Controlling Wild Sheep and Deer on Conservation Lands in Hawai‘i

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Hawai‘i Conservation Alliance

Position Statement

Wild ungulates (European mouflon, axis deer and Columbian black-tailed deer) introduced to Hawai‘i are detrimental to Hawaii’s native ecosystems via the damage they inflict on both vegetation structure and composition. These animals are very difficult to control. They have high population growth rates, are elusive, and can jump or circumvent most existing ungulate fences. Control and/or removal of these animals should be a high priority on all lands designated for protection of native biodiversity in Hawai‘i.

Summary

The highly endemic ecosystems of the Hawaiian Islands evolved in the absence of large land mammals and thus are vulnerable to browsing and other impacts of the numerous ungulates[1, 2] introduced to Hawai‘i. These ungulates now including feral domesticated species such as cattle, pigs, and goats, and wild species such as European mouflon sheep and feral sheep hybrids, axis deer and Columbian black-tailed deer. Wild ungulates are more difficult to manage than their feral domestic relatives [See HCA Position Paper 2005.1] because they are able to jump fences that normally control feral species. However, if control measures are not implemented these wild species will expand their ranges and population numbers, severely limiting our ability to protect the endemic Hawaiian biota and ecosystems.

Wild sheep and deer in Hawai‘i

The European mouflon (an undomesticated form of *Ovis aries* l .) and Armenian mouflon (*O. orientalis* Gmelin) are wild sheep that are closely related to the early ancestors of domestic sheep (*O. aries* L.)[3] European mouflon from Corsica have been introduced widely throughout the world, including many parts of Europe, the Canary Islands, North America, the subantarctic Kerguelen Archipelago, and Hawai‘i[4, 5, 6, 7] as game animals. On islands previously lacking ungulates, mouflon populations have grown rapidly, severely damaging endemic plants through trampling and browsing[5, 6]. Introduced to the Hawaiian Islands in the 1950’s[4, 7], mouflon currently are wild on Lāna‘i and Hawai‘i[4], and in game ranches on Maui. On Hawai‘i a mouflon-feral domestic sheep crossbreed was developed and released on Mauna Kea in 1962[7]. The Mauna Kea population now extends across Saddle Road onto northern Mauna Loa. In 1968, mouflon were introduced at Kahuku Ranch[15] and now inhabit southern Mauna Loa including the portion of Kahuku Ranch acquired by Hawai‘i Volcanoes National Park. Both herds have expanded into forest reserves where they browse on native endangered plants such as silverswords (*Argyroxiphium* spp.)[8].

The native range of axis deer (*Axis axis*), or chital, includes India, Sri Lanka, and Nepal[4, 9]. They have been introduced widely in the USA (including California, Texas and Hawai‘i) and in Australia[4, 10, 11, 12]. Axis deer were brought to the Hawaiian Islands from India in late 1867 as a gift to Kamehameha V and released on Moloka‘i in early 1868. Axis deer were moved to O‘ahu before 1898, to Lāna‘i in 1904 and to Maui in 1959[4, 12]. Populations are currently in excess of 8000 on Lāna‘i and Moloka‘i, and increasing on Maui where they have recently invaded Waikamoi Preserve and high elevations in Haleakalā National Park[12]. A small population may remain in Moanalua Valley[4]. In the Hawaiian Islands axis deer damage agricultural crops, native plants, and ornamental vegetation through browse and bark stripping, which can contribute to erosion. They are a traffic hazard and can carry zoonotic diseases[13]. Axis deer have very high reproductive rates [10, 11] and no natural predators in Hawai‘i.

Columbian black-tailed deer (*Odocoileus hemionus columbianus*) is a subspecies of mule deer from the northwestern mainland states and provinces. In 1961, 40 animals were introduced from Oregon to Pu‘u Ka Pele Game Management Area on Kaua‘i. There is now a large population of more than 700 animals around Waimea Canyon, including Koke‘e State Park.

