



Development and evaluation of environmental enrichment for captive Humboldt penguins

Utveckling och utvärdering av miljöberikning till humboldtpingviner som hålls i djurpark

Anna Larsson

Etologi och djurskyddsprogrammet

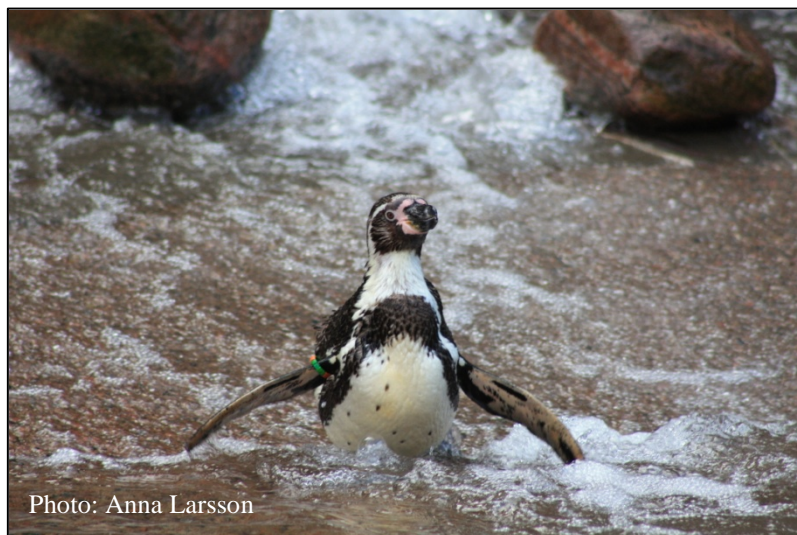


Photo: Anna Larsson

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1. Abstract

Environmental enrichment is of high importance for zoos. Borås zoo asked SLU (Swedish University of Agricultural Sciences) for a student to perform a bachelor thesis for them. The task was to develop and evaluate environmental enrichment for their Humboldt penguins. A structure was made, consisting of a sinking skeleton with a floating bridge attached to it. It was presented in an area of the pool that the keepers had experienced that the penguins did not use to any extent. The structure was then evaluated using instantaneous scan sampling looking at the penguins' use of their enclosure. Observations were made for seven days during a period of two weeks after the introduction of the enrichment. During the two weeks, the results show an increased percentage of usage of the pool area with time and also of the zone where the structure was placed. It is however difficult to conclude that the results are due to exclusively the structure, although fewer observations were made in the outside enclosure with time, indicating that the enrichment could be a contributing factor.

2. Introduction

Optimizing welfare for animals kept in captivity is an important task for zoos. Borås zoo, a Swedish zoo located in Borås, asked SLU (Swedish University of Agricultural Sciences) for a student to perform a bachelor thesis for them. The task was to develop and evaluate environmental enrichments for the Humboldt penguins (*Spheniscus humboldti*), which is the topic of this study.

The zoo had not been experiencing stereotypic behaviour among their penguins which often is a cause of enriching animals (Mason *et al.*, 2007). Instead, the striving to increase the penguins' welfare was the reason for Borås zoo to engage in enriching their penguins.

Since the penguin is a highly pelagic bird, adapted to an aquatic lifestyle (Martin & Young, 1984), it is most natural for them to spend a lot of time in water. As they feed on aquatic prey, they spend a lot of time foraging (Hennicke & Culik, 2005). In this study, it was desired to increase the time that the penguins spent in the water. Spending time in water was considered a species-specific behaviour important to increase.

Animal welfare is a recurrent topic of discussion (Tarou & Bashaw, 2007). It is of high importance to allow animals to behave in a species-specific way (Mellen & MacPhee, 2001). Because of that, it is important to provide and evaluate species-specific enrichments (Mellen & MacPhee, 2001).

The definition of environmental enrichment used in this thesis was “*a change in the animals' environment which serves to increase their species-specific behaviour repertoire*”. This definition is a combination of other definitions.

2.1. Environmental enrichment

Deciding which definition of **environmental enrichment** to use was a difficult task. Newberry (1995) pointed out the difficulty in defining environmental enrichment which “...*promotes natural behaviour*”, since natural behaviour is such a fuzzy expression. She proposes a different definition, namely “...*an improvement in the biological functioning of captive animals resulting from modifications to their environment.*” If using an environmental enrichment with the definition that it is to promote natural behaviour, Newberry (1995) emphasizes the importance of pinpointing out the behaviour that is desired and understand how the animal benefits from conducting the behaviour.

Swaigood & Sheperdson (2005) defines enrichment as “...*an animal husbandry principle that seeks to enhance the quality of captive care by identifying and providing environmental*”

stimuli necessary for optimal psychological and physiological wellbeing.” Several authors have emphasized the importance for animals to have the opportunity to perform species-specific behaviour (Moran & Sorensen, 1984; Mellen & MacPhee, 2001; Swaisgood, 2007).

The definition used in this thesis was **“A change in the animals’ environment which serves to increase their species-specific behaviour repertoire”**. This is a definition which combines previously mentioned definitions. The term “natural behaviour” is avoided, it is clear that there has to be an environmental change, and the goal is to increase the wellbeing among animals by increasing their species-specific behaviour. In this study, the species-specific behaviour of highest interest was behaviours conducted in water.

As mentioned earlier, it is important to create species-specific enrichments (Mellen & MacPhee, 2001), why it is of great value to evaluate the enrichments effect after it has been presented. A structure that enriches one species is not deemed to work for all species.

2.2. The Humboldt penguin

Humboldt is the species of penguins kept in Swedish zoos (personal communication, Daniel Roth, 2012-05-18). They are kept at Borås zoo and two other institutions in Sweden.

All penguins are predatory seabirds (Martin & Young, 1984; Culik *et al.*, 2000). The Humboldt penguin feed on fish, cephalopods and crustaceans (Martin & Young, 1984). They are a small species of penguin, endemic to the coast of Chile and Peru in South America (Culik, 2001).

Wild Humboldt penguins breed almost all year round, through mid March to beginning of December, according to Paredes *et al.* (2002). The adult penguins molt between January and March and they stay on land for a three week period when molting (Paredes *et al.*, 2003). On the coast of Chile and Peru, the penguins’ natural habitat is affected by the Peruvian Current (Hays, 1986), also called the Humboldt Current. This current is characterized by highly productive, nutrient, cold water (Hays, 1986; Echevin *et al.*, 2012).

The Humboldt penguins live in colonies and form pairs in the beginning of the breeding season (Schwartz *et al.*, 1998). These pair-bonds have long been thought to be monogamous; however this might not be completely true. A study of Schwartz *et al.* (1998) found that extrapair copulations did occur. However, none of the extrapair copulations resulted in offspring.

