

Evaluating guest perceptions and animal behavior to inform exhibit design



Prepared and submitted by AWARE Institute

October 7, 2022



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Project Summary

AWARE Institute scientists Cheryl Meehan and Brian Lynn conducted three visits to Zoo Boise on 4-7 April, 22-26 May, and 25-28 June 2022. During these visits, we developed data collection protocols, conducted observer and surveyor trainings, and conducted a check-in to trouble shoot data collection protocols and logistics. This project had two objectives: (1) to collect baseline measures for comparison with new exhibits and (2) to develop evaluation tools to specifically support other small zoos.

Baseline animal behavior and guest perceptions measures for comparison with new exhibits were collected for four exhibits housing 4.5 Magellanic penguins, 1.1 red pandas, 0.1 sloth bear, and 1.1 snow leopards, respectively.

Animal behavior data were clumped into four major behavior categories that have potential correlations to the welfare states (i.e., happiness) of the animals: Active Natural, Inactive, Undesirable, and Non-visible behaviors.

Active Natural behaviors, which suggest that animals are engaged in their environments and likely to impart empathetic learning outcomes, were most prevalent in penguins (63.1%), followed by sloth bear (40.0%), then red pandas (24.5%), and lowest in snow leopards (9.6%).

Undesirable behaviors were also highest in penguins (14.4%), followed by snow leopards (6.5%), then sloth bear (5.9%), and lowest in red pandas (0.2%). These behaviors suggest that animals are unable to meet their own needs or are focused on human-controlled activities.

Inactive behaviors, which are often associated with boredom or a lack of behavior opportunities, were highest in snow leopards (71.0%), followed by red pandas (61.2%), then sloth bear (46.8%), and lowest in penguins (21.5%). Inactivity is a significant mental and physical health concern across all taxa in zoological institutions.

Non-visible behaviors indicate that animals can seek and find privacy from conspecifics as well as zoo guests. Non-visible rates were highest for snow leopards (12.9%), followed by red pandas (12.2%), sloth bear (7.3%), and lowest in penguins (1.0%). Providing animals with the option to seek shelter, privacy, and protection from conspecifics and zoo guests has major implications for the health and happiness of animals when designing their future homes.

Guest surveys revealed that engagement, perceptions, and empathy development may all be closely related to how visitors experience animal behavior. At a fundamental level, we know that increased time spent at habitats provides greater opportunities to communicate educational messaging and impart a sense of connection with nature and wild places. In our study, we found that increased time spent at habitats was associated with the number of active behaviors visitors observed. Additionally, when asked to provide suggestions for new habitats at Zoo Boise, guests frequently cited increased opportunities for animal engagement as an important category for improvement. Suggestions that were

specified for improving engagement included additional enrichment options, foraging and hunting opportunities, climbing/leaping, exploration, and play.

We also learned that visitors are curious about the thoughts and feelings of the animals they observed. The natural curiosity of Zoo Boise guests provides a great starting point for empathy development because it shows an interest in the internal experiences of the animals, which is key to perspective taking. Their ratings of the animals on verbal scales gives us some insight into how they interpreted the internal experiences of the animals. Ratings related to perspective taking, which included assessments of animal comfort, engagement and happiness averaged between 3-4 on a scale of 1-5, which indicates that guests have an expectation that the animals' experiences of happiness, comfort and engagement could be further enhanced. Habitat renovations can address this expectation through the inclusion of features that support active behaviors, choices between micro-climates and resting spaces, and opportunities for exploration and play. In addition, updates to signage and interactive experiences can help guests understand how opportunities to make choices and engage with the environment support animal well-being. These changes may also influence how guests perceive the quality of animal care the animals are provided. In the current study, scores in this domain (quality of care, physical health, and mental health) ranged from 3.5-3.7 on a scale of 1-5 with assessments of mental health receiving the lowest ratings in this domain.

In the following sections we provide analyses and interpretations for both the behavior and guest perception studies, as well as recommendations for future habitat design informed by these findings.

Guest Perception Surveys

Methods

The survey was designed in seven sections. Each section included between 1 and 10 questions. Section descriptions:

1. Date and time (pre-completed by survey taker).
2. Time spent at habitat
3. Behaviors observed
4. Connection to nature and Conservation awareness
5. Habitat quality ratings
6. Rating animals on verbal scales
7. Free response suggestions

Survey development was informed by Clayton *et al.* (2013), Mayer and Frantz (2004), Measuring Empathy: A Collaborative Assessment Project (2019), Meehan *et al.* (2017), and Packer *et al.* (2018). The full survey is provided in Appendix A.

Surveys were formatted using Google Forms and presented to respondents on iPads. Potential respondents were identified by survey takers during their visit to the habitat and were approached as they began to walk away from the habitat. All guests were considered potential respondents if they were over 18 and were not chaperoning groups of children.

Surveys were collected by four seasonal employees during scheduled shifts across the day, seven days per week. Shifts were scheduled to capture morning and afternoon time blocks. Shifts were also scheduled to avoid guest feeding opportunities (Sloth bear). Surveys were collected daily between 1 June and 31 July.

Respondents were asked to complete all questions, but skipping questions was permitted. Surveys with skipped questions were included in analyses.

Responses

Our goal was to collect 100 surveys per habitat. There were several conditions that made survey collection challenging including animals being temporarily off exhibit (Sloth bear), low attendance due to extreme temperatures, and staff illness.

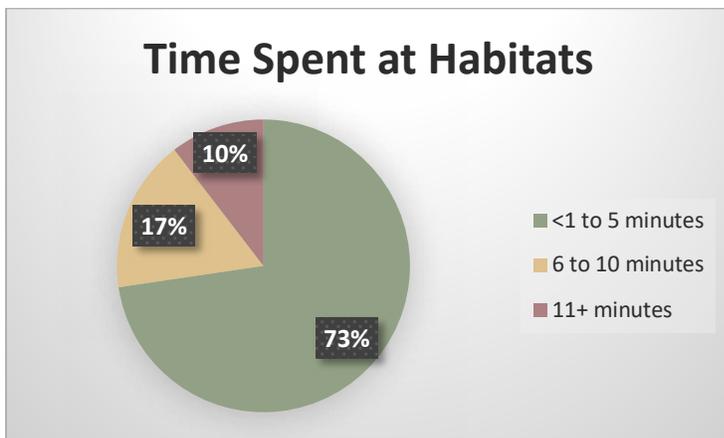
Habitat	Survey Count
Red Panda	100
Snow Leopard	86
Penguin	90
Sloth Bear	63

Results

Time Spent at Habitats

Respondents were asked to estimate the time that they spent visiting the habitat prior to completing the survey. Categorical responses included: Less than 1 minute; 1-5 minutes; 6-10 minutes; 11-15 minutes; 16-20 minutes; and more than 20 minutes.

There were very few responses in the less than 1-minute (n=15 across all habitats) as well as the 16-20 minute (n=4 across all habitats) and more than 20 minutes (n=4 across all habitats) categories. Categories were condensed into <1 to 5 minutes; 6-10 minutes and 11+ minutes for analysis. There were also no meaningful differences between habitats with respect to distribution of the time spent categories. Results across all four habitats are presented below:



The majority (73%) of respondents indicated that they spent <1 to 5 minutes at the habitat. The remaining respondents spent 6-10 minutes (17%) or 11+ minutes (10%) visiting the habitats.

Visit times at habitats are important because spending more time watching animals and reading interpretive signage can increase the likelihood that guests make connections with the animals and absorb educational messaging (Godinez and Fernandez, 2019).

One factor that can entice guests to spend additional time visiting a habitat is the behavior of the animals (Godinez et al., 2013). Active behaviors (locomotion, feeding, social interactions, play, etc.) may be more engaging to guests than inactive behaviors (sleep and rest) and guests who observe active behaviors may be more likely to spend longer visiting a habitat.

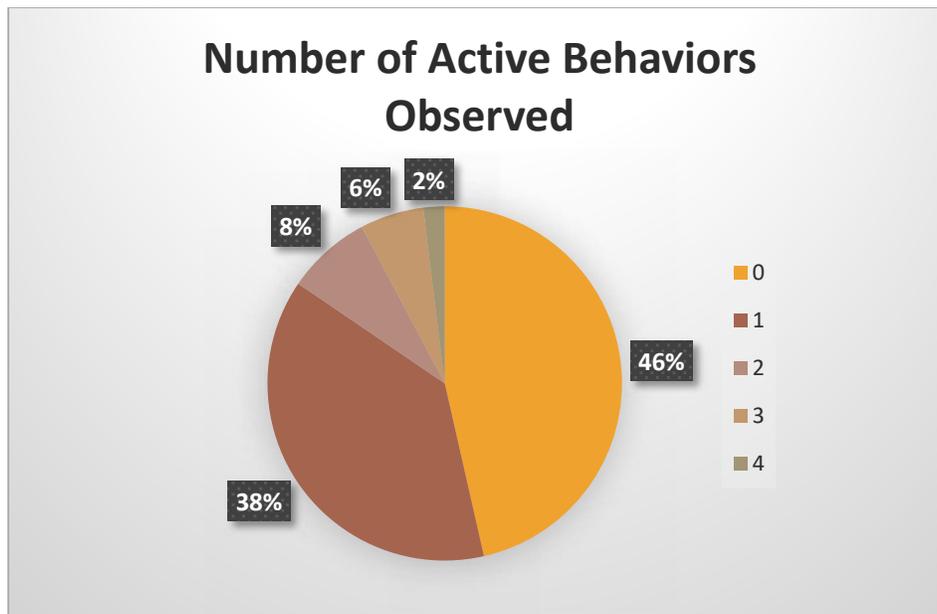
Observed Active and Inactive Behaviors

Guests were asked to report which behaviors they observed when visiting the habitat from the following list:

- Sleep
- Rest
- Walking, Running or Swimming
- Grooming
- Eating or Drinking
- Climbing
- Play
- Social Interactions (all but Sloth bear)

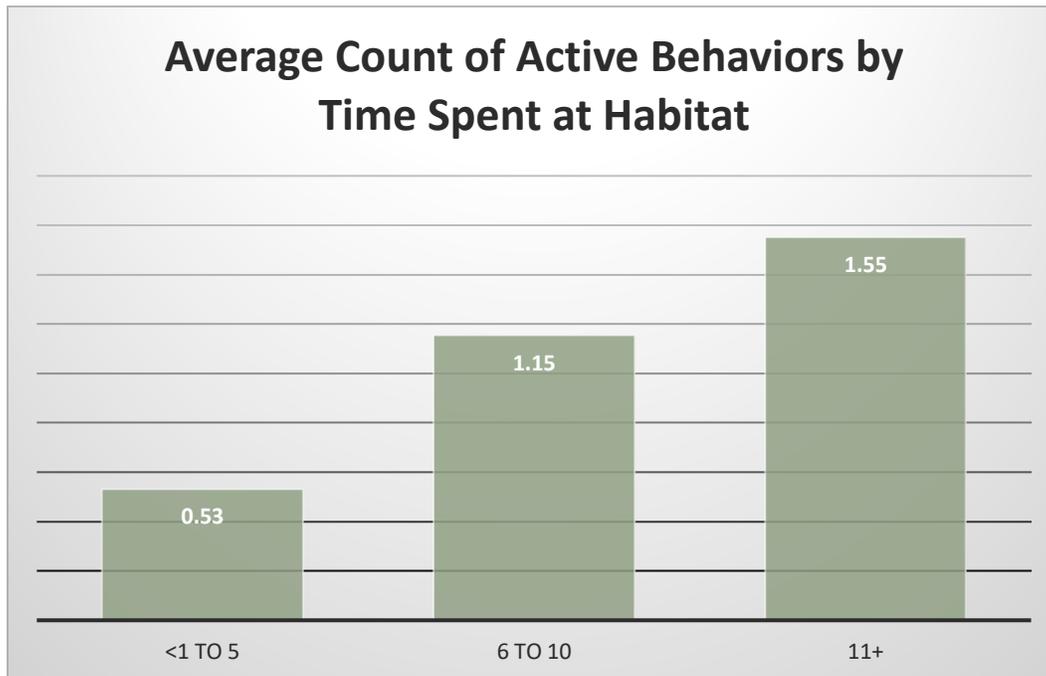
For a complete analysis of how the animals spent their time in these various behaviors, please see the time budget analyses.

For the purposes of the visitor surveys, we were interested in the number of active behaviors visitors observed, and how the number of active behaviors observed was related to the time spent at the habitat. Across all habitats, 46% of visitors reported observing only sleep or rest (0 active behaviors) during their time at the habitat. One active behavior was observed by 38% of visitors. Fewer than 16% of visitors reported observing more than one active behavior.



To look further into the relationship between observing active behaviors and time spent at the habitats, we looked at the average number of active behaviors reported to have been observed by visitors who spent <5 minutes, 6-10 minutes, and 11+ minutes at the habitats.

In the figure below, you can see the relationship between these two types of data.

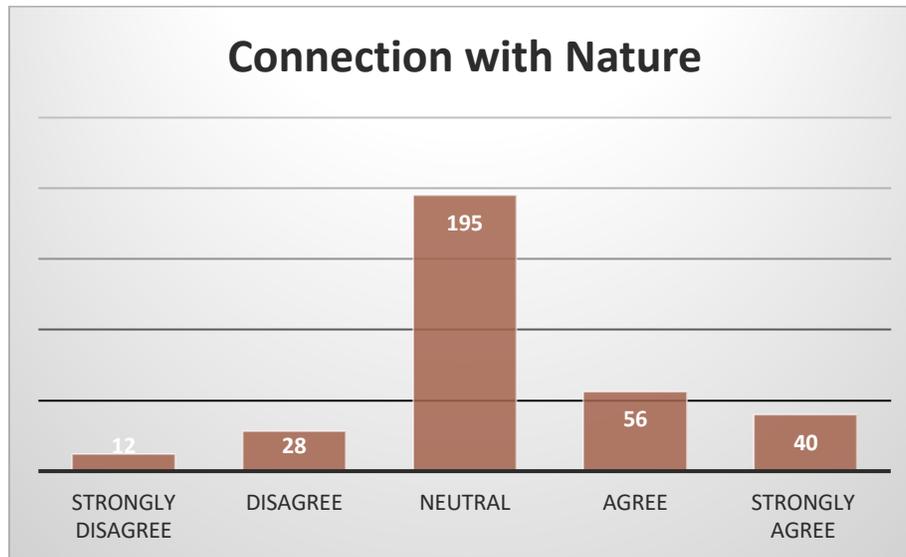


With each successive increase in time spent at the habitat, visitors report observing more active behaviors. Despite this trend in the data, we are unable to confirm the causal relationship between observing more active behaviors and increased time spent at the habitats. Does the ability to observe more active behaviors cause visitors to stay longer, or do those who stay longer just happen to also observe more active behaviors? While we cannot definitively answer these questions with our data, we do know from the behavioral analyses that the snow leopards and red pandas spent 71% and 61% of their time inactive. Given these lower overall frequencies of active behavior it seems that, for these two species at least, the relationship between visit times and active behaviors occurred because the visitors who stayed longer were those who happened to stop at the habitat while the animals were active.

