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Implementation of Seasonal Diets through Seasonal Diet Surveys in Sloth Bears (Melursus ursinus): A Case Study at Idaho Falls Zoo

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Abstract

Wild sloth bears (*Melursus ursinus*) display seasonal diet preferences for insects and fruit during the dry and monsoon season respectively. To potentially utilize as a method for reducing abnormal behaviors and improving animal welfare, the purpose of the study is to survey zoos with captive sloth bears and determine if zoo-housed individuals display seasonal diet preferences. From May 18th, 2022 to March 2nd, 2023 data was collected on Priya, a sloth bear from Idaho Falls Zoo, and her preference for fruit and insects. Temperature, season, fruit choice based on sugar levels, and insect choice based on texture of exterior were investigated as potential drivers of diet preference. Analysis determined there was no significant difference in preference of insect or fruit between fruit used (P = 0.317), insect used (P = 0.355), temperature (P=.167), and season (P = 0.150). Overall, insects were selected most of the time (75.9%) followed by fruit (20.7%), and neither fruits nor insects (3.4%). Potential factors such as Priya's baby Jagger and the selection of fruits and insects could have an impact on the individual's preferences. Further studies that replicate the study with more subjects, a greater time frame such as multiple years, and the replacement of fruits and insects with more natural options could provide a more supported conclusion on captive sloth bear preference. If significance is determined with more data, applications towards the effect of seasonal diet as food enrichment towards mitigation of abnormal behaviors could be studied.

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Introduction

The Association of Zoos & Aquariums (AZA)'s mission is to ensure the highest quality animal welfare using research and collaboration to achieve this goal. Care manuals have been created by nutritionists, veterinarians, taxon advisory groups (TAGs), and species survival plans (SSP) as guidelines for standards set by the AZA but also as a resource on the species itself and how to better improve its overall welfare. Sloth bears (*Melursus ursinus*) are one of the few species that have a "completed" care manual that is shared with the public. For sloth bears, seasonal food preferences have been identified as a topic that needs further study (AZA Bear Taxon Advisory Group, 2019).

The diets of most ursid species, while varied, share some common foods such as insects. Almost all species consume insects, excluding polar bears (*Ursus maritimus*), and some diets consist of 40% or greater of an individual's overall consumption during a season (Joshi et al. 1997; Baskaran et al., 2015). Climate and natural habitat with warmer temperatures and tree-heavy biomes influence a more varied diet of fruits, vegetables, and flowering plants (AZA Bear Taxon Advisory Group, 2019). With the variety of foods that sloth bears consume, research into the potential seasonality of sloth bear diet found certain foods were eaten primarily in certain months of the year (Joshi et al. 1997; Baskaran et al., 2015).

Seasonal and habitat-related variations in sloth bear diets occur as they adapt to changing food availability (Bargail et al., 2004; Baskaran et al., 2015). In the wild, seasonal movements between terrains seem to be determined by termite availability, one of the primary components of the bear's diet (Palei et al., 2020; Akhtar et al., 2004). When observed in natural habitats at Royal Chitwan National Park, Nepal, sloth bears transition between both floodplain and riverine forest to upland habitat during the year (Laurie & Seidensticker, 1977). While the primary cause

for this movement is attributed to flooding during the monsoon season in May through November and elevation alone is significant in sloth bear habitat range, the bears still moved in pursuit of other foods (Joshi et al., 1997, Ratnayeke et al., 2007). The months of September through April found the largest component of the overall diet to be insects, but May through August showed an increase to fruit (Joshi et al., 1997). Despite termite mounds being more common in the upland areas often inhabited during the fruiting season, sloth bears had been found eating more fruit than insects during the other time of the year, suggesting a choice over the usual insects of their diet. After three years of periodic observation, termites were discovered to be the number one food no matter the season but fruit rose in the percentage of overall diet from 16.4% to 38.1% and continuous observation saw a percentage of 31.1% during the fruiting season (Joshi et al., 1997). Sloth bears have not only shown preferences in Nepal with riverine forest and floodplain habitats, but also in deciduous forests where fruit is more plentiful. Another study observed sloth bears at Bandhavgarh Tiger Reserve, and findings have been consistent in the seasonal variation of diet (Rather et al., 2020). While there were some unique observations such as Lantana fruit being consumed in higher quantities due to fruiting availability at the end of the monsoon season, insects still remained the top consumed food, forming 95% of the estimated dietary energy content during winter months (Rather et al., 2020). During the summer months, Rather found that fruits had a higher occurrence, with Tendu fruit having a percent occurrence of 47.45% compared to termites and ants at 27.74% and 3.65% respectively (2020). Palei, Subrat, and Hemanta's research into diet of sloth bears in agroforest landscapes in eastern India also utilized scat sampling and found that insects comprised 77.8% of all scats regardless of season but also saw plant matter surpass animal matter in summer (2020). Another study in the Pendra and Marwahi regions of central India found plant matter from various fruit species in

