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Survey to identify factors affecting breeding of Wolverines *Gulo gulo* within the EEP

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Conservation biologists have long faced the challenging task of large-carnivore conservation. The hunting habits and specific ecology of these species make their conservation difficult and Wolverines *Gulo gulo* are no exception. Wolverines are close to extinction as a result of human persecution and habitat loss. The European Association of Zoos and Aquaria (EAZA) introduced the European Endangered Species Programme (EEP) for the Wolverine in 1994 but only irregular breeding has been achieved. The aim of this study was to identify factors that could be connected to breeding success in Wolverines in human care with a particular focus on the characteristics of enclosures, species biology, characteristics of the institutions and the influences of human–animal interactions. Based on these factors, we produced and distributed an online survey to almost all holders of Wolverines included in the EEP. Overall, no main factor or group of factors investigated in this study seemed to be the clear defining feature that would explain the differences in breeding success between institutions participating in the Wolverine EEP. However, a negative effect of small enclosures on breeding success was indicated by the results. Furthermore, zoos with non-successful breeding tended to separate keepers and Wolverines during routine enclosure maintenance compared to zoos that reported successful breeding. Both these factors are interesting and need further investigation.

Key-words: breeding; enclosure size; human–animal interactions; reproduction; wolverine.

INTRODUCTION

The Wolverine *Gulo gulo*, the largest terrestrial member of the Mustelidae family, is known as one of the rarest and least-known carnivores from the Northern Hemisphere (Landa *et al.*, 2000; Dalerum *et al.*, 2006; Aronsson, 2009). Wolverines are solitary animals occupying a variety of habitats with very harsh environmental conditions, ranging across boreal forests, and arctic and alpine tundra in North America and Eurasia (Aronsson, 2009; Copeland *et al.*, 2010; Aronsson & Persson, 2018). Wolverines are opportunistic generalist predators and scavengers (Aronsson, 2009; Mattisson *et al.*, 2016; Aronsson & Persson, 2018). Their diet is dominated by ungulates and they are able to kill large prey such as Reindeer *Rangifer tarandus* and even Moose *Alces alces* (Aronsson, 2009). They also hunt livestock, especially domestic Sheep *Ovis aries* (Ekblom *et al.*, 2018) and semi-domestic Reindeer (Mattisson *et al.*, 2016), which is likely the main reason for a long history of persecution of the Wolverine by humans (Ekblom *et al.*, 2018). Persecution and habitat loss have brought the Wolverine population in Scandinavia close to extinction (Landa *et al.*, 2000; Aronsson & Persson, 2017).

According to the Swedish Environmental Protections Agency the wild population of Wolverine in Scandinavia during one year is estimated to be *c.* 890 individuals (Swedish Environmental Protections Agency, 2018). In North America there are fewer than 300 individuals in the wild (Defenders of Wildlife, 2018), and in Russia the estimated wild population is more than 18 000 Wolverines in the eastern part of the region and *c.* 1400 in European Russia (Abramov, 2016). Globally the species is listed as

Plate 1. Wolverine *Gulo gulo* **cub at Nordens Ark, Sweden.** *Erik Edvardsson, Nordens Ark***. [Colour figure can be viewed at wileyonlinelibrary.com]**

Least Concern (LC) in *The IUCN Red List of Threatened Species*, with a decreasing population trend (Abramov, 2016). The European Wolverine is considered Vulnerable (VU) (Andrén, 2018). Moreover, recent molecular studies have raised concern about the status of the genetic pool of the Scandinavian Wolverine population (Ekblom *et al.*, 2018). The European Endangered Species Programme [EEP: now the European Association of Zoos and Aquaria (EAZA) Ex situ Programme] for Wolverine was launched in 1994. At the time of writing there are 140 individuals at 60 institutions recorded in the EEP programme, and 38 of those institutions are members of EAZA (Plate 1).

Compared with other carnivores, knowledge about Wolverine reproduction is poor (Persson *et al.*, 2006). Even though Wolverines have bred in captivity since 1915 (Blomqvist, 1995), they are still considered difficult to breed (Blomqvist, 2012). Wolverines have small litters (mean litter size in captivity = 2·1; range 1–4 kits; n = 163) and generally reproduce every 2 years in the wild (Landa *et al.*, 2000; Persson *et al.*, 2006), which makes this a species with a low reproductive rate. This factor may make the task of achieving successful breeding, defined in this study as 'live cubs born', even more difficult for Wolverines in human care (Aronsson & Persson, 2018). The breeding of Wolverines and other threatened species in zoos and aquariums is important because these individuals provide a back-up population in the event that the wild population decreases to critically low numbers as a result of threats, such as hunting pressure, climate change and emerging diseases (EAZA, 2019).