The Humboldt penguin is classified as “Vulnerable” at the Red List of International Union for Conservation of Nature (IUCN red list, 2012-04-15). Ellis reported in 1999 that the entire world’s population of Humboldt penguins consists of 15,000 individuals (7,500 breeding pairs), and that the number is declining. According to Paredes *et al.* (2003), there are less than 5,000 wild individuals left in Peru after the 1997-98 El Niño event. The El Niño Southern Oscillation event (ENSO) is one of the factors affecting the population of the Humboldt penguin (Culik *et al.*, 2000). ENSO depresses the cold nutrient-rich water to well up, making the Humboldt penguins feed to change their range of residence (Culik *et al.*, 2000), forcing the penguins to change area of feeding.

Besides the effect of the ENSO events, there are several other causes for the decline of the Humboldt penguins. Hays (1984; 1986) writes that the penguins are threatened due to humans extracting the guano (consequently damaging their breeding sites), humans capturing penguins for zoos and for keeping as pets, overfishing of their prey and that the penguins get caught in fishing nets.

2.3. The Humboldt penguins at Borås zoo

Borås zoo keeps their penguins in two enclosures, which consist of an indoor- and an outdoor enclosure with a door in between, making the enclosures easy to connect. The penguins' nests are in the inside enclosure. Both enclosures each contain a pool- and a land area. During summer time, the penguins are kept outdoors during daytime, and the staff considered the penguins to be inactive. The keepers had observed that the penguins mostly resided on one specific area on land instead of using the entire enclosure. They had also noticed that the birds only preferred one part of the pool area, when in water.

For a predator like the Humboldt penguin, giving them live prey in their pool would be natural for them and serve as a good enrichment. However, this raises an ethical dilemma (Mason *et al.*, 2007), considering the welfare of the live prey. Providing live prey that is kept by humans is also forbidden in Sweden according to the 2, 13 and 14 §§ in the Swedish Animal Welfare Law (Djurskyddslagen 1988:534) and the 16 Ch. 13 § in the Swedish criminal code (Brottsbalken 1962:700).

3. Aim

The aim of this thesis was to develop and evaluate environmental enrichment for the Humboldt penguins at Borås zoo. The study conducted evaluated the following questions;

Do the penguins change or increase their use of the enclosure during the two weeks the enrichment is present?

Is there a habituation effect after this short period of time, indicating that the enrichments value is only the novelty effect (if any novelty effect exists)?

The predictions were that the penguins would increase their use of their enclosure, especially the pool area, and also that they would interact with and take interest in the enrichment.

The goal of the enrichment should be a permanent structure in the penguins' enclosure and demand little effort from the keepers.

4. Material & Method

4.1. Individuals

There were 24 penguins at Borås zoo at the time of observations, 18 adults and six chicks. The chicks were not involved in the study.

The adult penguins were from 1-24 years old. Most of the older adults had formed pairs, while the young adults born in 2011 had not. There were three adults born in 2011.

Penguin chicks have, for a period of time, a different plumage than the adults. Due to this, it was easy to tell them apart and excluding them from the study (Figure 1).



Figure 1. The differences in plumages of the adult Humboldts (to the left) and the chicks (to the right).

4.2. Routines

During the study period, the penguins were handled according to their ordinary routines for April month. A day without unforeseen events proceeded as follows;

10.00 – the door between the penguins' inside enclosure and outside enclosure were opened, so the animals could choose to go outside.

11.00 – morning feeding. The penguins were given fish, presented either on the land area or in the pool, in both the inside and outside enclosure. They were given food on the location they resided at the time of feeding. The keepers also handled their penguins, if the penguin was close enough and wanted to take the fish that the keeper was holding.

15.45 – 16.30 – if the penguins still were outside at this time, they were driven in to the inside enclosure. The door between the inside enclosure and the outside enclosure was then shut for the day. The penguins resided indoors until the upcoming day.

16.20 – afternoon feeding in the inside enclosure, presenting the penguins with fish.

The zoo was closed to the public during the weekdays in the two weeks the study was conducted. No observations were made when the zoo was open to the public.

4.3. Methods

The study was conducted at Borås zoo during the period from 2012-04-16 until 2012-04-27 (week 16 & 17). Observations were made only in the outside enclosure since it was here the enrichment was placed and to limit the scope of the study (Figure 1). Temperature data were collected by the observer approximately ten minutes before the observation periods (both noon and afternoon) started by looking at a weather program on a cell phone. Precipitation and wind was recorded if it occurred, as it occurred. Hence, it could be recorded anytime during the observation period. The definitions used were the following;

Rain – Any water precipitation

Snow – Any snow precipitation

Wind – Strong winds making swirls on the water surface of the pool

4.4. Observations of enclosure use

Observations were made during seven days in a period of two weeks. On each observation day, observations were made two times, at noon and in the afternoon. The first week there were three observation days and during week two, there were four observation days. Every observation period lasted for one hour and was conducted between 12.00-13.00 and 14.30-15.30. Observation periods were scheduled outside fixed routines, so that the penguins would not be affected by any occurring event during these periods (elaboration of routines; Routines).

On Monday the 16th of April during week 16, the enrichment was placed in the enclosure. No observations were made on this first day, due to the plausible change in the penguins' behaviour. The observer was present when the penguins were let out in the outside enclosure after the enrichment was placed and made personal observations of how they reacted. Enclosure observations started on

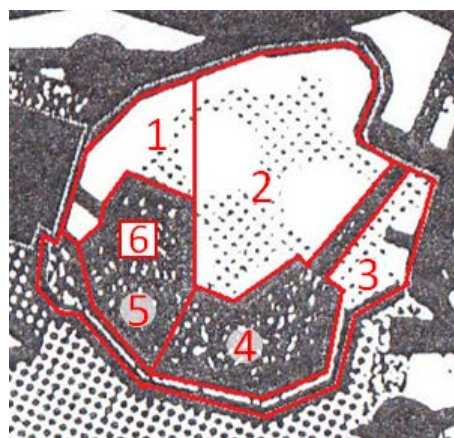


Figure 2. The outside enclosure, divided in to the six different zones used for observations at Borås zoo. The inside enclosure is located to the left of zone 1. Each number represented a zone, marked with a red number. Zone 6 was the floating bridge of the enrichment. Zone 1, 2 and 3 are shore areas and zone 4, 5 and 6 are pool areas. Picture: Borås zoo.

Wednesday, April 18th.

Data on the penguins' use of their enclosure was collected using instantaneous scan sampling. Every two minutes the location of all penguins residing outdoors was recorded. If no recordings were made, the penguins resided indoors.

The location was decided by using zones (Figure 2). The protocol used is found in Appendix 1.

The outside enclosure was divided in-to six zones (Figure 2). There are more detailed photos of the outside enclosure with zone division in Appendix 2.

4.5. Developing the enrichment

In the effort of developing new environmental enrichments for the Humboldt penguins, the literature was searched to discover what had already been tested. This was done with little success. Either there has been plenty of environmental enrichment trials made on penguins, although this has not been published, or there has been very little research made on the topic. Swaisgood & Sheperdson (2005) acknowledges the fact that little research on enrichment is published for most zoo species.

To create something that might enrich the penguins, the aim of the study was considered; to increase the penguins' use of their enclosure, preferably in the pool areas. So, the conclusion was to develop enrichment with the aim to attract the penguins to the pool. In lack of literature about enrichment of penguins, the search was broadened to other animals that live in water and also enrichment in general.