more scats samples than insects during the summer season at 90.6% and 65.1% respectively before seeing a switch back to animal matter at 81.8% (Bargail et al., 2004). The studies may have slight variations on focus and geographic range, but there is consistency in the support of seasonal variations of a lean towards fruits in summer months and insects in winter months in wild sloth bears.

In contrast to wild sloth bears, captive animals' preferences are different as factors like habitat and foraging behaviors are not necessary for survival. Captive individuals' diets in AZA-approved zoos consist of commercially available feeds that fulfill all nutritional needs as well as some meat mixes with produce, bones, and insects as enrichment (AZA Bear Taxon Advisory Group, 2019). If insects are used as a primary source, significant time would be spent using enrichment and feeders to stimulate natural foraging behaviors. As a result, the switch to commercial feed is more practical for the keeper's time. With the domestic model of dieting found in captive species, feeds that are used for omnivorous dogs have a target composition of overall nutrition range of 30-60% of an individual's complete diet, and also makes vitamin and mineral supplementation unnecessary (AZA Bear Taxon Advisory Group, 2019). The zoo community also acknowledges that wild bears would consume fruits seasonally, however both availability and off-seasons prevent the incorporation of fruit in daily diets. The fruits found in the natural habitats of sloth bears are completely different from those found in the United States in lipids, sugar, dry matter, and fiber levels, furthering the reason for the lack of daily inclusion (AZA Bear Taxon Advisory Group, 2019). Finally, seasonal diets in wild populations account for variability in body condition whereas captive individuals could run the risk of obesity as this fluctuation in body condition is not as drastic in zoo-housed individuals. While there is some inclusion of foods that sloth bears would find in the wild such as termites and dates, the

utilization of seasonal diets is a topic that could be studied further for its effects on captive behaviors such as abnormal behaviors.

Applications of seasonal diets through food enrichment could improve welfare by reducing abnormal behaviors. As sloth bears spend 50% engaged in active behaviors, feeding enrichment designed to condition natural foraging behavior could enhance the overall welfare of captive individuals (Wagmen et al., 2017). Since bears' natural habitat includes large ranges and a significant time dedicated to foraging for food with low energy output, this would make sense. Additionally, when observing stereotypic or abnormal behaviors, the intensity and frequency were found to increase as a result of anticipation of feeding times, indicating that including food-based enrichment would mitigate said behaviors (Wagmen et al., 2017). Stereotypies can be defined as repetitive behavior patterns with no obvious goal or function with the classification of abnormal if a behavior is not commonly found in a species' normal repertoire that would occur in the wild (Bauer et al., 2013). One common example of a stereotypie is pacing, which can occur in a species whose normal range is broader than the habitat it is housed in but also is an indicator of its needs not being met with the pacing being its accommodating behavior. Due to stereotypies indicating needs not being met, zookeepers are attempting to avoid these behaviors as much as possible. Unfortunately, carnivores including bear species are not only particularly prone to these types of behaviors but also have a lot of their time budget consisting of stereotypies (Bauer et al., 2013). Shifting hormone levels or natural changes in food resources have been implicated as a potential cause for seasonal pacing in bear species (Bauer et al., 2013). While studies have found that the abnormal behavior increase during feed time, it could also be correlated to visual food cues as the most apparent change in said behaviors was through variable feeding time and food delivery methods (Wagman et al., 2017). As there are lots of different types and methods of

food-based enrichment, finding the right tools that promote natural behaviors and maintain the interest of the individual is important for developing a welfare plan. One study showed sloth bears preferring honey logs and underground food pipes compared to wobbling boxes (Veeraselvam et al., 2013). The Arignar Anna Zoological Park used food pipes to simulate sucking termites or ants but replaced the insects with fruits and peanuts, so using this method but with seasonal-appropriate food is just one example of enrichment and seasonal diets meshing together.

