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Methods for Population Control: A Case Study on the Axis Deer of Maui Island, HI

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ABSTRACT: This study is an exploration of the social, ecological, and economic components of creating a commercialized hunt of non-native axis deer on Maui Island, Hawaii. It consists of three analytic phases to determine the preferred population control policy alternative. The first phase was a series of qualitative interviews and surveys with wildlife managers, deer processors, and any potential suppliers who may be interested in selling deer meat and/or products to consumers, including suppliers such as natural food stores, pet food companies, and jewelers. Phase 2, on which this report focuses, involved email surveys sent to two groups: residents of the island of Maui, and hunters registered in Maui, to determine attitudes about population control methods, including a commercialized harvest. This survey also investigated the opinions of consumers about purchasing axis deer meat and other products. Phase 3 will be a cost-benefit analysis of various population control techniques for axis deer on Maui Island to determine the most economically efficient methods. The conclusion of this research will result in the proposal of preferred policy alternatives for population control that take into account the economic, social, and ecological aspects of each policy alternative.

KEY WORDS: *Axis axis*, axis deer, commercialized harvest, deer management, Hawaii, Maui wildlife, venison industry

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INTRODUCTION

The island of Maui has reached a critical threshold with the growing population of axis deer (*Axis axis*), which have been linked to the degradation of the natural ecosystem and cause of human-wildlife conflicts, including increased deer-automobile collisions and damage to agricultural operations. Axis deer are not native to Hawaii, but were introduced to the island of Molokai in 1868 and then the island of Maui in 1959 (Demarais et al. 1990). Because axis deer were not initial colonizers in Hawaii, endemic life forms on the islands evolved without need to compete with or defend against them. Axis deer devour and demolish native plants and ground cover, which facilitates sediment run-off and the smothering of coral reefs. The disturbance caused by hooves churning the soil also aids in the introduction and expansion of invasive plants, and creates breeding grounds for mosquitoes that transmit avian diseases to native birds. The invasion of non-native species poses one of the greatest threats to Hawaii's native ecosystems and their inhabitants (Reeser and Harry 2005). Current hunting regulations allow for any axis deer encountered while hunting on a public hunting area on Maui to be taken by the hunter regardless of number or sex of deer taken (State of Hawaii DLNR 2003).

Despite these lax regulations, populations continue to increase. There is a clear necessity to manage these axis deer populations in order to aid in ecosystem recovery; such a recovery cannot be successful in the presence of axis deer. Although many native species continue to decline in number, some species are on their way to recovery due to habitat protection and management efforts. Continued progress toward recovery will require the application of good science to natural resource management and policy decisions (Reeser and Harry 2005). Population control must be administered in the

most efficient ecological, social, and humane manner possible. A balance between these needs is critical in preserving the cultural and natural aspects of Hawaii's rich heritage (Reeser and Harry 2005).

In an attempt to manage axis deer populations, the Maui Axis Deer Working Group (MADWG), a group composed of various stakeholders including government officials, hunters, ranchers, and concerned citizens, has been created within the Maui County government. The MADWG has developed a comprehensive management plan to support control efforts in targeted areas with the initial focus on reducing damage to agricultural and ranch lands. They describe the following actions as being needed: obtain accurate information about axis deer population and distribution; identify specific Management Focus Areas for initial cooperative suppression efforts; engage the community including hunters through a series of facilitated stakeholder meetings; and educate and involve the broader public in the issue (MADWG 2012).

The purpose of this paper is to focus on Phase 2 of our research to gain an understanding of attitudes towards axis deer populations, different axis deer control methods, and the axis deer venison industry. Two groups of people were surveyed about their opinions: current licensed hunters of Maui, and current residents of Maui. In addition to control methods like fencing, contraceptives, and sharp shooting, participants were asked about a commercialized axis deer hunt – a potential control method that is virtually unheard of in the United States. Currently, commercialized harvests are being attempted on Maui, but U.S. Department of Agriculture (USDA) inspection regulations make harvests so expensive they are not currently cost-effective. The “commercialized harvest” method that is discussed in these surveys is a currently hypothetical harvest where hunters could apply for special permits allowing them to harvest axis deer and

sell the carcasses to processors, who would then process and sell the meat to grocery stores, restaurants, and other vendors. It is assumed in this scenario that USDA regulations have been updated to allow for this type of harvest while still verifying that the meat is in accordance with USDA standards.