Because published reports about Wolverines are scarce, the literature search was expanded to establish what factors have an effect on breeding success in other mammals. Studies show that the various characteristics of the environment can affect the breeding success of mammals in human care. Past research on a variety of species has demonstrated that husbandry practices, enclosure complexity and enclosure size may affect breeding; for example, in Burmese brow antlered deer *Rucervus eldii thamin* (Wall & Hartley, 2017). Other factors may also affect breeding success in mammals in zoos in general, such as stress (Price & Stoinski, 2005) and visitor presence (Davey, 2007), or familiarity with the breeding partner; for example, in Giant pandas *Ailuropoda melanoleuca* (Peng *et al.*, 2007). Furthermore, physiological, health and behavioural problems, such as hormonal imbalance in Giant pandas (Zhang *et al.*, 2004) and White rhinoceros *Ceratotherium simum* (Hermes *et al.*, 2006), or inappropriate mating position in Black-footed ferrets *Mustela nigripes* (Wolf *et al.*, 2000), can all influence successful reproduction. Individual and gender differences between animals also need to be taken into consideration; for example, as noted in Black rhinoceros *Diceros bicornis* in zoos in the USA (Carlstead *et al.*, 1999). It is therefore important to consider both the environment and the biology of the species when studying Wolverine reproduction in zoos.

The aim of this study was to identify factors that could be connected to breeding success in Wolverines, such as species biology, enclosure characteristics, institutional characteristics and influence of human–animal interactions. To study these factors, an online survey was compiled and distributed to Wolverine holders within the EEP.

MATERIAL AND METHODS

The online survey

The questions in the survey were formulated with consideration of the identified key factors of successful breeding in Wolverines according to literature. For example, use of den sites (Magoun & Copeland, 1998), population ecology (Persson, 2003), conservation genetics (Hedmark, 2006), reproductive characteristics of female Wolverines (Persson *et al.*, 2006), spatial ecology (May, 2007), and general husbandry and management guidelines (AZA Small Carnivore TAG, 2010; Blomqvist, 2012) (Appendix 1).

The online survey was sent to 42 zoos in total, 33 EAZA members, three World Association of Zoos and Aquariums (WAZA) members, and six non-EAZA members. The zoos that were excluded from the survey, had animals that were too young, only single-sex individuals or lacked proper contact information for the appropriate person at non-EAZA zoos. One EAZA-member zoo submitted two surveys because they had two breeding pairs in two enclosures.

The online survey was created with the *Google* survey administration app that is included in the *Google Drive* office suite called *Google Forms* (Version 71.0.3578.98, 2018: https://www.google.co.uk/chrome). An e-mail with a direct link to the survey was sent to institutions that had Wolverines. Before starting the survey, a small introduction, stating the aims and the functioning of the software, was provided for participants (Appendix 1).

The survey contained 68 questions, split into ten sections: general, enclosure (with three subsections: outdoors, indoor accommodation and other), nestboxes/dens, nutrition, enrichment, training, health, behaviour, human–animal interaction and breeding. The questions were either multiple choice (one or more options) or short answer and, where possible, paragraphs to upload to the questionnaire. All questions were compulsory, except for those that allowed participants to upload files. The answers were exported to Microsoft Excel 2010.

Data handling

Data were summarized and processed in Microsoft Excel 2010. For statistical analyses, RStudio (Version 1.1.463, 2019) was used.

Institutions were sorted into two categories depending on breeding success: institutions that had never had successful breeding (non-successful breeding, NSB) or institutions that had had successful breeding (successful breeding, SB). Fifty-two factors were extracted from the questions; both categorical and numerical (Table 1). NSB and SB were then compared in light of these factors, to see if a pattern for breeding success could be found.

For the numerical factor Outdoor Enclosure Size, three groups were created (Table 2) with different size categories in each. This was done to explore how enclosure size could affect breeding success. In the different groups the area of the enclosures has been categorized differently and later analysed to understand whether enclosure size affects breeding success and, if it does, where the limit of enclosure size is.

The factor Neighbouring Species was sorted into two groups depending on the type of species: (1) carnivores and (2) non-carnivores.