Connection to Nature and Conservation Awareness

This section consisted of three questions where visitors were asked to report their responses on a scale of Strongly Disagree to Strongly Agree. The questions were intended to determine the degree to which spending time at the habitat influenced their feelings of connection to nature and awareness of conservation challenges and solutions.

Question 1: Please rate your response to the following statement: I have a greater sense of connection with nature as a result of visiting this habitat.



More than twice as many visitors selected AGREE or STRONGLY AGREE (38%) than DISAGREE or STRONGLY DISAGREE (16%). However, the majority (59%) of respondents chose the NEUTRAL rating. Fostering empathy for wildlife is facilitated when visitors have a sense of connection to the natural world, and the high rate of ambivalent responses indicates that there is an opportunity to engage visitors more fully so they may sense a stronger connection.

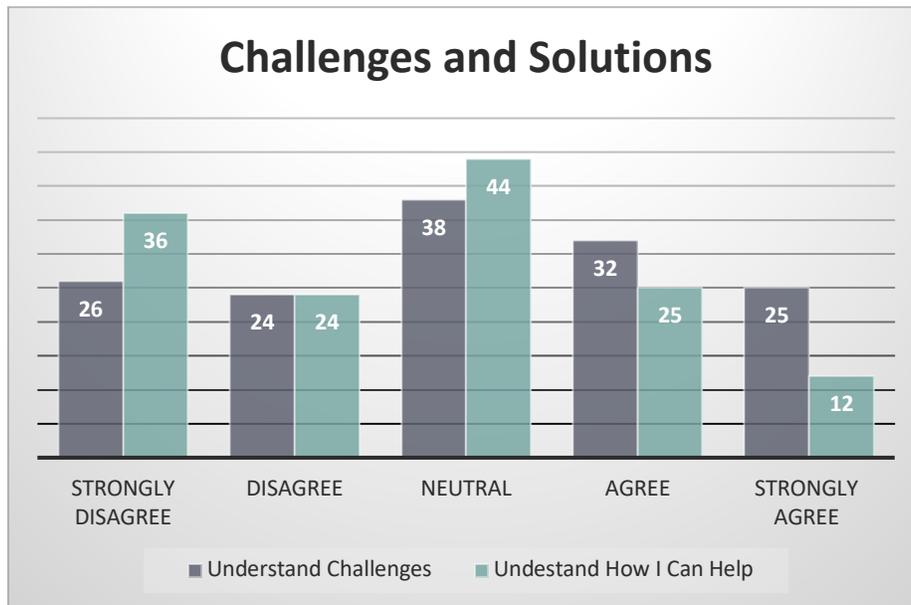
A pair of questions were presented to ascertain how time spent at the habitat influenced visitors' understanding of conservation challenges and potential solutions.

Question 2: Please rate your response to the following statement: Visiting this habitat helped me understand the challenges this species faces in the wild.

Question 3: Please rate your response to the following statement: Visiting this habitat helped me understand how I can help this species in the wild.

The responses to these two questions are presented simultaneously in the figure below. When it comes to understanding the challenges species face in the wild, the most frequently selected answer was the NEUTRAL rating. Slightly more (n=57 respondents) chose either AGREE or STRONGLY AGREE than chose DISAGREE or STRONGLY DISAGREE (n=50). This response pattern indicates that overall, visitors are not being presented with accessible information about the challenges faced by wild-living members of this

species, or that the information that is presented is not as effective as it could be to raise levels of understanding.

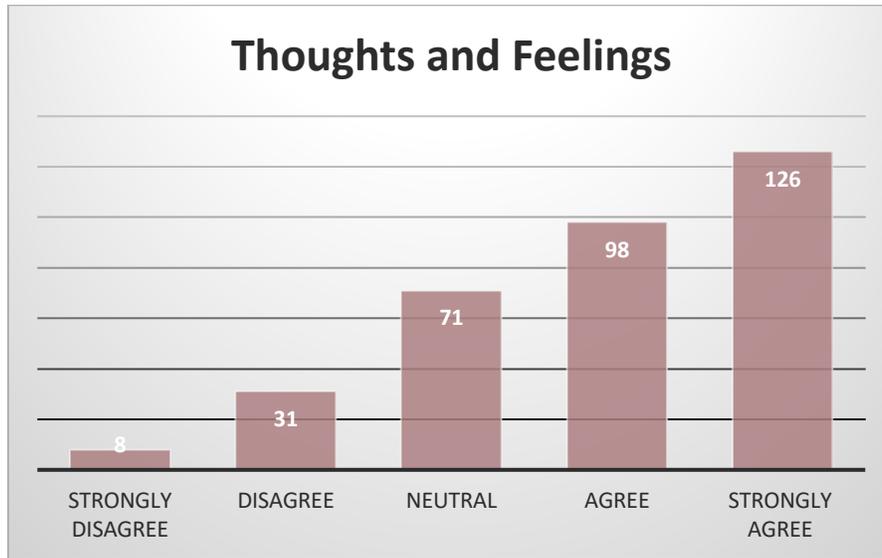


A somewhat different pattern is found when visitors are asked about their understanding of was that they can help these species in the wild. Although the most frequently selected response was the NEUTRAL rating, more visitors reported that they STRONGLY DISAGREE or DISAGREE with the statement that visiting the habitat helped them understand how they could help (n=60) than responded that they AGREED or STRONGLY AGREED with that statement (n=37). This indicates that information provided about ways to help these species either did not exist at the habitat or was not effectively communicated through signage. When we look at the STRONGLY AGREE response category across the two questions simultaneously, we see that while 25 visitors responded that they had an improved understanding of the challenges faced by the species in the wild, only 12 chose this response when it was asked if they had an improved understanding of how to help. This pattern demonstrates that the most engaged visitors when it came to understanding conservation challenges, were not supported along the conservation awareness pathway such that they understood how to act.

Re-designed interpretative signage, conservation-focused zoo chats, and potentially, the integration of in-situ opportunities for guests to take caring action are all potential interventions that may result in both increased understanding of challenges and increased empowerment to participate in solutions.

Animal Thoughts and Feelings

Perspective taking is a key component of building empathy for wildlife. As an entry point to understanding how visitors conceived of the internal states of the animals, we asked them to rate their agreement with the following statement on a scale of STRONGLY DISAGREE to STRONGLY AGREE.



Question 4: Please rate your response to the following statement: Visiting this habitat inspired me to wonder about the thoughts and feelings of the animals.

Just over two-thirds of respondents selected AGREE or STRONGLY AGREE as their response. This indicates that visitors are being presented with experiences (visual, emotional, or educational) that are triggering their curiosity about the internal experiences of the animals they observe.

This is an important finding given that curiosity about the experiences of others is a key component to the development of empathy. We can gain some additional perspective into how visitors are interpreting the internal experiences of the animals in these habitats through their responses to the questions in the next section of the survey.

Rating Animals on Verbal Scales

We asked visitors to provide their ratings of each species on a scale between two descriptive terms. The terms were chosen to gather insight into visitors' appraisal of the animals with respect to features associated with components of the empathy bridge. Participants chose a number from 1-5 to assign their rating between each pair of words. The words were presented in both Right to Left (desired term on the left) and reverse scales to avoid directional bias. Average scores were calculated for each rating.

The average scores are displayed for each species in the tables that follow. The top half of the tables include word sets that were scored left to right (1-5) and the bottom half includes the word sets that were scored right to left (1-5).

Rate the Snow Leopards on a Scale Between the Two Words Below						
Ugly						Beautiful
No Personality						Lots of Personality
Sad						Happy
Neglected						Cared For
Bored						Engaged
Reverse Scale						
Important						Not Important
Interesting						Not Interesting
Physically Healthy						Physically Unhealthy
Mentally Healthy						Mentally Unhealthy
Comfortable						Uncomfortable

Rate the Penguins on a Scale Between the Two Words Below					
Ugly					Beautiful
No Personality					Lots of Personality
Sad					Happy
Neglected					Cared For
Bored					Engaged
Reverse Scale					
Important					Not Important
Interesting					Not Interesting
Physically Healthy					Physically Unhealthy
Mentally Healthy					Mentally Unhealthy
Comfortable					Uncomfortable
Rate the Red Pandas on a Scale Between the Two Words Below					
Ugly					Beautiful
No Personality					Lots of Personality
Sad					Happy
Neglected					Cared For
Bored					Engaged
Reverse Scale					
Important					Not Important
Interesting					Not Interesting
Physically Healthy					Physically Unhealthy
Mentally Healthy					Mentally Unhealthy
Comfortable					Uncomfortable

Rate the Sloth Bear on a Scale Between the Two Words Below					
Ugly					Beautiful
No Personality					Lots of Personality
Sad					Happy
Neglected					Cared For
Bored					Engaged
Reverse Scale					
Important					Not Important
Interesting					Not Interesting
Physically Healthy					Physically Unhealthy
Mentally Healthy					Mentally Unhealthy
Comfortable					Uncomfortable

The questions in this section of the survey can be grouped into three domains based on components of the empathy bridge as shown below:

Empathy Component	Rating Scale
How well cared for is the animal?	Neglected to Cared For Physically Healthy to Physically Unhealthy Mentally Healthy to Mentally Unhealthy
Animals as individuals	Ugly to Beautiful Important to Unimportant Interesting to Uninteresting No Personality to Lots of Personality
Perspective Taking	Sad to Happy Bored to Engaged Comfortable to Uncomfortable

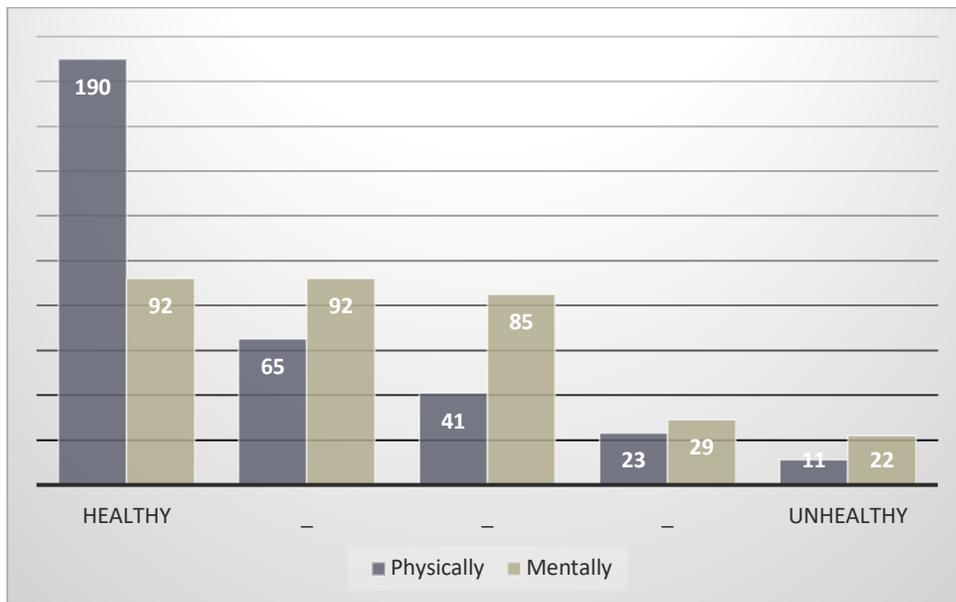
Assessment of Animal Care

Three questions were used to evaluate this domain. Visitors were asked to rate the animals on a scale of Neglected to Cared for; Physically Healthy to Physically Unhealthy; and Mentally Healthy to Mentally Unhealthy. Composite scores for this domain were calculated by rescaling all responses from 1-5 and using average mean scores across all questions.

Species	Domain Composite Score
Red Panda	3.5
Snow Leopard	3.6
Penguin	3.7
Sloth Bear	3.5

Physical Health Compared to Mental Health

Visitors were asked to assess the animals' Physical and Mental Health on a scale from 1 (Healthy) to 5 (Unhealthy).



In these data, a score of one indicates the highest assessment of health and a score of five indicates the lowest. The frequency with which visitors assigned a score of one to describe the animals' physical health was 2.22 times greater than the frequency with which visitors assigned a score of one to animals' mental health. While relatively few visitors assigned a score of five to either physical (n=9) or mental (n=18) health, it is notable that twice as many visitors assigned the lowest possible score to describe the animals' mental health as compared to physical health.

Animals as Individuals

Four questions were used to evaluate this domain. Visitors were asked to rate the animals on a scale of Ugly to Beautiful; Important to Unimportant; Interesting to Uninteresting; No Personality to Lots of Personality.

Composite scores for this domain were calculated by rescaling all responses from 1-5 and using average mean scores across all questions.

Species	Domain Composite Score
Red Panda	3.8
Snow Leopard	4.3
Penguin	4.3
Sloth Bear	4.4

Perspective Taking

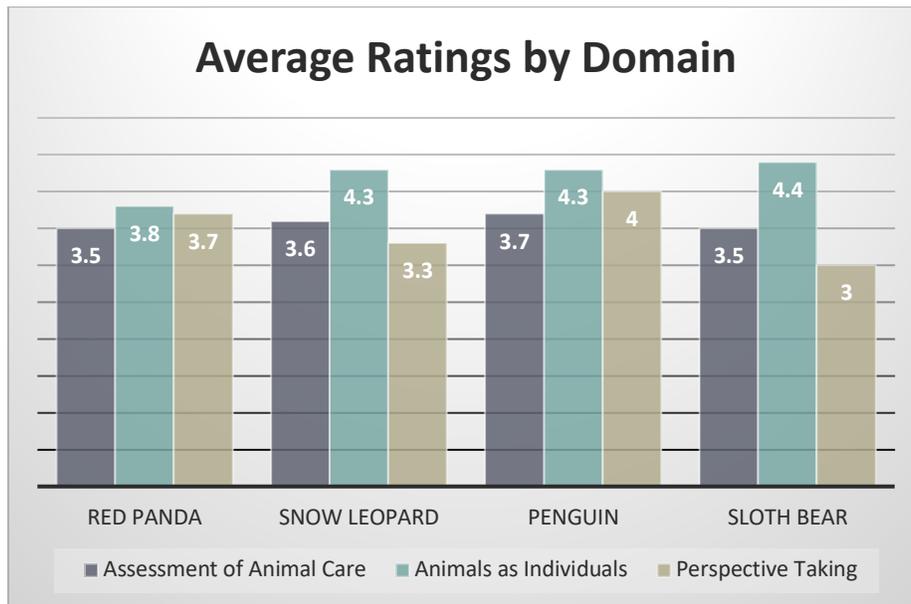
Three questions were used to evaluate this domain. Visitors were asked to rate the animals on a scale of Sad to Happy; Comfortable to Uncomfortable; Bored to Engaged.

