

Axis Deer Overview & Profile

Following the “Harmful Non-Indigenous Species in Hawaii” Questionnaire

(1) Species: Axis deer, chital or spotted deer.

The deer introduced to the Hawaiian Islands, from its native India, is *Axis axis axis* (Simpson 1945, as seen in Graf & Nichols 1967). *Axis axis axis* was originally classified as *Cervus axis* (Lydecker 1913-16), making it a species of elk (the North American elk is *Cervus elaphus*). However, the classification of chital was shifted in the 1950's, elevating *Axis* to its own genus.

Today, there are two distinct species in the *Axis* genus: *Axis axis* (chital) and *Axis porcinus* (hog deer). Furthermore, *Axis axis* now contains at least three subspecies. On mainland India and Nepal we find *Axis axis axis*, in Sri Lanka we find the closely related *Axis axis cylonensis*. At least one other island subspecies is recognized as *Axis axis calamaniensis*.

(2) General Physical Description (size, growth form, identifying characteristics):

Schaller (1967, page 38) describes axis deer as follows:

“The chital is a medium sized deer standing about 35-38 inches at the shoulders. Its coat is rufous brown and covered with white spots that persist throughout the life of the animal. A dark stripe runs down the back from the nape to the tip of the tail. The abdomen, rump, throat and insides of the legs, tail and ears are white.”

Antlers are present only on bucks, and immediately upon shedding a set of antlers, growth begins on the next set. The larger the antlers, the longer the development period, from “velvet” through “hard” antler. Antlers over 30 inches take roughly five months to fully develop.

Male axis deer are generally larger than female axis deer wherever they occur. Bucks in India weighed 150-200 pounds, while does weighed 100-125 pounds. These weights are roughly similar wherever axis deer are found. Some exceptions have been noted. In Hawaii, bucks weighed up to 250 pounds on Molokai (Graf & Nichols 1967). On trophy game ranches in Texas, fed axis bucks have weighed well over 300 pounds. Throughout Hawaii, axis deer average 158lbs. for males and 98lbs. for females (Graf & Nichols, as seen in Elliott 1971).

(3) Federal Noxious Weed Status: N/A

(4) Federal Seed Act Status: N/A

(5) Local Noxious Weed Status: N/A

(6) Local Seed Act Status: N/A

(7) Native Range of this (sub)species: ASIA- India, Nepal

(8) Distribution within the native range:

Axis deer are found almost exclusively at lower elevations (below ~3000 feet) throughout dry and mixed deciduous forest habitat (Ables 1977). They are most commonly associated with a mixture of forest and more open grass-shrub associations, but the deer occupy a wide range of habitats throughout their native range (Moe & Wegge 1994).

(9) Climate of native range:

The native range is characterized by significant seasonal changes in temperature and, more significantly, extreme swings in precipitation. The deer regularly encounter long periods of drought and poor forage availability, as well as widespread flooding and lush seasonal growth during the rainy season. It is not uncommon, however, for a year to go by without the arrival of the rains.

Researchers have characterized the annual seasonal cycle in India/Nepal as follows: Hot-Dry season (Feb.-June); Monsoon season (June-Sept.); Cool-Dry season (Sept.-Feb.). Forage availability peaks following the onset of the first monsoon rains in June, July and August. The leanest time for forage occurs during the cool-dry season, from September-February. These patterns are disrupted somewhat where controlled burns of the grasslands occurs, creating an abundance of new shoots during the middle of the cool-dry season.

(10) Relevant aspects of biology/ecology:

(11) Value of this species to humans: Food (venison), recreation (hunting), aesthetic appreciation (beauty)

(12) Details of value to humans:

Axis deer venison is widely regarded as one of the best in the world. It consistently ranks in the top ten of all venison in the world. The meat is extremely lean and can be served as steaks, in sausages or ground for a wide variety of preparations. As a result, there is an economic value for the meat. Poaching and black market sales are common wherever axis deer occur.

