Sheep vs. Palila on Mauna Kea

AFTER 200 YEARS OF HABITAT DAMAGE, CAN NATIVE PALILA RECOVER?

By Steven C. Hess and Paul C. Banko

Courtesy of USGS

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During the first half of 2010, trained marksmen working with the Hawaii Division of Forestry and Wildlife flew in helicopters over Hawaii's Mauna Kea volcano and took aim, killing nearly 300 wild sheep spotted wandering across the landscape. The effort was criticized by both hunters and animal rights activists—highlighting a classic dilemma in the battle over how to control invasive species.

The need for control has become critical on the slopes of Mauna Kea. Rising to 13,796 feet—the highest point in the central Pacific—this volcano once had tall forests of koa (*Acacia koa*) trees that extended up its montane flanks to the subalpine zone, where a dense woodland of mamane trees (*Sophora chrysophylla*) encircled the entire summit. Mamane seeds are the primary food of the endangered palila (*Loxioides bailleui*), a forest bird endemic to Hawaii. Yet Mauna Kea's slopes have been seriously denuded by populations of browsing domestic sheep (*Ovis aries*) and European mouflon sheep (*O. gmelini musimon*), both introduced within the last 200 years. If palila are to survive, the sheep must go.

Hawaii has made repeated attempts to rid the region of sheep. In 1979, the U.S. Federal District Court first ordered their eradication from Mauna Kea, and according to state records, from 1998 to 2010 almost 11,000 sheep were removed from designated critical habitat of the palila by aerial shooting and unrestricted public hunting. Yet despite a three-fold increase in removals from 2005 to 2010, obvious signs of severe browsing damage suggest no diminution in the population growth of domestic sheep or European mouflon hybrids.

Conversely, the palila is experiencing its eighth consecutive year of decline as Mauna Kea's subalpine woodland continues to deteriorate due to sheep browsing and a prolonged drought. According to the most recent multi-agency count, palila numbers plummeted from nearly 6,000 in 2003 to

On the slopes of Mauna Kea, the gnarled limbs of dead and dying mamane resulted from damage caused by mouflon and feral domestic sheep, introduced species that are degrading swathes of Hawaii Island. Because mamane trees provide critical food and nesting habitat for endangered palila, conservationists are attempting to eradicate sheep populations, a controversial and arduous task.

Credit: David Leonard

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about 1,300 in 2011, more than a 78 percent decline (USGS unpublished data). Extinction is imminent if the trend continues unchanged (Leonard *et al.* 2008). How did this predicament come about?

Anatomy of an Invasion

Prior to European settlement in the 19th century, Mauna Kea rose from the Pacific, ringed in lush native flora. From the coast, the dormant volcano alternately appeared to be covered with golden mamane flowers, a cap of gleaming snow, and the glare of silverswords (*Argyroxiphium sandwicense*) blanketing slopes in between. On February 14, 1793, Captain George Vancouver liberated a domestic ram, two ewes, and a lamb at Kawaihae on the west side of Hawaii Island. By 1825, the descendents of those sheep could be found at the volcano's summit, and before the start of the 20th century, the introduced ungulates had converted forests to pasturelands, separating the subalpine mamane woodland from the lower montane forest.

In his day, Vancouver convinced Hawaii's King Kamehameha I to enforce a 10-year *kapu*, which forbade the killing of wild livestock, including sheep and cattle (*Bos taurus*). Hoping to use the animals for food to resupply his ships, Vancouver believed that the kapu could not "... fail to render the extirpation of these animals a task not easily to be accomplished" (Tomich 1986). Prophetically, the animals became firmly entrenched within the island's fragile insular ecosystems. Without the benefit of biogeographic theory, Vancouver could not have anticipated the potential consequences of introducing hoofed herbivores to oceanic islands where these animals did not naturally exist.

Problems with introduced sheep, cattle, goats (*Capra hircus*), and other ungulates grew so quickly that by 1830, Kamehameha III lifted the *kapu* and hired John Palmer Parker—a Massachusetts native who brought the first American musket to Hawaii—to round up feral cattle. Enlisting the help of Mexican cowboys, locally known as *paniolos*, Parker and his team killed thousands of feral cattle and shipped the meat and hides to the Americas. At this point, vast areas of Hawaii had already been deforested, and feral animals still ranged freely over remote subalpine slopes.

