

Investigating the Effects of Novel Hay Presentation for Bighorn Sheep (*Ovis canadensis*) in Managed Care

Honors Thesis

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Abstract

For many ungulate species including horses (Rochais et al., 2018), cattle (Redbo & Nordblad, 1997), and giraffe (Koene, 1999), the benefits of feeding enrichment in replicating natural foraging behavior have been demonstrated. Ruminant species such as cattle (Van Os et al., 2018) have also been shown to demonstrate contrafreeloading when feeding enrichment is presented. Contrafreeloading behavior as well as novelty may impact the amount of interactions with feeding enrichment. The effects of feeding enrichment for *Ovis canadensis* in managed care have not been studied. In this study, *Ovis canadensis* housed at the Colorado Parks and Wildlife Foothills Wildlife Research Facility were presented with hay bags in addition to ad libitum hay and their behavior was recorded using scan sampling. This data was used to address three questions: do bighorn sheep spend more time engaged in feeding behavior when hay bags are present, do they spend more time foraging ad libitum or from a hay bag, and do they interact more with the hay bag when it is new to the environment? Results suggest that bighorn sheep do spend more total time engaged in feeding behavior when a hay bag is present in addition to ad libitum forage and they interact more often with a novel hay bag. For one pen studied, results suggest the bighorn sheep housed there prefer the hay bag to ad libitum hay.

Introduction

For years, the benefits of presenting animals in managed care with enrichment have been demonstrated. Enrichment can help decrease aggression and abnormal behavior, promote natural behavior, and improve health (Carlstead & Shepherdson, 2000). Although the effects of enrichment are understudied in ungulate species, some studies have shown that attempts to replicate natural foraging behavior improves welfare. Presenting hay in hay bags or slow feeders

has been shown to increase foraging time in horses and decrease undesirable or stereotypic behaviors (Rochais et al., 2018). In cattle, increasing feeding duration decreases frequency of oral stereotypies (Redbo & Nordblad, 1997). In exotic ruminants such as giraffe, individuals in managed care spend significantly less time foraging than their wild counterparts, which may contribute to oral stereotypies (Koene, 1999). However, welfare of ruminants should be evaluated not only by the absence of negative welfare indicators such as stereotypic behaviors but also by positive welfare indicators, including natural behaviors such as exploration, foraging, and affiliative social behavior (Mattiello et al., 2019).

Ungulates in managed care should be provided with as varied opportunities for foraging as possible to more closely replicate their natural foraging behavior as well as provide a higher degree of choice and control for these animals (Powell et al., 2023). Foraging behavior of *Ovis canadensis* in managed care is affected by many factors, including season and sex (Zine & Krausman, 2000). Varied feeding enrichment also seems to improve the welfare of the animal as evidenced by contrafreeloading, a phenomenon where animals in managed care choose to work for food when the same food is available for free. This may be because the sensory reinforcement from the activity of working for food outweighs the reinforcement of the food itself (Inglis et al., 1997). Cattle have been shown to push gates open to obtain forage that is also available for free (Van Os et al., 2018). It has also been demonstrated that the provision of novel objects as enrichment can increase interaction with the object (Trickett et al., 2009).

Although there have been several studies conducted on *Ovis canadensis* in managed care, there have not been any into the phenomenon of contrafreeloading or the effect of novel enrichment. Investigating the behavior of this species can help improve welfare for *Ovis canadensis* living in zoos and research facilities, as well as provide insights into the care of

closely related species. The goals of this study were to (1) investigate whether bighorn sheep spent more time engaged in total feeding behaviors when hay bags were present in addition to ad libitum hay, (2) investigate whether bighorn sheep spent more time foraging using the hay bags or ad libitum hay when both were present, and (3) investigate whether bighorn sheep interact with novel items more when they are first presented than when they have been present in the enclosure.

Methods

This study was conducted at the Colorado Parks and Wildlife Foothills Wildlife Research Facility in Fort Collins, Colorado. The facility houses 31 Rocky Mountain Bighorn Sheep (*Ovis canadensis*) across 5 separate pens. The first pen, referred to in this paper as “Rams”, held 5 intact adult males. The second, referred to as “Ewe Pen E2/E2”, held 7 adult females, raised by humans. The third, “Ewe Pen E4”, held 5 adult females and 2 male lambs, all of which were raised by other bighorn sheep. The fourth, “Castrates”, held 3 adult castrated males, and the fifth, “Ewe Pen A2/B2”, held 5 adult ewes and 3 female lambs. Each pen is provided with a supply of hay ad libitum in a trough, which is refilled daily.