It is important to note that other countries are not only dealing with invasive species, but have also already transitioned to a commercialized harvest system to help control population numbers. Although the United States has not yet fully embraced this idea, countries like New Zealand and Australia have been utilizing the invasive species they are trying to control as an economic resource, often times exporting the meat to other countries where demand is higher. New Zealand supplies to international red deer, Himalayan tahr, and possum markets, while Australia supplies to international feral goat and feral pig markets (Forsyth and Parkes 2004, Parks 2006).

METHODS

Hunter Survey

The study population of approximately 45 hunters was found using various hunting group online bulletin boards and through networking with axis deer hunting guides. Additionally, the MAWDG forwarded this study information to the leadership of various hunting groups on Maui, who forwarded the information to group members. The survey instrument was only available online, but it could be accessed using the forwarded URL link in an email or by visiting a website that was set up for the sole purpose of housing the URL link. This webpage was easy to search for online and its URL was easier to type into a browser than the full URL of the survey.

The purpose of this survey was to seek the opinions of hunters about axis deer population control and the potential venison industry on Maui. Hunters on Maui are very aware of how the government manages axis deer, because they are a favorite game species on the island. As a result, this study sought to focus on hunters as a group in order to understand their attitudes towards potential changes that might affect their hunting. This hunting survey asked questions regarding whether the respondent had hunted axis deer, their preferred hunting methods, success in hunting axis deer, knowledge of axis deer, and preferred control methods.

Resident Survey

The residential survey was designed to understand consumer-side demand for products related to a venison industry in Maui. Although the survey was online-based, information about the survey was distributed over a series of media and the goal was to reach a sample size of 200 responses. On January 13, 2014, an article entitled "New Survey Finds 8,000 Axis Deer in E. Maui: Separate Effort Looks into Viability of a Venison Market," by Chris Sugidono, was published in the *Maui News*, a local Maui newspaper. This paper highlighted the recent axis deer population survey efforts by the MADWG and also gave information about this resident survey. The article noted the purpose of the survey work and listed the link to

the online survey so that readers could participate in the survey. The article was published in print and online.

Another effort to bring attention to this residential survey was made by the *Maui Now* newspaper. *Maui Now* posted a Facebook status about the survey on January 15, 2014 stating, "If you'd like to have a say in axis deer population control here on Maui, fill out this 10 minute survey on control and harvest methods you approve of (anonymously). It's via the University of Delaware and the information may be shared with governmental groups and the Maui Axis Deer Working Group," and provided a link to the survey.

The final method of distribution involved using the Maui Yellowbook to randomly select 1,000 people to mail about the residential survey. Approximately 5 people were randomly selected per "Business and Resident: 2014-2015" page by including every tenth entry listed on a page in the mailing list; if the tenth entry was a business, the next residential entry listed was included. Once a list of 1,000 names and addresses were collected, 1-page letters were mailed to these Maui residents. These letters explained the background and purpose of the resident survey and listed the link to visit to reach the online survey.

The first two questions ensured that those who answered the survey either currently live in Maui or lived there within the past 2 years. The first series of questions asked if the respondent has suffered from damage relating to axis deer and if they think populations should be increased, decreased, or remain the same. The next series of questions were about the commercialized harvest: do they anticipate problems with a commercialized harvest, and would they be interested in purchasing products such as meat, pet food, or jewelry from harvested axis deer. The next series asked about their preferred methods of control where they can rank which methods they prefer. The residential survey also contained the questions from the hunter survey as a subset if the respondent answered that they were a hunter registered and Maui who had not already taken the hunter survey. The final questions were to collect demographic information.

