Anatomy of an Eradication Effort

REMOVING HAWAII'S ILLEGALLY INTRODUCED AXIS DEER

By Steven C. Hess, Jake Muise and Jan Schipper

Credit: Mathew Thayer/The Maui News

Axis deer run through a thicket of thorny scrub. Introduced to the island of Maui in 1959, they're now overabundant and cause extensive damage to crops and other resources.

In February 2011, a rancher in the rural southern part of Hawaii Island reported a large mammal on her land. Her call mobilized several agencies led by the Big Island Invasive Species Committee (BIISC), a partnership to prevent, detect, and control the establishment and spread of invasive species, to sit up and take notice. Agency biologists installed camera traps to identify the animal, and a few months later verified the diagnostic field marks of a cervid with spots. The animal in question was a *chital*, or axis deer (*Axis axis*) — a species native to tropical and subtropical India. Although the deer are abundant on the islands of Molokai, Lānai and Maui, officials knew they weren't capable of swimming across the notoriously treacherous 'Alenuihāhā channel, and consequently suspected human intervention.

Soon after the rancher's report, the U.S. Fish and Wildlife Service launched an investigation, which revealed that in December 2009, a helicopter pilot and rancher from Maui had covertly transported four deer in exchange for about a dozen European mouflon sheep (*Ovis gmelini musimon*) (Tummons 2011a, b) — a species also valued for trophies and meat. Because neither species was established in the wild on either of the islands, in June 2012, state lawmakers responded by specifically banning "the intentional possession or interisland transportation or release of wild or feral deer" (Honolulu Star-Advertiser 2012). The two individuals were prosecuted under the Lacey Act for transporting wildlife between islands with the intent to guide hunting for out-of-state residents (Stephens Media 2012), while the individual who provided the mouflon was sentenced to community service. Further, the helicopter pilot agreed to provide 500 hours of flight time to locate and eradicate the Hawaii Island deer population in restitution.

Illegal and Disruptive

Deer introductions in Hawaii cause concern due to populations going from unnoticeable to unstoppable in a few decades and have also sparked debate and controversy. Hunters and game biologists have typically

supported the practice because of increased harvesting opportunities and additional revenue from guided trophy hunting. As a tourist attraction, environmentalists, ranchers and farmers have argued that the introduced animals cause agricultural damage, livestock disease and damage to native plants and habitats. In fact, axis deer were considered pests on Molokai after their numbers increased from eight in 1868 to 7,000 by 1898. In 1900, the Molokai Ranch Company — a private ranching outfit — engaged hunters from California who killed more than 4,000 individuals by 1901 (Kramer 1971). Further, state agricultural officials documented bovine tuberculosis (*Mycobacterium bovis*) in as much as five percent of deer from Molokai as late as 1995, posing an ongoing threat to cattle trade throughout the islands (Sawa et al. 1974, Anderson 2003, Miller and Sweeny 2013). Damage to the pineapple industry on Lānai, where deer had been established since 1920 (Tomich 1986), was severe and extensive (Anderson 2003). The island of Maui — where axis deer had been brought in 1959 under a legislative mandate to enhance hunting opportunities (Tomich 1986) — also was struggling with burgeoning populations. There, deer were causing more than one million dollars of damage each year to vegetable crops, sugarcane fields, vineyards, ranches, golf courses and ornamental plants at resorts (Yamamura 2013).

Credit: J. Muise

Hawaii is not the only place in the U.S. that has had trouble with these deer. Axis deer were introduced to California's Point Reyes in 1947 before it became a National Seashore in 1962, and comprised over 600 individuals by 1974 (NPS 2006). Non-native deer species at Point Reyes degraded the diverse coastal plant communities and competed for forage with native black-tailed deer (*Odocoileus hemionus columbianus*) and tule elk (*Cervus canadensis nannodes*), which were reintroduced in 1978. In addition to carrying several livestock and wildlife diseases, a small percentage of axis deer also harbored Johne's disease (*Mycobacterium paratuberculosis*) — a contagious bacterial disease of the small intestines of ruminants (Riemann et al. 1979). Contractors for the National Park Service completely eliminated axis deer from Point Reyes by 2009, primarily through shooting from helicopters.

Eliminating the Problem

Although eradicating a small population of deer on Hawaii Island may have seemed to be a straightforward proposition, agency officials ran into several challenges. The island is covered with dense thickets of Christmas berry (*Schinus terebinthifolius*), a scrubby invasive tree also common in southern Florida, as well as rocky lava that flows from Mauna Loa — the world's largest active volcano. Further, because the island is a mosaic of small land parcels, BIISC biologists required permission from owners to access their land. As a result, even though biologists used high-tech tools such as camera traps and Forward Looking Infrared Radar or FLIR — a thermal imaging device — to locate crepuscular deer in weedy scrub, they could only be used where the BIISC deer team had worked to secure access with the good faith and trust of landowners. The deer easily moved from accessible to inaccessible lands where the team could not follow them, although biologists did manage to capture four deer and continue to respond to reported sightings and monitor the area. Adding to the challenge, techniques to exploit social behavior of deer such as the use of Judas animals

Credit: J. Muise

Biologists have implemented a number of monitoring measures to track axis deer in Hawaii, including the use of Forward Looking Infrared Radar or FLIR (below, left), which, in addition to helicopter surveys, serve as an invaluable tool to locate cryptic deer. The surveys are carried out at dawn and also use FLIR to track down reported deer sightings throughout Hawaii Island.