For this study, hay bags were provided in addition to the ad libitum hay for treatment groups. One hay bag was provided for every two sheep in a pen. Scan sampling was used, with intervals of 3 minutes and 60 minute observation periods. Each pen was observed four times over the course of the ten week study, twice with hay bags present and twice with them absent. Two pens were observed per week, one with hay bags and one without, and the order in which they were observed was randomized. Behavior was recorded visually and in person using ZooMonitor software (Ross et al., 2016). Behavior was recorded using the following ethogram.

Table 1*Ovis canadensis* foraging ethogram

Behavior	Description
Grazing (G)	Animal is consuming naturally growing forage in pen.
Ad libitum forage (AL)	Animal is consuming hay and/or grain placed ad libitum in a trough.
Hay bag forage (HB)	Animal is consuming hay from a novel hay bag placed in pen as part of this study.
Other (O)	Animal is visible but not engaged in any of the above behaviors.
Out of View (OOV)	Animal not visible.

I used this data to investigate three questions. The first was comparing the time spent in feeding behaviors (including grazing, ad libitum foraging, and hay bag foraging) in groups with hay bags present versus absent. The second was comparing the time spent ad libitum foraging to time spent hay bag foraging in groups with hay bags present. The third was comparing the total number of individuals recorded interacting with the hay bags in the first 30 minutes after they were presented to the total number of individuals recording interacting with the hay bags 30-60 minutes after they were presented. Data was downloaded from Zoomonitor to Microsoft Excel for analysis.

For the first question, the total time spent in feeding behaviors was calculated by summing the percentage of time visible each pen spent in grazing, ad libitum foraging, and hay bag foraging. The average time spent in feeding behaviors when both hay bags and ad libitum hay were present was subtracted from the average time spent in feeding behaviors when ad libitum hay alone was present. A paired two sample t-test was used to compare the total time spent in feeding behaviors when hay bags were present versus absent. For the calculation of the

total p-value, the average of all trials was used. For the second question, the percentage of time visible foraging ad libitum when both ad libitum and a hay bag were present was subtracted from the percentage of time visible spent foraging from a hay bag when both options were present. A two-sample t-test assuming equal variances was used to compare the time spent foraging ad libitum and from a hay bag. For the calculation of the total p-value, the average of all trials was used. For the third question, the average total number of observations made of animals foraging from the hay bags for the last 10 intervals (30 minutes) of observation was subtracted from the average total number of animals foraging from the hay bags for the first 10 intervals. A paired two sample t-test was used to compare the total number of individuals recorded foraging from the hay bag in the first 10 intervals versus the second 10 intervals. For the calculation of the total p-value, the average of all trials was used.