RESULTS

Hunter Survey

Two responses were labeled as incomplete within the Qualtrics software, so those were discarded from the data set, leaving a total of 44 responses. Respondents were allowed to skip questions while taking the survey, so although not every respondent answered every question, the vast majority of questions were answered by all 44 respondents. All respondents were currently registered hunters on Maui and 93% of respondents were male. When asked to describe their hunting patterns within the past 2 years, 11% indicated that they only hunt axis deer, 61% primarily hunt axis deer but also hunt a few other species, 18% occasionally hunt axis deer but focus mainly on other species, and 9% of respondents never hunt axis deer. The 9% who never hunt axis deer were redirected within the survey to questions about management and hunting attitudes; they were not asked questions specific to where, how, and why they hunt axis deer.

Of the over 90% of respondents who at least occasionally hunt axis deer, 78% indicated that their most important reason for hunting axis deer is for the meat, whereas the next closest answer was only 15% who noted they hunt for sport and recreation. Additionally, when asked, “If you could sell the axis deer you hunted on Maui for a profit, how would your hunting behavior change,” approximately 58% of respondents said they would hunt more, approximately 36% said their behavior would not change, and approximately 6% said they would hunt less.

All respondents answered the following questions about axis deer populations and management, regardless of whether or not they actually hunt deer themselves. Respondents were asked how they thought populations of axis deer have changed on Maui compared to 5 years ago and 52% thought there are a lot more deer, 29% thought a few more deer, 14% thought there is the same number of deer, and a combined 5% thought there are either a few less or a lot less deer. Additionally, respondents were asked to fill in the blank, “I believe axis deer populations on Maui should be _____,” where nobody indicated populations should be greatly increased, 7% indicated populations should be increased, 39% indicated populations should stay the same, 27% indicated populations should be decreased, and 27% indicated populations should be greatly decreased.

Hunters were also asked how aware they were of the problems caused by the overpopulation of axis deer on Maui, and the vast majority indicated they were aware, with 82% responding “very aware,” and 14% responding “fairly aware.” When given information about the potential for a commercialized hunt where hunters could sell the axis deer carcasses they have harvested to a meat processor, hunters were asked if they foresaw any problems with legalizing the commercial harvest of axis deer. Most respondents indicated they “foresee few

and/or minor problems” or they “do not foresee any problems” (41% and 30%, respectively), while 27% of respondents indicated that they “foresee many and/or serious problems.”

All respondents were also asked to note how they felt about various axis deer population control methods. Hunters were asked to indicate their level of support for a series of control methods (fencing, trap and transfer, contraceptives, recreational hunting, hired sharp shooting, commercial harvesting, and take no action) where they could mark a score on a scale of 1 (“completely support”) to 5 (“do not support at all”) for each method. Overall, recreational hunting was the most supported with an average scale score of 1.3, and contraceptives were the least supported with an average scale score of 4 (Table 1). In the following question, hunters had to rank each of the 7 methods, forcing respondents to order the methods based on preference. For this ranking question, recreational hunting was again the most supported method with an average ranking of 1.78, although “take no action” (populations should remain the same) was the least supported with an average ranking of 5.7 (Table 2).

Resident Survey

There were a total of 159 responses to the resident survey after 8 responses were deleted because they were incomplete, and 5 responses were not used because the respondent was not currently a resident of Maui and had not been in the past 2 years. Of the 150 respondents, 51% were male and 49% were female, and 19% indicated that they were hunters and 81% were not hunters. The age distribution indicated that 20% of respondents were 65 years old or older, 31% were between 55 and 64, and 21% were 45 to 54, with the remaining 28% being between 18 and 44 years old.

The first set of questions given within the resident survey was about axis deer populations and attitudes

Table 1. Number of answers per scale score and average scale scores of various control methods by hunters.

Method	1 (completely support)	2	3 (neutral)	4	5 (do not support at all)	Mean Scale Score
Fencing	22	3	10	2	7	2.3
Trap and Transfer	10	3	5	3	3	3.6
Contraceptives	4	0	10	2	27	4.1
Recreational Hunting	38	2	3	0	1	1.3
Hired Sharp-Shooting	9	4	10	4	16	3.3
Commercialized Harvesting	17	8	6	5	8	2.5
Take No Action	6	4	8	1	25	3.8

Table 2. Number of answers per rank and average rank of various control methods by hunters.