There have been issues with some sloth bear enrichment model's effectiveness. While sloth bears did show a reduction of stereotypies and an increase of exploratory behaviors in honey logs for one trial, another trial found no change (Wagman et al., 2017). There is debate as to whether or not enrichment promotes natural behaviors or rather masks them by removing the free time for the animal to perform stereotypies (Wagman et al., 2017). Regardless of the potential benefits or disadvantages of enrichment, implementing seasonal diets by itself can help determine improved diets and potentially reduce abnormal behaviors.

Applying seasonality to food enrichment could have benefits for individuals' behavior and overall welfare. To determine the validity of these changes, preference in zoo-housed sloth bear diet must be first determined. Zoo surveys where information is gathered from multiple locations to provide data regarding diet is the most efficient model that has already been used in other studies (Cabana, 2014). One example of a zoo diet survey and subsequent analysis of results was Francis Cabana's (2014) study on Pygmy slow lorises (*Nycticebus pygmaeus*) at European zoos. Created to address issues with diets mimicking wild individual nutrition and learning what foods are fed to captive populations, surveys were used to identify all foods being fed to slow lorises (Cabana, 2014). Another similar study was done with giant anteaters, though

this also focused on the inclusion of food enrichment and vitamin supplements in diet (Morford, 2003). Separating this research from Cabana's (2014) is the idea that conclusions can be drawn without deep analysis. In this instance, data could be collected on what food institutions fed giant anteaters without insight into issues like diet-related health concerns and be used to conclude the standardization of feed with leaf litter, dry cat food, and dog food (Morford, 2003). Even case studies, while not enough to create generalized conclusions, can serve as a starting point for further study or drawing of conclusions. A plethora of research is already utilizing zoo surveys and with the knowledge that if seasonal diets are preferred in captive sloth bears they can be used in food enrichment to improve overall welfare. Therefore, conducting a seasonal preference, even in a case study, is necessary for determining the benefits that diet could have on sloth bear welfare.

The objective of this study is to survey zoos with captive sloth bears about diets and to undergo a diet preference study using their animals.

Methodology

Zoos in the United States were selected if they had at least one sloth bear in their collection. After the 18 zoos had been identified, emails or other forms of correspondence (LinkedIn invites, zoo forms, etc.) were sent to those that were either curators that were responsible for the sloth bears, research teams for the zoo, or heads of animal care. The template for reaching out to these zoos is as follows:

> Dear [Insert Zoo Name],
>
> I'm working on research on seasonal preferences in sloth bears and was hoping that you'd be interested in being involved with this study. This is work towards an undergraduate research thesis that's being overseen by Dr. Calinger-Yoak at Otterbein University. I'm looking to address seasonal diets as determined in Joshi et al.'s article, members of the department of fisheries and wildlife looked at sloth bear's food preferences and seasonal effects, being utilized to optimize bear engagement as well as mental stimulation. What I would propose is a potential enrichment plan:
>
> - Present both insects and fruit to the sloth bears (recording what specifically is used)
> - Utilize enrichment balls (provided by myself) or whatever preferred tool for food
> - For the duration, once a week during a designated food enrichment day
> - Take note of which food (insect or fruit) the sloth bear eats first
>
> Since food enrichment is already utilized by the zoo, if a recording of which of

the two is picked first by the sloth bear each time this process is followed, that would be much appreciated. I look forward to hearing your response.

Sincerely, Noah Clever

Of the 18 zoos that were initially contacted, only two responded back. The Chicago Zoological Society Curator of Mammals reached back and informed of the facility's inability to participate at the time, however provided insight in their sloth bears preferring insects almost all of the time (Mark Warner, personal communication, April 28, 2022) The other zoo that reached out was Idaho Falls Zoo at Tautphaus Park to confirm their participation in my research. Those zoos who agreed to partake in the study had their keeper present fruit and insects in an attempt to keep both consistent in presentation and quantity. While this could vary from time to time, during each time presented, both insect and fruit options would be in the same location of the exhibit and if enrichment tools were used, both insect and fruit would be available with the same tool. The observer would identify what was selected first by the sloth bear and record preference, if enrichment was used and what enrichment it was, and the species of fruit and insect. Idaho Falls keeper did not include any enrichment tools as it could influence Priya's decision based on what food she could uncover first. All recorded entries happened in the bedroom outside of public view and were simultaneously slid under the holding door evenly. The keeper had complete control of what fruit and insect was used each entry, including whether each species was selected for wild diets (mangos, figs, termites, ants) or preexisting enrichment foods.