The axis deer generally cannot be 'farmed' in small pens as other venison, so large deer ranches are the rule in areas where the animals have been introduced. The axis deer is a prized hunting quarry owing to its beauty, especially bucks with antlers > 30 inches. Many 'game ranches' receive upwards of \$1000 for each trophy buck 'taken' on a guided hunt.

(13) Attempted successful control strategies:

The most successful control strategies for axis deer to date are fencing and shooting. Reproductive control is likely a future option for axis deer, but is certainly not available currently. Realistically, 5-10 years of funding and research are needed to develop reproductive control and delivery methods (contraception, sterilization...) for wild deer populations.

(14) Details of control strategies:

Fencing has been used for years to confine deer to 'game ranches' in Texas and Florida. Unfortunately, fences that can be considered ~100% effective are prohibitively expensive. Even with 8 foot fences, numerous animals have escaped from Texas ranches and thousands of deer now run wild in that state. A critical question that remains regarding axis deer centers on the cost effectiveness of fencing. Clearly a 10 foot high fence is very close to 100% effective at containing axis deer, but a 6 foot fence is quite effective as well. Research is needed to address how high a fence needs to be, and what sorts of manipulations can be made to current fences in order to improve their efficacy. It is also important to note that humans will frequently sabotage or cut fences either to gain hunting access, or to allow the deer to spread more widely in an area. Thus, the 'human factor' must be considered with regard to fencing axis deer.

New Zealand has lots of experience with using recreational and commercial hunting to control exotic deer populations (principally Red deer). Clearly, hunting is an effective population control tool for axis deer. Unfortunately, the principle challenge faced here is usually land ownership and deer distribution. Given the aforementioned value of axis to humans, there is a great demand to harvest axis deer. The challenge, however, is having legal access to land where there are enough deer to offer sufficient hunting success. Maui does not currently have anywhere near the acreage of public hunting that would be required to control the deer population island-wide. It is also not clear that hunting alone would be a sufficient control mechanism for deer on Maui, as deer are readily spreading into suburban areas where rifle hunting is not a practical option.

(15) Specific problems caused OUTSIDE Hawaii:

Axis deer have frequently been noted to cause crop damage throughout their native range when available forage is scarce. Axis deer also compete directly with cattle for forage in both Pt. Reyes, CA (Elliott) and in Texas (Mungall & Sheffield 1994). Their strong preference for grazing grass underlies this competition. Axis deer populations have also been shown to grow rapidly under ideal conditions both in their native range (Schaller 1967) and in exotic locales such as California (Wehausen & Elliott 1982) and Texas (Mungall & Sheffield 1994). Annual increases of 20-30% have been documented in these instances. The axis deer is also listed as “by far the most common ungulate” in Nepal’s Royal Bardia National Park (Moe & Wegge 1994) with densities exceeding 200/sq. km (Neass & Andersen 1993, as seen in Moe & Wegge 1994). In their native India, axis deer have also been shown to carry and transmit bovine Tuberculosis and several other diseases (Schaller 1967).

(16) Specific problems caused IN Hawaii:Direct Impacts:

- ◆ Native Vegetation
- ◆ Crops/Nurseries/Ornamentals
- ◆ Golf Courses
- ◆ Erosion/Watersheds
- ◆ Archaeological sites (stone walls, heiaus...)
- ◆ Cattle Ranching
- ◆ Deer-vehicle collisions
- ◆ Diseases issues (*Leptospirosis*, *E. coli*, *Cryptosporidiosis*, cattle *TB*)

The axis deer have been shown to consume an extremely wide range of forage items throughout their native range (Schaller 1967) and in introduced locales (Elliott 1971; Elliott 1983). Axis have been documented to eat over 75 species of plants, as well as the full spectrum of plant parts including leaves, stems, fruits, seeds, flowers and bark (Schaller 1967). Although they prefer to graze grass, it is clear that the deer will respond to available forage conditions and eat what is available to them. This adaptability and high variability in forage consumed is a serious problem that axis deer present here in Hawaii. Art Medeiros has documented a ‘foraging hierarchy’ near Puu o’ Kali under extreme drought conditions, whereby axis will eat the most palatable item available until it is rare. They will then choose the next most palatable item and eat it. Eventually, in the peak of the drought of 1999, the axis were eating highly unpalatable bark off of trees.