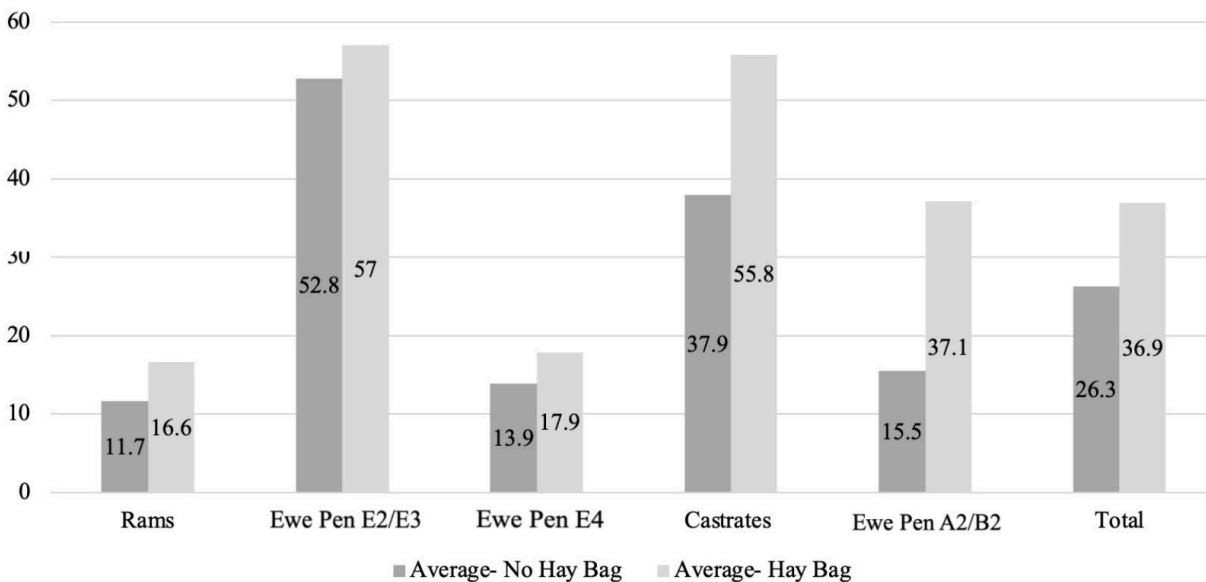
Results

The following results investigate the time spent in feeding behavior when hay bags were present versus absent.

Figure 1

Average percent time spent engaged in feeding behavior

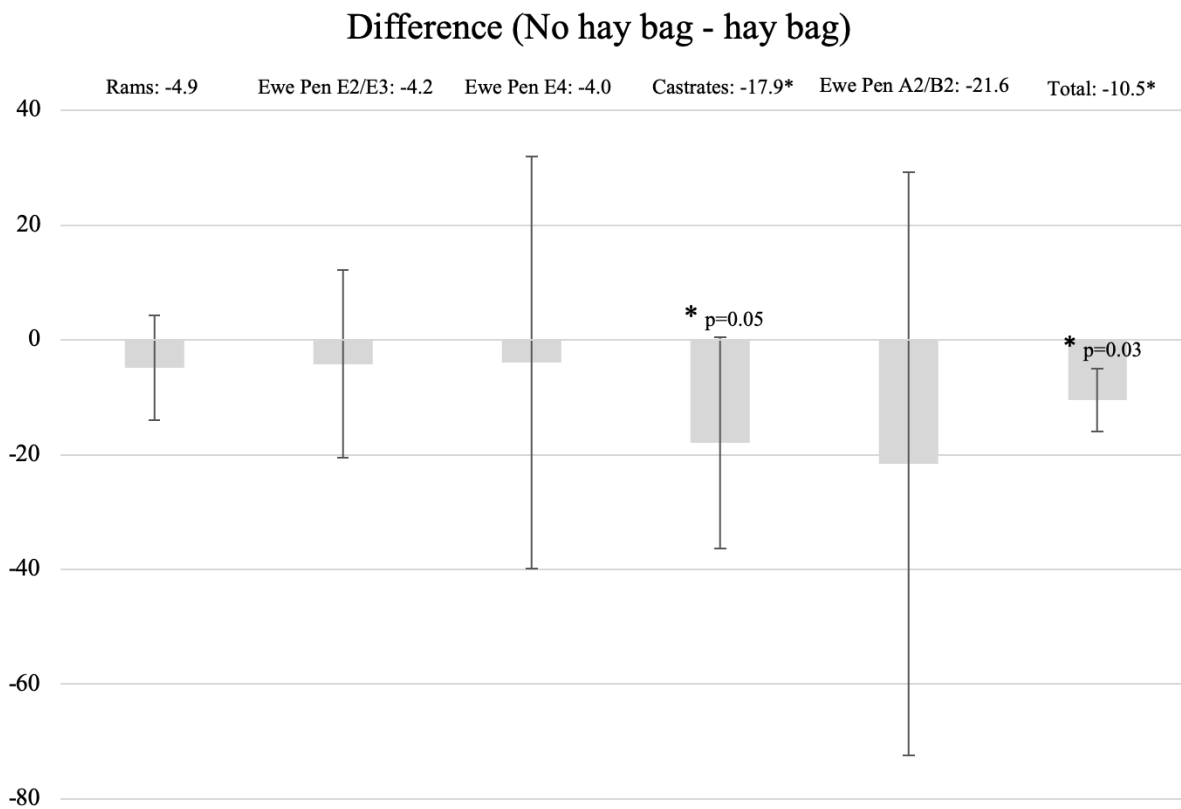
Average % time, feeding behaviors



Using this data, the following differences were calculated. Confidence intervals were calculated using an alpha value of 0.10 to reflect a one-tailed p-value.

