

Environmental Enrichment for Captive Komodo Dragons

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Research Questions

Can we make Komodo dragons more active during zoo hours with forms of environmental enrichment?
How can zookeepers get Komodo dragons more active in their enclosures during zoo hours?

Abstract

Studying Komodo dragons in captivity is worthwhile because studying them in the field involves many difficulties, such as the remoteness of their native habitat, their large home range, and the possible dangers of field studies for the dragons and researchers. Studying captive Komodo dragons has already presented much knowledge about successful breeding in captivity with proper diet and habitat conditions. An additional goal is to provide adequate environments and experiences for the dragons in their individual enclosures. To do this, we introduced three different enrichment challenges/activities and analyzed how each form of enrichment stimulates more behavior in the enclosure.

The first enrichment trials were based off of burying eggs in the dirt of the enclosure to simulate turtle eggs in a sandy beach (a meal the dragons often eat), but instead of eggs we buried a boomer ball with a rat inside of it. We did not use eggs because it was not a part of the diet that the zoo placed for the dragons. The second trial consisted of using meat juice as a form of leaving scent trails of a prey item in the enclosure and placing the prey so it can be found by the dragon at the end of the trail. In the third trial, we placed a boomer ball, covered in meat juice, in the exhibit that was meant to stimulate a 'play' behavior. We analyzed these behaviors and learned that there was a definite increase in the activity level of the two dragons. These different enrichments increased activity in the dragons and can be used as strategies for other zoos to get their Komodo dragons active.

The Dragons



Fig. 1. Selat resting on one of the observations days during the baseline study.



Fig. 2. Loki resting on one of the observations days during the baseline study.

Introduction

The purpose of this capstone was to create an opportunity for public visual interest for the Komodo dragons through enrichment activities during busy zoo hours. In their enclosure, Komodo dragons are given a strict diet and spend the majority of their time resting. In the wild, Komodo dragons have a high fitness level and have been known to travel over 10 kilometers to obtain their prey, run speeds of up to 13 miles per hour, and swim various kilometers from island to island (Auffenberg, 1981). Komodo Dragons are very active creatures, so it is essential to find ways of stimulating their senses and physical attributes. A captive Komodo dragon may not have to worry about predation, territory dominance, habitat dependence, or movement from one habitat patch to another.

To cope with zoo habitat restrictions such as limited space and a dynamic environment, enrichment projects are great ways of providing captive animals with an outlet to exercise their unique and wonderful instincts that make these animals so wild and unpredictable. With the information we obtained from the pre and during enrichment trials, we have come up with convincing data that support our theory of the positive outcomes of the exposure of enrichment activities on captive Komodo dragons.

Study Setting

The Woodland Park Zoo exhibits nearly 1,100 animals representing almost 300 different animal species—among these species there is the largest living lizard on the planet, the Komodo dragon. Woodland Park Zoo is one of only 20 zoos with Komodo dragons nationwide. The Woodland Park Zoo is very aware of many of the Earth's struggling species and they are determined to help conserve as many endangered species as possible. The Komodo dragon is considered a threatened species on the verge of becoming endangered, and in order to help, WPZ has joined the Association of Zoos & Aquariums Species Survival Plan on behalf of the dragons and many other species.

The mission of an AZA Species Survival Plan Program is to cooperatively manage specific, and typically threatened or endangered, species population within AZA-accredited Zoos and Aquariums, Certified Related Facilities, and Approved Non-Member Participants. According to the AZA "Each SSP is responsible for developing a comprehensive population Studbook and a Breeding and Transfer Plan which identifies population management goals and recommendations to ensure the sustainability of a healthy, genetically diverse, and demographically varied AZA population.

There are two male Komodo dragons housed at the Woodland Park Zoo, named Loki (18 years old) and Selat (13 years old). Loki is about 100 lbs and Selat is 120 lbs, seemingly more active and muscular. The study area was the two adjacent enclosures of the Komodo dragon exhibit. Each male has their own separate enclosure with heat gradients ranging from 26.6-48.9°C. There is a water source (pool of water), cave where the dragons can sleep, logs, leaf debris, and the ground is covered in sand with soft dirt underneath. The older male Loki usually is in the larger exhibit that is roughly 14 square meters. The younger heavier male has about 9 square meters to live in. We observed the animals from the visitor viewing section of the exhibit where there are two large glass windows that allowed us to see everything that was going on once we introduced each enrichment item for the dragons.



