai‘i lacks many plant groups common to other island and continent ecosystems; thus the natural vegetation, which serves as habitat for wildlife, is largely made up of relatively few dominant tree and shrub species (Pratt and Jacobi 2009). The montane mesic forests are dominated by koa and ‘ōhi‘a (Metrosideros polymorpha), and typically occur between 1,000 and 2,000 m elevation (3,200 and 6,600 ft, respectively). Early Hawaiians extracted select koa trees from these forests but otherwise there is little evidence that they altered this habitat. After Western contact, people expanded into these forests where they established permanent agriculture fields that resulted in deforestation, erosion and conversion of many of these forests to grasslands by exotic grasses. Koa was the preferred wood for timber, and its extraction was typically concurrent with
forest clearing for pasture improvement. As noted by Pratt and Jacobi (2009:146) "today, almost treeless pastures of alien grasses cover the upland slopes of windward Mauna Kea and Waimea, Hawai‘i Island, as well as the west slope of Haleakalā, Maui," where koa- and koa/‘ōhi‘a-dominated forests were converted to pastures for livestock grazing. It is in many of these areas that forest restoration for conservation is focused.

Although historic forests were a mix of koa and ‘ōhi‘a, restoration of wildlife habitat has focused on koa (Price et al. 2009) because it is an easy species to propagate by seed, has high survivorship, can survive mild frost, and grows more quickly than ‘ōhi‘a (Yelenik 2016). Koa forest restoration methods have taken three general approaches that are dependent on the severity of degradation. The first is a passive approach that relies on the natural regeneration of native species, particularly koa, after ungulates and select alien plants have been reduced or removed. An example of this approach is the fencing and removal of ungulates in the State of Hawai‘i Department of Land and Natural Resources’ Kahikinui Forest Reserve and adjacent Nakula Natural Area Reserve, Maui (note: the state has recently included outplanting of native plants in this area to boost restoration). The second approach involves scarification where a bulldozer is used to scrape the surface soil to remove the dense grass cover, which leads to high density koa recruitment where seeds persists or vegetatively from adjacent living trees (McDaniel et al. 2011). This approach has been successfully applied on Kamehameha School’s Keauhou Ranch and the Kahuku Unit of Hawai‘i Volcanoes National Park, Hawai‘i. Finally, in areas that have been heavily degraded, the planting of seedlings of canopy trees and understory species is required. This is the approach taken in the former pastures of the U.S. Fish and Wildlife Service Hakalau Forest National Wildlife Refuge, Hawai‘i. An alternative objective has been to replant and manage koa as a silvicultural species for timber production following timber harvest or cattle grazing on private lands.

Through a number of surveys we are seeing two general patterns emerge as birds and insects respond to koa restoration. The colonization rate, or process by which a species spreads into restored areas, is dependent on time since reforestation and distance to intact forest. The rate is species specific with some bird/insect species able to move into the restored area rapidly when koa are still small—more shrub-like than tree-like. As time passes and the koa develop into trees, the restored areas support more species and greater numbers of individuals, presumably because larger trees are better habitat for wildlife. At both Hakalau and Keauhou we see a few native bird species using young koa, such as Hawai‘i ‘amakihi (Chlorodrepanis virens) and ‘apapane (Himatione sanguinea), but as time passes the number of species and individuals increase (Camp et al. 2010,
Paxton et al. in review). This pattern is most clearly seen in the endangered birds at Hakalau where they are absent during the first 10 to 15 years after koa planting before eventually moving into the restored areas. Sakai (1988) noted that no birds were present in the restored, scarified koa area at Keauhou for the first several years, but two decades later there were approximately equal numbers of birds in the restored area as in the adjacent intact forest (Camp et al. 2010). At Hakalau, Goldsmith et al. (2007) observed that the numbers of longhorned beetles (*Plagithmysus* spp) in younger koa (3-8 yrs old) were about a quarter of the number found in older koa (12-15 yrs old). However, beetles collected in older koa in the restoration area were only slightly less abundant than those collected in the adjacent intact forest. Thus, for some species, koa reforestation areas can support similar numbers as adjacent intact forest, but other species still lag and may take much longer to colonize.