Biology and Behavior

Population growth rates of wild ungulates can be high in the absence of natural predators. Introduced populations of axis deer have exhibited annual population growth rates of 20-30% in the absence of their natural predators[10, 11]. On Hawai'i a founding population of 11 mouflon at Kahuku Ranch has increased to more than 2500 animals in 36 years while trophy males were under substantial hunting pressure[9, 18]. Populations of polygamous species, such as mouflon on Moana Loa, can double in three to four years when the ratio of females to males is high[18]. When high quality forage is available, females become reproductive at younger ages and the rate of twinning may also increase[19]. On Lāna'i and Moloka'i, some axis deer does reached sexual maturity as early as four to six months of age, but most matured by the end of their first year[9].

These wild ungulates present new control challenges in Hawai'i because they are able to jump over most fences designed for feral ungulates, disperse in small groups, hide in dense cover, and actively evade control efforts. Mouflon segregate by sexes and only aggregate in large groups during the breeding period[20]. Mouflon become difficult to control because they disperse widely as single individuals or in small groups, making radio-telemetry tools become ineffective[21]. The hybrid mouflon-feral sheep of Mauna Kea exhibit variation rare in populations of the parent species. They are larger and show a wide variety of coat colors. Hunting pressure may select for cryptic coat colors, making the animals more difficult to detect.

Axis deer are semi-nocturnal, resting in cover during the warmest period of the day[9]. They congregate mainly in small family groups of 15-24[9, 11] but herds of 300 animals have been observed on Maui pasturelands[12]. Although axis deer rarely occur above 1160m elevation in their native range[14], they have been observed above 2150m on Maui[12].

Conservation Implications

Wild ungulates, along with feral domesticated sheep, pigs, and goats, have been a major source of habitat degradation and of population decline of native Hawaiian species. Mouflon and hybrid mouflon, along with feral domestic sheep and goats, contributed to the degradation of palila finch (*Loxioides bailleui*) habitat in the māmane-naio forest, resulting in two court orders for ungulate eradication. Nearly two decades of intensive population control were needed to improve ecological conditions on Mauna Kea[25,] but the Mauna Kea silversword (*Argyroxiphium sandwicense*) still suffers browse damage when even small numbers of hybrid mouflon are present. Where mouflon occasionally have invaded fenced areas in the Mauna Loa strip of Hawai'i Volcanoes National Park, they have destroyed outplanted Ka'u silverswords (*A. kauense*), damaged the threatened Hawaiian catchfly (*Silene hawaiiensis*), and stripped bark from koa (*Acacia koa*) and māmane (*Sophora chrysophylla*)[22]. A large and growing population of mouflon now threatens endangered plants and degrades habitats of endangered forest birds throughout Mauna Loa.

Axis and Columbian black-tailed deer produce similar environmental impacts through browsing and habitat degradation. Under extreme conditions they can consume all available vegetation and will strip bark from trees[26]. Bucks also rub their antlers on tree trunks and branches[13], girdling and killing mature trees[2]. Deer population concentrations are highest in fragile, seasonally wet areas below the cloud forests. Here they create trails through thick vegetation causing soil compaction, decreasing ground mosses and increasing runoff and erosion[13]. Such impacts by feral pigs and axis deer on East Moloka'i have reduced the 'ōhi'a-hapu'u rainforest to a grassy scrubland and contributed to siltation of the coral reefs on the south coast[27]. These trails also damage a variety of cultural and archaeological resources[13]. Without constraints, deer populations will increase and degrade new areas, particularly on Maui and Kaua'i.

The foregoing discussion indicates that:

1. Existing feral ungulate control fences for pigs, sheep, and goats are inadequate to exclude introduced wild ungulates such as mouflon and deer. Land managers will need to either upgrade fences or undertake supplemental control measures when less effective fences cannot be upgraded,
2. Fences adequate to exclude all wild ungulates are expensive to build and to maintain,

3. For a variety of reasons, eradication of wild ungulates over large areas is currently beyond our capability.

Management Recommendations

1. HCA opposes the introduction of additional wild ungulates to Hawai‘i.
2. HCA supports the active control (i.e., population reduction) of wild ungulates outside of game parks.
3. HCA supports the construction of high, protective fences and wild ungulate eradication within high-priority conservation areas.
4. HCA supports the removal of wild ungulate populations from game parks on any island where the species is not currently naturalized.
5. HCA supports the development of new control methodologies aimed at reducing wild ungulate populations outside of game parks (e.g., fertility reduction drugs).