Fig. 3. Komodo Dragon exhibit at the Woodland Park Zoo

Methods

We had two male Komodo Dragons each take part in a 3 month baseline activity survey where we came in twice a week and recorded their actions for the first 15 minutes of every hour for nine hours. Saturdays were dedicated to Loki and Tuesdays belonged to Selat. Once we finished the three month baseline survey, we then came up with three unique enrichment activities.

Enrichment Plan: Three unique enrichments that hopefully encourage and stimulate additional behaviors.

- Digging: bury a ball with a dead mouse inside, away from plain sight.
- Scent Trail: using meat juice, create a simple yet intricate path leading to a hidden dead mouse.
- "Play": provide the dragons with a boomer ball (toy) and see how they react to it.

We would then take turns exposing the dragons to the enrichment activities: on Sundays, Loki would be exposed to the "digging" enrichment, and we would return on Tuesday to record his activity level. The following week, this would be repeated with Selat. Each dragon would take turns with the enrichments, and once they finished all three, we would repeat the process one more time and expose them to all three enrichments once again.

Results

Fig. 1. These are the averaged percentages of how the Komodo dragons spent most of their time. There are only six behaviors that were recorded in the baseline study and Resting seemed to take up a lot of the dragons time each day.

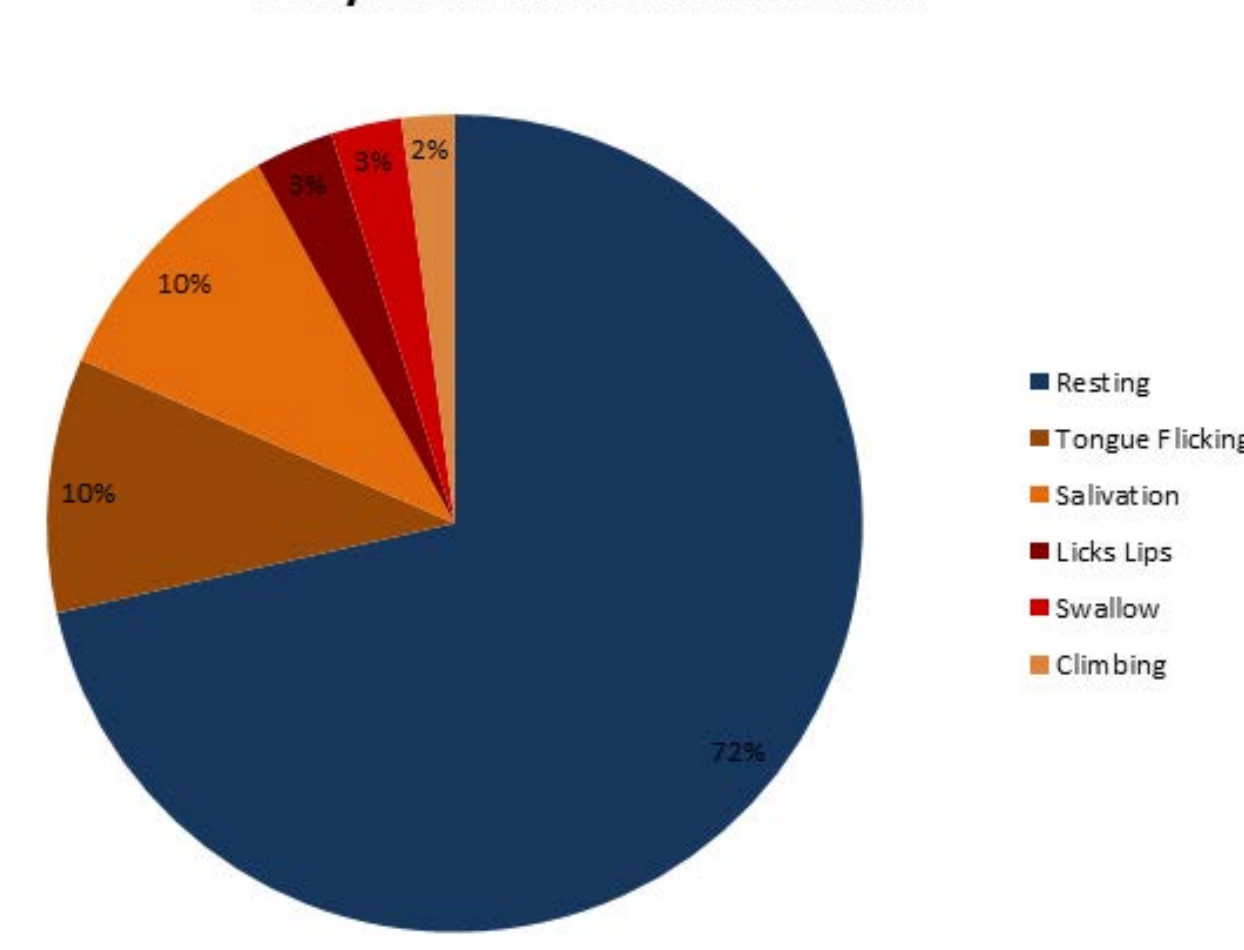


Fig. 2. The averaged percentages of the behaviors shown by the two dragons during the day of each enrichment activity. There are many more behaviors shown here than there were in the baseline study and resting time has been cut down significantly.