Data was collected roughly four times a month from May 2022 until March 2023 (**Table 1**). Slight variations in the number of times per month occurred because of keeper scheduling. Once data was collected over as close to one year as possible, analysis for patterns and preferences were determined.

Subject & Exhibit Background

The sloth bear used in the study is Priya, a 14-year-old female born on 1/10/2009. She currently shares an enclosure with her cub Jagger, a 1-year-old male born on 11/18/2022 (**Figure 1**). There is a male sloth bear also located at the Idaho Falls Zoo however he is kept separate from Priya and Jagger. The exhibit has a back section with trees to allow individuals to hide from the public, a tree structure, a slide, and a large pool (**Figure 2**). Additionally, two access doors are currently used for Priya and Jagger and the other male respectively. In the building where all sloth bears are housed is a play yard in case they prefer being inside, with a door also located in the building (**Figure 3**).

The zoo in the study is the Idaho Falls Zoo at Tautphaus Park located at 2925 Rollandet Ave. Idaho Falls. The AZA accredited zoo itself houses 300 individual animals comprising 130 species from all over the world and participates in over 40 Species Survival Plans. Entirely located on 7 acres, the zoo is split into 7 sections: Primates, Patagonia, Australia, North America, Children's Zoo, Africa, and Asia. Around 145,000 visitors are hosted annually during the open season and offers education programs, events, and is owned and operated by the City of Idaho Falls' Park and Recreation Department.

Stats methods

A univariate generalized linear model was used to compare the effects of fruit species and insect species, temperature, and date on the preference for insects or fruit over one another. Fruit type was categorized based on sugar content, with high sugar being above 10 g/100g of fruit and low sugar being based below 10g/100g of fruit. Similarly, insect type was broken down based on the exterior of the body with those that are crunchy into one category and those that are soft into the other. Temperature was determined after the last entry by using weather software to determine

the general temperature for each day in Fahrenheit, which was then converted to Celsius. Season was divided into four categories, with dates from March through May as spring, dates from June through August as summer, dates from September through November as fall, and dates from December through February as winter.

Food item preference was calculated by determining the number of times each food option was presented and comparing the number of times fruit or insect was selected when the food option was presented.

Figure 1 Sloth bears in Idaho Falls Zoo enclosure. Sloth bear on top of the structure is Priya, the subject of the study. Sloth bear nearest the bottom is Jagger, Priya's cub. Photo credit Amy Tracy.

Figure 2 Sloth bear exterior at Idaho Falls Zoo. Access doors to the left of the image, wooden play structure with slide in the middle, and lumber enrichment to left. Priya is located on top of the structure with Jagger below. Photo credit Amy Tracy.