In addition to a time lag for the habitat to become suitable, the distance from adjacent intact forest plays a role. This pattern was more pronounced at Hakalau than at Keauhou due to the size and configuration of the restored areas. For example, during the first decade after planting koa, Hawai‘i ‘elepaio (*Chasiempis sandwichensis*) ventured no further than 1-km (0.6 mi) upslope from the forest at Hakalau. However, 25 years after the initial koa were planted, Hawai‘i ‘elepaio had moved more than 2.5-km (1.6 mi) upslope (Paxton et al. in review). Hawai‘i ‘amakihi and ‘apapane also demonstrated this pattern and now occur throughout the reforested area.

Todd et al. (2016) showed that Hawaiian hoary bats occurred in remnant koa forest cleared of understory for pasture in Kahikinui FR and Nakula NAR, Maui. Interestingly, after the area was fenced and ungulates were removed, koa started to regenerate but bat occupancy declined. Gorresen et al. (2013) observed a similar pattern at Hakalau, where Hawaiian hoary bats were not common in the koa restoration area. They also observed that bat occurrence was lower in intact forest sites where koa was a dominant or co-dominant tree, even though koa hosts the koa moth (*Scotorythra paludicola*), an endemic moth that is a prey of Hawaiian hoary bats. Gorresen et al. speculate that "koa does not offer sufficient shade cover for day-roosts, and may not be sufficiently important in affecting overall prey availability other than for brief periods and episodic koa moth outbreaks." Thus, Hawaiian hoary bats appear to require a more diverse habitat than provided by koa dominated forests.

An important goal of habitat restoration for wildlife is the rapid progression from young pure koa stands to a dense forest consisting of an understory of native shrubs, and a subcanopy and canopy of koa and other native trees. This forest composition and structure would offer varied resources
(nesting and foraging sites, prey, fruits, etc.) that can support wildlife species diversity and abundance. Yelenik (2016) showed that forest succession from an early restoration community can stall when koa is the only canopy tree and the understory consists of exotic pasture grasses and scattered shrubs. Recent data has shown that there is equivalent seed rain under trees in koa restoration stands as in the adjacent forest. In addition, birds, such as the native ‘ōma’o (*Myadestes obscurus*), are dispersing seeds from fruiting shrubs and trees into these koa restoration areas (USGS unpublished data). There was, however, almost no native seedling emergence within koa stands. Thus, the understory of exotic grasses may stifle succession by prohibiting native seedlings from establishing and growing.

In conclusion, a number of factors—lag time since restoration started, distance from adjacent forest edge, and composition of replacement plant community—influence the diversity, abundance and timing of wildlife colonization. There is a general trend toward increasing wildlife species diversity and abundance as koa stands mature and in sites close to existing forest. Seed rain surveys indicate that ample propagules are being delivered by birds to restoration stands, but native plant regeneration may eventually be limited by weeds, especially exotic grasses. To advance restoration beyond a simple koa-grass system, weed management under trees could promote the establishment of understory species being dispersed by birds. Forestry and ecosystem restoration goals may not always be in line with each other. For example, koa trees that are profitable for timber production do not necessarily benefit wildlife, and, conversely, gnarled and twisted trees that benefit wildlife are not necessarily marketable. In the end, management objectives should drive restoration methods.
Figure 1: Outplanting of *Acacia koa* seedlings in abandoned pasture areas such as this one at the Hakalau Forest National Wildlife Refuge is only partly successful in restoring wildlife habitat. At this site volunteers also outplanted native understory species such as naio (*Myoporum sandwicense*), ʻōlapa (*Cheirodendron trigynum*), and ʻakala (*Rubus hawaiiensis*) to provide understory cover and food for frugivorous birds.
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References