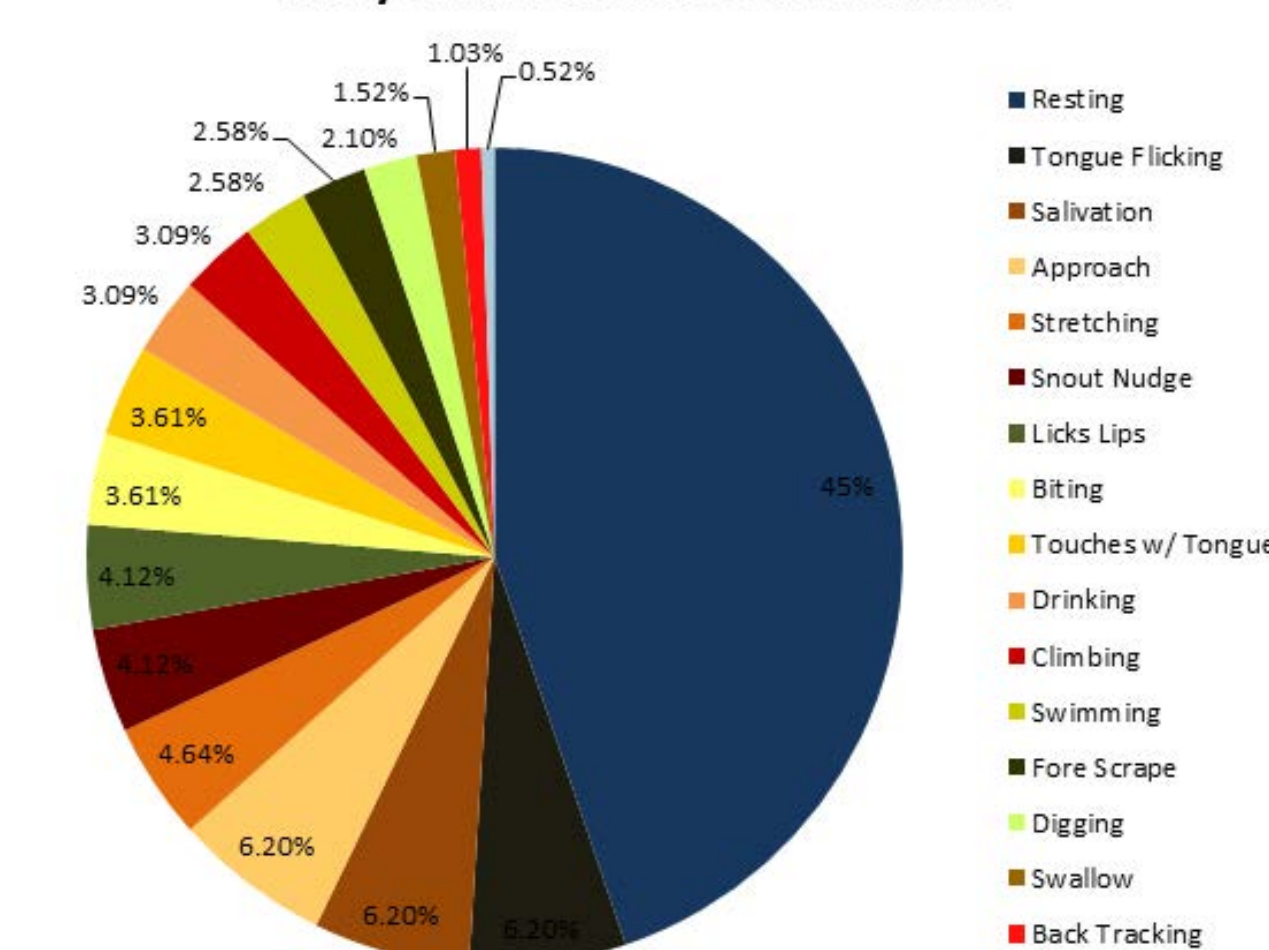


Fig. 3. Line graph showing the average amount of behaviors/actions observed at every hour of the day. Zero amount of actions means