Title: Wildland Fire Management Plan and Critical Habitat Risk Analysis for the Hawaiian Volcano, Mauna Kea.

Date: 2010 - 2011

Background: The palila (*Loxioides bailleaui*), a finch-billed species of Hawaiian honeycreeper (Figure 1), is protected by federal law under the Endangered Species Act. On Mauna Kea, a large volcano with an elevation of greater than 13,000 feet on the Island of Hawaii, critical habitat for this species has been designated by the U.S. Fish and Wildlife Service to help stabilize the palila population. The palila has a close ecological relationship with mamane (*Sophora crysophylla*), a small stature tree, which it requires for habitat, including food. Fire is a primary threat to the mamane ecosystem due in part to invasive grasses that have produced a continuous fuelbed in the understory that did not exist historically. The Mauna Kea Fire Management Plan represents an interagency effort to develop a comprehensive approach to protect palila critical habitat from wildfires and address general wildfire issues on Mauna Kea. Groups involved in the planning process included representatives from the State of Hawaii Division of Land and Natural Resources Department of Forestry and Wildlife, U.S. Fish and Wildlife Service, U.S. Army Garrison Hawaii, U.S. Department of Transportation Federal Highway Administration, U.S. Geological Survey, Hawaii Wildfire Management Organization, and the Mauna Kea Watershed Alliance. The plan was written by the Center for Environmental Management of Military Lands (CEMML) at Colorado State University. As part of this plan, the CEMML Fire Ecology and Management Specialist used LANDFIRE National data to help map fuels on the landscape and as inputs for a risk analysis.

Figure 1. Palila – an endangered finch-billed species of Hawaiian honeycreeper.

Methods: The minimum travel time (MTT) function of FlamMap was used to assess the risks posed by fire on Mauna Kea. LANDFIRE data provided the majority of the spatial data for the analysis and included elevation, slope, aspect, stand height, canopy base height, and canopy bulk density. Fuel model classifications were gathered from local fuels data within the study area with LANDFIRE fuel model classifications serving as a backdrop. Standard fire behavior fuel models often are not effective in Hawaii for reasons explained below. Several local Remote Automated Weather Stations (RAWS) were used to produce 97th percentile weather conditions to simulate a worst case scenario. A predominant wind direction was determined from this subset of the RAWS data. To produce an adequate sample size, 10,000 ignition points were located on the landscape. Of the 10,000 points, 10 percent of these were randomly allocated to represent lightning strikes while 90 percent were randomly allocated but weighted heavily based on proximity to roads to represent human caused fires. No ignition points fell in unvegetated areas. The 10/90 percent split in lightning versus human caused fires was based on the recorded fire history of the area, lightning ignitions are very rare in Hawaii.

The analysis team determined that LANDFIRE stand height and canopy base heights were not representative of the mamane forest due to a paucity of field data from this vegetation community. LANDFIRE stand height data were reclassified to remove the very high values to more accurately represent actual stand heights which typically are no more than 30 feet in the study area. Canopy base height was similarly inaccurate and the team used a single value of one meter to replace the LANDFIRE data across-the-board. This was based on personal anecdotal observations of the forest by the CEMML Fire Ecology and Management Specialist. These canopy base heights are a result of grazing by invasive ungulates (feral goats and sheep) and little canopy exists below one meter.

Another issue encountered using LANDFIRE National data in Hawaii was that custom fuel models are not supported. Fuels in Hawaii are not well represented by the standard 13 or 40 fire behavior models and custom models are necessary in many cases. This required pre-processing the fuels layer in order to replace standard fuel models with custom models. Pre-processing was complicated because standard fuel models were not replaced everywhere, but rather in select areas where local detailed information existed. This required a series of GIS calculations and processes that, though relatively straight-forward, were time consuming.

Results: The risk analysis showed there are few areas where fuels management or firebreaks would have a higher than average effect on fire suppression effectiveness (Figure 2). The terrain, weather, and fuels are highly conducive to fire spread and are relatively homogenous, allowing fires to spread somewhat uniformly across the landscape with few fire spread choke points. This analysis boosted the opinion of fire managers that much of the southern aspect of the mountain is highly fire prone. Response times and fuels management activities (thinning treatments, firebreaks, etc.) are critical to successful fire suppression and continued conservation of the mamane ecosystems that support critical palila habitat.