References Cited

[1]Scowcroft, P. G., and J. G. Giffin. 1983. Feral herbivores suppress the regeneration of mamane and other browse species on Mauna Kea, Hawaii. Journal of Range Management 36:638-645.

[2]Scowcroft, P. G., and H. F. Sakai. 1983. Impacts of feral herbivores on mamane forests and Mauna Kea, Hawaii: bark stripping and diameter class structure. Journal of Range Management 36:495-498.

[3] Hiendleder S, Kaupe B, Wassmuth R, Janke A. 2002. Molecular analysis of wild and domestic sheep questions current nomenclature and provides evidence for domestication from two different subspecies. Proc. Biol. Sci. 269:893-904.

[4]Tomich, P. Q. 1986. Mammals in Hawaii, 2nd Ed. Bishop Museum Press, Honolulu, HI.

[5]Luengo, J.-L. R., and J. C. Piñero. 1991. Autumn diet of the Corsica mouflon *Ovis ammon musimon* Shreber 1782 on Tenerife, Canary Islands. Transactions of the 18th IUGB Congress, Krakow, Poland.

[6]Chapuis, J. L., P. Boussès, and G. Barnaud. 1994. Alien mammals, impact and management in the French sub-Antarctic islands. Biological Conservation 67:97-104.

[7]Giffin, J. G. 1982. Ecology of mouflon sheep on Mauna Kea. State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu, Hawaii.

[8]Robichaux R., S. Bergfeld, M. Bruegmann, J. Canfield, P. Moriyasu, T. Rubenstein, T. Tunison, and F. Warshauer. 2000. Reintroducing Hawaii's silverswords. Endangered Species Bulletin 25:22-23. http://www.fws.gov/endangered/esb/2000/05-06/22-23.pdf

[9]Graf, W., and L. Nichols Jr. 1966. The axis deer in Hawaii. Journal of the Bombay Natural History Society 63:629-734.

[10]Wehausen, J. D., and H. W. Elliott III. 1982. Range relationships and demography of fallow and axis deer on Point Reyes National Seashore. California Fish & Game 68:132-145.

[11]Mungall, E. C., and W. J. Sheffield. 1994. Exotics of the range. Texas A&M University Press, College Station, Texas. 265 pp.

[12]Waring, G. 1996. Preliminary study of the behavior and ecology of axis deer (*Axis axis*) on Maui, Hawaii. Research report to Haleakala National Park and the National Park Service. www.hear.org/AlienSpeciesInHawaii/waringreports/axisdeer.htm.

[***], Monroe, C. (1962). manuscript.

[13]Anderson, S. B. 1999. Axis Deer Overview & Profile. www.hear.org/hnis/reports/HNIS-AxiAxiV01.pdf.

[14]Schaller, G. B. 1967. The Deer and the Tiger: a Study of Wildlife in India. Univ. Chicago Press, Chicago, 370 pp.

[15]O'Gara, B. W. 1994. Report to trustees of the Damon Estate concerning mouflon on the Kahuku Ranch. Unpublished report, K. Ross Toole Archives, Mansfield Library, University of Montana, Missoula MT.

[16]Titcomb, M. 1969. The axis deer—impending threat to the Big Island. `Elepaio 30:21-25.

[17]Walker, R. L. 1969. Staff report by state division of fish and game on question should axis deer be introduced to the island of Hawaii. 'Elepaio 30:31-36.

[18]Hess, S., B. Kawakami, D. Okita, K. Medeiros. 2006. A preliminary assessment of mouflon abundance at the Kahuku Unit of Hawaii Volcanoes National Park. US Geological Survey Open File Report OF 2006-1193. http://pubs.water.usgs.gov/ofr2006-1193/

[19]Garel M., J.-M. Cugnasse, J.-M. Gaillard, A. Loison, P. Gibert, P. Douvre, and D. Dubray. 2005. Reproductive output of female mouflon: a comparative analysis. Journal of Zoology 266:6-71.

[20]Cransac, N., J.-F. Gerard, M.-L Maublanc, and D. Pepin. 1998. An example of segregation between age and sex classes only weakly related to habitat use in mouflon sheep (*Ovis gmelini*). Journal of Zoology London 244:371-378.

[21]Taylor, D., and L. Katahira. 1988. Radio telemetry as an aid in eradicating remnant feral goats. Wildlife Society Bulletin 16:297-299.

