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## **Outplanting at Ka'upulehu; Restoring Native Hawaiian Dry Forests**

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On January 24, 2002 over 650 native Hawaiian dry forest seedlings were outplanted in the Ka'upulehu dry forest, located on the leeward side of the Big Island. The 30 or more eager planters represented nine agencies including the Hawaii Forestry Industry Association (HFIA), the USDA Forest Service, US Fish and Wildlife Service, Division of Forestry and Wildlife, the Hawaii Community College Forest TEAM Program coordinated by Fred Stone, and the Kona Environmental Work Force (State of Hawaii) supervised by the USDA Forest Service and the Big Island Invasive Species Committee (BISC). Brian Kiyabu, the Dryland Forest Working Group's (DFWG) full time technician coordinated the day's event. To date over 1300 native shrubs, trees and vines have been outplanted at Ka'upulehu as part of a restoration and land stewardship mission by the DFWG.

Native dry forests are among the most diverse plant communities in Hawaii, and also the most endangered (Wagner et al. 1990). Today, the Ka'upulehu region represents one of the largest and highest quality areas of remaining dry forest habitat within the state. Dry forests once covered the entire North Kona region (ca. 128,000 ha) except for areas with very recent lava flows. However, most of remaining habitat within this region consists of only fragmented, degraded, or senescent patches of scattered native tree species. The majority of this forest has disappeared, and fountain grass (*Pennisetum setaceum*) now dominates the entire understory of this region from sea level to 2800 m (Gagne et al. 1990), where it suppresses native vegetation and promotes devastating fires (Blackmore and Vitousek 2000). Cattle and feral goats continue to browse and trample the few remaining fragments of dry forests, and introduced rodents consume the seeds and seedlings of many native dry forest species (Cabin et al. 2000). In addition, drought and fire (primarily resulting from fountain grass) have been prevalent in the area in the last 5 years. In October of 1999 a 10,000 acre fire came within two miles of the Ka'upulehu preserve and destroyed some of the best patches of dry forest left on State land on the Island of Hawai'i.

The Ka'upulehu dry forest is located approximately 17 km east of Kailua-Kona at 600 m elevation, and contains two adjacent dry forest remnants that are owned by Kamehameha Schools and actively managed by Working Group. The first area, leased to the National Tropical Botanical Garden, is a 2.3 ha remnant that was fenced in 1956 by the Territory of Hawaii to protect its rich diversity of native species. The second preserve is a 25 ha area that consists mainly of degraded fountain grass pasture with only scattered bands of native tree species. The Working Group fenced this area in 1997 as a first step towards its preservation and restoration.

The members of the Working Group have responded to an urgent need to protect, manage, and restore these threatened forests. Various research activities conducted over the past five years have revealed cost effective techniques for successful restoration

projects. Some of these techniques are included in the information guide to our outplanting procedures below.

**Nursery Phase:** A typical outplanting begins at least 3 months prior to a specific outplanting date. Fountain grass is cleared by weedwhacking and follow-up applications of the herbicide Round-up, and native seeds and cuttings are collected (typically onsite) and germinated in the greenhouse. Species selection is based on a number of factors ranging from plant availability, funding sources (the working group receives a number of grants specific to outplanting federally listed endangered species), and previously known successful species. For example, over the past five years of outplanting we have documented a 75 % survival rate of the endangered species Koki'o (*Kokia drynarioides*) and a 60% survival rate of Kauila (*Colubrina oppositifolia*), whereas the common tree species Lama (*Diospyros sandwicensis*) has had only a 20% survival rate. Other successful species include the native understory shrubs Chenopodium (*Chenopodium oahuense*) and A'ali'i (*Dodonaea viscosa*), the federally listed native morning glory Bonamia (*Bonamia menziesii*) and the native tree species Halapepe (*Pleomele hawaiiensis*) and Uhiuhi (*Caesalpinia kawaiensis*).

**Field Phase:** Seedlings are moved from the greenhouse to onsite benches two days prior to planting and hand watered. Two battery-operated timers are placed on an existing ¾ inch PVC line connected to the primary water source, a 5,000-gallon catchment tank. Approximately 400 ft of poly tubing (¾ in. diameter) is attached to each timer, and this tubing is snaked back and forth throughout the site.

**Planting phase:** Bales of Pro-Mix are cut in half and spread throughout the site to be added to each planting hole. As plants are placed in the ground, one or two person crews give each plant approximately one half gallon of water to keep them from drying out before irrigation begins.

**Irrigation phase:** Spaghetti tubing (1/8 in. diameter) is connected to the poly tubing and sent to each individual plant with a drip head which delivers one half gallon of water per hour. Initially, the timers are set to run twice per day for thirty minutes; at 5 am and 6pm, which allowed the plants a gallon of water per day. This is reduced after ten days to 15 minutes twice a day for 10 days, then once every third day for 15 minutes, and finally twice per week for the same interval. After 6 months irrigation is turned off completely and outplants are monitored for growth and survival rates.

In conclusion, given the degraded nature of the dry forest community, it appears that successful establishment of most of the native dry forest species requires outplanting into shaded, irrigated, and cared-for areas. However, it may be possible to restore some of the more degraded areas by direct-seeding the hardier, faster growing native species. Once these species are established, they may eventually create patches of suitable habitat for the slower-growing/rarer tree species. At present we are considering how to best utilize our outplanting insights to restore even larger areas in a cost-effective and efficient manner.

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### **Photo Captions**

- #1 Hawaii Community College Forest TEAM Program students assisting in a Ka'upulehu dry forest outplanting day.
- #2 Hawaii Community College Forest TEAM Program student and Environmental Work Force employee assisting in a Ka'upulehu dry forest outplanting day.
- #3 Heather Cole outplanting a *Kokia* (*Koki'o drynarioides*) seedling.
- #4 Successful Outplants at Ka'upulehu dry forest.
- #5 Ka'upulehu dry forest five years after fountain grass removal.