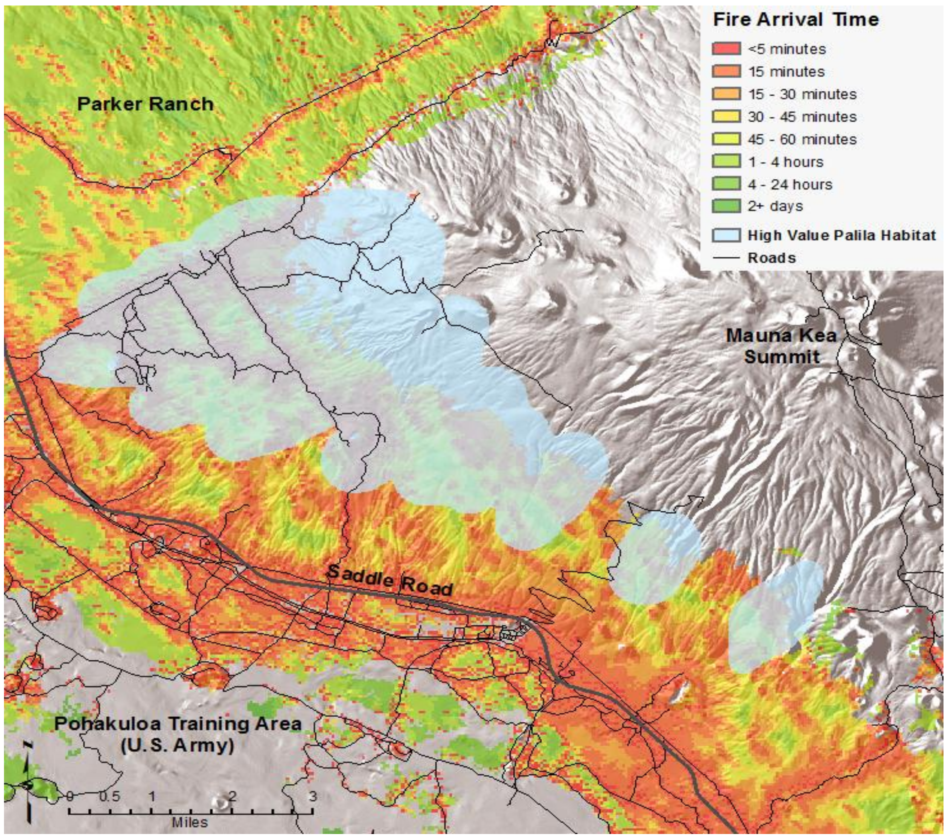

Figure 2. Fire risk estimated on the southwestern slopes of Mauna Kea under 97th percentile conditions. The sharp change in minimum travel time in the northern portion of the map indicates the transition from forest reserve to neighboring grazed lands. Nearly all palila habitat is at high risk with the majority of fire arrival times occurring in minutes rather than hours or days.

Management Implications: An existing system of firebreaks and fuels management treatments has been in place for many years. This analysis demonstrated the need to introduce or reinforce barriers to fire between high probability ignition areas and highly valued resources. LANDFIRE data was essential to this risk analysis. Without it, the risk analysis would have been severely hampered by a complete absence of data outside the study area, a lack of important canopy data within it, and significant time/costs in developing similar data sets. LANDFIRE served its role as a high level, consistent dataset that could be modified for local use. The risk analysis also supported fire managers' opinions that fire response time is key to catch fires while they are still small enough to be effectively suppressed by the limited resources that can respond within the first burning period. The remote location of Mauna Kea on the Island of Hawaii, essentially equidistant from the coastal cities, and the difficulty of bringing resources, particularly equipment, from other islands, makes effective response heavily dependent upon initial attack success.

The fuels management decisions made as a result of the risk analysis formed the core of the fire management plan. Once these decisions were made, costs were estimated and other firefighting infrastructure such as artificial water sources were located to best support the firebreak and fuelbreak network. One of the primary objectives of the plan was to reduce maximum fire size to levels that do not threaten the viability of the mamane ecosystem as a habitat for the palila. In the core of the mamane ecosystems (the primary palila habitat), the objective was to limit fires to less than 50 acres to minimize disturbance. It is hoped that fewer and smaller fires will allow the area to recover from previous fire disturbances by promoting a much longer fire return interval. These actions are expected to permit regeneration of the mamane forest within its current bounds as well as expansion into locations from which it was previously extirpated. This proactive management approach will support the stabilization of the palila population and help to increase suitable habitat for the future.

Recommendations: We found the LANDFIRE data to be a very useful foundation on which to expand our ability to assess risk beyond the limits of our internally/locally available data. In this respect, LANDFIRE is irreplaceable because it is consistent across the landscape and provides full coverage for all required fire behavior inputs. In Hawaii, however, we found the accuracy of the data to be appreciably lower than comparable data on the mainland, particularly canopy characteristics. Many inaccuracies can be attributed to a lack of available input data for use by the LANDFIRE modeling team as there has been no effort to develop canopy attribute data for Hawaiian tree and shrub species. The canopy information was provided to the LANDFIRE team as part of the LANDFIRE 2008 "Refresh" update and many data inaccuracies have since been addressed. Despite these drawbacks, the data provide a starting point, which did not previously exist, from which manipulations can be made to produce a respectable dataset to assess fire risk.

One suggested improvement for LANDFIRE is the inclusion of custom fuel models, either in the primary fuels datasets or as a secondary fuels dataset where custom models replace standard ones wherever they are known to improve fire behavior prediction accuracy. This would be a tremendous help in Hawaii, and potentially in other locations as well, where standard fuel models are often of limited use. The lack of custom fuel models in LANDFIRE make it far more difficult for uninitiated users and/or users without a strong background in spatial data manipulation to use LANDFIRE fuels data effectively at the local level. Users may not realize that the model assignments may not be accurate at a local scale. Additionally, LANDFIRE may be a good platform through which to 'spread the wealth' of custom modeling expertise. Many custom fuel models have been developed over the years for specific applications or locations, both in Hawaii and on the mainland, but often these models are not made readily available to others and the only way to find them is often through personal or professional contacts. LANDFIRE may be a good central storehouse of custom fuel modeling efforts throughout the country.