By the early 20th century, territorial foresters and plantation owners recognized the damage that herbivores caused to Hawaii's watersheds through erosion, trampling, and deforestation. To address the problem, foresters established a system of protected forest reserves and eliminated tens of thousands of ungulates starting in 1934. One of those areas—the 82-square-mile Mauna Kea Forest Reserve—was entirely surrounded by fencing to exclude browsing ungulates (Bryan 1937a). During the following decade, foresters and Civilian Conservation Corps workers drove and hunted animals by foot and on horseback, eliminating nearly 47,000 sheep and over 2,200 other ungulates entirely from within the fenced reserve (Bryan 1937b, 1947).

Priorities for Mauna Kea soon changed, however. Sport hunting became a major management goal of territorial wildlife biologists, who imported European mouflon in 1957 and began hybridizing them with feral sheep to improve the quality of game animals. One rationale for the hybridization program was that mouflon congregated in smaller bands, so their damage was less concentrated than that of high-density bands of feral sheep. By the time Hawaii became the 50th state in 1959, sheep and feral goat populations had already rebounded from the earlier control efforts.

One year after statehood, biologist R. E. Warner published an article titled "A Forest Dies on Mauna Kea," in which he decried the dire condition of the volcano's subalpine zone, writing: "Continued neglect of the present situation can have only one outcome: the ultimate and complete destruction of the habitat. ... The mountain will then no longer support either sheep or native plants or birds" (Warner 1960). Biologists of the newly created Hawaii Department of Agriculture and Conservation discontinued the sheep hybridization program in 1963, but nonetheless released mouflon on the eastern slopes of Mauna Kea, and a small number of hybrid sheep on the western slopes as well (Giffin 1982).

Credit: Jack Jeffrey

Honed by evolution, a palila eats the unripe green seeds from pods of the mamane tree, source of nearly all the palila's food. One of three remaining species of finch-billed Hawaiian honeycreepers, the palila evolved highly specialized feeding habits. If feral sheep and other ungulates are allowed to continue killing mamane trees through browsing and girdling, palila will move closer to extinction.

Credit: Christina Cornett

Courtesy of Kealii Bio and Ian Cole

Mauna Kea's feral sheep (top and above) are a mix of introduced domestic sheep and European mouflon, hybridized in the 1960s to improve game qualities. Now overpopulated and destroying vital palila habitat, the sheep are popular targets for sport hunters. However, much more than public hunting is needed to eliminate the threat to palila or even to keep sheep populations in check.

Too Little, Too Late for Palila?

A finch-billed species of Hawaiian honeycreeper, the palila gained federal recognition as an endangered species in 1967. Given the ongoing destruction of palila habitat by introduced ungulates, the Sierra Club Legal Defense Fund in 1976 asked the governor of Hawaii to remove feral sheep and goats from palila habitat on Mauna Kea. Two years later, the U.S. Fish and Wildlife Service formally designated nearly the entire subalpine region of Mauna Kea as critical habitat for the species, a designation that brought legal protection to the habitat, not just the bird.

Habitat degradation continued, however, sparking legal action. In 1979, the Sierra Club, the Hawaiian and National Audubon Societies, and others brought suit against Hawaii's Department of Land and Natural Resources, charging that ungulates, by destroying the palila's habitat, were harming the birds. As a result, the U.S. Federal District Court issued orders in 1979 that goats and feral sheep must be removed from areas designated as Palila Critical Habitat. In 1987 the court issued similar orders for removal of mouflon.

A great deal of research conclusively shows that, on Mauna Kea, you can have a forest or you can have ungulates—but not both. Although the endemic vegetation of the Hawaiian Islands is said to have lost most defenses against herbivory, it is certainly capable of recovery if ungulates are eliminated, providing that viable seedbanks remain and invasive plants do not suppress regeneration (Loope and Scowcroft 1985, Hess *et al.* 1999).

Exclosures, aerial photography, and tree size classes all demonstrate the effects of browsing and bark-stripping by sheep, cattle, and goats on Hawaii's subalpine vegetation (Scowcroft 1983; Scowcroft and Giffin 1983, Scowcroft and Sakai 1983). In the short-term, bark stripping stresses mature live trees and browsing kills or stresses saplings. Over the long-term, sustained browsing causes the forest to thin out, which results in less food for palila and other species. Habitat conditions began to improve when sheep were reduced to low levels in the early 1990s, but relaxed diligence after 1996 allowed ungulate populations to rebound (Tummons 1999a). In addition, because the aging 55-mile fence surrounding the Mauna Kea Forest Reserve was not maintained, sheep have moved freely between critical habitat and adjacent areas to evade helicopters. So, although more than 91,000 sheep have been removed from the Mauna Kea Reserve over its 75-year history, sheep seem farther from being eradicated today than they did 20 years ago.