that the animal was resting. These are the actions of both dragons during the baseline study.

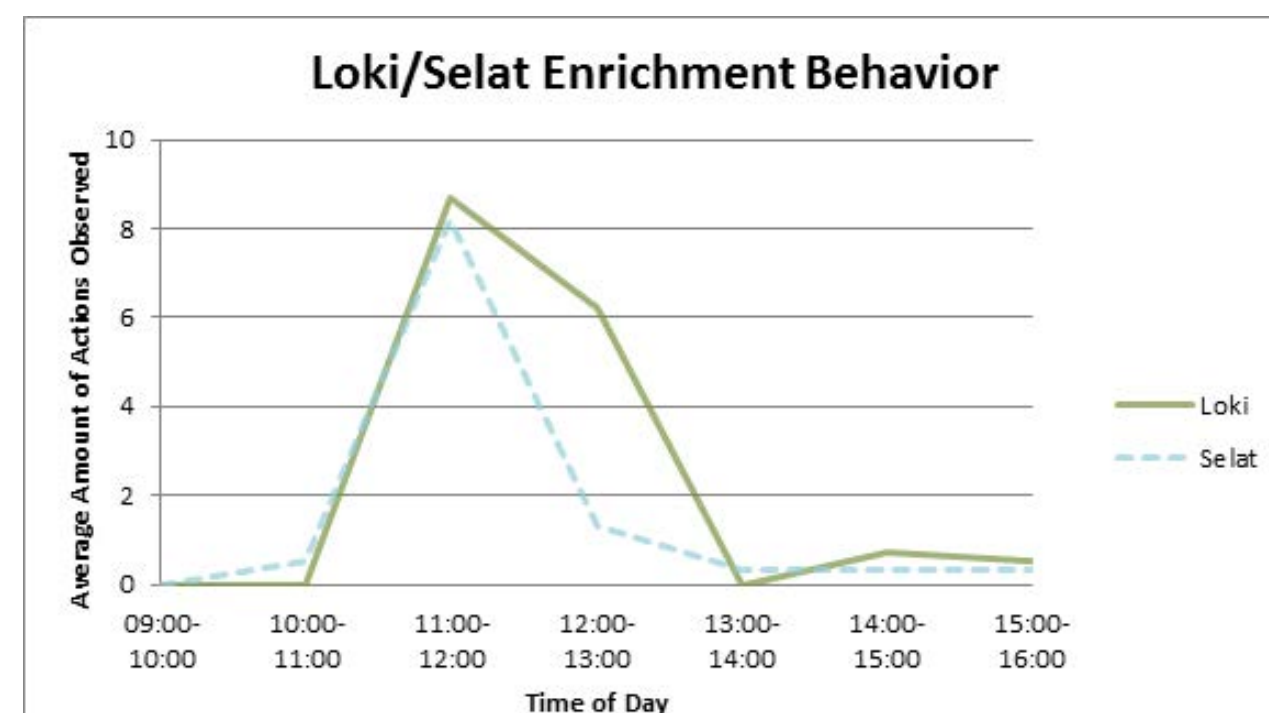
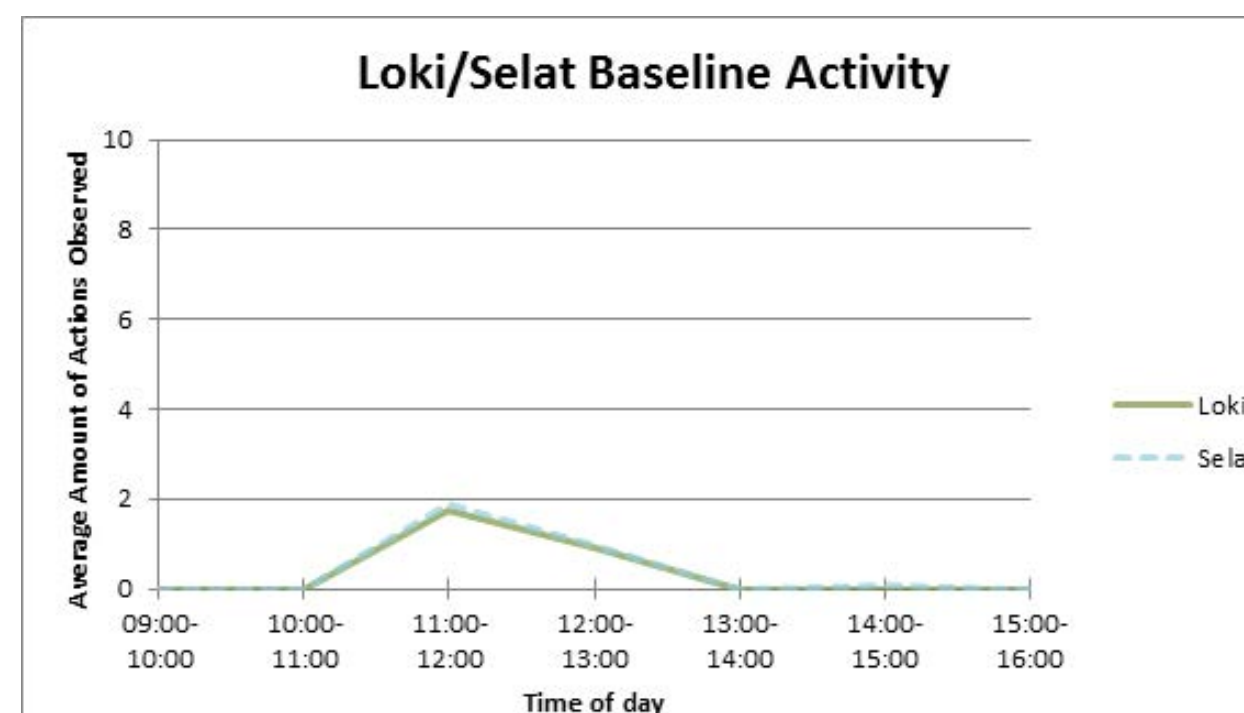