Method	Slot 1 (most supported)	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7 (least supported)	Mean Ranking
Fencing	10	10	9	8	2	2	0	2.7
Trap and Transfer	0	5	4	13	7	9	3	4.5
Contraceptives	1	1	5	5	10	14	5	5.1
Recreational Hunting	24	9	3	3	2	0	0	1.8
Hired Sharp-Shooting	0	6	6	4	14	7	4	4.5
Commercialized Harvesting	3	9	10	6	4	5	4	3.7
Take No Action	3	1	4	2	2	4	25	5.7

towards potential control methods. When asked about current Maui populations compared to 5 years ago, 71% respondents noted that they thought there are a lot more deer now compared to 5 years ago. About 17% of respondents thought there are a few more deer, 7% thought populations are about the same, and 1% and 3% thought there are a few less deer and a lot less deer, respectively. Additionally, respondents were asked to fill in the blank: "I believe axis deer populations on Maui should be _____," where nobody indicated populations should be greatly increased, 2% indicated populations should be increased, 16% indicated populations should stay the same, 35% indicated populations should be decreased, and 47% indicated populations should be greatly decreased. Residents were also asked to indicate how aware they are of problems caused by the overpopulation of axis deer on Maui, and the majority said they were either fairly aware (39%) or very aware (55%), whereas only 6% said they were fairly unaware, and nobody said they were very unaware.

The next set of questions related to a potential commercialized harvest. Residents were first asked if they foresee any problems with legalizing the commercial harvest of axis deer: 17% of respondents foresee many and/or serious problems, 43% foresee few and/or minor problems, and 35% do not foresee any problems. Respondents were then asked a series of questions about their interest in products that would be available if a commercialized harvest became a reality. The first question asked if residents would be interested in purchasing axis deer meat (for example, steaks or ground meat) either to prepare themselves or at a restaurant: 76% of respondents indicated that they would be interested, 11% indicated that they would not be interested because they do not eat any kind of meat, and 13% indicated that they would not be interested in axis deer meat, but they do eat other kinds of meat.

Respondents were also asked about their interest in purchasing pet food or chew toys that contain axis deer meat or some part of an axis deer (for example, deer bones or antlers): 20% of respondents indicated that they were not interested because they do not have a pet; 23% responded that although they have a pet, they are not interested in pet food or chew toys containing axis deer parts; 13% were interested in only pet food made from axis deer meat; 6% were interested in only chew toys made from axis deer parts; and 39% were interested in both pet food and chew toys containing axis deer.

Respondents were also asked about their interest in jewelry made with beads from axis deer antlers. Respondents were the least interested in this possibility, with only 36% of respondents noting that they would be interested in this kind of jewelry, 32% indicated that they do not wear any kind of jewelry (and would thus not be interested), and the remaining 32% indicated that they do wear jewelry, but they are not interested in jewelry made with axis deer antler beads.

When asked if they thought that educating citizens about problems caused by the overpopulation of axis deer on Maui would affect if people purchase axis deer products, 21% of residents responded that they did not think education would impact purchasing decisions, 41% thought education would impact purchasing decisions to a small degree, and 38% thought education would impact purchasing decisions to a large degree.

Finally, residents were asked about their attitudes towards the seven axis deer population control methods discussed earlier. Residents were asked to indicate their level of support for each method using the scale score (1 for "completely support" through 5 for "do not support at all"), as well as using the ranking method. For the scale question, residents most preferred recreational hunting with an average scale score of 1.6, with commercialized harvesting as a close second with an average scale score of 2.0 (Table 3). "Take no action" was the least supported with an average scale score of 4.4 (Table 3). For the ranking question, again, recreational hunting was the most supported method with an average ranking of 2.5, and "take no action" was the least supported with an average ranking of 6.5 (Table 4).