Fisher's Exact Test was used to analyse the effect of Outdoor Enclosure Size, Feeding Every Day and Training (RStudio). Pearson's Chi-squared test was performed to analyse the effect of Keepers Separated (RStudio).

RESULTS

Thirty-seven of the 42 institutions that received the survey submitted an answer, providing a 88% response rate. Two institutions were excluded from the results and all

CATEGORICAL FACTORS		
Country	Presence of barriers/wires	Indoor accommodations
Way of individuals being held	Substrate outdoor enclosure	Indoor accommodations public displayed
Separated or together	Vegetation outdoor enclosure	Substrate indoor accommodations
Experience holding Wolverines	Type of vegetation outdoor enclosure	Off-public enclosures
Open top	Hiding places	Separation keepers
Material outdoor enclosure	Possibility to climb	Night locking
Possibility build den/shelter	Pond	Neighbouring species
Nestboxes/dens provided	Special feeding routines	Types of enrichment
Bedding material provided	Feeding frequency (e.g. every 2 days)	Change of enrichment
Weekly diet	Water resource	Training
Health problems	Food enriched	Individuals trained
High season months	Type of stereotypic behaviours (current)	Presence stereotypic behaviours (former)
Institution opening	Type of stereotypic behaviours (former)	Presence stereotypic behaviours (current)
Institution always open		
NUMERICAL FACTORS		
Total number of individuals	Age	Total number of nestboxes provided
Total number of females	Pond size	Total number of outdoor enclosures
Total number of males	Number of indoor accommodations	Visitors per day during high season
Outdoor enclosures size	Indoor accommodations size	Visitors per day during low season

Table 1. Categorical and numerical factors of the data collected during a survey study to investigate breeding of Wolverine *Gulo gulo* in European zoos.

further analyses because their animals had not been given the opportunity to breed. Nine institutions (26% of $n = 35$ institutions) had never had successful breeding (NSB) and 26 institutions (74%) had successful breeding (SB). In total, data related to 86 Wolverines [41.45 (♂♂.♀♀)] were included in the study from the 35 responding institutions.

Enclosure

There was a significant difference in size of the outdoor enclosures between NSB ($n = 8$, because one institution did not submit enclosure size data) and SB ($n = 26$) institutions in all groups (Fisher's Exact Tests: Group 1, $P < 0{\cdot}001$; Group 2, $P < 0{\cdot}05$; Group 3, $P < 0{\cdot}01$). Enclosure sizes < 800–1000 m^2 negatively influenced the breeding success of the Wolverines. The majority of institutions, both NSB and SB, had one or two outdoor enclosures. However, the median size was 701 m^2 for NSB (range 314–840 m^2) and 2757 m^2 for SB (range 120–15 000 m^2).

We found no difference in complexity of the enclosures between NSB and SB. All institutions had vegetation, such as trees, bushes, grass and shrubs, and provided places to hide and climb. Most institutions (89%; $n = 31$ of 35 total institutions) had a pond in their enclosures, and almost all enclosures (94%; $n = 33$ of 35 total institutions) were open top, except for two SB institutions. Fences were mostly made of mesh (46%; $n = 16$ of 35 total institutions) with natural ground as substrate in all zoos ($n = 35$ institutions). Electric barriers or wires were used in 80% ($n = 28$ of 35 total institutions) of the institutions.

All institutions used enrichment in their enclosures, with sensory (94%; $n = 33$ of 35 total institutions) and manipulative (86%; $n = 30$ of 35 total institutions) enrichment being the most common types used. Two-thirds of the institutions (63%; $n = 22$ of 35 total institutions), both NSB and SB, had indoor accommodation, ranging from one to six indoor dens with sizes from 2 to 275 m^2. The most-used substrates were hay/straw and wood shavings/

	GROUP 1			GROUP 2			GROUP 3		
CATEGORY	SIZE	n_{SB}	n_{NSB}	SIZE	n_{SB}	n_{NSB}	SIZE	n_{SB}	n_{NSB}
Very small	0–200 m^2	3	0	0–150 m^2	1	0	0–200 m^2	3	0
Small	201–800 m^2	2	6	150–500 m^2	2	2	201–850 m^2	3	7
Medium-small				501–1000 m^2	6	5			
Medium	801–1500 m^2	9	2	1001–2000 m^2	8	1	851–1500 m^2	8	1
Big	1501–3000 m^2	7	0	2001–3000 m^2	4	0	1501–3000 m^2	7	0
Very big	> 3000 m^2	5	0	> 3000 m^2	5	0	> 3000 m^2	5	0