Fig. 4. Line graph showing the average amount of behaviors/actions observed at every hour of every day the dragons were given a form enrichment. As compared to the baseline graph there can be seen a definite increase in the amount of behaviors displayed and increase in activity level throughout the day.

Fig. 5. Line graph showing the average amount of behaviors/actions observed at every hour of every day the dragons were given a form enrichment. As compared to the baseline graph there can be seen a definite increase in the amount of behaviors displayed and increase in activity level throughout the day.



Fig. 4. Selat observing the boomer ball during the 'play' enrichment activity.

Mann-Whitney Test

In order to provide statistical evidence to our results, we used the 2 Sample Mann-Whitney on the actions of "before" and "after" enrichment data from both Komodo Dragons. It is applied to compare whether the average difference between two groups of data are significant, or, due to random chance, and in our case, we noticed that the "after enrichment" data was not evenly distributed. We figured this out by graphing our data and, instead of the data creating a bell shaped curve, it was an uneven curve. The easy fix to this problem is the nonparametric Mann-Whitney test, which we used to determine if two samples come from the same distribution, then obtains its data from the differences between the mean ranks of the two samples. The Mann-Whitney test rejected our null hypothesis and confirmed our original hypothesis. Our enrichment trials impacted the behavior of the Komodo Dragons positively.