The one experimental study that was found on the pool use of Humboldt penguins, had tried to increase the penguins' use of the pool by filling plastic bottles with tin foil and water, so it would resemble fish scales on the bottom of the pool (Clark, 2003). These had little effect, so there was no use in testing this enrichment again.

It took some time to develop ideas for environmental enrichment for the penguins. By combining own knowledge and literature, the author came up with an idea of a structure to be made that should be a permanent element in the penguins' pool. In consultation with Borås zoo, this enrichment was chosen for construction and evaluation. A similar structure has earlier been made for sea lions at Toronto Zoo (Hosey *et al.*, 2009).

The chosen structure, called a "whale skeleton", consists of a sinking ground structure with a floating bridge attached to it (Figure 3 and Appendix 3). The author had some ideas of how the penguins could use the skeleton. One was that they would learn to jump up on the floating bridge and reside there, so that they had to get in the pool and swim to their "island". Another was that they would use the sinking ground structure as a form of "tunnel".

It was built by Borås zoo, so exact measurements were decided by them. The sinking skeleton part has a measurement of; 145 cm long with the ten bars at 55 cm each (five on each side), leaving cavities with a



Figure 3. The enrichment tested in this thesis; called the whale skeleton.

size of 31 cm. The floating bridge was 110x110 cm with a height of approximately 13 cm. The structure was built mainly by wood and Styrofoam.

4.6. Evaluation

The evaluation of the enrichments impact on penguin behaviour was to be made by observing changes in the penguins' use of their enclosure. The structure was thought to be successful if the penguins' use of their enclosure increased or changed (with emphasis on an increased use of the entire pool area) during the period of time the study was conducted. Hopefully, the enrichment would have a long lasting effect and the desired increased use of the enclosure was consistent.

4.7. Data analysis

The observation data was analyzed using Microsoft Excel 2007. The calculation functions were used to transform the data in to percentages. All diagrams not showing difference between noon and afternoon has got values of both noon and afternoon observations pooled together. For the weather data, a mean value was calculated and presented.

4.8. Changes in method

Due to several unforeseen events (weather conditions, building of a hyena enclosure), the method had to be changed when the study already had started. The original plan was to conduct two experiments during a three week period (week 15-17).

Base-line data, without any new enrichment present, was to be gathered during the first week of observations (week 15). The plan was to place the enrichment in the pool at the end of the first week (Sunday the 15th of April). Observations with enrichment was planned to be conducted for a two week period (week 16-17), starting on the 16th of April.

The experiments planned to be conducted were the following;

Experiment 1. Use of the enclosure was to be examined by using instantaneous scan sampling with an interval of two minutes. All eighteen adult penguins were participating in the experiment.

Experiment 2. Behaviour was to be recorded using continuous recording with focal animal sampling. Every focal animal was to be observed continuously for a five minute period during each observation period using experiment 2. A group of six penguins were randomized to participate in experiment 2, to be a representation for the entire group of eighteen penguins. For the study to be as representative as possible, the two adults whose chicks had hatched late were removed when randomizing the individuals to participate in experiment 2. They were removed because their chicks were still very dependent on their parents, and their behaviour was thought to be non-representative for the group.

The randomization were conducted using www.slump.nu by giving the adults a number from 1-16 through their taxon-report, in order of appearance. The generator was then asked to pick out six numbers in the interval of 1-16, which resulted in the individuals participating.

The weather conditions combined with constructions in a nearby enclosure during the first week of observations, week 15, made it impossible to collect any data in the outside enclosure. This resulted in excluding experiment 2 since this method was assessed to give little results.

Besides from changes in experiments, which enrichment to use also had to be modified. Due to lack of time, only one of the planned two enrichments was tested in this thesis.

The structure excluded from the study was a food box, also built by Borås zoo from the author's original idea. The food box was supposed to be placed in the pool area of the outside enclosure to increase the penguins' foraging behaviour. It was desired to make them eat in the water with a bit more effort than they were using originally. The food box contains of a metal container with a "net" on the top, from which the penguins can manipulate out the fish that the keepers put in the box before lowering it down in the water (Figure 4).



Figure 4. The enrichment that was not tested in this thesis; the food box.

Borås zoo could hopefully use the box as an alternative way of feeding in the future. It would be interesting to see a study made on the effects of the food box. If the effects of the food box are successful, it would be interesting to test the penguins for contra-free loading.

5. Results

The total number of penguin observations with scan sampling was 1149. 23 % of the total number of observations was made in water (263/1149). If no observations were made, the penguins resided indoors. The differences in observations per day, noon and afternoon, shore and water and weeks are found in table 1. There were more observations made during week one (56 %) than week two (44 %) (Table 1).

Table 1. Compiled data in numbers from the observations made in the period of 2012-04-18 – 2012-04-27.

Day	Obs. Shore	Obs. Water	Obs. Noon	Obs. Afternoon	Tot. nr of obs.	Tot. nr of obs./week
1	499	51	526	24	550	639
2	53	9	6	56	62	
3	21	6	14	13	27	
4	251	77	308	20	328	510
5	3	0	0	3	3	
6	21	34	26	29	55	
7	38	86	122	2	124	

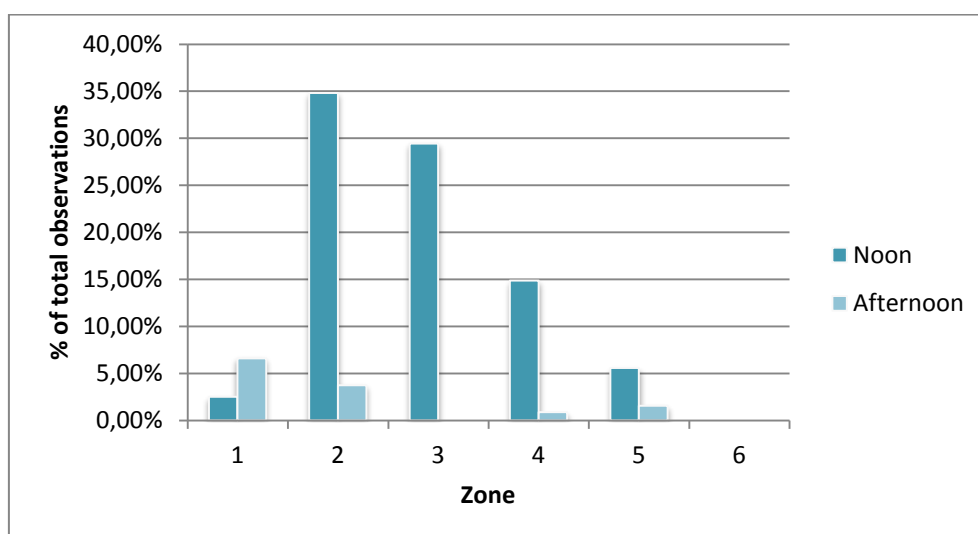


Figure 5. Percentages of total observations that were made in each zone depending on time of day. Total number of observations was 1149. Observations were made two times a day in the period 2012-04-18 – 2012-04-27.