Composite scores for this domain were calculated by rescaling all responses from 1-5 and using average mean scores across all questions.

Species	Domain Composite Score
Red Panda	3.7
Snow Leopard	3.3
Penguin	4.0
Sloth Bear	3.0

Species Averages by Domain

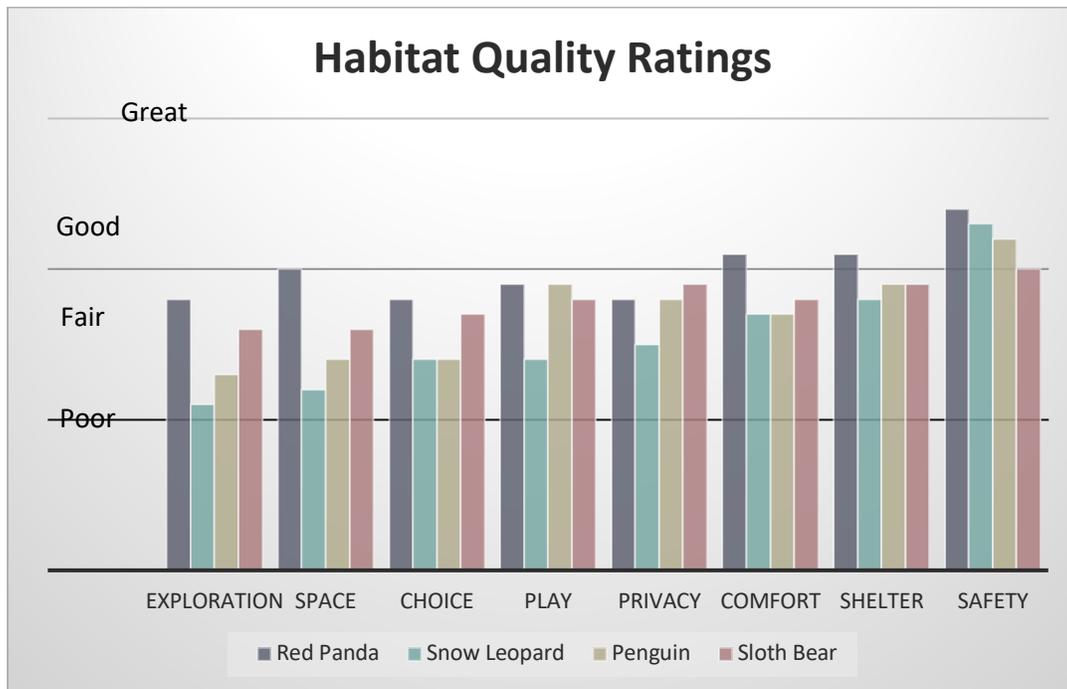
Across the four species, the domain with the highest ratings was the “Animals as Individuals” domain. Visitors rated the animals highest on this domain based on their assessment of the importance and interestingness of the species, their physical characteristics, and personality. Of these, visitors’ perspectives of the importance and interestingness of the species may be augmented through updated signage, while their assessment of the animals’ personality may be enhanced by design features that support active or interactive behaviors. For red panda and penguins, the second highest rated domain was “Perspective Taking” which reflects visitors’ assessment of the animals’ internal states of happiness, comfort, and engagement. Habitat design choices that provide more opportunities for the animals to engage with their environments to meet their own needs and desires may influence these ratings.



Habitat Quality Ratings

Visitors were asked to rate eight qualities of each habitat based on how well they thought the habitats met the needs of the species. The eight qualities that were rated included both basic needs (privacy, comfort, shelter, and safety) and behavioral needs (exploration, choice, and play). Space was also included and can be considered as fundamental to both basic and behavioral needs.

Visitors rated each quality as either Poor, Fair, Good or Great. For analysis, numeric scores (1-4) were assigned to the categories and an average score for each quality was calculated for each species. The combined results are presented in the figure below.

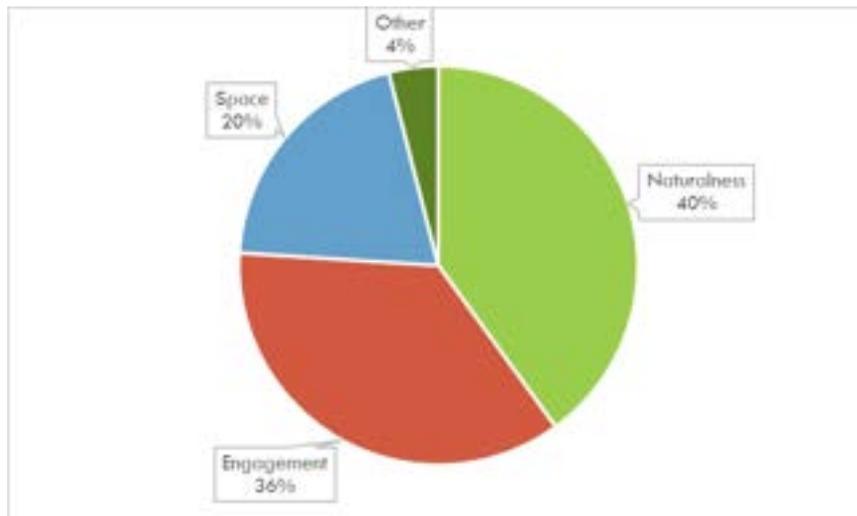


Overall, most ratings were in the range of Fair to Good. The overall average scores across species were highest for Comfort (overall average=2.8), Shelter (overall average=2.9) and Safety (overall average=3.2). Play and Privacy were ranked similarly (overall average=2.75) and Choice (overall average=2.6), Space (overall average=2.5) and Exploration (overall average=2.4) were rated lowest. These findings indicate that visitors are more confident in the way these habitats meet basic needs of the animals as compared to behavioral needs. Ratings of the space provided to the animals were lowest for Snow Leopard, but it is unclear whether the visitors were aware of both sides of the habitat (surveys were collected on both sides, but not from the same individuals). In general, space was rated second-to-lowest across all species which indicates that visitors would prefer to see larger habitats for these species in the future. While there is not empirical evidence on the effect larger habitats may have on the well-being of these species, in general it is true that larger spaces afford more opportunities for supporting behavioral needs, in particular those that stimulate natural, active behaviors. Whether or not footprints expand during the renovation of these habitats, these data indicate visitors would appreciate seeing more evidence of the spaces supporting behavioral needs through exploration, choice, and play.

Free Response

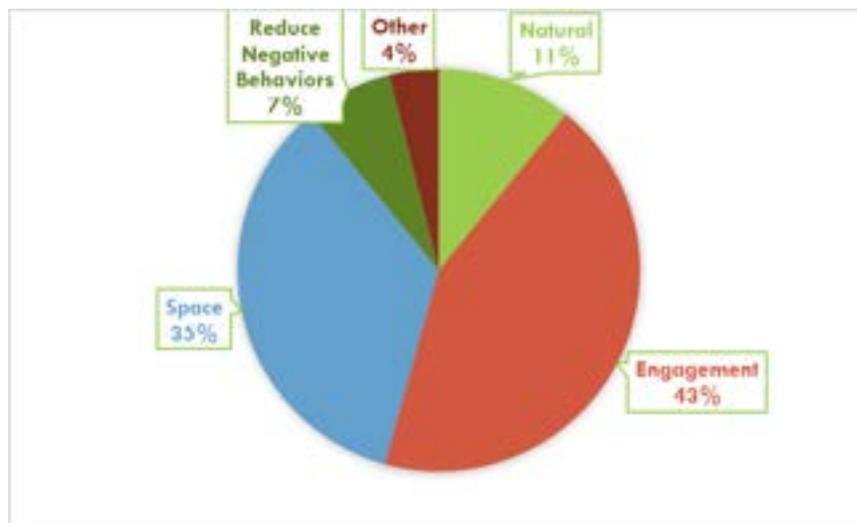
Visitors were asked to provide any feedback or suggestions they had for future improvements of each habitat. A word cloud of provided responses as well as a distribution of responses by category are provide for each species.

Red Panda



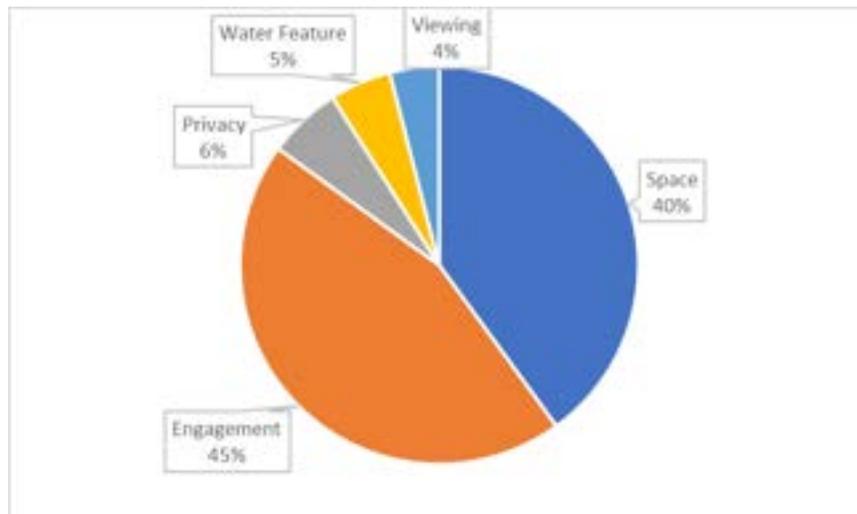
Most suggestions for this habitat involved the addition of features to increase the “naturalness” of the environment. These included requests for more trees, foliage, and browse. Visitors also prioritized opportunities for engagement as suggested improvements including opportunities for climbing, play, and interaction with the environment.

Snow Leopard



The most frequently cited recommendation for the snow leopard habitat was opportunities for engagement. Specific suggestions included opportunities to climb, hunt, and play. About 1/3 of the comments included suggestions for more space allowance, and 7% of the comments mentioned the reduction of negative behaviors such as pacing. This is the only species where guests commented on the potential for a new habitat to help alleviate negative behaviors.

Sloth Bear



The most commonly mentioned recommendations for this habitat pertained to engagement such as toys, enrichment and opportunities to explore. Increased space was the second most common recommendation. Privacy was mentioned by 6% of the respondents, but it is unclear if they were aware that the habitat includes a private den area that can be accessed at all times.

Behavior Data

Methods

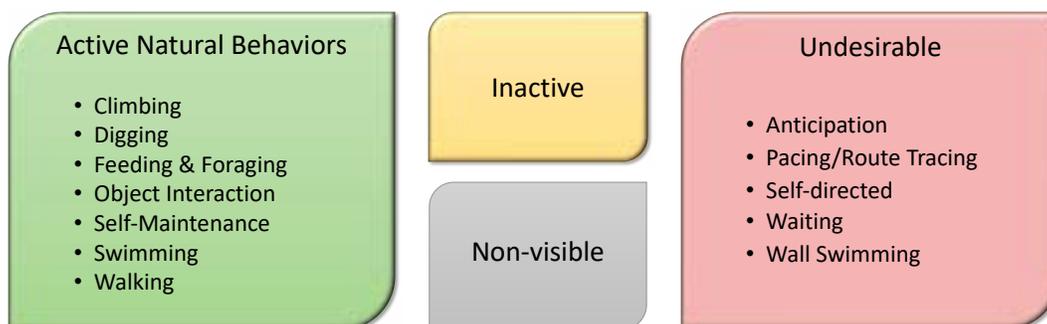
Behavior observations were conducted for 1.1 snow leopards, 0.1 sloth bear, 1.1 red pandas, and 4.5 Magellanic penguins by four seasonal employees using iPads equipped with ZooMonitor (Ross *et al.*, 2016). ZooMonitor is a web-based software platform used to record, visualize, and analyze animal behavior data, with the goal of supporting animal management decision-making and evaluation (Wark *et al.*, 2019).

Observer training took place on 25 May 2022 and concluded when observers passed interobserver reliability testing with 85% agreement. Behavior data collection began on 1 June 2022 and concluded 31 July 2022. Observers ran 20-min focal animal observations at 60 sec intervals using species-specific ethograms that were derived from previously published studies (Wark *et al.*, 2021). Full ethograms are included in Appendix B. Observers also documented the location of the focal animal at each interval using a schematic graphic of the exhibit loaded into ZooMonitor.

Observations were scheduled so that individual animals maintained an approximately equal number of observations spread across both AM (9am – 12pm) and PM (1pm – 4pm) observation blocks. We paused data collection when animals were off exhibit for medical or management reasons and resumed a few days after they returned to their respective homes.

Behavior rates were computed from Microsoft Excel files exported from ZooMonitor. For high-level analyses and interpretations, behaviors are grouped into four behavioral categories: Active Natural, Inactive, Non-visible, and Undesirable. Behaviors of interest for certain individuals, exhibits, or contexts were extracted from these groupings for further analyses and reporting.

SPECIES SPECIFIC ETHOGRAMS



Heat maps were generated using ZooMonitor for overall space use as well as behavior-specific space use. In the heat maps, single data points are indicated in purple and change to green, yellow, then red as intensity of use increases. Schematic graphics were developed concurrently with behavior data

collection, and therefore space use data collection commenced on 1 June for red panda and snow leopard, 15 June for sloth bear, and 16 June for penguin.

Results

Behavior Time Budgets

Observers collected 296 hours of behavior observations during 887 sessions across all four species. Time budgets for each species are clumped by behavioral category and presented below. Further tables and graphics provide breakdowns of all behaviors by each individual animal observed in this study.