Loki
2 Sample Mann-Whitney

H₁: Median Difference = 0
H₂: Median Difference = 0

Results

	Before	After
Count	16	12
Median	4	5

Mann-Whitney Statistic = 146.00
P-value (2-sided, adjusted for ties) = 0.0000

The data above takes into account the number of actions observed (and frequency of the actions) during the pre-enrichment and compares that with the number of actions during the enrichment.

Selat
2 Sample Mann-Whitney

H₁: Median Difference = 0
H₂: Median Difference = 0

Results

	Before	After
Count	15	12
Median	4	6

Mann-Whitney Statistic = 175.00
P-value (2-sided, adjusted for ties) = 0.0782

Discussion

In captivity, the dragons do not need to exert themselves to obtain food, and instead, spend their time resting. Considering that Komodo dragons travel up to 10 kilometers per day in the wild, and that they have evolved to store food surplus in case it is an extended period of time before their next meal, regular feeding for these animals in zoos can quickly lead to obesity. Our purpose here was to see if it would be possible to stimulate the dragons and make them more active by introducing them to environmental enrichments. The three enrichments that were used were all different types of enrichment to prompt different responses. The digging enrichment was chosen to lark out some predatory behaviors (side swipe), and unearthing hidden food such as carcasses or turtle eggs on a beach by digging. The scent trail was made as an imitation of the track an injured, bleeding animal would leave and this would hopefully bring out the stalking behavior of a wild dragon when they follow fleeing prey. The boomer ball was used to stimulate some playful behavior in the dragons. When beginning this study we realized that there was a limitation in the number of animals we could use for the trials since there are only two Komodo dragons in zoos in Washington. To be able to observe more than one animal, we would have to go abroad and find other dragons in different zoos. This would then also lead to a limitation of time to do the observations. If we had more time to do this project, we could study the long-term effects in each trial that was carried out.

The two male dragons had quite similar forms of behavior, however, the younger 13 year old male, Selat, seemed to be more active than 18 year old Loki, but that can be related to age and size difference even though Selat is a lot more muscular and weighs about 20 lbs heavier. According to Woodland Park Zoo staff the dragon Loki has osteoarthritis in all of his joints and this could be something that was slowing him down when compared to the behavior of Selat. Selat displayed some activity that was not possible in Loki's condition; climbing. Selat would climb on an almost daily basis during his normal activity peak hours occurring both pre- and post-enrichment. Throughout the sessions, visitors were present and seemed to swarm when they saw that the dragons were active and interacting with the enrichments. Though there was an increase in crowd size, we believe that the dragons behavior was unaffected by their presence because of the animal's history living in close proximity to their human zookeepers. The dragons were born and raised in captivity all their lives.

It turned out that all three enrichments showed a positive effect on the dragon's activity and on the expression of their behavior. From there only being about 6 observed behaviors in the baseline study, there were now 17 different behaviors being displayed. Out of these behaviors, at least 5 of them can be directly linked to predatory behaviors (Auffenberg, 1981). It turned out that the digging and scent trails were the enrichments that seemed to stimulate the greatest variety of behaviors. During the digging trial, we made note that given his second trial, Loki didn't even attempt to dig out the ball from the ground. In the first digging trial he seemed to paw and scrape at the dirt around the ball a little, but failed to get the ball out of the ground. We believe there are many possibilities and reasons why he did not dig up the ball each time. It is possible that he never learned the digging trick because he is a captive bred animal. That may be something that is learned in the wild, or it is possible that his joints were hurting because of his osteoarthritis. Lastly, it could be that he did not try to dig the ball up the second time because he remembered that there was no reward for digging it up the first time.

The scent trail was the trial that seemed to give the highest activity level for each dragon. At first, each trial was carried without any food award at the end. We believe if this enrichment were to be carried out for many days in a row, we thought an addition of a food award at the end of the trial occasionally could be good for the animals as well as help keep up interest for the trial. In the remaining two scent trail trials, we presented a prey item at the end of the trail to see if that would change how long the dragons continued to follow the trail after it had already consumed the food. We noticed that the dragons stayed following the path without food for a very long time. They also followed the paths with treat trials for approximately the same length of time. Also, a variety of types of scents in the trial could have a positive effect and be interesting for further investigations. When running these tests in the zoo atmosphere, we must think about how active we want these dragons to be, and for how long do we want the dragons to stay active. We ask the question, is there a risk in having the dragon active for too long and why or why not? We did not want the dragons in a caloric deficit after being active, so it was necessary to perform these trials around the same time that they would be busy in peak activity hours in the wild.