Differences in use of the enclosure are quite large depending on time of day (Figure 5). The results shows that they reside outdoors mostly during noon (Figure 5 & 6). 87 % of the total number of observations was made in the observation period starting at 12.00. The zones the penguins' reside in during the afternoon are predominantly 1 and 2 ($\approx 10\%$) (Figure 5). More than half ($\approx 65\%$) of the total registrations were made in zone 2 and 3 during noon observations (Figure 5).

During most of the observation days, the observer noticed that the penguins went inside before the keepers came and closed the door between the inside and outside area at 15.45 – 16.30. Before the afternoon observation started (14.30), the penguins often were outside, swimming. If several penguins were out together, they used to go in together as well. A few of the younger adults could stay outside for themselves, but not for a very long time.

The observer noticed that during the afternoons, the penguins mostly resided indoors, however they went outside to zone 1 seemingly to investigate something in order to decide if to go outside for a longer period of time. When residing outdoors during the afternoon, they mostly stood still, looking around for a while, perhaps swimming a few “laps” in the pool before heading inside again (personal observations).

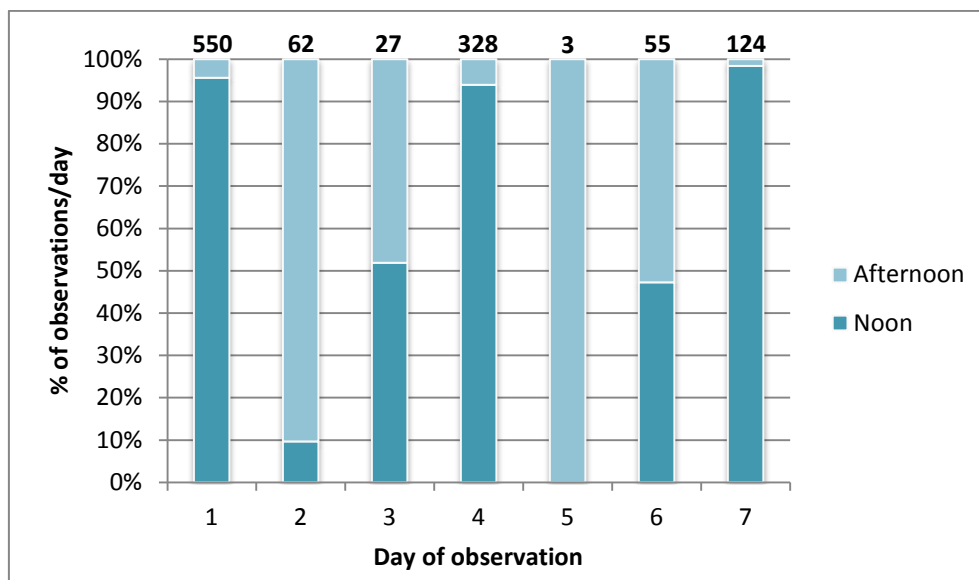


Figure 6. During which time period most observations were made on each day. A total of 1149 observations were made. The numbers above the bars shows the precise number of observations per day.

The fact that the penguins predominantly reside outdoors during noon (Figure 5 & 6) does not seem to change with time (Figure 6).

An interesting observation was that it was mostly the younger adults, born in 2011, which resided outside during the afternoon which means that the observations made on the afternoon were almost exclusively on these younger adults.

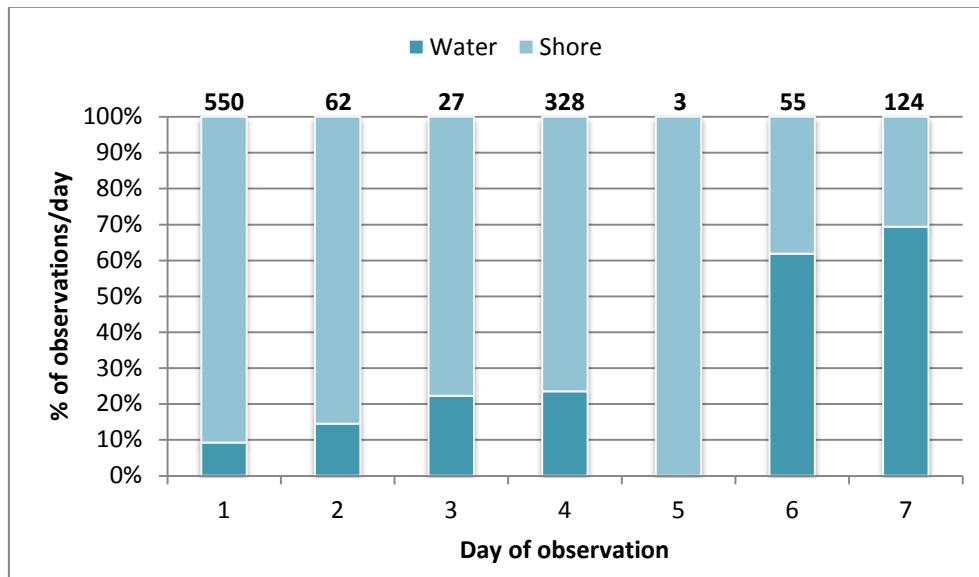


Figure 7. Percentage of observations on land (zone 1, 2 and 3) and in water (zone 4, 5 and 6) per day, for each day of observation. The numbers above the bars shows the number of observations each day.

The results show that there are fewer observations made with time (Figure 6, Table 1), however the percentage of observations made in water increases (Figure 7).

The younger adults and the older adults resided in different zones in the water and they seemed to affect each other. When only the young adults were outside in the pool area, they spent a lot more time in zone 5 and around the enrichment, than when the adults were in the pool. The older adults seemed to spend more time in zone 4, grooming themselves, than the young adults did.

It was found that the penguins had specific groups that they resided in, so it was possible to tell which penguins were outside by identifying a few individuals.

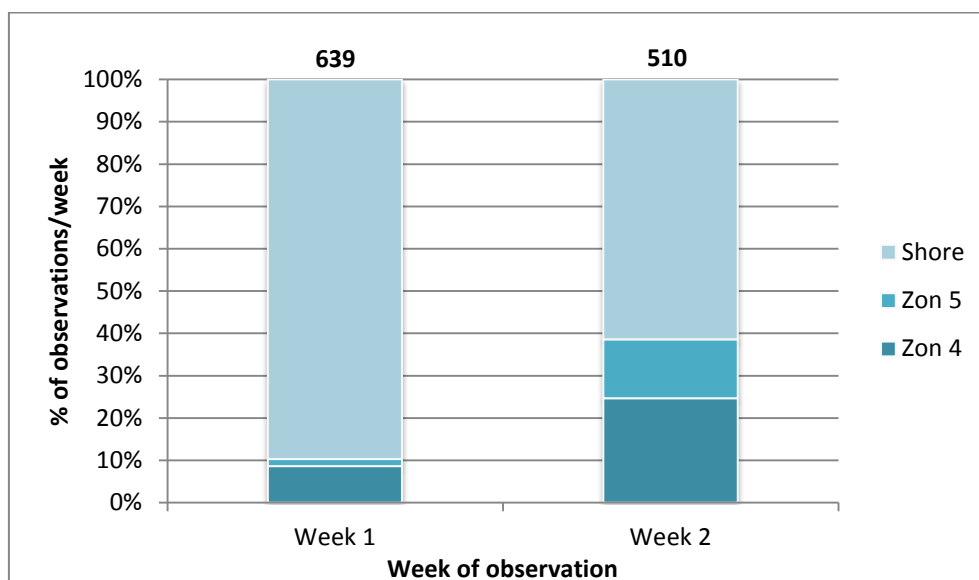


Figure 8. The division of the 23 % of observations that were made in the pool area, during the seven days of observations conducted between 2012-04-18 – 2012-04-27. Both noon and afternoon observations are pooled in this diagram. The numbers above the bars shows the number of observations made each week.