Table 2. Three groups, each with various categories related to the area of outdoor enclosure, were used to explore the effect of enclosure size on breeding success of Wolverines *Gulo gulo* in European zoos; n_{SB}, number of institutions reporting successful breeding for each enclosure-size parameter (n = 26); n_{NSB}, number of institutions reporting no breeding for each enclosure-size parameter (n = 8, because one institution did not submit data on enclosure size). All institutions that submitted data are represented in each group.

woodchips. No clear pattern could be found when comparing the access to dens between NSB and SB institutions. Almost all institutions (89%; n = 31 of 35 total institutions) provided Wolverines with the opportunity to build a shelter/den themselves, and almost all institutions (91%; n = 32 of 35 total institutions) provided nestboxes/dens for their Wolverines.

The type of neighbouring species varied, from carnivores such as bears, lynx, wolves and tigers to non-carnivores such as Reindeer, Moose and farm animals. This did not seem to affect breeding because a majority of NSB (67%; n = 6 of 9 NSB institutions) and SB (77%; n = 20 of 26 SB institutions) had predators as neighbouring species and the rest had prey species.

Human–animal interaction

Separating the Wolverines from the keepers during routine enclosure maintenance had a negative effect on breeding success (χ^2 = 6·3, P < 0·05). The majority of NSB (67%; n = 6 of 9 NSB institutions) separated their Wolverines before the keepers entered the enclosure while the majority of SB (81%; n = 21 of 26 SB institutions) kept their Wolverines in the enclosure when the keepers entered.

Breeding success could not be shown to be dependent on training (Fisher's Exact Test P = 0·24). More than half of all institutions (57%; n = 20 of 35 total institutions) trained their animals. Of those that trained their Wolverines, most institutions (90%; n = 18 of 20 total institutions) trained all their individuals, except one SB institution that trained only males and one SB institution that only trained adults. The types of training that were reported were mainly husbandry-related training; for example, to facilitate moving animals and routine weighing, and for medical procedures (e.g. blood sampling).

Wolverine biology

There was no difference in age of the Wolverines between NSB (mean age 6·7 years) and SB (mean age 6·6 years) institutions. The ages ranged from 1 to 14 years. All Wolverines in NSB institutions were held in pairs, as they were at all SB institutions that had only two individuals. Practically all individuals (89%; n = 31 of 35 total institutions) were together all the time.

About one third (31%; n = 11 of 35 total institutions) of the institutions reported having observed stereotypic behaviour in current and former Wolverines at their institution, and this involved both NSB and SB institutions. The types of stereotypic behaviours performed were pacing, somersaulting and fence-biting.

Institution characteristics

There was no effect of feeding regime on the breeding success (Fisher's Exact Test, $P = 0{\cdot}14$), and most Wolverines [78% of NSB ($n = 7$ of 9 total institutions); 50% of SB ($n = 13$ of 26 total institutions)] were fed every day. Most institutions (60%; $n = 21$ of 35 total institutions) only presented their food in an enriched way some of the time.

Holding time did not seem to influence breeding success (Fig. 1). The NSB institutions were almost equally distributed in each group of years of experience and a majority of SB (58%; $n = 15$ of 26 SB institutions) had more than 20 years of experience. In total, almost half of the institutions (49%; $n = 17$ of 35 total institutions) had more than 20 years of experience of managing Wolverines at their facilities.

DISCUSSION

The two factors found in the survey that seem to have a significant effect on breeding success were the size of the outdoor enclosure and the practice of separating the Wolverines from the keepers during routine husbandry and maintenance procedures.

Despite the small sample size of NSB, our results gave an indication that enclosure size influences the breeding success of Wolverines in human care. The results show that having outdoor enclosures of < 800–1000 m^2 is more common at institutions with non-successful breeding. This is in accordance with several studies in other species that found that enclosure size is correlated with reproductive success, and that increasing the size of the enclosure has a positive effect, such as McCusker (1978) showed in felids, Carlstead & Shepherdson (1994) in Gorillas *Gorilla gorilla*, Carlstead *et al.* (1999) in Black rhinoceros and Peng *et al.* (2007) in Giant pandas. However, the opposite has also been demonstrated, in small exotic felids *Felis* spp (Mellen, 1991) and Burmese brow antlered deer (Wall & Hartley, 2017).