1.1 Snow Leopards (n=121)

Behavior	Time
Active Natural	9.59%
Inactive	71.01%
Undesirable	6.52%
Non-visible	12.88%



Red Pandas (n=172)

Behavior	Time
Active Natural	24.45%
Inactive	61.22%
Undesirable	0.18%
Non-visible	12.18%



Magellanic Penguins (n=441)

Behavior	Time
Active Natural	63.12%
Inactive	21.51%
Undesirable	14.42%
Non-visible	0.95%



Sloth Bear (n=55)

Behavior	Time
Active Natural	39.99%
Inactive	46.84%
Undesirable	5.85%
Non-visible	7.33%



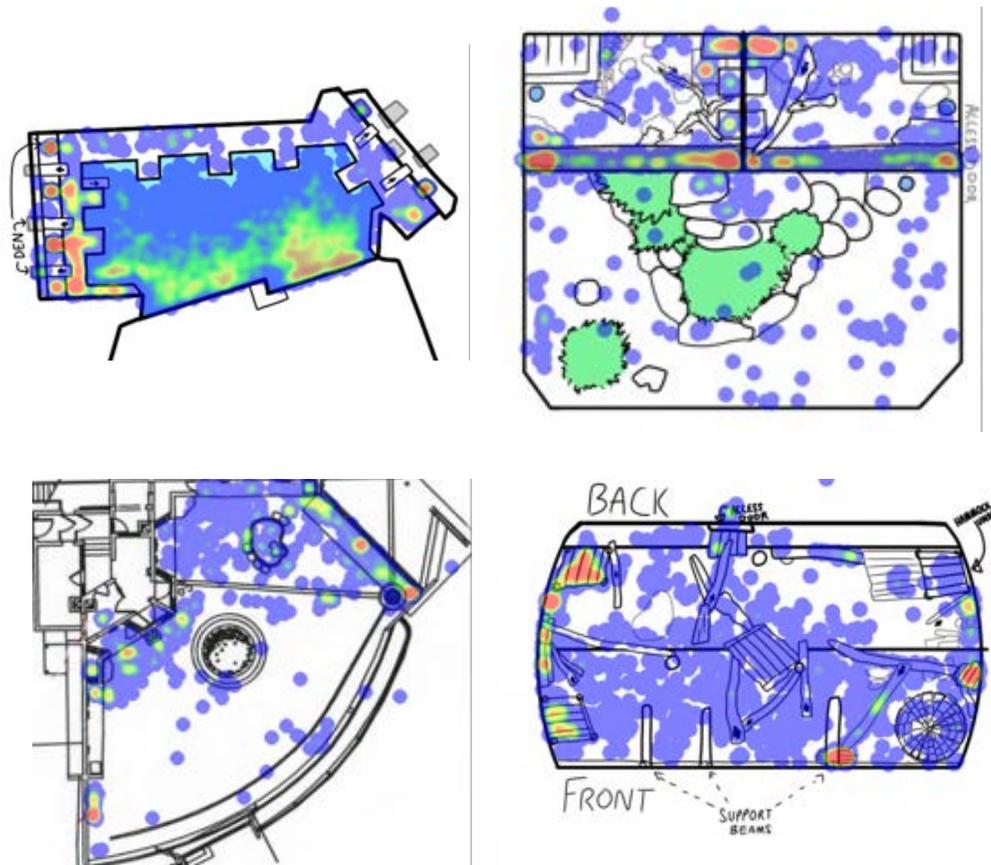
Overall, penguins spent the most time performing Active Natural behaviors (63.1%), followed by sloth bear (40.0%), red pandas (24.5%), and snow leopards (9.6%). Snow leopards spent most of their time inactive (71.0%), as did red pandas (61.2%). Sloth bear and penguins were inactive for 46.8% and 21.5% of observations, respectively. Undesirable behaviors were most prevalent in penguins (14.4%), followed by snow leopards (6.5%) and sloth bear (5.6%). Red pandas performed very few undesirable behaviors (0.2%).

For detailed behavior time budgets at the species and individual level, see Appendix C.

Space Use Heat Maps

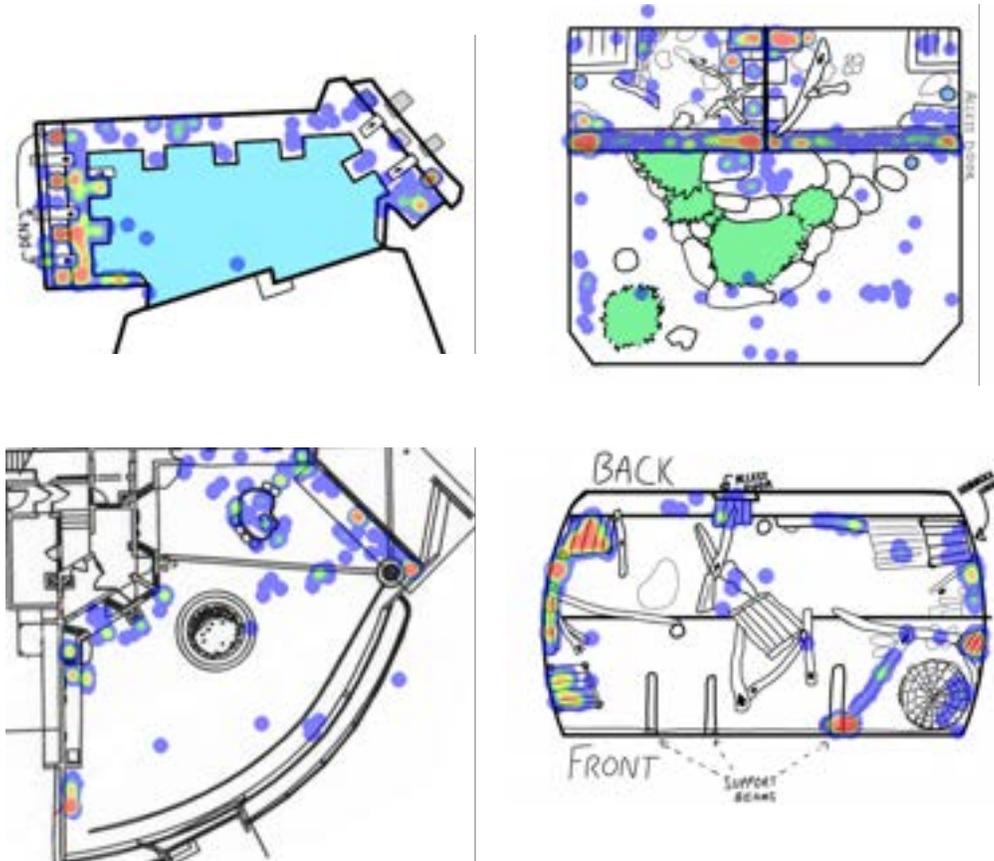
Heatmaps of overall space use for the (clockwise from top left) penguin, snow leopard, red panda, and sloth bear exhibits are shown below. These are oriented such that the main visitor viewing areas are at the bottom of the graphics. The snow leopard and sloth bear exhibits have additional viewing areas at the along the entire top and top left, respectively.. See Appendix D for heatmaps of all behaviors.

OVERALL SPACE USE



Penguins (top left) and red pandas (bottom right) use most of the overall space that is available to them. Penguin space use is concentrated in the pool, especially along the underwater viewing windows, and on the land areas near dens and keeper access points. Red pandas show similar preference for specific elevated exhibit features. Snow leopards (top right) and sloth bear (bottom left) regularly use less than half of their available space. Snow leopard space use is concentrated in the smaller back exhibits, especially on elevated ledges and platforms. Sloth bear space use is focused along walls that provide keeper and guest interactions and rest/privacy.

RESTING



Most hotspots on the Overall Space Use heat maps can be attributed to preferred resting areas. For penguins, rest often occurs on land by their dens; for sloth bear, rest often occurs along guest viewing areas, near shift doors, and in a bear-built nest in natural substrate; and, for snow leopards and red pandas, rest often occurs on elevated platforms.

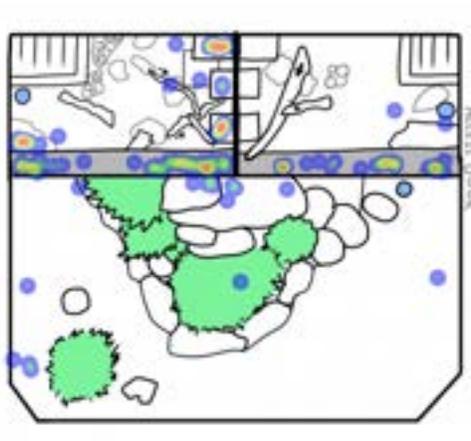
Active Natural Behaviors

In addition to indicating that an animal is healthy and happy, these species-typical behaviors are more engaging for zoo visitors and likely inspire direct conservation. Active natural behaviors include Climbing/Leaping, Digging, Feeding, Grooming, Investigation, Object Interaction, Self-maintenance, Swimming, and Walking.

Snow Leopards

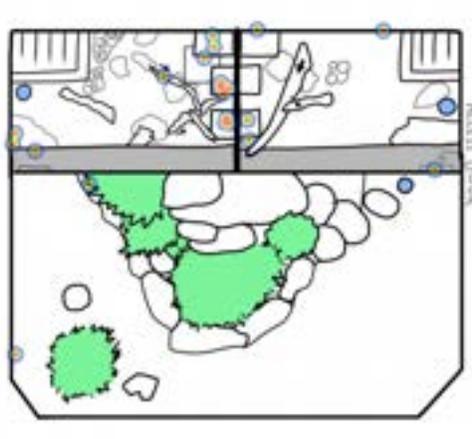
Snow leopards Kabita and Sabu spent the least amount of time performing active natural behaviors. To find out which behaviors were least frequently performed, we broke down this behavioral category for a closer look at Grooming & Self-maintenance, Climbing & Leaping, and Feeding.

GROOMING / SELF-MAINTENANCE



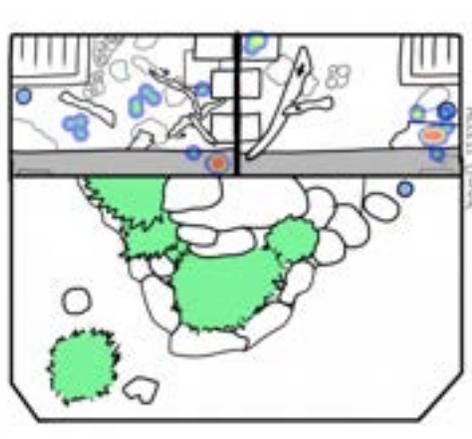
Grooming & Self-maintenance often occurred in preferred resting locations. These types of luxury behaviors indicate that Kabita and Sabu's needs are being met and they feel safe, secure, and comfortable. Again, these locations tended to be elevated platforms with extended visual vistas of the surrounding area.

CLIMBING / LEAPING



Snow leopards in range countries display astounding physical prowess when seeking and acquiring food, shelter, and social partners. This exhibit provides few opportunities for vertical movement, and these are generally located within the smaller back exhibits. When Kabita and Sabu were housed together for a short time during this study, these climbing features became a preferred location for social interactions and play behaviors.

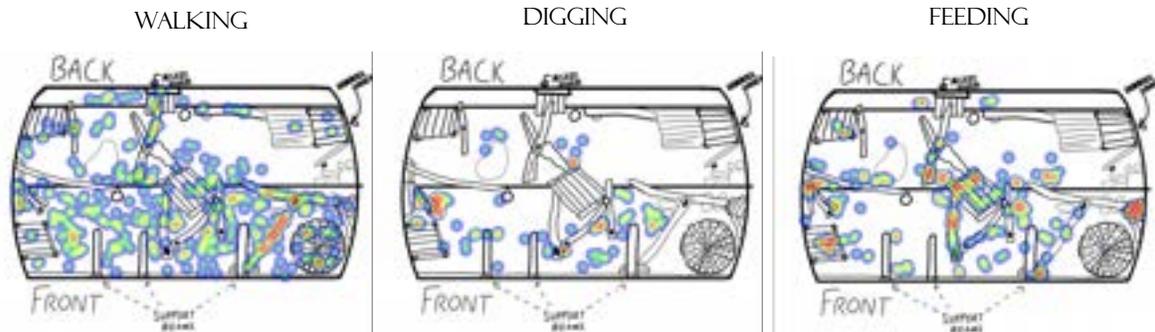
FEEDING



Feeding behavior is concentrated in the smaller back exhibits. This behavior occurs in a predictable manner (i.e., in a bowl, on a concrete shelf), and no feeding behavior was observed in the larger front exhibit. Presenting the snow leopards with feeding opportunities that vary across space and time will likely improve their overall space use. Making feeding events more complex would also extend the appetitive, information gathering phase of feeding, and motivate the snow leopards to engage with their environment for longer periods of time.

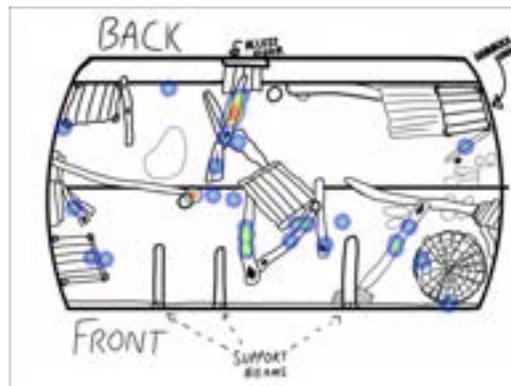
Red Pandas

Red pandas Dolly and Spud often engaged in the Active Natural behaviors of walking, digging, and feeding.



These heatmap indicates that red pandas Dolly and Spud cover most of the available space in the exhibit with particular focus on the front and sides of the exhibit. This could be due to feeding resources being spread across the midline of the exhibit, often as bamboo atop or secured to exhibit features. Digging is another active natural behavior that indicates the red pandas are engaged and perhaps searching for food or sensory input from their environment. Creating additional opportunities to perform this behavior via novel substrates, dig boxes, etc., would likely be appreciated by the red pandas and zoo guests. Shade use may also play an important role in how these individuals use their space, though this was not directly measured in this study.

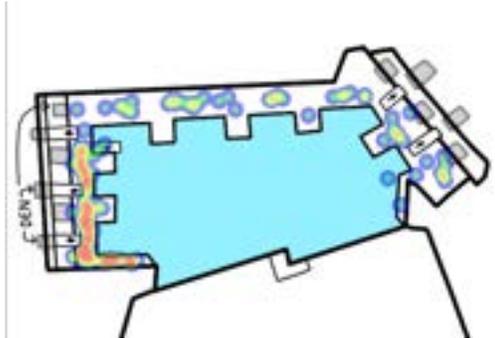
CLIMBING



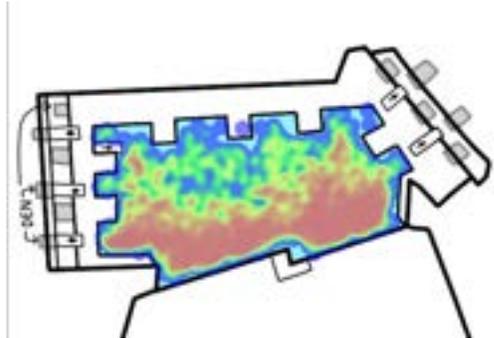
Red pandas Dolly and Spud spent relatively little time climbing, which is surprising for an arboreal species. Often, they climb down to the ground to walk from one place to another. Providing contiguous elevated pathways would create additional opportunities to perform this behavior. Opportunities for treetop travel could also develop balance, coordination, and problem-solving skills, particularly if these features are kinetic when used, modular for easy installation, and moveable to various locations throughout the enclosure.