Figure 2

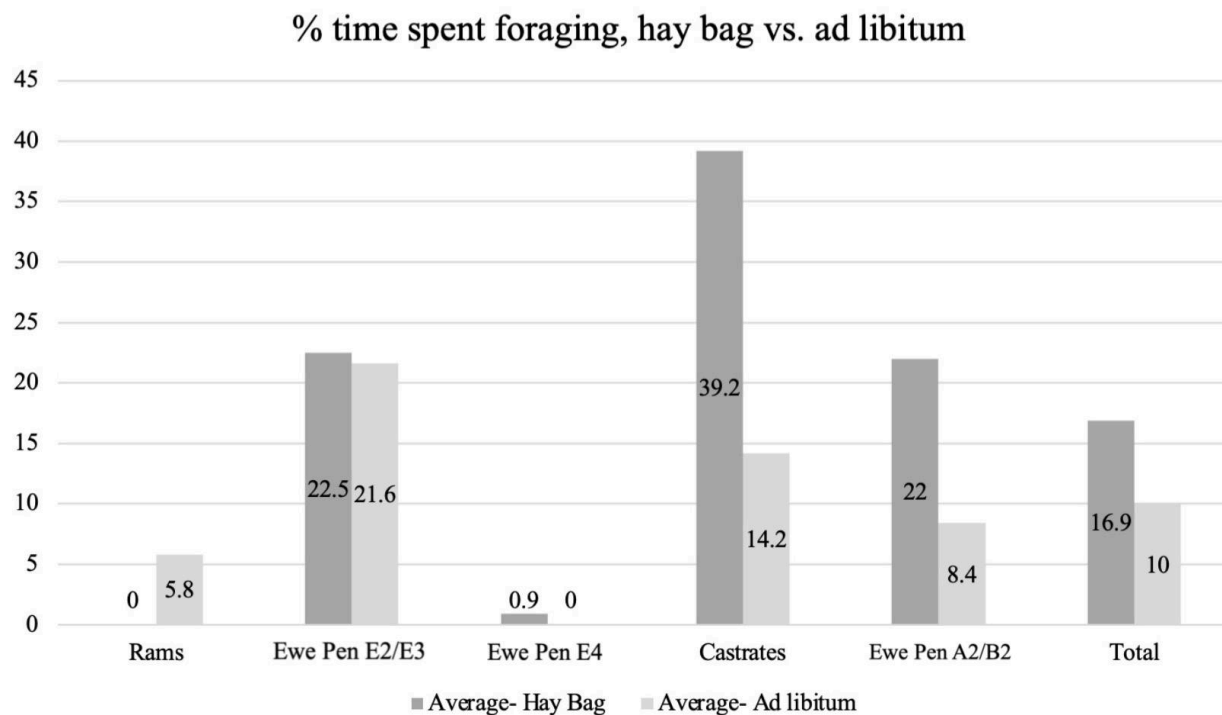
Paired differences between average time spent in feeding behavior with hay bag present versus absent



The following data compares the percent time spent foraging from a hay bag versus ad libitum hay when both were present.