Aside from direct foraging impacts by axis deer, there is a significant impact to trees from axis bucks rubbing and polishing their antlers on the bark. This can frequently result in the death of these trees. As the numbers of axis deer grow, the ‘trailing’ behavior of axis creates dirt pathways through the thickest of vegetation. These trails can lead to significant erosion and, in wet forest areas, will increase runoff by decreasing the mossy layer available to retain water. Further, the trailing behavior has caused damage to a variety of culturally or archaeologically significant sites. I have documented very significant damage to native sites, heiaus and old Hawaiian stone walls as the deer consistently pass through in large numbers.

During my study, I have witnessed two warnings come true about axis deer behavior in Hawaii. Both were first voiced by Harold Lyon in November, 1950 regarding the proposed release of axis deer at Pohakuloa Training Area on the Big Island. He warned:

“They will range in the cane fields as well as in the forest...[further]...The deer can graze down the forage grasses and other plants much closer to the ground than can the cattle, so in all overstocked pasture the deer can thrive while the cattle starve”

On Maui, the deer are now frequently encountered in cane fields owned by HC & S Sugar. Unfortunately, I have also witnessed cattle in very poor condition (nutritionally) co-existing with deer that had continued to thrive under extreme drought conditions.

Another highly significant human health issue that the axis deer pose in Hawaii is the threat of deer-vehicle collisions on the roads and highways of Maui. Deer vehicle collisions have occurred regularly on Molokai for years, but the generally slower speeds of automobiles on Molokai has limited the potential for damage and injury.

Unfortunately, cars on the higher speed roadways of Maui are increasingly encountering axis deer, and collisions are on the rise over the past few years (Maui Police Dept., pers. comm.)

Disease is also certainly an issue that is significant here in Hawaii regarding axis deer (research is currently addressing this). It is almost certain that the deer carry common parasites that can directly affect humans if droppings enter freshwater and hence our drinking water supply. These include: *leptospirosis*, *cryptosporidiosis*, and strains of *E. coli*.

Indirect impacts:

- Fence damage
- Firearms Safety & Poaching

Axis deer are responsible for extensive damage to fences throughout the ranchlands on the western slopes of Haleakala. This is problematic as the deer population continues to expand into more mauka areas. There are currently at least 15 deer living on the boundary of Waikamoi and the Hosmer's Grove area of Haleakala National Park at over 6,000 feet of elevation. Both of these reserves absolutely depend on their current fencing to safeguard native vegetation from the impacts of introduced ungulates. If the deer begin to damage the fencing as we have seen elsewhere on Maui, current measures of protecting these areas will prove insufficient. Goats and pigs will have a powerful new force acting to open fence gaps (aside from treefalls, mudslides etc...), allowing for their passage into these areas. The current fences are an insufficient barrier to deer movements.

A final, indirect, human health issue that axis pose in Hawaii is the potential for stray bullets to hit people as un-regulated hunting (poaching) increases. This most frequently occurs at night, but is more regularly occurring in the daytime as well. Numerous residents in the Makena and Wailea areas as well as upcountry have frequently reported unauthorized gunfire very close to dwellings, hotels and golf courses. This clearly is a cause for concern.