The trial with the boomer ball seemed to also be successful with activity level and interest. The dragons seemed very intent on biting the ball, however we were unsure if the dragons knew there was a food reward inside. It is possible that since there was meat juice poured on the ball, they might have thought the ball can be bitten and ripped open exposing the food inside. The combination of all of these enrichment activities seemed to have a great effect with the visitors to the zoo. There was a definite rise of excitement and joy in the atmosphere surrounding the Komodo dragon Exhibit at Woodland Park Zoo. The crowds of people would see us alongside the exhibit and asked us more questions of what the dragons were doing and how we were a part of it. We would get many questions asking how we got the dragons to move, or why are they moving so much, along with many more intriguing questions about the dragons. We believe that this process led to many more happy visitors. With some psychological surveys of the visitors and some further enrichment studies, we could begin to see if what we did here could be passed along to other zoos. It is also possible that these enrichment trials could help hone the skills of many of the endangered animals in the zoos worldwide, which could lead to the release of many species and help repopulate wild populations.



Fig. 5. Loki resting in a 40°C (104°F) heated spot in the exhibit.

Dragons in Action



Fig. 6. Loki seen tongue flicking rapidly near a large splash of meat juice during the 'scent trail' enrichment activity.



Fig. 7. Selat swiftly digging up the boomer ball during the 'digging' enrichment activity.



Fig. 8. Loki trying to bite the boomer ball ferociously during the 'play' enrichment. There is also a lot of salivation accompanied with the biting.

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References

Auffenberg, W. 1981. The Behavioral Ecology of the Komodo Monitor. University Press of Florida, Gainesville, FL.

Bacon, J.P. 1975-76. Thermoregulation in Varanus komodoensis in captivity—a preliminary report. American Association of Zoological Parks and Aquariums Regional Conference Proceedings, pp. 211-214.

Behler, J.L. 1986. The Komodo monitor consortium - 1986. American Association of Zoological Parks and Aquariums Annual Conference Proceedings, pp. 159-161.

Benirschke, K. 1986. Vanishing Animals. New York: Springer-Verlag.

Ciof, C., de La Panouse, C., Murphy, J.B., Walsh, Trooper. 2002. Komodo Dragons: Biology and Conservation. Smithsonian Institution Press, Washington and London.

Farlow, J.O. 1983. Dragons and dinosaurs. Paleobiology, 9(3):207-210.

Horn, H.G. 1985. Contributions to the behavior of monitor lizards the ritual fights of Varanus komodoensis and Varanus semiremex as well as the display phases of the ritual fights of Varanus timorensis timorensis and Varanus timorensis similis. Salamandra, 21(2-3):169-179.

Judd, H.L., J.P. Bacon, D. Rasedi, J. Girard, K. Benirschke, and P.J.S. Olney (Ed.). 1977. Determination of sex in the Komodo dragon Varanus komodoensis. International Zoo Yearbook, 17:208-209.

Lange, J. 1989. Observations on the Komodo monitors Varanus komodoensis in the zoo aquarium Berlin West Germany. International Zoo Yearbook, 28:151-153.

Lutz, A. & J.M. Lutz. 1997. Komodo, The Living Dragon. Dimal Press, Salem OR.

McNabb, B.K. and W. Auffenberg. 1976. The effect of large body size on the temperature regulation of the Komodo dragon Varanus komodoensis. Comparative Biochemistry and Physiology A. Comparative Physiology, 55(4):345-350.

Peccenko, N. 1989. Dragons from the island of Komodo. Protus, 52(7):243-250.

Prigato, C. 1995. Komodo: A modern dragon. Zootails (Fort Wayne Zoo), May/June:1-3. (Also found as an supplement in Wildlife Conservation, 98(3):F1-F3.

Preston, D.J. 1982. Komodo dragon. Natural History, 91(3):72.

Walsh, T., R. Rossico, and G.F. Richard. 1993. Dragon tales. The history, husbandry, and breeding of Komodo monitors at the National Zoological Park. Vivarium (Lakeside), 46(2):23-26.