MANAGEMENT IMPLICATIONS

Management implications from this survey fall into two components: the first relating to the public's preferred axis deer population control techniques, and the second relating to the market demand for axis deer venison. The two are clearly separate, yet connected; it can be assumed that those who do not support the commercialized harvest of axis deer as a control method would not be interested in the establishment of a venison industry. It should be noted that while farm-raised axis deer could potentially be available to supply the venison, the survey explicitly stated that venison or other axis deer products mentioned in the survey would be the result of a commercialized harvest.

Table 3. Number of answers per scale score and average scale scores of various control methods by residents.

Method	1 (completely support)	2	3 (neutral)	4	5 (do not support at all)	Mean Scale Score
Fencing	80	22	25	12	14	2.1
Trap and Transfer	54	11	20	15	51	3.0
Contraceptives	57	9	32	14	40	2.8
Recreational Hunting	117	14	5	4	14	1.6
Hired Sharp-Shooting	58	19	22	17	37	2.7
Commercialized Harvesting	90	24	11	9	20	2.0
Take No Action	9	3	15	10	110	4.4

Table 4. Number of answers per rank and average rank of various control methods by residents.

Method	Slot 1 (most supported)	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7 (least supported)	Mean Ranking
Fencing	26	30	23	33	19	14	0	3.2
Trap and Transfer	3	16	23	33	27	39	4	4.4
Contraceptives	22	14	20	15	38	27	9	4.0
Recreational Hunting	51	34	21	20	11	6	2	2.5
Hired Sharp-Shooting	7	17	27	22	35	28	9	4.3
Commercialized Harvesting	34	32	26	17	10	20	6	3.1
Take No Action	2	2	5	5	5	11	115	6.5

Different communities and areas will likely require different management methods based on a variety of factors not limited to the terrain, population number objectives, and how residential the area is. However, it can generally be asserted that the people of Maui believe that some form of population control is necessary. The vast majority (82.5%) of the residents surveyed want to see axis deer populations decreased or greatly decreased. Even the majority of hunters (54.5%) – a subpopulation that historically prefers high game populations – think that populations should either be decreased or greatly decreased, and approximately 39% think populations should remain the same, with low percentages pushing for increases in axis deer numbers.

For hunters, fencing, recreational hunting, and commercialized harvesting were all methods that were, on average, considered supported (meaning they scored higher than “neutral” in the scale question) (Table 1). The same three methods were the highest ranked in the hunters’ ranking question (Table 2). The general public was generally more supportive of all control methods, where all 6 techniques were supported, and only take no action was not supported in their scale question (Table 3). However, “fencing,” “recreational hunting,” and “commercialized harvesting,” again, were the top three most supported, on average, for both the scale and ranking questions for residents (Table 3, Table 4).

Results from the resident survey regarding interest in products from a commercialized axis deer harvest corroborate the findings that the idea of a commercialized harvest is generally supported on Maui. The resident survey attempted to shed light onto the market demand for products resulting from a commercialized deer harvest, including venison, pet food and chew treats, and jewelry made with beads from axis deer antlers. Results indicate that 76% of respondents would be interested in purchasing axis deer venison, 58% were interested in either dog food with axis deer meat, chew treats made from axis deer parts, or both products for pets, and 36% were interested in axis deer jewelry. Overall, there appears to be a healthy demand for axis deer products, indicating that a commercialized axis deer harvest could fulfill this niche of the market that is currently available. Furthermore, because of the range of products that could result from a commercialized axis deer harvest, this industry has the potential to be a virtually “zero waste” industry, meaning that all parts of the animal could be sold and used for some purpose, adhering to the traditional Hawaiian idea of sustainability and avoiding waste.

A combination of control mechanisms should be used throughout Maui to decrease the number of axis deer, hopefully resulting in ecosystem restoration and decreases in deer-vehicle collisions. Incentive structures should be used to encourage recreational hunting and commercial harvesting, as these methods are preferred by hunters and general residents, alike. There is ample market demand for products resulting from a commercialized harvest so, once USDA regulations are addressed to make a commercialized harvest a cost-effective option for everyone interested, such a harvest would be beneficial to hunters, the general public, and the ecosystem.

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