Figure 3

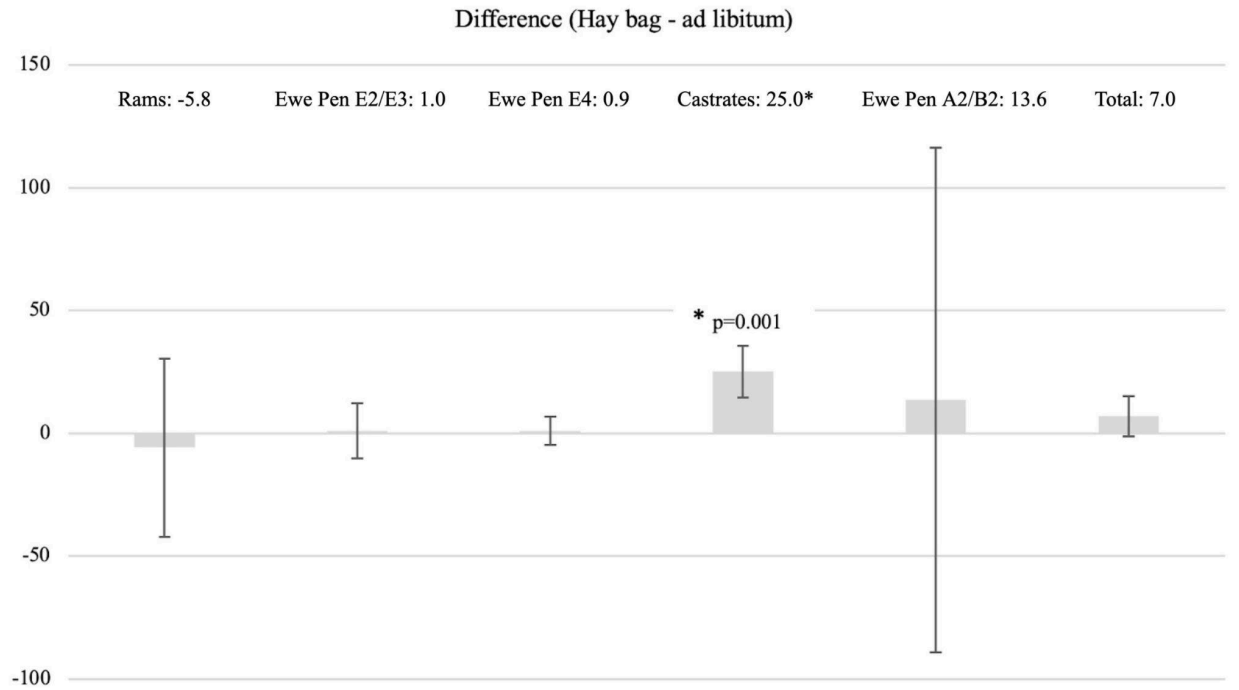
Average percent time spent foraging from differing hay presentations



Using this data, the following differences were calculated. Confidence intervals were calculated using an alpha value of 0.10 to reflect a one-tailed p-value.

Figure 4

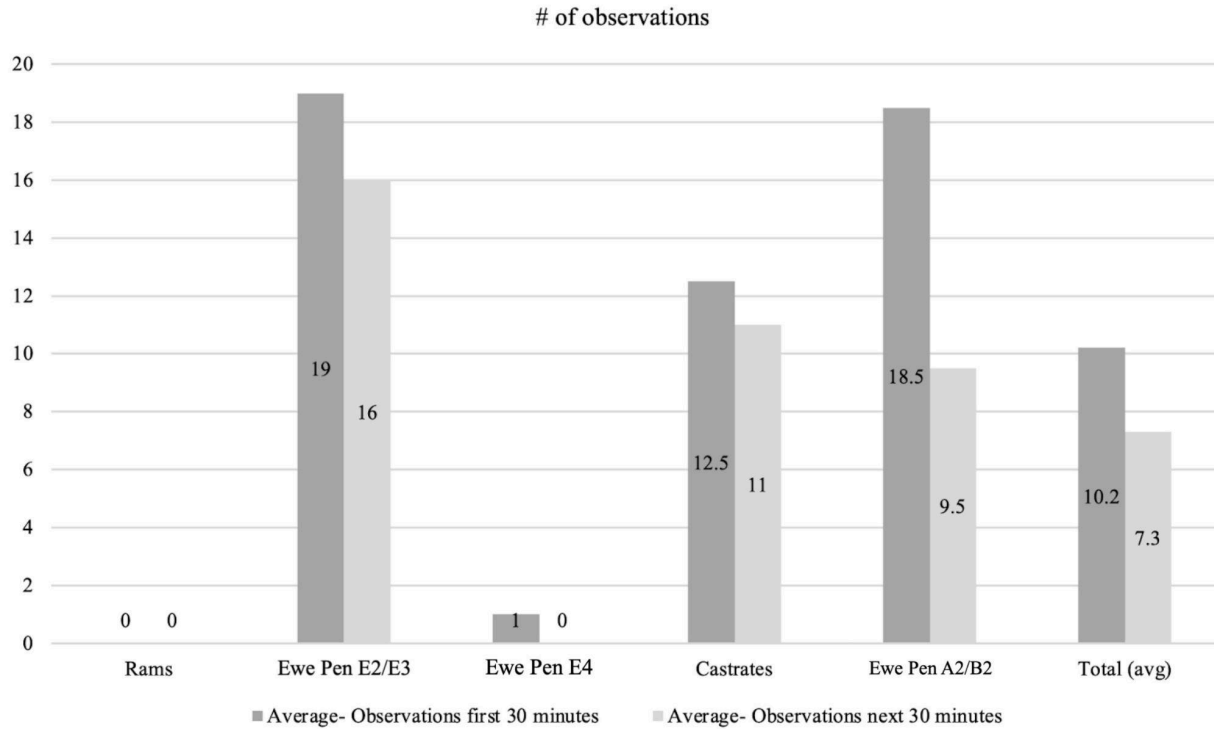
Paired differences between time spent foraging from a hay bag versus ad libitum