Replacing the fence around Mauna Kea and removing all the sheep within it would allow critical habitat to recover and provide ample food resources for the survival of palila (Banko *et al.*

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2009). A major segment of the fence has already been replaced, and the rest of the fence line is planned, but the pace of sheep removal is lagging and needs to be accelerated. The removal of predators such as feral cats, which depredate approximately 11 percent of palila nests annually, would also improve the birds' reproduction and survival. The effects of predation are often exacerbated by poor habitat conditions, which make birds spend more time in search of food and less time in vigilance and nest defense (Martin 1992).

The Critics' Flawed Arguments

Critics of sheep eradication often maintain that ungulates reduce fire hazards by eliminating alien grasses that contribute fine fuels and threaten to destroy the critical habitat of palila in one big fiery blaze. However, the only study of sheep diet on Mauna Kea found a strong preference for mamane, not grasses (Giffin 1982). Indeed, claims that sheep reduce fire threats did not prove persuasive in the courtroom of the late Federal Judge Samuel P. King. Arguing that "ungulates are the best defense against fire," quipped King, "suggests that in order to save the palila from extinction by fire, we should increase the number of sheep so they can share in the destruction of the palila" (Tummons 1999b).

While mamane is a drought-adapted species that can sometimes recover quickly from fire, it is not easy for a mamane seedling to push through the dense layer of pyrogenic grasses on many parts of Mauna Kea. Tree seedlings face fierce competition from these water-robbing grasses, but their fate from herbivory is worse until they have grown well above the reach of sheep. Studies of some of the same grass genera at similar elevations in the Serengeti and Yellowstone demonstrated that the presence of ungulates promoted greater grass biomass, primarily roots, through accelerated nutrient cycling (Frank *et al.* 1998).

Volcanic soils of the Hawaiian Islands are quite nutrient poor, but native trees are well-adapted to this natural condition. If protected, increasing native forest cover would eventually shade out alien grasses and reduce fine fuels that create fire hazards, as it has in woodlands dominated by naio (*Myoporum sandwicense*) on the southwestern slope of Mauna Kea (Thaxton and Jacobi 2009). Given enough time, it is possible that the grass-fire cycle might be broken in the absence of ungulates and the nutrients they enhance (D'Antonio and Vitousek 1992). Full recovery, however, may take as many centuries as it has taken for this ecosystem to become degraded, and because ungulates have not been eliminated from Mauna Kea, the recovery clock has yet to start.

Critics also argue that sheep are needed to control pernicious weeds, such as gorse (*Ulex europaeus*), but this line of reasoning overlooks a strong relationship between weed invasion and disturbance from ungulates (Mueller-Dombois *et al.* 1981). Judge King also dismissed sheep as agents of weed control (Tummons 1999b), writing: "The sheep on Mauna Kea do not limit their browsing only to baby gorse seedlings; they also devour baby mamane seedlings. The latter aspect of their appetite was an important consideration in the earlier orders for their removal. To increase the number of sheep to control gorse infestation would simultaneously endanger mamane growth."

Hunter groups and state officials have opposed the eradication of sheep from Mauna Kea for more than 30 years (Juvik and Juvik 1984, Tummons 1999a) despite the fact that sheep are widely distributed over the rest of Hawaii Island. Animal rights groups have only recently joined the fray. By claiming that the Mauna Kea animals are a unique breed of Hawaiian wild sheep, they trivialize the true uniqueness of the endemic Hawaiian plants and animals that evolved here over several million years. Moreover, the spurious claim that Corsican mouflon are endangered, even if true, would be premised on a pure lineage, not hybrids. Mouflon are widely introduced throughout the world; Hawaiian plants and animals are not.

Allowing ungulate populations to rebound while expecting a different outcome for forests and palila defies the history of repeated degradation over the past two centuries. No endangered Hawaiian forest bird has yet been recovered, but the major threats to palila are well understood and are entirely within our means to manage. ■

For a full bibliography, and to see a video of the USGS palila count, go to *www.wildlife.org*.

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