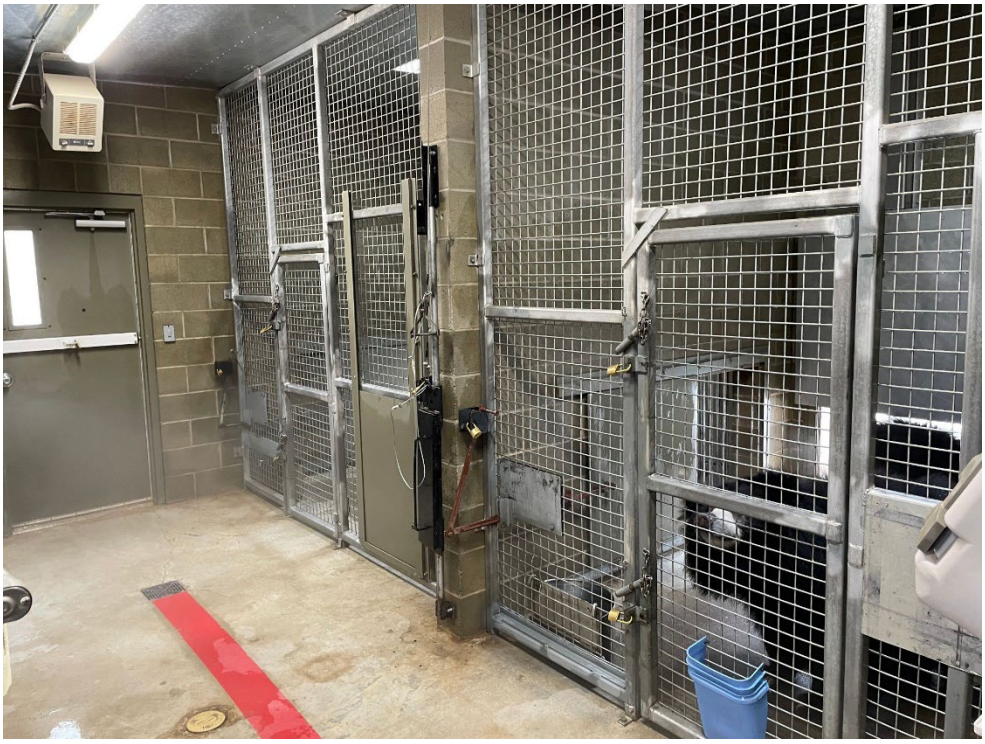

Figure 3 Interior of sloth bear enclosure at Idaho Falls Zoo. Priya is seen in the right most enclosure behind the door. Photo credit Amy Tracy.

Results

By the end of the data collection period (May 18th, 2022 to March 2nd, 2023), there were a total of 29 data points recorded. The raw data can be found in Table 1. For fruit selection, both grapes and apples were utilized the most with 9 entries, tomatoes with 7, and raspberries and oranges with 2. In insect species selection, mealworms comprised 12 entries followed by superworm with 9, hornworms with 4, waxworms with 2, and both earthworms and crickets with 1 entry. The data show 20.7% preference for fruit, 75.9% for insects, and 3.4% for neither fruits nor insects. Food item preference based on times selected found tomatoes (14.3%) and grapes (55.6%) to be the only fruits to be preferred while insects all had preferences above 75% except for earthworms that was preferred 0% of the time (**Figure 5**)

The univariate generalized linear model found no statistically significant effect on preference of insect or fruit between the fruit used (P = 0.317), insect used (P = 0.355), temperature (P=.167), and season (P = 0.150)