The following data compares the total number of observations made of individuals foraging from the hay bags in the first 10 intervals of observation versus the second 10 intervals.

Figure 5

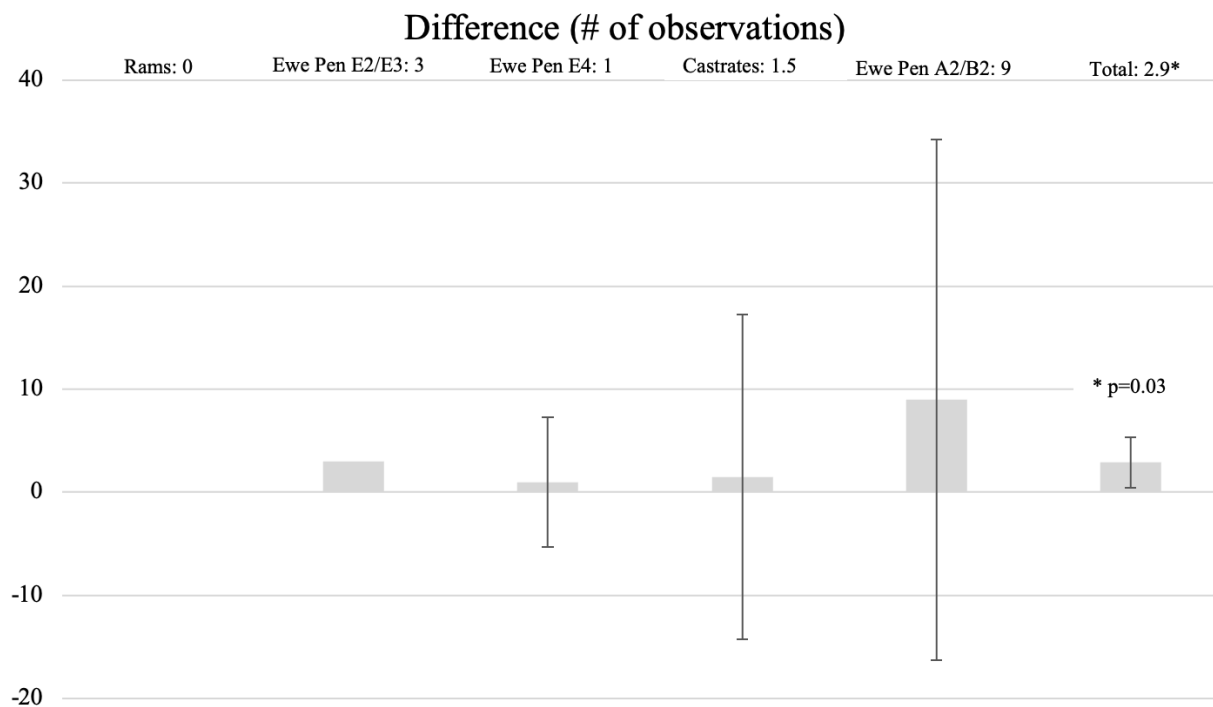
Average total observations of animals foraging from hay bags, first 30 minutes versus second 30 minutes



Using this data, the following differences were calculated. Confidence intervals were calculated using an alpha value of 0.10 to reflect a one-tailed p-value.