Penguins

WALKING



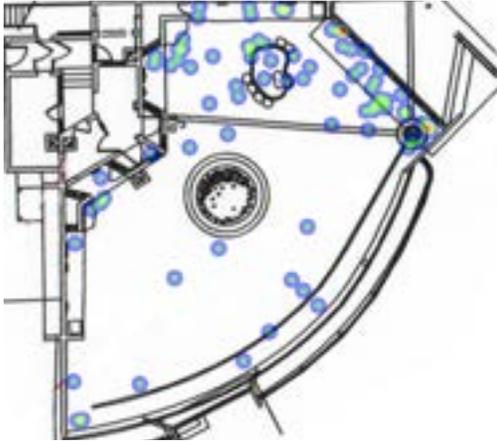
SWIMMING



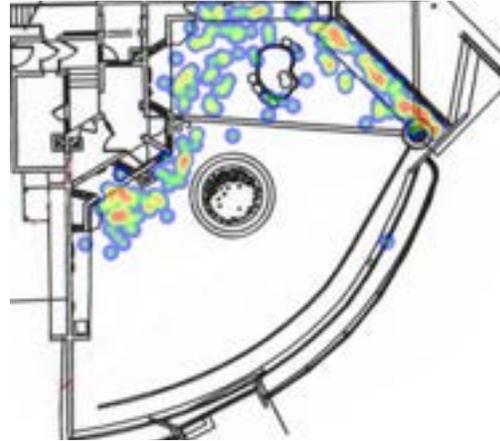
The penguins engaged in active natural behaviors for 63% of observations. Most of this time was spent swimming (45.4%), often near the underwater viewing area. While this gets the penguins close to zoo guests, it also means that the penguins are not fully utilizing the pool space equally, and often swim along loosely patterned routes from one end to the other. In addition, the penguins walk on land infrequently (2%), possibly because they always have visual access to all parts of the exhibit. There are also few opportunities for exploration on land and in the pool. The hotspots on the left side of the walking heatmap are concentrated at the exhibit's only keeper access point. A new exhibit would benefit from multiple keeper access points and strategies for providing the penguins with variable environments that are not solely reliant on direct penguin-keeper interactions.

Sloth Bear

INVESTIGATION



LOCOMOTION

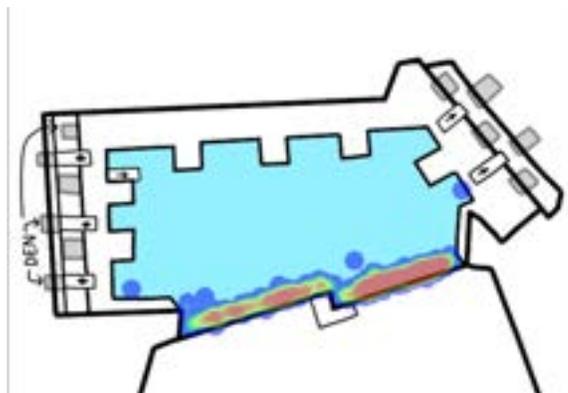


Sloth Bear Paji appears to be highly motivated to investigate certain areas of her environment. This natural curiosity is mirrored in her walking behavior and is focused in keeper service areas as well as the guest viewing and mealworm feeding experience areas. These are locations where food and human interaction are likely to be available. Spreading resources throughout her exhibit will likely result in these behaviors being spread throughout the exhibit.

Undesirable Behaviors

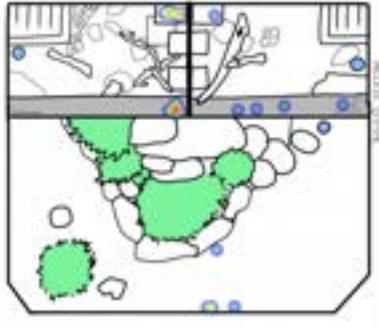
Undesirable behaviors include various forms of abnormal repetitive behaviors (ARBs), as well as waiting and anticipatory behaviors. ARBs, identified by their apparently functionless, repetitive nature, reflect frustration, repeated attempts to cope, central nervous system dysfunction, boredom, and the inability of animals to meet their own needs. Waiting and anticipatory behaviors reflect an animal's focus on human-controlled activities, often because of a lack of other behavioral opportunities in their environment. These behaviors can be precursors to ARBs.

WALL SWIMMING

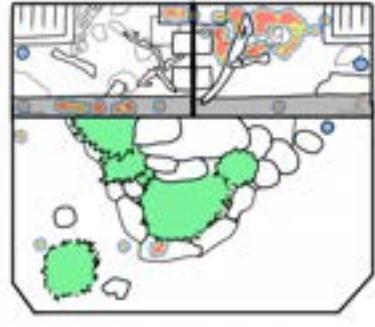


Many penguins exhibited a concerning behavior that has not been previously described in the scientific literature. Wall swimming, a highly patterned swim along a pool barrier with no apparent function, was observed from multiple penguins. Observers noted that certain individuals performed this behavior much more often than others, and that there was perhaps a social learning aspect where, as the study progressed, the youngest animal (Kusi) performed this behavior more often, and in tandem with other penguins. While the mechanisms and motivations behind this behavior are unknown, we suspect that the penguins are seeking sensory inputs or information from outside the physical bounds of their enclosure. In a future exhibit, the curiosity and exploratory nature of penguins could be better utilized to create engaging experiences for both the penguins and zoo guests.

SELF-DIRECTED

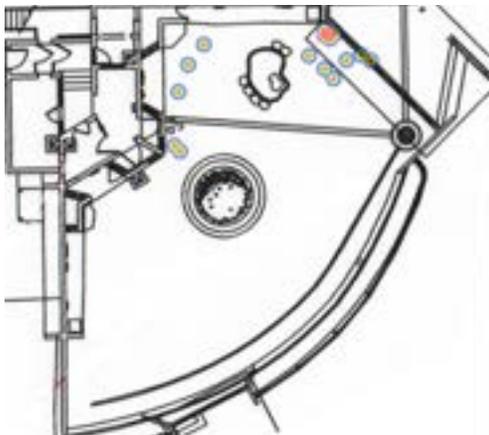


ROUTE-TRACING

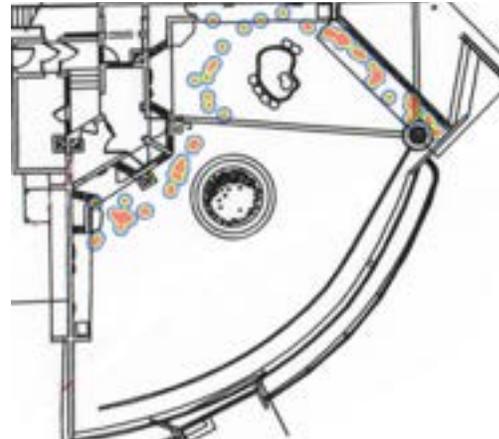


Snow leopards Kabita and Sabu showed moderate levels of self-directed and route tracing behavior, particularly in their smaller exhibit spaces. These highly patterned behaviors suggest that they are experiencing boredom, frustration, or an inability to meet their own needs in these environments. While their unmet needs could be social, environmental, or cognitive in nature, additional consideration is owed as to how we can best meet their needs in a future exhibit design.

ANTICIPATION



ROUTE-TRACING



Sloth Bear Paji performs anticipation and route-tracing behaviors in the same spaces in which she has come to expect the delivery of meaningful behavioral opportunities (i.e., keeper and guest interaction spaces). Providing greater opportunities to perform active natural behaviors like investigation, climbing, digging, and object interaction would likely decrease the performance of these undesirable behaviors.

Design Innovation

AWARE's design perspective incorporates evolving societal values regarding our duties to provide superlative animal care, and the missions of zoos and aquariums to support the development of empathy among zoo guests as a precursor for positive social change. As a result, we prioritize habitat designs that support animal thriving and empower and inspire guests to practice perspective taking and take caring action.

Animals thrive when they are both physically and psychologically healthy. This means that we are taking the best possible care of not only their bodies but also their emotions and minds. Thriving animals have agency in that they engage purposively with their environments to make choices, solve problems, and gather information. They express species-appropriate behaviors like play and exploration and utilize their unique skills to meet their own needs. The animal-environmental relationship is central to the concept of thriving. Animals bring their perceptual abilities, cognitive facilities, and behavioral competencies to this relationship. The environment provides information in the form of salient cues and patterns, and opportunities to utilize information through change and challenges.

Providing guests with assurances that animals are thriving and receiving exceptional care is the keystone to empathy development. How animals behave in their habitats and visible evidence of opportunities for animals to thrive are powerful tools in establishing guests' confidence in the quality of animal care. Animal behavior also invites observation and supports perspective-taking. As such, habitat designs that support species-typical animal behavior can engage guests and increase stay times, which may facilitate greater impact of educational messaging or interest in engaging in caring actions in situ.

To achieve these goals, we recommend that the following general principles are considered during the design process:

- Support activity in the animal communities throughout visitor hours. Movement through space, searching for and accessing resources, visiting guest interaction areas by choice, and displaying natural social and feeding behaviors are potential strategies.
- De-couple animal behavioral opportunities from zoo staff schedules and intervention via the integration of automated and programmable feeding, sensory, and problem-solving opportunities.
- Provide opportunistic and staff-led experiences where zoo guests are led to care about the animal residents by observing them utilizing their natural physical and cognitive skills.
- Provide opportunities for care staff to demonstrate aspects of animal care or facilitate guest interactions in which animal residents can choose to engage or control the timing and manner of these interactions.

Species specific recommendations follow.

Penguins

- **Greater exhibit complexity:** The current penguin exhibit includes a rudimentary pool and dry area with minimal topographic and environmental variation. Building an exhibit with variation in elevations, substrates, and geological features would encourage a greater diversity of active natural behaviors, like walking, climbing, and investigation, and increase the penguins' abilities to respond adaptively to novelty. This complexity should extend into the underwater environment, potentially in the form of topography, sounds, water current, or temperatures.
- **Multiple keeper access points:** The current exhibit has a single access point for initiating all direct human-penguin interactions. Thus, the penguins focus much of their time in this area, particularly during times of day when keepers are likely to enter the enclosure for feeding sessions. Multiple access points will reduce the performance of undesirable behaviors, like anticipation and waiting, and provide care staff with a greater ability to provide the penguins with clearer cues and contingencies that build stronger human-animal relationships.
- **Numerous terrestrial and aquatic routes:** Giving the penguins multiple pathways both on land and in water will encourage movement in mixed modalities. This will also enhance their ability to choose where, how, and with whom to spend their time. Being intentional about the inclusion of multiple terrestrial and aquatic pathways would also encourage more active natural behaviors, like exploration, walking, and swimming, and possibly preclude the performance of undesirable wall swimming.
- **Designing to support multiple vantage points:** A new exhibit should include features that create different vantage points for the penguins. This will prevent the penguins from seeing their entire habitat at once, and therefore encourage them to explore different areas of the habitat that may change throughout the day. This would also support social management and allow animals to self-separate or gather. This would also be a way to provide areas of privacy from public viewing.
- **Multiple viewing areas:** The penguins are highly motivated to engage with novel stimuli both within and outside their enclosure. This is particularly true of guest viewing areas, which are limited to a contiguous wall of windows along one wall of the current exhibit. Providing multiple viewing areas, both underwater and on land, would facilitate more diverse penguin-guest interactions, more robust use of spatial and environmental resources, and minimize the performance of undesirable wall swimming behavior.
- **Substrate diversity:** The current exhibit is constructed of concrete with limited rockwork for den areas. While this may be important for sanitation purposes, we know that housing animals on hard surfaces for extended periods of time can lead to significant issues related to musculoskeletal, joint, and foot health.

Snow Leopards

- **Larger, naturalistic spaces:** Zoo guests often observe the snow leopards while they are housed in enclosures that are predominantly dirt and concrete. Visitor surveys indicate that these small spaces and their artificial aesthetic are impacting guests' impressions of the leopards' mental health and presumably their ability to thrive. Providing continuous access to high quality exhibit spaces will not only improve visitor perceptions but also minimize undesirable behaviors by providing additional spatial and environmental resources that promote a diversity of active natural behaviors.
- **More vertical exhibit features:** Climbing, leaping, running, investigating, and self-maintenance behaviors are all limited to specific locations in the current exhibit. We recommend providing additional vertical resources in the form of rock ledges, cliff faces, living trees, and hanging platforms to promote a higher level of active behavior in general, and reduce resource competition when the leopards are housed together. Ideally, these features would be modular and modifiable so to provide variety and challenge over time.
- **Roundabout access:** Providing a flexible exhibit complex with multiple spaces that can be connected to facilitate continuous co-housing of the snow leopards would allow the leopards to make their own social choices and mediate their own social interactions, while avoiding dead ends and areas where the leopards may be able to corner each other.
- **24/7 access:** Currently, only one cat at a time can have access to the larger planted exhibit. This means that the other cat is housed in a smaller, lower quality space for 18+ hours per day. The design of a new exhibit should prioritize housing animals in high quality spaces across the 24-hour day.
- **Dynamic exhibit features:** Integrating scent or sound systems to provide environmental cues for challenging hunting opportunities would considerably increase the behavioral repertoire of the snow leopards and would allow care staff to design a variety of food acquisition experiences with varying degrees of challenge. These experiences will also be exciting to zoo guests and provide an opportunity for educational intervention with an engaged audience.

Red Pandas

- **More naturalistic spaces:** Zoo guests report that they would improve the current exhibit space by adding additional features and natural plantings that more closely mirror the pandas' natural habitat. This modification would also provide behavioral opportunities to practice foraging skills and could provide micro-climates within the habitats that the pandas can choose between throughout the day and night.
- **Arboreal opportunities:** These are limited in the current exhibit, and the pandas often climb to the ground to move throughout the exhibit. Providing dynamic and complex arboreal pathways could increase overall activity levels and introduce additional layers of choice and challenge. Guest viewing at elevated areas could also provide more engaging opportunities for guest-panda interactions.
- **Multiple substrate types:** The current exhibit is predominantly dirt, and the pandas show an interest in investigating the available substrate and digging. While this interest could be motivated by food or novel sensory inputs, the opportunity to provide additional opportunities to engage in this active natural behavior of digging could be better supported with multiple dig areas. These could be seeded with scents and treats, and the substrates could be varied, to build their skillset in responding adaptively to novelty and challenge.
- **Automated and Enriched Feeding Opportunities:** Much of the red panda's active behavior is concentrated around the times that food is supplied by care staff. While red pandas are naturally crepuscular, it is possible to extend their active periods throughout the day by providing more frequent foraging opportunities at varied times. This approach to feeding would be facilitated by the inclusion of timed automated feeding systems that disperse food throughout the day and night. Additionally, these timed feeders can be paired with enriched feeding apparatuses that encourage the pandas to use a variety of manipulative skills to access browse items.