No observations were made on the structure itself (zone 6) during the two week period. There was an increase in percentage of observations made in zone 4 and 5 (Figure 8). During week one the percentage of observations made in water was 10 % (1,72+8,61 %) (Figure 8). During week two, 39 % (13,92+24,71 %) of the observations was made in water (Figure 8).

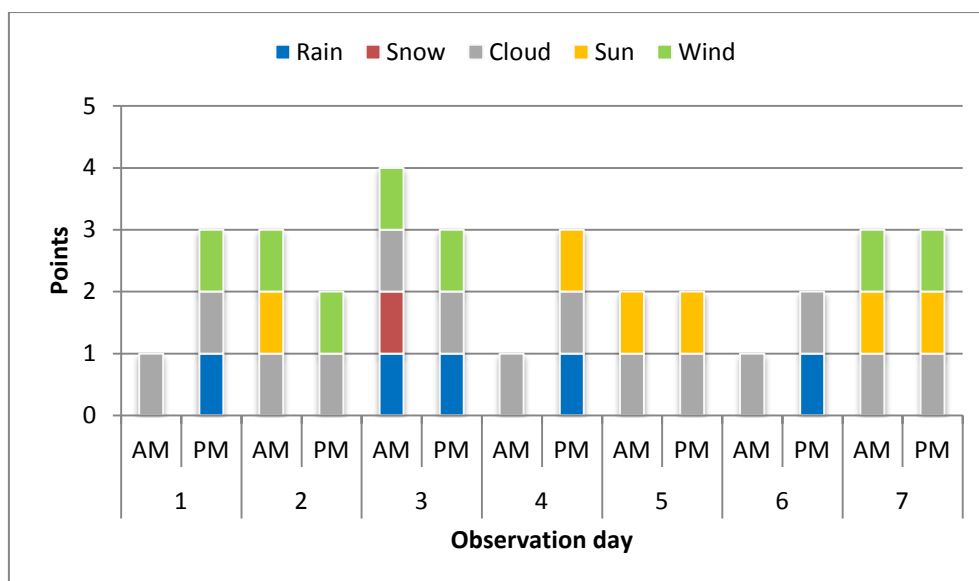


Figure 9. The weather conditions recorded during each observation period during the seven days of observations between 2012-04-18 – 2012-04-17. N: Noon, A: Afternoon. Each weather condition that occurred during the observation period has been given one point.

The weather condition varied a lot during the study (Figure 9). Raining occurred in 5 out of 14 observations. Wind occurred during 7 out of 14 observations and it was cloudy on every occasion.

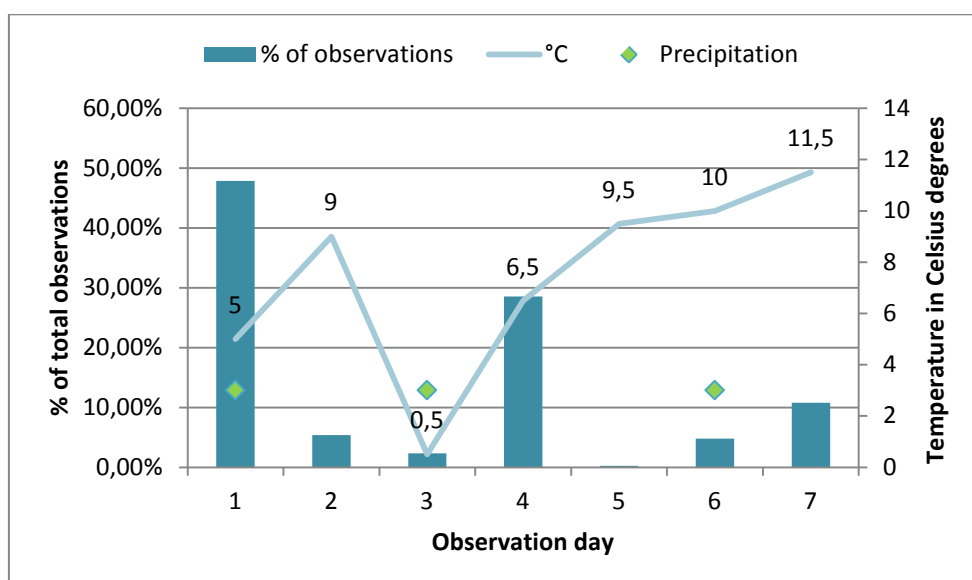


Figure 10. The connection between total percentages of observations made and the temperature of the day. Also shows what day it was precipitating. Days with precipitation is marked with a rhomb. Total number of observations was 1149.

As shown (Figure 10), there is no clear connection between precipitation, temperature and the percentage of observations made. There were not more observations when the temperature increased. The mean temperature for the entire seven days of observation was 7,4°C +/- 3,7°C.

Occasionally, it was noticed that some penguins (especially males from a pair) went outside to fetch nesting material to their inside enclosure. They collected sticks, spruce-needle and other organic materials and brought them in to the inside enclosure. This was repeated a few times in a row and took approximately two-three minutes each time.

Besides bringing nesting materials in to the inside enclosure, all penguins were interested in picking up and investigating tiny objects, e.g. pebbles and leaves, especially from the bottom of the pool.

The observer noticed that the adults seemed to “play” more during the last days of observations. They were swimming fast, doing quick turns and making flying jumps over the water surface. A majority of the “playing” penguins were young adults.

During the study period, the penguins seemed to be spending a large amount of time grooming.

The enrichment was placed on Monday the 16th of April. As previously mentioned (Observations of enclosure use), no records were made on the day the skeleton was placed. The observer was there, helping with placing the enrichment when the penguins still were residing indoors and the doors were shut. The penguins did not see the observer installing the enrichment, so that the observer would not be connected to the enrichment. When the skeleton was in place, the keeper opened the door between the inside and outside enclosure and the observer observed the penguins’ reactions to the structure. They first seemed a bit skeptical against it, and hesitated in the doorway. Then they resided as far away from it as possible (zone 3), for a short period of time, before they started to ignore it. It took some time though, until they started exploring it, but then they kept exploring the skeleton and the floating bridge for the entire two weeks that it was present. The part of zone 3 where the penguins mostly resided when being in that zone was the paved edge towards the pool (Figure 11).