[22]Belfield, T. R., and L. W. Pratt. 2002. Rare plants of the Mauna Loa Special Ecological Area, Hawaii Volcanoes National Park. PCSU Technical Report 130, University of Hawaii at Manoa, Department of Botany, Honolulu, HI. 61 pp. http://www.botany.hawaii.edu/faculty/duffy/techr/130.pdf

[23]Eisenberg, J.F. and M.C. Lockhart. 1972. An ecological reconnaissance of Wilpattu National Park, Ceylon. Smithsonian Contributions to Zoology 101:1-118.

[24]Moe, S. R. and P. Wegge. 1994. Spacing behavior and habitat use of axis deer (*Axis axis*) in lowland Nepal. Canadian Journal of Zoology 72:1735-44.

[25]Hess, S. C., P. C. Banko, G. J. Brenner and J. D. Jacobi. 1999. Factors related to the recovery of subalpine woodland on Mauna Kea, Hawaii. Biotropica 31: 212-219.

[26]Personal communication by A. C. Medeiros in: Anderson, S. B. 1999. Axis Deer Overview & Profile. www.hear.org/hnis/reports/HNIS-AxiAxiV01.pdf.

[27]Page 360 *in*: Scott, J. M., S. Mountainspring, F. L. Ramsey, and C. B. Kepler. 1986. Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Studies in Avian Biology No. 9.

[28]Maui axis deer group. 2002. Initial findings for a Maui deer management plan. www.nps.gov/applications/parks/hale/ppdocuments/ACF214.doc

Appendix 1. Nomenclature and taxonomy of mouflon and domestic sheep

"The taxonomy of the genus *Ovis* is highly contested. Among some of the arguments summarized by Nowak (1999), various authorities have lumped *O. aries* (domestic sheep) with *O. orientalis* (mouflon) as members of the same species. Others recognize the two as distinct species, but claim that *O. orientalis* is the ancestral species from which domestic sheep were derived. Some consider populations of sheep on the islands of Corsica and Sardinia as subspecies of *O. orientalis*, whereas others separate them as a distinct species. In north India, populations of *O. ammon* and *O. vignei* occur near one another, and some think they represent a single species. There are also those who consider *O. orientalis* and *O. vignei* conspecific." Hagen, A. 2003. "Ovis vignei" (On-line), Animal Diversity Web. Accessed February 13, 2006 at http://animaldiversity.ummz.umich.edu/site/accounts/information/Ovis_vignei.html.

Concerning the names (nomenclature), the International Commission of Zoological Nomenclature (2003) ratified the published 1996 Bulletin of Zoological Nomenclature opinion that the Asian mouflon shall be called *Ovis orientalis* and the European/Mediterranean mouflons are relegated with the domestic sheep, *O. aries*.

Appendix 2. Position Statement of the IUCN Caprinae Specialist Group on Introduced Populations of Caprinae

Several wild species of Caprinae have been introduced in areas where the local biota has evolved in their absence. Because the introduction of exotic species can have many undesirable ecological consequences, it is appropriate for the Caprinae Specialist Group of the IUCN-SSC to express its opinion on this matter. This Position Statement provides a general guideline on the management of Caprinae as exotics. It is not a management prescription for any particular situation.

1. New introductions of Caprinae as exotics must be avoided, except those specifically aimed at conservation, such as establishing a 'rescue' population in the face of disease or other threat.

2. Established exotic populations must not be allowed to expand their geographic range.

3. When they have a negative impact on native biodiversity that would be reversed by their removal, the exotic Caprinae should be removed if feasible. Impacts may include introduction of parasites and diseases, competition or hybridization with native species or subspecies, impact on vegetation or on native predator populations.

4. When removal is either impossible or unnecessary, control measures to keep population density low should be put in place, especially if those activities generate funds for the protection of native biodiversity.

5. Research efforts on the impacts of exotic Caprinae on native biodiversity are a key priority to better manage these exotic populations.

4th WORLD CONGRESS ON MOUNTAIN UNGULATES, Munnar (Kerala), India, September 12-15, 2006 http://www.wmcu2006.org/

5th International Mouflon Symposium, Het Nationale Park De Hoge Veluwe, The Netherlands 19-22 October, 2005 www.moflonsymposim.info.