Sloth Bear

- **Automated and Enriched Feeding Opportunities:** Paji is highly motivated to seek out food and foraging opportunities throughout the day. Currently, food is delivered directly from keepers, hidden throughout the exhibit when it is serviced, and provided as part of a guest encounter program at a predictable time each morning. Spreading these feeding opportunities throughout the day could reduce undesirable behaviors, like anticipation and waiting, while also promoting active natural behaviors and providing a more engaging guest experience. The current exhibit has multiple rooftop locations that would be ideal for the installation of an automated feeder that would deliver food (e.g., kibble, insects, etc.) at variable times and locations. This delivery system also reduces Paji's reliance on human-generated cues to predict the delivery of food. Often, cues such as the jingling of keys, opening of doors, and keeper voices immediately precede the presentation of food. With an automated feeder, food is provided by the environment in a manner that would require Paji to engage with her surroundings and learn new contingent cues such as sounds or scents that are not dependent on the presence of care staff. Additionally, automated feeders can be paired with enriched feeding apparatuses that encourage Paji to use a variety of manipulative skills to access food items. For example, automated feeders can be integrated into soft substrate areas to support digging behavior or into destructible logs or other containers to encourage scratching, clawing, and extraction behaviors.
- **Scent dispersal systems:** Because she is a bear, Paji is highly reliant on her sense of smell. We anecdotally noted that she would investigate gaps and windows in the wall between the keeper service and exhibit areas, presumably to detect when keepers were in the building and something interesting was about to happen. Because she does not have another bear as a social partner, this is perhaps the most important contingent relationship in her life currently. By adding additional olfactory inputs to her environment, and then pairing these with other types of meaningful events, Paji could learn additional contingencies that add complexity, challenge, and meaning to her life.
- **Honest signaling:** Every morning, a team of dedicated volunteers set up a guest feeding opportunity through a portal in the main viewing area of Paji's exhibit. She is clearly excited and motivated to participate in this activity that delivers high-value mealworms in a way that showcases her natural bug vacuuming abilities. Because she is excited to participate, Paji often waits in this location for extended periods before the experience begins. This may be because she is able to interact with the volunteers at the windows prior to the experience, or because there is a lack of additional opportunities in her environment at that time. When considering the format of the sloth bear experience, it may be beneficial to introduce a signal or environmental cue that tells Paji specifically when the experience will begin, and during the time prior to this cue, additional opportunities in her environment may be presented to reduce her tendency to spend long periods of time in place waiting for the event to begin.
- **Dynamic exhibit features:** The major features of the current exhibit consist of large concrete, stone, or deadfall elements that remain mostly static. Reconsidering the installation of "furniture" to create systems where items can be more easily moved and replaced across space and time would increase the complexity of the environment and build Paji's ability to responding adaptive to novelty and challenges.

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Appendix A: Guest Habitat Survey

Identical surveys were used to capture guest perceptions at each of the exhibits in this study.

Zoo Boise Snow Leopard Habitat Survey

Thank you for taking the time to complete this survey! Your feedback will help Zoo Boise plan for the renovation of this habitat.

1. Today's Date

Example: January 7, 2019

2. Time of Visit

Example: 8:30 AM

3. About how long did you spend at this habitat today?

Mark only one oval.

- Less than 1 minute
- 1-5 minutes
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- More than 20 minutes

4. Please check the box for any of the behaviors you noticed the animals performing in this habitat.

Check all that apply.

- Resting (awake)
- Sleeping
- Eating or Drinking
- Grooming
- Interacting socially with another animal
- Walking, running or swimming
- Climbing
- Playing

5. Please rate your response to the following statement: I have a greater sense of connection with nature as a result of visiting this habitat.

Mark only one oval.

	1	2	3	4	5	
Not at all	<input type="radio"/>	Very much so				

6. Please rate your response to the following statement: This habitat inspired me to wonder about the thoughts and feelings of the animals I saw.

Mark only one oval.

	1	2	3	4	5	
Not at all	<input type="radio"/>	Very much so				

7. Please rate your response to the following statement: Visiting this habitat helped me understand the challenges this species faces in the wild.

Mark only one oval.

	1	2	3	4	5	
Not at all	<input type="radio"/>	Very much so				

8. Please rate your response to the following statement: Visiting this habitat helped me understand how I can help this species in the wild.

Mark only one oval.

	1	2	3	4	5	
Not at all	<input type="radio"/>	Very much so				

9. In your opinion, how does this habitat meet the animal needs listed below?

Mark only one oval per row.

	Poor	Fair	Good	Great
Shelter	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Privacy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Space	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Exploration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Choices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Safety	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Play	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Comfort	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
UGLY	<input type="radio"/>	BEAUTIFUL				

11. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
IMPORTANT	<input type="radio"/>	NOT IMPORTANT				

12. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
INTERESTING	<input type="radio"/>	BORING				

13. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
NO PERSONALITY	<input type="radio"/>	LOTS OF PERSONALITY				

14. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
SAD	<input type="radio"/>	HAPPY				

15. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
NEGLECTED	<input type="radio"/>	CARED FOR				

16. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
PHYSICALLY HEALTHY	<input type="radio"/>	PHYSICALLY UNHEALTHY				

17. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
MENTALLY HEALTHY	<input type="radio"/>	MENTALLY UNHEALTHY				

18. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
COMFORTABLE	<input type="radio"/>	UNCOMFORTABLE				

19. Please select the number that best describes how you would rate this animal along the scale below.

Mark only one oval.

	1	2	3	4	5	
BORED	<input type="radio"/>	ENGAGED				

20. Please describe anything you would like to see changed about this exhibit.

21. Did you experience anything special while visiting this habitat today?

Mark only one oval.

- Yes
 No

Special experience

22. Please describe this experience.

Thank you for completing our survey!

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Google Forms

Appendix B: Ethograms

ETHOGRAMS						
Category	Behavior	Definition	Penguin	Red Panda	Sloth Bear	Snow Leopard
Active Natural	Climbing/Leaping	Propelling up or down a vertical surface or leaping to travel a distance greater than one body's length.	x	x	x	x
Active Natural	Digging	Using forelimbs or snout in a repetitive manner to excavate substrate.		x	x	x
Active Natural	Feeding Contained	Food delivered in a container (e.g., bucket, ball, box, barrel, cardboard, cylinder, disk, feeding wall, net, paper bag, trough) that does not require active behaviors to extract food (e.g., pulling, rolling, shaking, sliding, striking). Water and other liquids are always presented in containers.	x	x	x	x
Active Natural	Feeding Enriched	Food delivered must be worked for. Access to food is made more complicated by associating it with cognitive tasks, manipulation, physical activity, exploration, animal activated mechanisms, or time activated mechanisms (items become accessible after some amount of time).			x	x
Active Natural	Feeding Loose	All food items dispersed in piles, clumps, or scattered.	x	x	x	x
Active Natural	Feeding Vegetation	Vegetative food items including: foliage (e.g., trees, branches, or whole shrubs) and rooted vegetation (e.g., grass). Foliage can be precut, part of a living plant/tree, or secured to an object. If vegetative food items are in a container, score them as "vegetative." If vegetative food items must be worked for, score them as "enriched."		x	x	
Active Natural	Grooming	Interacting with their body using paws, beak or feet in rapid, often repetitive, movements across their fur, feathers or skin.	x	x	x	x
Active Natural	Guest Interaction	Focal is soliciting or responding to behaviors from the public.	x		x	
Active Natural	Investigation	Animal is intently sniffing the substrate or other elements of the enclosure.	x	x	x	x
Active Natural	Locomotion	Walking or running more than one body length in 10 seconds.	x	x	x	x
Active Natural	Object Interaction	Interacting or playing with a non-food delivery enrichment apparatus, an empty feeding container/enrichment apparatus, or object (e.g., log, rock).	x	x	x	x
Active Natural	Other	Performing a behavior not listed.	x	x	x	x
Active Natural	Panting	Animal is breathing quickly, spasmodically, or in a labored manner.		x	x	x
Active Natural	Self-maintenance	Using elements or features of the environment to promote comfort and/or maintain physical condition (e.g., dust bathing, rubbing on a log).	x	x	x	x
Active Natural	Swimming	Propelling itself through water at least a distance greater than one body's length.	x			
Inactive	Resting	Resting while standing, sitting or lying down.	x	x	x	x
Non-visible	Non-visible	Not visible or it is not possible to determine the behavior being performed.	x	x	x	x

Undesirable	Anticipation	Walking or performing learned behavior (i.e., begging) while focusing all of her/his attention towards a gate, door, training wall, food distribution area or people standing behind any of these areas. Animal is within one body length of the gate, door, training wall, or food distribution area.	x	x	x	x
Undesirable	Locomotor	Walking the same line of travel repeatedly. Watch individuals carefully to learn their routes. Note: Renamed Pacing/Route Tracing during first week on observations.				
Undesirable	Oral	Placing foreign objects in the mouth and sucking or chewing on them (e.g., bar biting, chain chewing).	x			x
Undesirable	Pacing/Route Tracing	Walking the same line of travel repeatedly. Watch individuals carefully to learn their routes.	x		x	x
Undesirable	Self-/Other-directed	Performing self-stimulating behaviors (e.g., hair pulling, limb sucking, nipple pulling).	x			x
Undesirable	Waiting	Performing a resting behavior while focusing all of her/his attention towards a gate, door, training wall, food distribution area or people standing behind any of these areas. Animal is within one body length of the gate, door, training wall, or food distribution area.	x	x	x	x
Undesirable	Wall Swimming	Animal is repetitively swimming against an exhibit barrier.	x			
Undesirable	Whole Body	Repeatedly performing stationary behavior (e.g., limb swinging, forward/backward motion [rocking, bobbing], side to side motion [swaying, weaving]). At least two repetitions must be performed within the 10 second scoring window.	x		x	

Appendix C: Species Behavior Time Budgets

PENGUIN BEHAVIOR TIME BUDGET



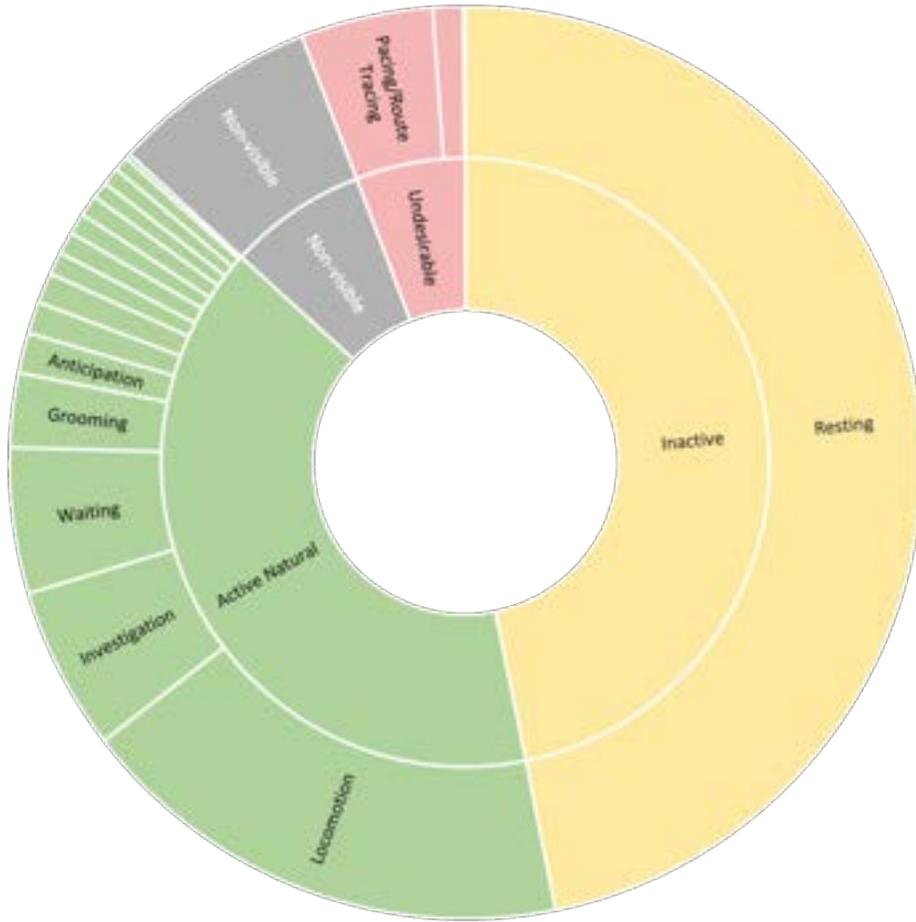
AFRICAN PENGUIN											
Category	Behavior	1.0 'Bocelli'	0.1 'Daisy'	0.1 'Isabelle'	1.0 'Jimmy'	0.1 'Kusi'	0.1 'Lois'	1.0 'Milo'	1.0 'Puddin'	0.1 'Rose'	Average
Active Natural	Climbing/Leaping	0.00%	0.19%	0.09%	0.00%	0.00%	0.00%	0.16%	0.00%	0.00%	0.05%
Active Natural	Feeding - Contained	0.26%	0.00%	0.09%	0.00%	0.08%	0.00%	0.08%	0.09%	0.41%	0.10%
Active Natural	Feeding - Loose	0.26%	0.00%	0.17%	0.29%	0.00%	0.09%	0.08%	0.26%	0.00%	0.13%
Active Natural	Grooming	27.69%	16.37%	7.65%	9.48%	10.11%	5.69%	7.90%	8.01%	9.26%	11.48%
Active Natural	Guest Interaction	0.00%	0.38%	0.09%	0.00%	0.00%	0.18%	0.39%	0.00%	0.00%	0.13%
Active Natural	Investigation	0.00%	1.32%	0.17%	0.00%	0.25%	0.54%	1.11%	0.34%	0.00%	0.45%
Active Natural	Locomotion	3.35%	2.54%	2.15%	0.00%	3.74%	2.35%	2.37%	1.38%	0.27%	2.19%
Active Natural	Object Interaction	1.03%	1.41%	0.17%	0.29%	0.51%	0.27%	1.03%	0.34%	1.09%	0.68%
Active Natural	Other	0.00%	0.38%	0.00%	27.16%	0.25%	0.00%	0.24%	0.09%	0.82%	2.16%
Active Natural	Self-maintenance	0.77%	0.38%	0.00%	0.14%	0.17%	0.27%	0.55%	0.17%	1.09%	0.38%
Active Natural	Swimming	36.80%	34.15%	75.06%	16.95%	52.85%	44.22%	31.20%	49.96%	61.99%	45.37%
Inactive	Resting	26.14%	27.28%	10.83%	44.68%	28.12%	12.09%	21.56%	10.42%	21.80%	21.51%
Non-visible	Non-visible	1.38%	1.32%	0.95%	0.29%	1.19%	0.09%	1.66%	0.69%	0.54%	0.95%
Undesirable	Anticipation	0.95%	0.66%	0.43%	0.00%	0.17%	0.45%	0.87%	0.17%	0.27%	0.47%
Undesirable	Locomotor	0.00%	0.00%	0.00%	0.00%	0.85%	0.00%	0.00%	0.52%	0.00%	0.17%
Undesirable	Oral	0.00%	0.56%	0.00%	0.00%	0.00%	0.00%	0.39%	0.00%	0.00%	0.12%
Undesirable	Pacing/Route Tracing	0.00%	0.00%	0.52%	0.00%	0.68%	1.99%	0.00%	0.17%	1.63%	0.52%
Undesirable	Self/Other-directed	0.26%	0.66%	0.09%	0.14%	0.25%	0.09%	0.79%	0.00%	0.14%	0.28%
Undesirable	Waiting	0.69%	0.66%	0.26%	0.43%	0.42%	0.09%	0.79%	0.26%	0.00%	0.42%
Undesirable	Wall Swimming	0.43%	11.76%	1.29%	0.00%	0.34%	31.59%	28.83%	27.13%	0.68%	12.42%
Undesirable	Whole Body	0.00%	0.00%	0.00%	0.14%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%