Figure 11. Half of zone 3 in the penguins outside enclosure. Photo: Anna Larsson.

To the observer, it seemed like the penguins resided in zone 3 when something happened in the inside enclosure or in the opposite end of the outside enclosure. The penguins were never alone in zone 3; they were always there as a group (Figure 12).



Figure 12. How the penguins usually used zone 3 in their outside enclosure. Photo: Anna Larsson

In zone 4 there was a waterfall that seemed to attract the penguins there. In zone 5 the keepers kept a water hose which function was to fill up the pool with water. This water hose was also of interest to the penguins, they swam through the beam and in the swirls that it conducted.

5.1. Sources of error

During the observation period the zoo was constructing a hyena enclosure straight across from the penguin enclosure. There were high noises from the construction consisting of construction sounds, trucks unloading earth and gravel etc.

A few school classes had field trips to the zoo.

The zoologist at Borås zoo, Daniel Roth, explained that they had experienced that the penguins' use of their outside enclosure was depending on weather conditions. The penguins did not reside outside to any extent during bad weather conditions.

Two penguins had late hatched chicks and they were participating in the study since they were still in the same enclosure as the rest of the group, and telling them apart from the other penguins during the experiment was estimated to be a difficult task. If possible, these would have been excluded from the study, since one of the parents always stayed in the nest, providing a source of error.

The loose end of the string keeping the floating bridge and the skeleton together got untwined and interested the penguins. The structure made and tested was a prototype. If the structure is deemed successful, and Borås zoo decides that they want to continue presenting it to the penguins, they have explained that they will build a more proper, sustainable structure.

During the last week of observations (on Wednesday 25th, week 17), one of the adults got injured. He was removed from the group for the night until the following day, and was then reintroduced to the group. There were no observations made with him missing, so the number of adults never changed during observation days.

On the 12th of April, one of the penguin chicks were caught in the extraction system which pumps the water up to the waterfall, and the chick drowned. This decreased the number of chicks from seven to six. This could have affected the parents' behaviour during the study, which lost their only chick.

6. Discussion

The results do not indicate an increased use of the penguins' enclosure, since fewer observations were made during week two. However, it does show a change in where the penguins choose to reside. The data indicate that the use of the enclosure has changed, but not increased during this two week period. This shows that the aim of changing the penguins' use of their enclosure is fulfilled, but is this sufficient to call the enrichment successful? No novelty effect or habituation was found, since the use of zone 5 where the structure was placed only increased with time.

All results indicate that the penguins prefer their inside enclosure over their outside enclosure at this time of year with the circumstances that were. During the study period, they resided outdoors less, even if the temperature increased. They resided more in the pool with time.

Looking at the results they show that there are a higher percentage of observations in the pool during the second week than the first week. This could be because the first week functioned as a period of accepting the structure and the second week as a learning period. It could also have been affected by the increase in temperature that occurred during the weeks of observation. In future studies, it would be interesting to see the effect of the skeleton over several weeks. To conduct a study over a longer period of time would answer the question if they learn to use it more or differently, or if they do not take interest in using it to any extent.

The results in this thesis show that there are ways to make the penguins' use their enclosure to a greater extent and that it is possible to increase their time in water. However, a larger study would be of great value, to conclude if the effects of the structure are consistent or if it only gives a small, short term effect. The consequence of this could be that zoos feels compelled to put more resources into environmental enrichment for penguins.

The observer experienced that the penguins used zone 3 when there was an event happening in the inside enclosure. If this is true, it could explain why they didn't reside there during the second week of observation (Figure 5); perhaps no events occurred that made them feel the need of residing in zone 3.

The results also provides insight on what areas of the enclosure the penguins prefer and gives ideas on how to increase their use of their enclosure, by altering the enclosure.

In this study, 77 % of the observations were made on land. That leaves 23 % of observations in water. Compared to how much time their wild conspecifics spend in water, this is very little. Hennicke & Culik (2005) found that Humboldt penguins on foraging trips could spend both day and night at sea, with a difference from colonies and prey availability (approximately 13-27 hours).

Five of the chicks were hatched in the period during 2011-12-27 until 2012-01-06. Two of the chicks were hatched late (2012-03-20 – 2012-03-21). The parents of the youngest chicks were more bound to their chicks than the other parents. Culik *et al.* (2000) writes that penguin chicks are supervised by a parent at all time in the beginning. When the chicks reach a certain age (age depending on habitat) they can be left alone in the nest so that both parents can forage simultaneously (Culik *et al.*, 2000). This could have affected the parents' behaviour.

The older chicks were independent enough for the parents and chicks to reside in different places. According to Paredes *et al.* (2002), the time from egg hatching to fledgling is approximately four months. The oldest chicks reached this age in beginning of May, shortly after the study period was over.

The results show a slight increase in residing in the zone of the structure; this could have been due to the structure. The observer noticed that the enrichment did appeal to at least some of the penguins. They used it differently than expected; they were diving close under the floating bridge instead of residing on top of it. They were also very interested in investigating the structure with their beaks. Perhaps it takes some learning for the penguins to understand how they can use the structure.

Placement of the skeleton could also be a factor affecting the penguins' use of it. It was deliberately placed in an area of the enclosure where the keepers experienced that the penguins didn't reside much (zone 5, Figure 13). If it was to be relocated, perhaps different results would have been found.



Figure 13. Zone 5 in the penguins' outside enclosure.
Photo: Anna Larsson.

For future studies it could be interesting to see if the penguins use the structure more if it gets placed in a different location and if they get a longer period of time learning how to use the structure. The results found in this study could be used in future studies aiming to increase penguins' use of their enclosure, since it indicates that placing a structure in the pool increases

the penguins' use of the pool area. The author's personal observations indicate that the penguins are mostly interested in the floating bridge and not the sinking skeleton.

It was also questioned if the skeleton was too small. The penguins seemed interested in swimming between the spleens (personal observations), but hesitated. It could also be that the structure was too close to the bottom for them to feel secure enough to reside under it. However, this could also be a result from the penguins having too little time to learn the structure. It would be interesting to see how they use a slightly modified structure, with the skeleton semi-floating so it would not be as close to the bottom as when in the original design.

During the last week, the observer noticed that the penguins tried to get up on the floating bridge more often. They were trying to jump up, but they pushed it away with their chest. To jump up on a bridge that was floating away was something they were not used to, so maybe it takes some practice. The colour of the floating bridge should also be considered. It might have had some effect on the penguins' use of it.

The whale skeleton is designed to have several usages. One thought is that the animal keepers could attach food to the bars of the enrichment when washing the pool bottom, when they never the less have to bring the skeleton out of the pool.

The results published in this thesis have intrinsic value in that they provide knowledge on when not to perform a study on captive Humboldt penguins in their outside enclosure. The difficulty in placing enrichment in the outdoor enclosure and trying to evaluate it during bad weather conditions is obvious. The weather conditions seemed to affect the penguins' willingness to reside outdoors, making it hard to evaluate enrichment placed in the outside enclosure. The results show that the most number of recordings were made on days with temperatures at 5-6,5°C. The temperature increased during the observation period, however the penguins resided outdoors less. This could depend on the remaining clouds. Clark (2003) found that the frequency of pool use decreases during cloudy weather.