Credit: J. Muise

A single axis deer joins a group of European mouflon sheep on the island of Lāna'i. Axis deer were introduced to Lāna'i in 1920 and mouflon were introduced in 1954. Many sightings of axis deer reported by the public on Hawaii Island turned out to be mouflon, which are superficially similar in body shape, but lack the diagnostic spots.

(Taylor and Katahira 1986) — employing radio telemetry to locate associated group members — are less reliable in the case of deer than for feral domestic livestock species because the former do not form true herds (Graf and Nichols 1966). A county ban on shooting animals from aircraft enacted in 2012 and a longstanding state ban on discharging firearms after dark precluded some of the most potentially effective control methods. Private landowners were concerned about attracting trespassers to their lands in search of deer to hunt, which would have also been disruptive to eradication efforts. Moreover, a small group of residents expressed opposition to eradicating deer on Hawaii Island by initiating a bumper-sticker campaign with the slogan: "Axis deer — manageable, sustainable food — say no to eradication."

Credit: J. Muise

This axis deer is the first of four that the Big Island Species Committee deer team killed as part of their effort to eradicate axis deer on Hawaii Island. Axis deer were illegally introduced to that island in 2009.

On Maui, the second-largest Hawaiian Island, deer eradication is not biologically feasible, nor would resident hunters support the eradication of such an established and popular game animal. There, the goal is to reduce deer numbers and minimize damage to agricultural crops and ranches and to natural areas where introduced herbivorous mammals can eliminate regeneration of native forest trees altogether (Scowcroft and Giffin 1983, Hodby 1993, Hess 2008). Recreational hunting alone has proven to be an ineffective control strategy even though seasons and bag limits for deer on Maui public lands have been lifted. Some large-ranch owners have already started to reduce deer numbers on their properties, while some businesses have been marketing meat and others plan to sell antlers and hides (The Molokai Dispatch 2012). Further, to enable the sale of deer products in Hawaii, volunteer hunters are required to be trained, licensed and NRA rifle-certified. Because inspection of wild game meat poses one of the largest challenges to marketing, an inspector from the U.S. Department of Agriculture will have to be present when the deer is shot, and the deer must be butchered within three hours. Further, a mobile processing facility would expedite the time from field to freezer. The movement to "eat invasive species" may prove beneficial if hunters can access lands with enough deer to make the venture profitable. Commercialization is far from a perfect solution, however, as it could incentivize sustained long-term farming and additional transportation of deer between islands instead of population reduction (Caughley 1983).

What the Islands Need

Better prevention strategies, early detection techniques, and control methodology for incipient invasive species would benefit the environment, agriculture, and economy of the entire Hawaiian archipelago. The pace of vertebrate introductions between islands appears to be accelerating and the role of Invasive Species Committees (ISCs) — preventing, controlling, or eradicating harmful non-native species — on each Hawaiian island is becoming increasingly important. Axis deer is only one of several incipient introductions that ISCs are trying to head off before they become full-blown invasions. Small Indian mongooses (*Herpestes javanicus*), which have infested nearly all of the other Hawaiian Islands, were first captured on Kauai in 2012, threatening endangered ground-nesting bird populations. Coquí frogs (*Eleutherodactylus* spp.) from Hawaii Island were captured on both Oahu and Kauai in early 2014, poised to disrupt residents' peaceful evenings with their persistent loud calls. Veiled chameleons (*Chamaeleo calyptratus*),

escaped exotic pets which are known to consume small birds, were first captured on Maui in 2002, and a concerted effort was organized to eradicate the incipient population before they spread to other islands. Several species of snakes, although banned as pets in Hawaii, have turned up repeatedly throughout the state and pose a persistent threat to the islands' fragile ecosystems, which developed in the absence of all terrestrial herptiles.

Successful eradication cannot be declared yet in any of these cases because it is virtually impossible to know if the last individual of a population has been removed from such large, populated islands. Abundant source populations of these and other invasive vertebrates throughout the archipelago present a growing risk for accidental and intentional introductions to cross-contaminate islands. As with deer on Hawaii Island, detection and control are dependent on the trust and cooperation of landowners, who can deny access at any time. Therefore, the best chance for stopping additional invasions includes prevention, early detection, and rapid response before newcomers have a chance to reproduce. Vigorous enforcement of existing importation laws would aid in the prevention of additional introductions, while outreach would inform the public of both ecological and legal consequences. Solid engagement from natural resource agencies would improve early detection and rapid response. Once a small population of invaders starts to reproduce and becomes established, long-term commitment to monitoring and removal in partnership with landowners is the best shot for ensuring successful eradication — particularly for cryptic species. ■

Courtesy of USGS

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