RED PANDA BEHAVIOR TIME BUDGET



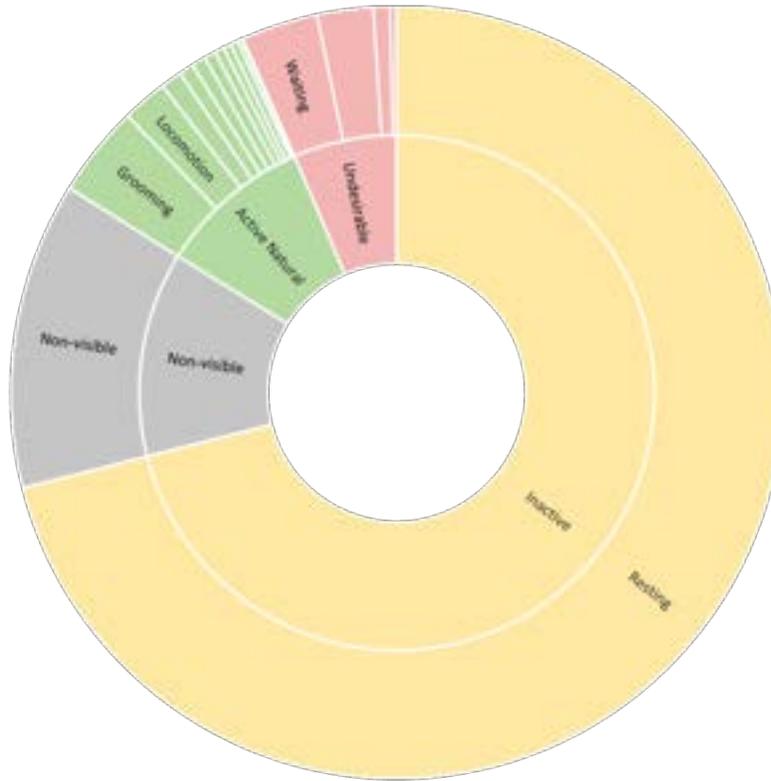
RED PANDA				
Category	Behavior	0.1 'Dolly'	1.0 'Spud'	Average
Active Natural	Climbing/Leaping	0.83%	0.72%	0.78%
Active Natural	Digging	1.95%	1.27%	1.62%
Active Natural	Feeding - Contained	0.27%	0.55%	0.40%
Active Natural	Feeding - Loose	1.07%	0.63%	0.86%
Active Natural	Feeding - Vegetation	6.69%	4.52%	5.65%
Active Natural	Grooming	7.54%	6.80%	7.19%
Active Natural	Investigation	1.34%	2.36%	1.83%
Active Natural	Locomotion	3.45%	8.44%	5.85%
Active Natural	Object Interaction	0.13%	0.03%	0.08%
Active Natural	Other	3.42%	0.40%	1.97%
Active Natural	Panting	0.11%	0.20%	0.15%
Active Natural	Self-maintenance	0.00%	0.06%	0.03%
Inactive	Resting	65.20%	56.95%	61.22%
Non-visible	Non-visible	7.78%	16.92%	12.18%
Undesirable	Anticipation	0.08%	0.03%	0.06%
Undesirable	Waiting	0.13%	0.12%	0.12%

SLOTH BEAR TIME BUDGET



SLOTH BEAR		
Category	Behavior	0.1 'Paji'
Active Natural	Climbing/Leaping	0.54%
Active Natural	Digging	0.74%
Active Natural	Feeding - Contained	0.81%
Active Natural	Feeding - Enriched	0.00%
Active Natural	Feeding - Loose	0.74%
Active Natural	Feeding - Vegetation	0.81%
Active Natural	Grooming	2.62%
Active Natural	Guest Interaction	0.20%
Active Natural	Investigation	5.78%
Active Natural	Locomotion	17.74%
Active Natural	Object Interaction	1.08%
Active Natural	Other	0.60%
Active Natural	Panting	1.14%
Active Natural	Self-maintenance	0.60%
Inactive	Resting	46.84%
Non-visible	Non-visible	7.33%
Undesirable	Anticipation	1.41%
Undesirable	Locomotor	1.08%
Undesirable	Pacing/Route Tracing	4.70%
Undesirable	Waiting	5.17%
Undesirable	Whole Body	0.07%

SNOW LEOPARD BEHAVIOR TIME BUDGET

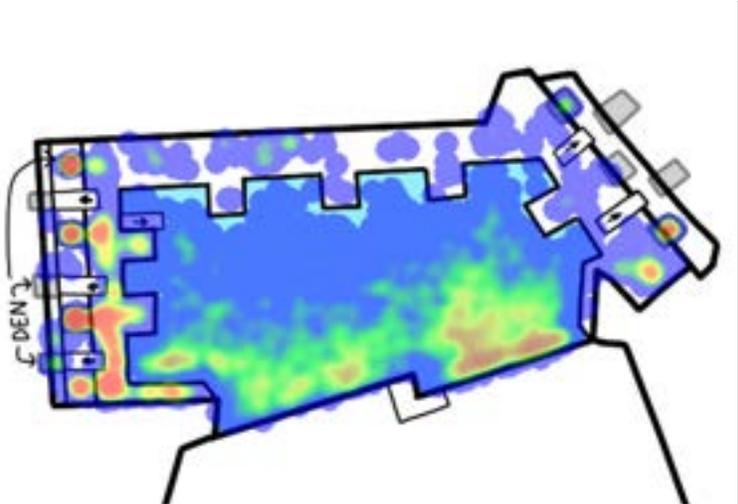


SNOW LEOPARD				
Category	Behavior	0.1 'Kabita'	1.0 'Sabu'	Average
Active Natural	Climbing/Leaping	0.69%	0.58%	0.64%
Active Natural	Digging	0.04%	0.00%	0.02%
Active Natural	Feeding - Contained	0.69%	0.33%	0.51%
Active Natural	Feeding - Enriched	0.00%	0.75%	0.37%
Active Natural	Feeding - Loose	0.12%	0.00%	0.06%
Active Natural	Grooming	4.96%	2.62%	3.79%
Active Natural	Investigation	0.89%	0.83%	0.86%
Active Natural	Locomotion	1.67%	2.21%	1.94%
Active Natural	Object Interaction	0.24%	0.12%	0.18%
Active Natural	Other	0.24%	0.37%	0.31%
Active Natural	Panting	0.33%	0.79%	0.56%
Active Natural	Self-Maintenance	0.57%	0.08%	0.33%
Inactive	Resting	72.36%	69.64%	71.00%
Non-visible	Non-visible	9.43%	16.41%	12.92%
Undesirable	Anticipation	0.28%	0.21%	0.25%
Undesirable	Oral	0.00%	0.04%	0.02%
Undesirable	Pacing/Route Tracing	1.30%	3.46%	2.38%
Undesirable	Self/Other-directed	1.38%	0.00%	0.69%
Undesirable	Waiting	4.80%	1.54%	3.17%

Appendix D: Space Use Heatmaps

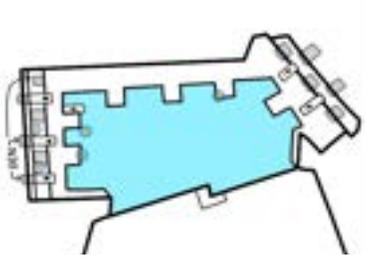


Overall Space Use

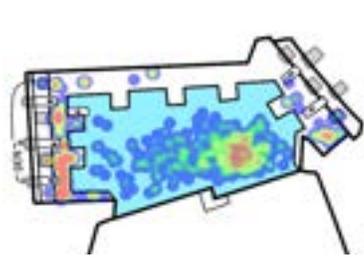


ACTIVE NATURAL

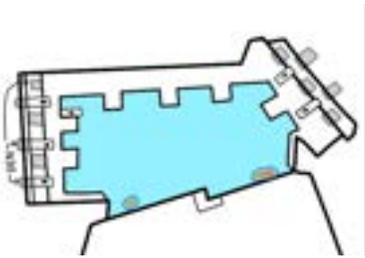
Climbing / Leaping



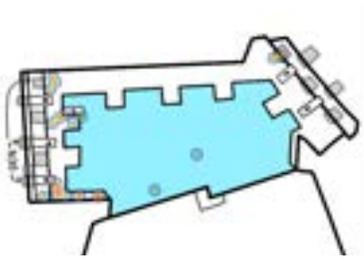
Grooming



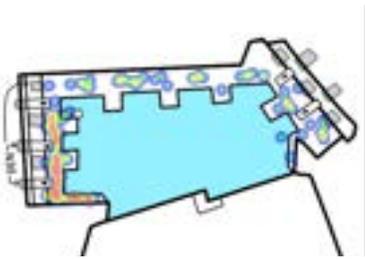
Guest Interaction



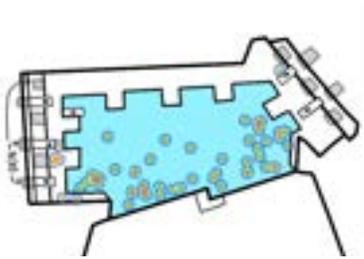
Investigation



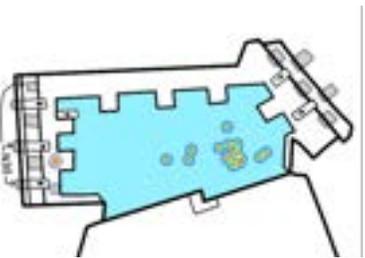
Locomotion



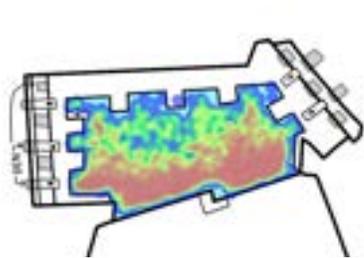
Object Interaction



Self-Maintenance

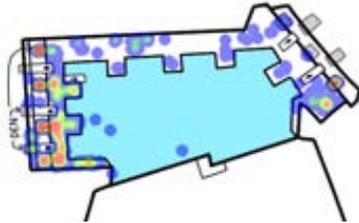


Swimming



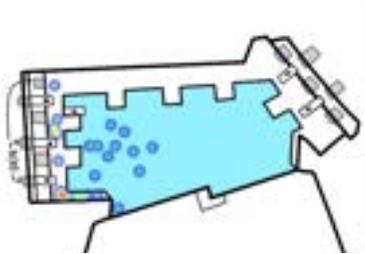
INACTIVE

Resting

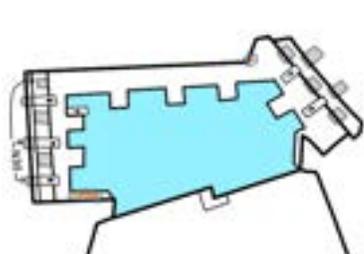


UNDESIRABLE

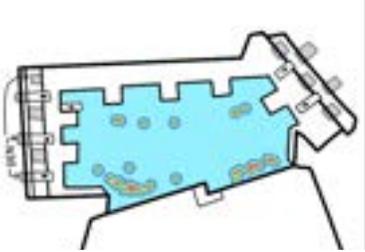
Anticipation



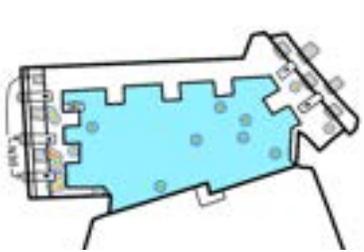
Oral Stereotypy



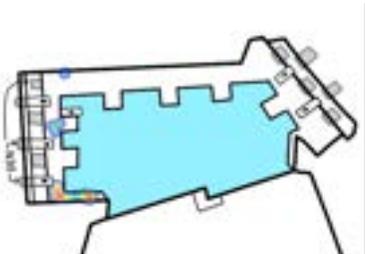
Pacing / Route Tracing



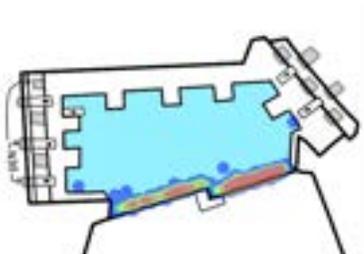
Self- / Other-Directed



Waiting



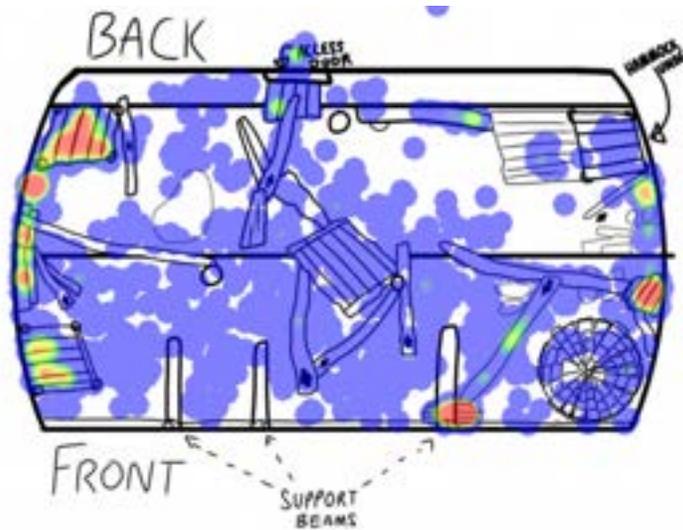
Wall Swimming



RED PANDAS

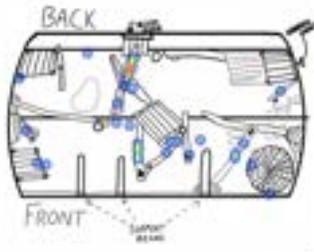


Overall Space Use

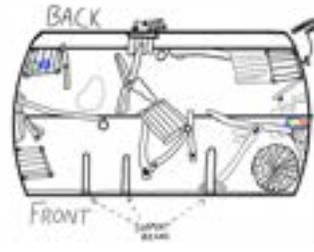


ACTIVE NATURAL

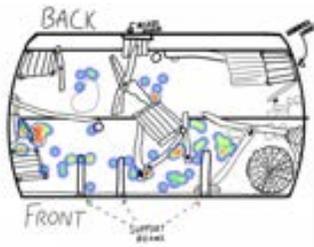
Climbing / Leaping



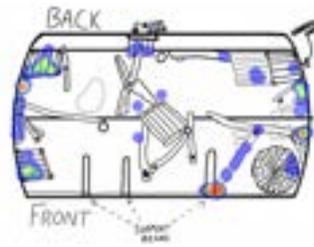
Contained Feeding



Digging



Grooming



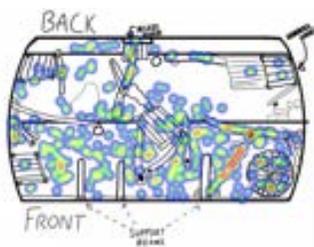
Guest Interaction

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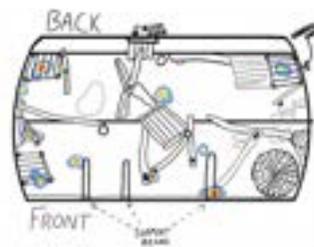
Investigation