The field trips of school classes previously mentioned was considered to have little effect on the penguins. Clark (2003) found no significant evidence of that the number of visitors would affect the penguins' use of the pool.

It was noted that grooming seemed to be one of the major occupations for the penguins, either they were in the water or on land. It would have been interesting to see if the penguins' behaviour changed after the skeleton was placed in the pool. This is a topic for future studies; how do the Humboldt penguins behaviour changes after the enrichment is placed?

The observer noticed a preference for all the paved and rocky areas. Blay & Côte (2001) conducted a survey in British zoos and found that hatching success for Humboldt penguins was the highest for zoos with concrete floors. However, it was noticed that the penguins seemed to need some kind of vegetation, since they fetched nesting materials like sticks and spruce-needles. The edges of the pool

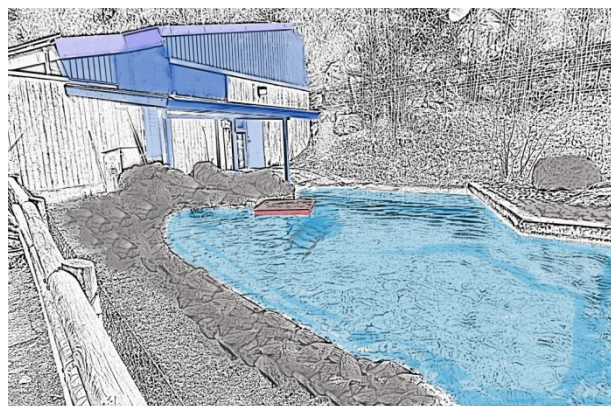


Figure 14. An example of how the pool's edge could be altered. The water hose that fills the pool could be drawn up on the rocks, creating a smaller waterfall. Original photo and design: Anna Larsson, Altered image: Christoffer Bromander.

could be altered to resemble a more natural cliff wall, with paved rocks/stones in it, to be more natural for the penguins' feet. The author supposes a reconstruction in the enclosure, with more paved and rocky areas. The edge to the pool should be made more complex, making it more natural and, what the author believes, easier for the penguins to jump up on, straight from the water (Figure 14).

A development of the waterfall could also be conducted, to make the fall more accessible for the penguins, since the observer noticed that they tried to climb up the fall. However, the water stream was too powerful and it was too few rocks in the fall, so the penguins could not climb so high. An interesting enrichment to evaluate would be to see if the penguins use the waterfall if the zoo makes a "waterslide" of it.

The weather during the study period was unpleasant and it seemed to have an effect on the penguins' time budget regarding outdoors residence. Humboldt penguins are, as previously mentioned used to cold waters (Hays, 1986; Echevin *et al.*, 2012), so the water temperature was assessed to not be an influencing factor. However, the construction of the hyena enclosure seemed to affect them. It seemed as the high noises were affecting the penguins.

Due to the issues regarding the weather and the construction of the hyena enclosure, the data might not be representative for the penguins' use of their enclosure in the month of April. For future studies, it would be interesting to see during which time-periods of year and day the penguins use their outside enclosure the most.

The placement of the enclosure could be discussed, since it was hardly any sun on the enclosure during the days, as the observer experienced it. However, this was in April and that makes it hard to speculate how the sun shines on the enclosure during summer time, when the penguins spends most time outdoors. During the times of observations (12.00-13.00 and 14.30-15.30), there was sun on parts of the enclosure on the days when the sun was out. Future studies could aim to investigate the effect the amount of sun hours on the enclosure has on the use of the enclosure and the willingness to reside outdoors.

Since there are very few articles written about the subject "environmental enrichment for Humboldt penguins", it is hard to evaluate the sources used in this thesis. This is a weakness in itself. The article by Clark (2003) has statistical calculations, references and is written in a scientific way. However, it is not published in a peer-reviewed paper, which decreases its credibility. The article did look at an interesting possible enrichment and on several different elements that could affect the results, which is of high importance.

The study method (instantaneous scan sampling) was very suitable for this kind of study. The interval of two minutes might sometimes have been too long, but since there were few occasions when there was a lot of activity, this is hard to assess in this thesis. The cons with using an instantaneous scan sampling on several individuals is that it is very hard to look at any behaviours, since it is necessary to scan the group as fast as possible. The lack of behavioural studies originates with the few number of penguins residing outside during the observation periods. The pro is the fact that you can involve the entire group of animals, there is no need to randomize some individuals out to represent the group.

Some of the major threats against Humboldt penguins in the wild are harvesting of guano, by-catch in fishing nets etc. According to Hays (1984; 1986) there are multiple factors influencing these threats, and most of them are caused by human activities. Humans exploit the guano from penguins to use as fertilizer, which consequently damages their ability to burrow (Hays 1984; 1986). Due to the human inflicted threats, we humans should feel and

have an obligation against the penguins. First and foremost, we need to stop exploiting the penguins, giving them a chance to recover on their own. Keeping penguins in zoos and breeding them could be helpful; however there are some difficulties with it.

Breeding of Humboldt penguins in captivity at Borås zoo is successful. Would the out-planting of penguins born in captivity, if conducted, work? In Sweden, our laws dictate that we are not allowed to feed our animals with live prey (Brottsbalken 1962:700, Djurskyddslagen 1988:534), but how are we going to learn the penguins to hunt? The keepers at Borås zoo explained that when the chicks parents have stopped feeding them the keepers often have to force feed the chicks, because the chicks has not learned what or how to eat. This is a serious issue, regarding the out-planting of animals. And if we humans do not stop exploiting them in their natural habitat, what could the use be of keeping them in captivity?

Keeping animals in captivity is always a source of ethical discussions. Keeping them in an environment as close to their wild habitat as possible is of great importance, why environmental enrichment has such high value. More research is needed on this subject and especially on more species. The results need to be published in a public forum, so that zoos and other institutions keeping animals can learn from each other's experiments. This is of high importance for science to develop and for animal welfare to increase. It also builds bridges between zoos, which could be beneficial in an otherwise quite closed society.

6.1. Conclusions

In conclusion, the structure increased the percentage of observations made in water, however, there were fewer observations made in the outside enclosure, indicating that something kept the penguins inside the indoor enclosure. Provided that the change in use of the enclosure is possible to derive to the enrichment, it could be considered partly successful. It did increase the penguins' use of their pool area; however it did not increase their use of the entire enclosure. If given a longer learning period, the whale skeleton could be an important element in the outside enclosure. A more long-termed investigation is however needed to properly evaluate the developed structure.

7. Populärvetenskaplig sammanfattning

Välfärden hos djur vi håller i fångenskap är ett ämne som ofta orsakar debatt. Debatten gällande djur som hålls i djurpark är generellt fylld av starka känslor och bestämda åsikter. Djurparker har som mål att hålla sina djur på ett så bra sätt som möjligt för att tillgodose deras behov och därav har miljöberikning fått mer uppmärksamhet under senare år.