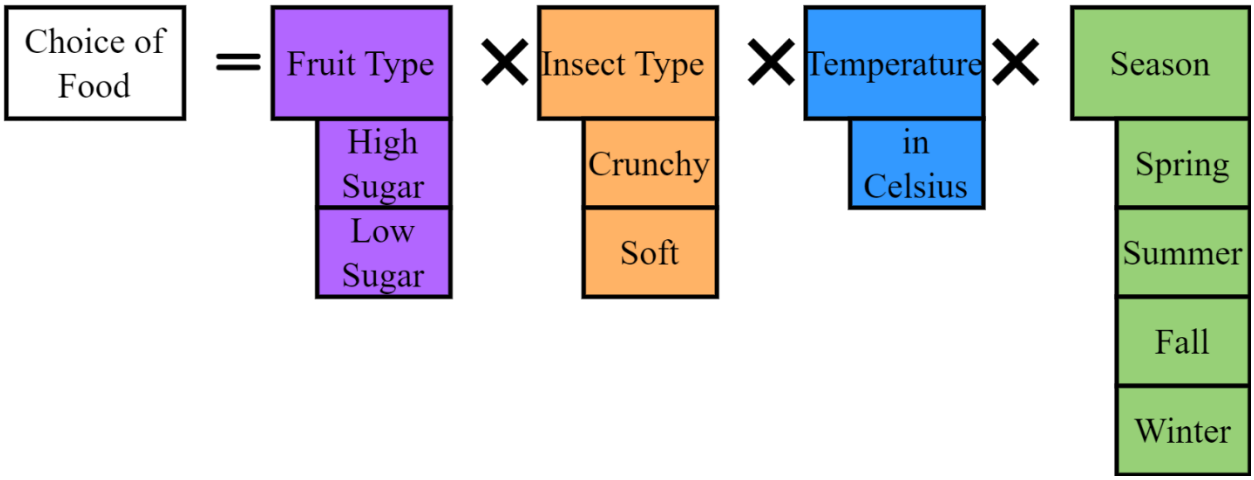

Figure 4 Equation of Potential Factors Impacting Choice of Food

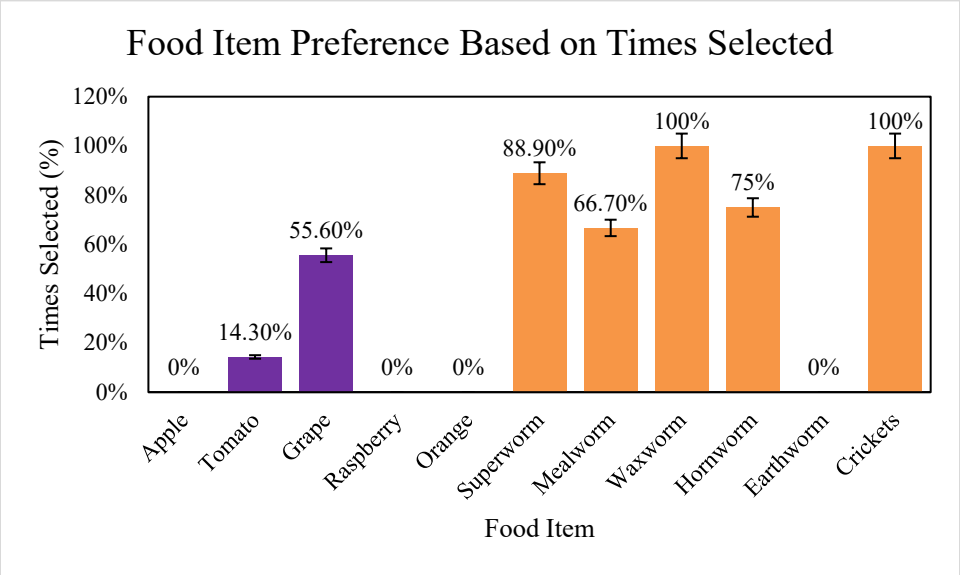

Figure 5: Food Item Preference Based on Times Selected

Table 1 Data Collection of Seasonal Diet Preferences in Priya with Fruit and Insect Species

Date	Name of Sloth Bear	Fruit (Species)	Insect (Species)	Fruit Sugar Level	Insect Exterior	Temperature	Which was picked first (F or I)
5/18	Priya	Apple	Superworm	11.1	Crunchy	18.9	I
5/25	Priya	Apple	Mealworm	11.1	Crunchy	18.9	I
6/2	Priya	Tomato	Waxworm	2.5	Soft	18.9	I
6/9	Priya	Apple	Hornworm	11.1	Soft	21.1	I
6/16	Priya	Tomato	Earthworm	2.5	Soft	23.9	F
6/22	Priya	Grapes	Mealworm	15	Crunchy	22.2	F
7/14	Priya	Grapes	Superworm	15	Crunchy	31.1	I
7/28	Priya	Raspberry	Mealworm	5	Crunchy	28.9	I
8/12	Priya	Apple	Mealworm	11.1	Crunchy	27.2	I
8/25	Priya	Grapes	Superworm	15	Crunchy	27.2	I
9/1	Priya	Tomato	Mealworm	2.5	Crunchy	28.9	I
9/13	Priya	Raspberry	Superworm	5	Crunchy	20.0	I
9/22	Priya	Apple	Waxworm	11.1	Soft	15.0	I
9/29	Priya	Grapes	Hornworm	15	Soft	23.9	F
10/4	Priya	Tomato	Superworm	2.5	Crunchy	18.9	I
10/13	Priya	Grapes	Mealworm	15	Crunchy	18.9	I
11/8	Priya	Grapes	Superworm	15	Crunchy	2.2	I

Date	Name of Sloth Bear	Fruit (Species)	Insect (Species)	Fruit Sugar Level	Insect Exterior	Temperature	Which was picked first (F or I)
11/16	Priya	Apple	Mealworm	11.1	Crunchy	-5.0	I
12/1	Priya	Grapes	Hornworm	15	Soft	0	F
12/7	Priya	Tomato	Mealworm	2.5	Crunchy	-6.1	I
12/13	Priya	Grapes	Crickets	15	Crunchy	-8.9	F
12/21	Priya	Apple	Superworm	11.1	Crunchy	-7.8	I
1/3	Priya	Tomato	Mealworm	2.5	Crunchy	-3.9	Neither
1/19	Priya	Apple	Mealworm	11.1	Crunchy	-5.0	I
1/27	Priya	Grapes	Superworm	15	Crunchy	-2.2	F
2/4	Priya	Orange	Mealworm	8.2	Crunchy	-5.0	I
2/18	Priya	Orange	Hornworm	8.2	Soft	-8.9	I
2/21	Priya	Apple	Superworm	11.1	Crunchy	0	I
3/2	Priya	Tomato	Mealworm	2.5	Crunchy	-3.9	I