Locomotion



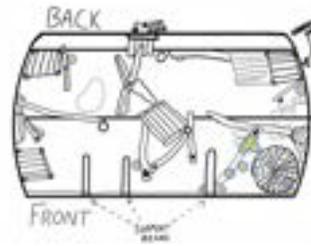
Loose Feeding



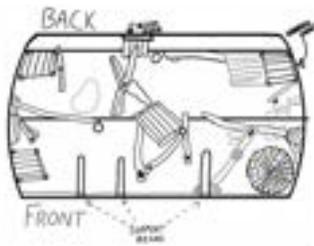
Object Interaction

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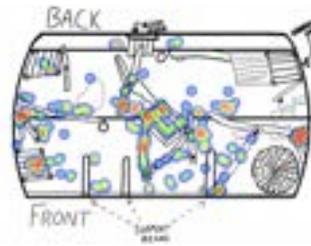
Panting



Self-Maintenance

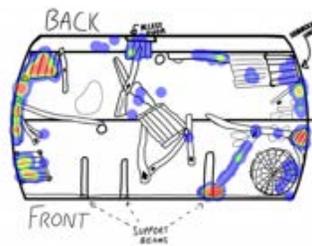


Vegetation Feeding



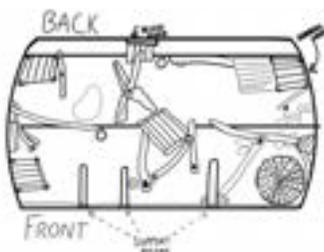
INACTIVE

Resting

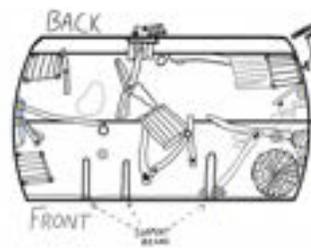


UNDESIRABLE

Anticipation

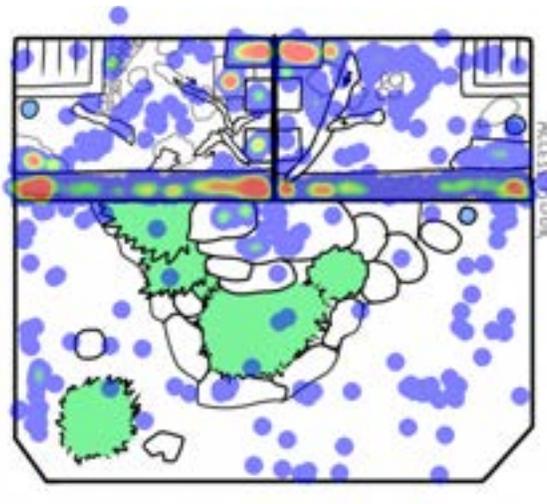


Waiting



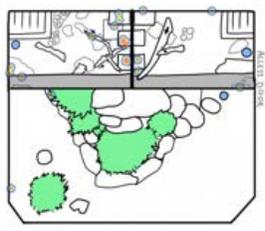


Overall Space Use

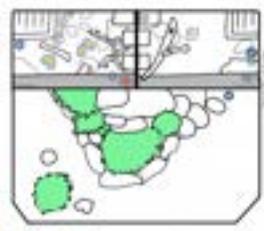


ACTIVE NATURAL

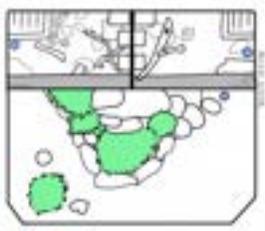
Climbing / Leaping



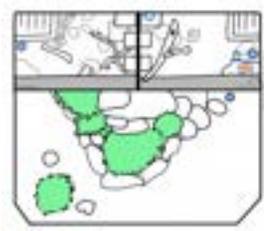
Contained Feeding



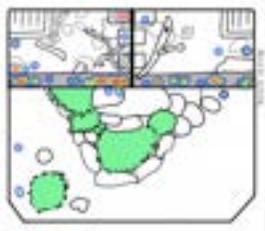
Digging



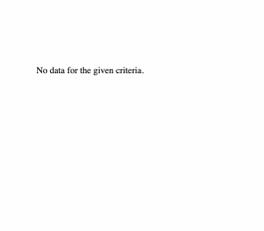
Enriched Feeding



Grooming

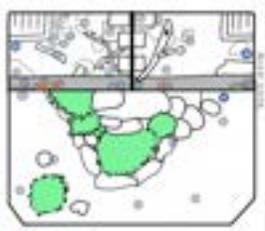


Guest Interaction

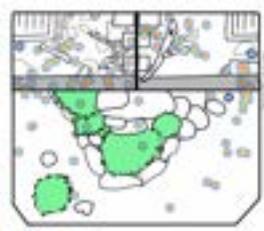


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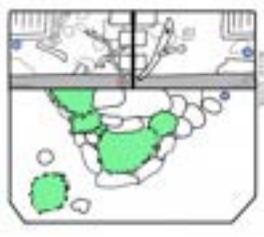
Investigation



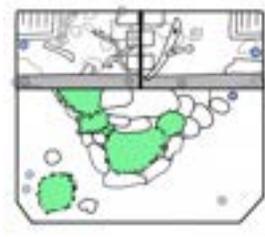
Locomotion



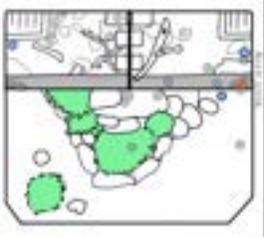
Loose Feeding



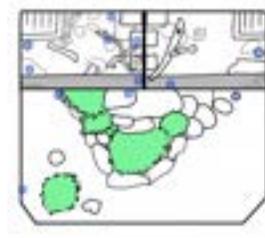
Object Interaction



Panting

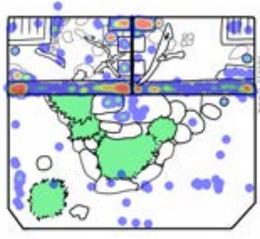


Self-Maintenance



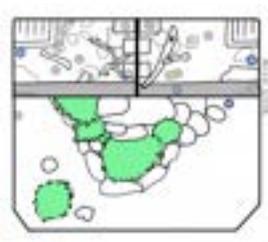
INACTIVE

Resting

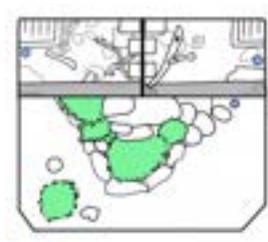


UNDESIRABLE

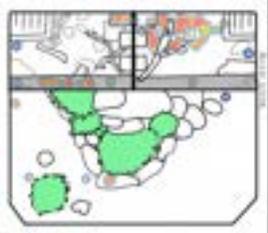
Anticipation



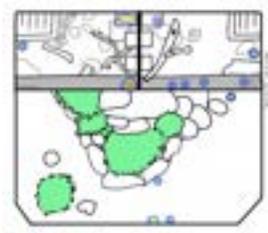
Oral Stereotypy



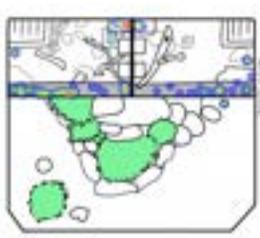
Pacing / Route Tracing



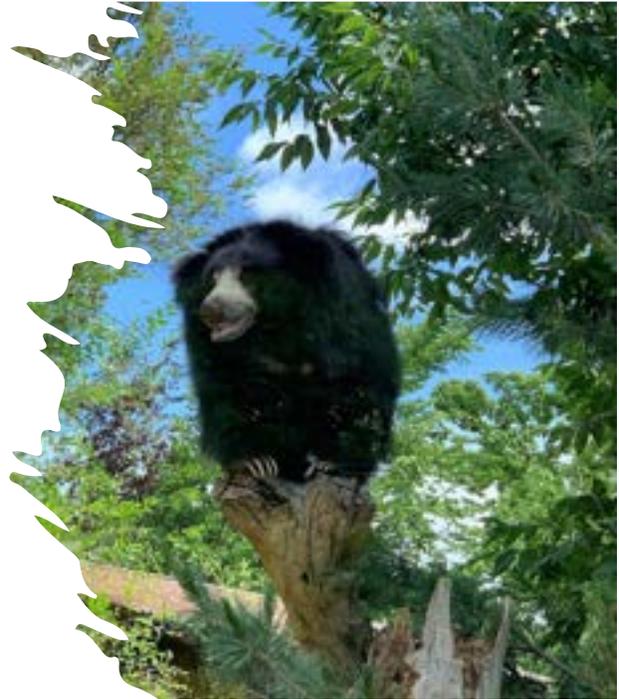
Self- / Other-Directed



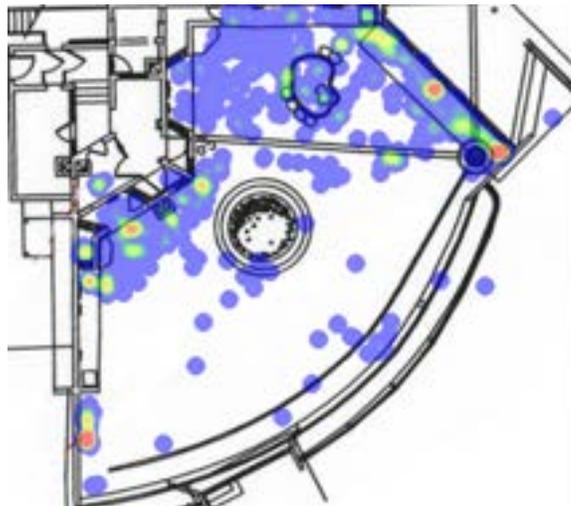
Waiting



SLOTH BEAR

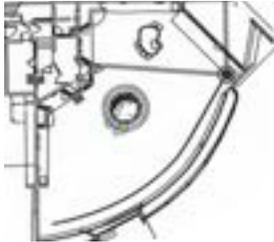


All Behaviors

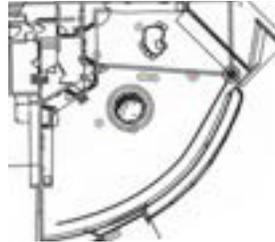


ACTIVE NATURAL

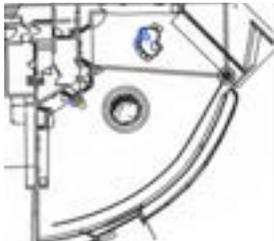
Climbing/Leaping



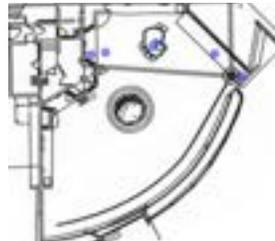
Digging



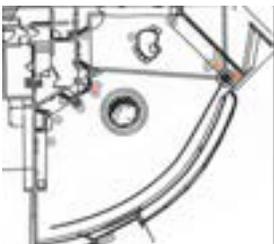
Feeding Contained



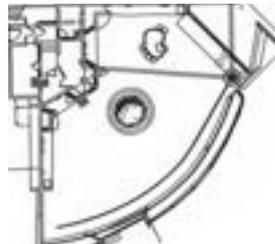
Feeding Loose



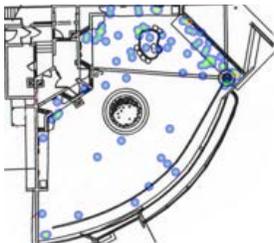
Grooming



Guest Interaction



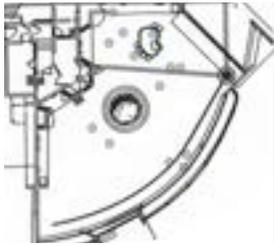
Investigation



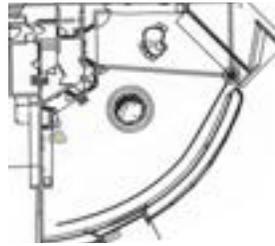
Locomotion



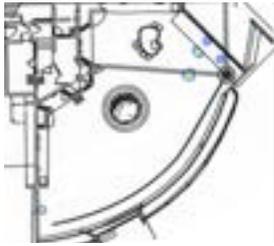
Object Interaction



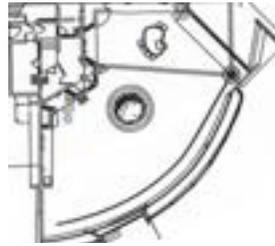
Other



Panting



Self-maintenance



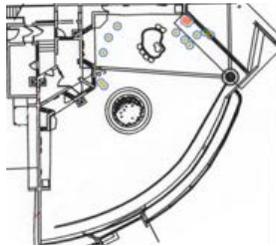
INACTIVE

Resting

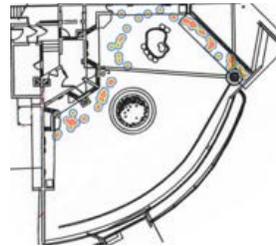


UNDESIRABLE

Anticipation



Pacing / Route-tracing



Waiting