Miljöberikning innebär att en förändring sker i djurens miljö – i hägnet, utfodringssätt, mentalt, etcetera. Detta kandidatarbete är utfört på önskan av Borås djurpark, via Sveriges Lantbruksuniversitet (SLU) i Skara. Syftet med studien var att utveckla och utvärdera miljöberikningar till humboldtpingvinerna på Borås djurpark.

Miljöberikning är ett ämne som ofta talas om, men för de flesta arter som hålls i fångenskap finns inte mycket forskning gjord. Miljöberikningsstudier görs generellt på djurparksdjur, men oftast inte på alla olika sorters arter, så bristen på forskning är stor.

Syftet var att utveckla en berikning vars önskvärda effekt var att locka pingvinerna till att öka nyttjandet av sitt hägn, framförallt av pooldelen. Utvecklandet av en berikning var en utmaning, då pingviner är en av de arter som är underrepresenterade i miljöberikningsstudier. Med hjälp av litteratur, egna idéer och samråd med Borås djurpark utvecklades en berikning ut för att utvärderas. Berikningen kallades för valskelettet och bestod av en sjunkande skelettdel och en flytbrygga.

Under två veckors tid utvärderades skelettet genom observationer på var i hägnet pingvinerna uppehöll sig. Observationerna utfördes i april 2012, som tyvärr medförde dåligt väder, vilket kan ha påverkat pingvinernas vilja att vara utomhus.

Resultaten tyder på att pingvinerna ändrade sitt användande av hägnet under de två veckorna strukturen var på plats. De uppehöll sig mer i vattnet, vilket var en del av syftet med studien.

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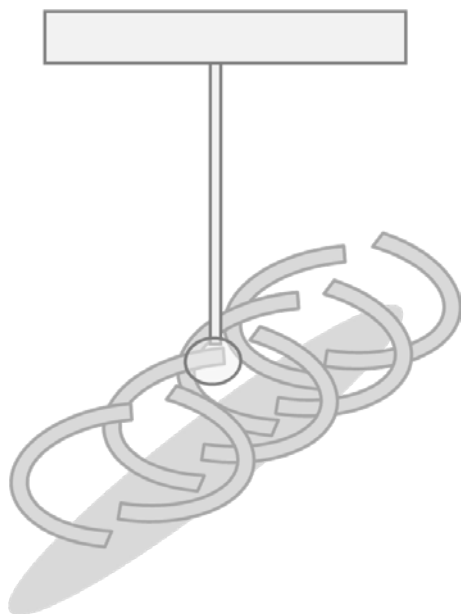
Appendix 1

Time	Opportunity	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
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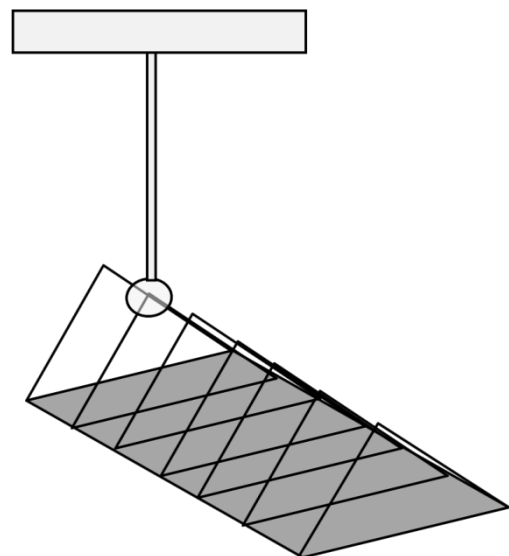
Time: _____ Date: _____ Weather: _____

The protocol used collecting data.

Appendix 2



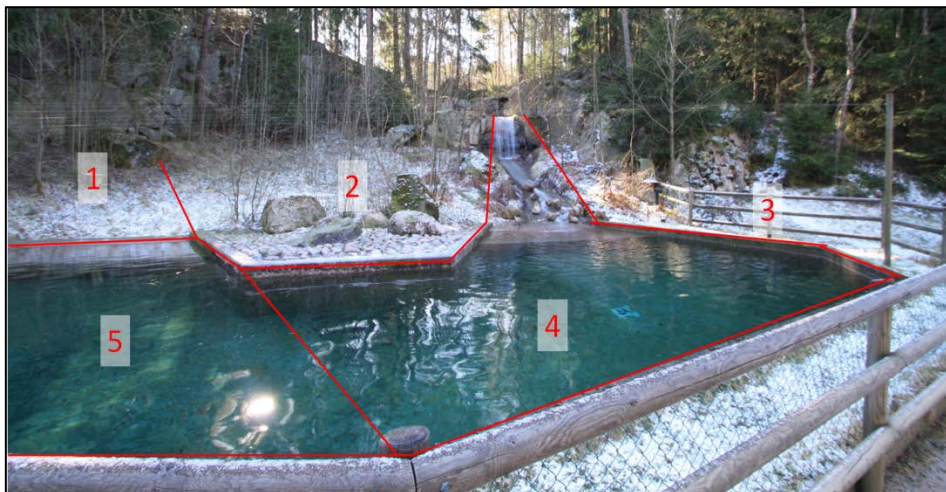
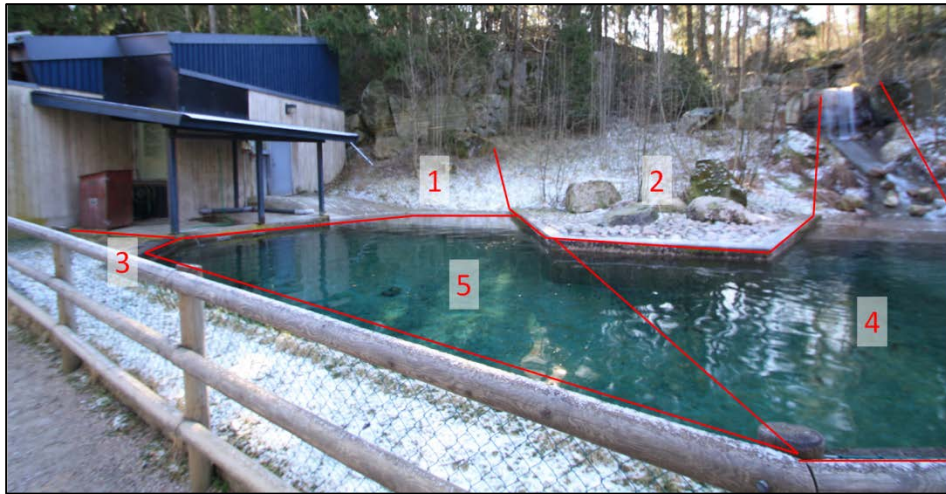
The first design proposal for the whale skeleton. Design: Anna Larsson.



The final design proposal for the whale skeleton. Design: Anna Larsson in collaboration with Borås zoo.

Appendix 3

Pictures over the outside enclosure with marks showing the division of zones. All following pictures are photographed by Anna Larsson.



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