(17) History in Hawaii: [as seen in Waring, 1996 (much after Tomich 1986)]

- 1868- January, 8 axis deer released on Molokai (3 bucks, 4 does, one male fawn). Several transferred to Oahu
- 1888- ~ 1000 animals on Molokai
- 1898- herd well established at Diamond Head
- 1900- ~ 7000 animals on Molokai
- 1901/2- Hired hunters kill >3500 animals on Molokai
- 1910- second herd established in Moanahua Valley (escaped captivity 1910- Lennox)
- 1920- 12 deer transferred from Molokai to Lanai
- 1938- Peak of Moanalua Valley popln.
- 1950- Deer scarce in Oahu by this time
- 1958- August, Estimated 1500 on Molokai (a FEW deer along Kaulapapa peninsula) estimated 700-800 on Lanai
- 1959- September, 5 axis (2 bucks, 3 does) released at Pu'u o' Kali on Maui
- 1960- July, 4 addl. deer (1 buck, 3 does) released at Ka'onoulu Ranch near 1959 site on Maui
- 1961- 3000 animals estimated on Molokai
 - 1500-2000 estimated on Lanai (by Graf/Nichols)
 - 1675 deer on Lanai reported ()
- 1962- ~ 25 deer left on Oahu, gone shortly thereafter
- 1968- ~ 90 animals estimated on Maui
- 1995- >>500 animals on western slope of Haleakala alone

(18) Who are the key contact people re Axis deer:

- In native habitats: Stein Moe, Per Wegge, Raj Mishra, Eric Dinerstein, Cyrille Barrette
- In exotic locales outside Hawaii: Henry Elliott III, Judd Howell (in CA); Texas A&M University (re TX)
- In Hawaii: Steven B. Anderson, Sumner Erdman, George Waring, Rick Potts

(19) What are the primary characteristics that cause this species to be problematic:

The principle elements of axis deer biology that cause it to be problematic here in Hawaii are:

- ◆ lack of natural predators
- ◆ extreme elusivity (hiding) and nocturnal activity
- ◆ behavioral variability, adaptability and opportunism

This species has also evolved in the face of environmental extremes in Asia that it will never encounter here in Hawaii. It is adapted to a much wider temperature range, a much greater breadth of precipitation extremes, a much broader range of common plant species, and much more stealthy predators (tigers) than generally are hunters.

Adaptability:

One aspect of axis deer that merits significant concern is the deer's extreme adaptability to changing circumstances. On Maui, this adaptability has been seen in the deer's rapid response to heavy hunting pressure (Waring 1995; personal observation) and in their responses to the changing availability of preferred forage (Art Medeiros pers. comm.). This appears to be the consensus throughout the published literature. Ables stated that "the axis [deer] is a plastic species capable of considerable adaptive response". Kurt (1978) wrote that "more generalized species like the axis deer are able to respond more flexibly to habitat changes, either natural or man-induced" (as seen in Martin, 1987). Dinerstein (1987) noted a high "degree of opportunism exhibited by [axis] deer" regarding their choice of forage.

Reproductive parameters that are cause for significant concern include:

- ◆ the present population size (particularly the number of does island-wide)
- ◆ the extremely low age of first estrous in does (from 4-6 months)
- ◆ the high annual pregnancy rate (~85% of adult does each year)
- ◆ the low mortality of fawns in their first year
- ◆ a 'harvest' bias that favors bucks over does

[the majority of this information comes from Graf & Nichols 1967 and my personal observations here on Maui].

Population Parameters:

Several published case studies of population growth for axis deer in a variety of native and introduced locales give us a strong warning that the deer population is likely to balloon significantly, and very rapidly. A noticeable population 'boom' appears to have begun here on Maui in 1997-98. The population explosion is most significant at the periphery of the deer's current range, where hunting pressure is much less intense.

Location	Begin	End	# of Years	Change
<i>Native India- Kanha</i>	5,000	13,000	5	+ 8,000
Ukraine	25	473	15	+ 448
Pt. Reyes, CA (min. est.)	8	400	23	+ 392
Texas- 1 st Five Years	6500	13,000	5	+ 6,500
Texas- Next Three Years	13,000	22,750	3	+ 9,750
Texas- Overall Growth	6,500	39,000	22	+32,500

[for references, see the online bibliography at <http://www.maui.net/~brooke/webbiblio.html>]