Discussion

Priya's preferences compared to wild sloth bear diet

Research was completed to determine Priya's preference of insects or fruits. The results show that insects were found to be selected more (75.9% times) often than fruit (20.7% times). To determine seasonal diet preferences, comparisons have to be made to wild sloth bears annual variations. Joshi's (1997) research determined wild bears had an increase of insects consumed in higher quantities in September through April and fruit selection increased from May through August. Using these two periods of time as markers, insects are still preferred in Priya's case in both, with fruit selection being higher in the September through April timeline. While fruit selection, in this case, does not reflect wild sloth bear's preferences, the higher overall numbers of insect selection do show a similarity with wild individuals. Research done in Royal Chitwan National Park during the years 1990-1993 had fecal samples tested for composition to measure the percentage of foods that were consumed and then dated to determine relationships between year-round, fruiting, and non-fruiting seasons (Joshi et al.,1997). It determined the year-round percentage of fruit found in fecal samples was 14% and insects at 83%, and despite in fruiting season, which had fruits at 38% and insects at 58%, the composition still had an increased number of insects (Joshi et al., 1997). Despite the change of seasons, sloth bears still have insects that comprise the majority of their diet, which can be reflected in the data here.

Zoo diets might account for the difference in fruit preference in Priya versus wild individuals. According to Amy Tracy, a zookeeper at Idaho Falls that works with Priya, the sloth bear is fed an omnivore diet composed of dog food and different produce depending on the day (personal communication, February 22, 2023). Starting with Monday and going throughout the week are either cucumbers or zucchini, hard-boiled eggs, bone, avocados, food enrichment,

grapes, and oranges (Amy Tracy, personal communication, February 22, 2023). Additionally, there is also enrichment throughout the week that varies. As some of the fruits presented in Priya's daily meals are also the types presented in the study, there could be a potential factor in Priya selecting the novel options (Canino & Powell, 2010).

Additional Factors Impacting the Study

With results being non-significant as to effects of time of year, temperature, fruit species, and insect species, factors and unexpected events may influence seasonal preferences. One such component is the number of zoos that participated in the study. 18 zoos were contacted and Idaho Falls was the one zoo to participate in data collection. This is a common occurrence in zoo-led research, with Cabana's (2014) research with slow lorises having a 53% response rate with all the zoos contacted. Despite this, both nutritional analyses and conclusions about diet sustainability towards captive welfare and health problems could be made with the gathered information. Case studies themselves are more difficult as broader conclusions about other individuals cannot be drawn from only one, but there are still benefits in a zoo setting. Animals, especially bears, are both intelligent and dynamic and can display different behaviors and mannerisms based on the individual (AZA Bear Taxon Advisory Group, 2019). As a result, using case studies to determine enrichment effects on abnormal behaviors or in this case seasonal diet influence at the very least determine effects on the individual that was studied. If there's no significance on the time of year or species of fruit and insects on Priya, then there may be an insight into the effectiveness or necessity of types of enrichment as determined by the keeper.

An unexpected factor that could have impacted the study was that Priya had recently had a cub, Jagger. Having a cub meant changes in access to conspecifics and potential food diets and behaviors, and while Jagger was separated from the bedroom during the presentation of both

food choices, the separation could also have had an impact. The recommended time for a cub and mother sloth bear to remain together is roughly two years to allow physical and social development, with the cub transitioning from riding on the mother's back to remaining in close proximity (AZA Bear Taxon Advisory Group, 2019; Baskaran et al., 2015; Laurie & Seidensticker, 1977). Additionally, research on the rearing and growth of neonate-stage sloth bears in captive settings found that significant care is required for the first six months to ensure survival (Arun et al., 2020). From the time of initial data collection, Jagger was roughly six months old and while passing the threshold for significant care, proximity to Priya was still important. This stage does begin to see a shift in milk consumption to other foods for young sloth bears, however, changes in the frequency of meals for the mother and the behaviors spent interacting with the cub both could impact captive behaviors (AZA Bear Taxon Advisory Group, 2019).