Figure 6

Paired difference of average number of observations for first 30 minutes versus second 30 minutes



Discussion

When comparing time spent in feeding behavior when hay bags were present versus absent, there was an increase in every pen of time spent in feeding behavior when hay bags were present (Table 2). However, none of these results were statistically significant using an alpha value of 0.05. When the average time spent in feeding behavior for all pens was tested together, the results were statistically significant with a p-value of 0.0033 (Table 3). Overall, the results from each pen support my hypothesis that adding hay bags increases time spent in feeding behavior.

When comparing time spent foraging ad libitum versus time spent foraging from a hay bag, all pens except Rams spent more time foraging from a hay bag (Table 4). The difference for the Castrates pen was the only difference which was statistically significant. When looking at the difference for all five pens together, there was on average more time spent foraging from a hay

bag but this was not statistically significant (Table 5). The results from the Castrates pen supported my hypothesis that more time would be spent foraging from a hay bag than ad libitum.

When comparing the total number of observations of hay bag foraging in the first 10 intervals to the number of observations in the second 10 intervals, there were fewer observations in the second 10 intervals than the first 10 intervals for every pen except Rams (Table 6). While none of the differences for individual pens were statistically significant, all the pens together had a statistically significant one-tailed p-value of 0.0253 (Table 7).

Overall, the results observed that the sheep spent more time foraging when hay bags were present are more likely due to the novelty of the enrichment than contrafreeloading behavior. There were more significant results when comparing the number of observations of hay bag foraging at the beginning of the period to the end than significant results comparing observations of hay bag foraging to ad libitum foraging. However, further studies would be necessary to further isolate these variables.

Limitations

This study had a number of limitations, including small sample size and limited time. It has been observed that the foraging behavior of *Ovis canadensis* in managed care is variable by season (Zine & Krausman, 2000). The pens holding the animals in this study also have variable amounts of wild forage available depending on season, which may affect the amount of time spent grazing versus foraging on provided hay. This study was conducted September-November, and so it offers an overview of these behaviors in the fall months only. In addition, all pens were different sizes, with the Rams pen and Ewe Pen E2/E3 considerably larger than the others.

Observations were also recorded in person. All observations were conducted by a single observer, myself, so observer bias may be present.

It is also worth noting that the effect of the observer had significant impacts on the data. For the Rams pen and Ewe Pen E4, there were far fewer observations of interactions with hay at all compared to the habituated animals. For the habituated animals in the Castrates pen, Ewe Pen E2/E3, and Ewe Pen A2/B2, the observer may have also had an impact, as some individuals did attempt to interact with me during the observation period, time they otherwise would have spent engaged in other behaviors. Further studies should utilize cameras to record data to account for this.

Time limitations also meant there was no habituation period for the hay bags in this study. It is therefore difficult to determine if interaction with hay bags can be attributed to contrafreeloading behavior or the novelty of the hay bags themselves. Observation periods also were only an hour long during the morning. Further studies should consist of longer observation periods throughout a full 24 hour cycle. Finally, this study had a relatively small sample size. I expect more statistically significant results may be achievable with a larger sample size.

Recommendations

As a result of this study, I would recommend facilities housing bighorn sheep to regularly supply them with varied methods of hay presentation as part of an enrichment program. In environments where providing varied forage types for grazing animals is not feasible, providing the same forage type in different forms can increase choice and control in diet, and help replicate natural foraging behavior through increased foraging time and varied foraging methods. Hay bags are a simple and affordable way to do this, as they are easy to fill and can be placed in

various places around an enclosure. However, it is important to switch the location and type of enrichment often to maintain novelty. Although not tested in this study, I would expect similar results with other forms of varied hay enrichment as well. Devices such as hay balls, hay nets, or stuffed tubes also represent varied methods of foraging. This study only looked at the impact of novel hay presentation in *Ovis canadensis*, but I would expect similar results in other exotic and domestic ungulate species.

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