Additionally, balancing the needs of the animals in a zoo's collection with financial constraints can require concessions and compromises. While studies have shown that enrichment in its various forms has benefits for the welfare and natural behaviors of species, finding the money to afford specialized items and foods, especially when specific to a particular animal can be difficult (Veeraselvam et al., 2013). As mentioned previously, fruits found in the United States have nutritional differences from fruits naturally found in the wild. Sloth bears in the wild eat fruits such as mangos and figs that are not as common here in the United States, so providing them with these fruits consistently might not be as viable. With wild individuals experiencing changes in body condition throughout the year based on their diet, captive zoos avoid the drastic changes so supplementing with fruit commonly found here is an acceptable practice. However, if keepers wanted to provide fruits that contain higher sugars and carbohydrates in the form of

starch to simulate natural fruits, there is a risk of causing digestive upset (AZA Bear Taxon Advisory Group, 2019). While utilizing common fruits that are easily accessible in the United States can be used across more species and are fine supplemental options in the sloth bear diet, preferences could be different if fruits found in the wild were provided.

Further Research

While case studies are beneficial to determine behaviors in animals, more zoo participation in the study would be an excellent next step. Having a wider data set could allow more solid conclusions to be drawn regarding preferences in captive sloth bears. There would also be a greater pool of data and would allow more factors to be considered such as gender or age. A longer study that is able to fully encompass at least one year or preferably multiple would also help to determine if captive sloth bears have preferences or if something unexpected had happened during the course of the year. In the study of wild sloth bears in Nepal, three years was the minimum observed and could be a good baseline for captive studies (Joshi et al., 1997). As mentioned above, the inclusion of more natural fruits and insects, such as mangos and termites respectively, could determine if captive sloth bears would display seasonal preferences or if the natural food encountered in the wild would have any effect for individuals completely grown in captivity. Finally, interactions between multiple sloth bears housed together could be studied for potential impact. Sloth bears are typically solitary creatures, and are recommended to be housed separately for long periods of time, so having groups could have an effect on diet selection due to stress (AZA Bear Taxon Advisory Group, 2019). If the methodology was changed to offer options to individuals in the sight of other sloth bears, there could be a potential correlation.

If results from larger sample sizes did indicate a potential preference for certain foods during two seasons, further research could be done into the effect it might have on animal

welfare. Research is still ongoing to determine the effects of environmental enrichment on sloth bears, though some results have suggested positive effects with lowered stereotypic behaviors (Veeraselvam et al., 2013). Implementing food would be similar to the Arignar Zoological Park, with behavioral budgets used to collect data, and certain bears receiving food enrichment that zoos use now versus the newer seasonal enrichment. Additionally, there could be a collaboration with different types of enrichment using environmental tools that were liked by sloth bears in previous research with the addition of seasonal foods placed in them. The ultimate goal is to decrease stereotypic behavior and determining the effect of seasonal diets is a good step for sloth bears.

Conclusion

The purpose of this study was to survey captive sloth bears and determine the similarity in seasonal preferences to their wild counterparts. Wild sloth bears have displayed a preference for insects during the dry season and fruits during the monsoon season (Joshi et al., 1997). It would be expected that if captive bears shared the same seasonal preference as those in the wild, insects would be preferred during the fall, winter, and most of the spring while fruit would be preferred during the end of spring and summer. Based on data collected of the individual Priya at the Idaho Falls Zoo, the effect of fruit species, insect species, temperature, and season was not significant in this case study. While additional factors such as Priya's cub Jagger being born affecting behaviors and financial constraints on food purchase can cause the lack of significance, the particular sloth bear is not impacted by seasonal preferences for food. With more data on multiple sloth bears, further research could be conducted to further support or dispute captive bears seasonal preference. Expansions of number of subjects, duration of study, and natural-occurring fruits and insect species can yield results that could be more applicable to the captive zoo community.

The study has supported evidence found by studies of wild sloth bears preferring insects above fruit the majority of the time (Bargali et al., 2004). As established in other studies around Nepal and India, Priya's overall preference for insects was higher than fruit by 75.9% (Joshi et al., 1997). The research could have further impacts on utilizing seasonal foods for animal welfare, however if there is no significance found between fruit, insect, or season, then zoos can focus on other ways to mitigate abnormal behaviors. Recommendations for further study on this topic to allow for more supportive conclusions on the impact of seasonal diets is expected on sloth bears.

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