Different recommendations and regulations apply, dependent on country and organization. The Association of Zoos and Aquariums (AZA) Small Carnivore TAG (2010) recommends housing Wolverines in a space larger than the accepted minimum (150 m^2) to improve breeding success, because small enclosures are quickly worn down by this active species. The minimum enclosure size recommended by the

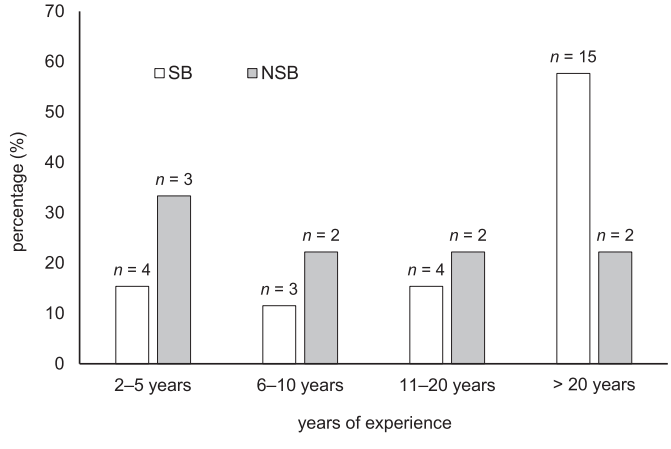

Fig. 1. Percentage of institutions in relation to number of years of experience of managing Wolverines *Gulo gulo*: *n,* **number of institutions in each category; NSB, institutions with non-successful breeding ($n = 9$); SB, institutions with successful breeding ($n = 26$).**

husbandry guidelines is 500 m^2 for a pair, with an additional 300 m^2 enclosure to separate the male or kits when necessary (Blomqvist, 2012). In Sweden, the regulation sets the minimum enclosure size for keeping Wolverines at 600 m^2 (Swedish Board of Agriculture, 2009). Our results indicate that even 600 m^2 is insufficient because sizes below 800 m^2 were more-often seen in NSB institutions. Two NSB institutions had enclosure sizes below the recommended 500 m^2. There are studies on large birds showing that the complexity of the enclosure, rather than just size, must be considered (Stevens & Pickett, 1994; Marshall *et al.*, 2016); however, no effect of the influence of complexity was observed in our study.

In a majority of the NSB institutions, the keepers separate the Wolverines before entering the enclosure for routine husbandry. This indicates that keeping the Wolverines separated from the keepers seems to have a negative effect on their breeding success. Daily husbandry procedures can raise the levels of stress in carnivores and affect their breeding success (von Schmalz-Peixoto, 2003). It is possible that the process of locking the Wolverines away when keepers enter the enclosure is not ideal for the species. However, the cause for this is difficult to understand from the data received in this survey because it was not possible to extract details of the procedures used from the answers submitted.

In this study, stereotypic or abnormal behaviours did not seem to explain the differences in breeding success between NSB and SB institutions. However, stereotypic behaviours easily develop among Wolverines, especially if they are kept in small enclosures with little possibility to exhibit their natural behaviours (Blomqvist, 2012). Abnormal and aggressive behaviours have been observed in other Mustelidae species, affecting social and mating behaviour; for example, male Black-footed ferrets (Wolf *et al.*, 2000), American mink *Neovison vison* (Dallaire & Mason, 2017) and European mink *Mustela lutreola* (Kiik, 2018). All types of stereotypic behaviours mentioned in the survey have been stated in other studies with Wolverines (Chaudhary *et al.*, 2007), other mustelids such as the North American river otter *Lontra canadensis* (Morabito & Bashaw, 2012) and American mink (Díez-León & Mason, 2016), and carnivores in general (Clubb & Vickery, 2006). It is known that Wolverines have a polygamous mating system (Hedmark *et al.*, 2007), but the knowledge of specific mechanisms of Wolverine reproduction is incomplete (Inman *et al.*, 2012). Further research to establish whether the outcome of a mating attempt in Wolverines depends mainly on the male or the female (i.e. freedom of choice of partner) could help clarify the differences in breeding success.

Even though 88% of the institutions that received the survey responded, giving a good overview of this Wolverine population, the population sampled is not large enough to definitively identify factors that significantly affect breeding success. The fact that there were fewer institutions with no breeding (NSB, $n = 9$) than with successful breeding (SB, $n = 26$) made comparisons difficult because slight variations in a small sample have a large impact on the possibility of finding significant effects of the factors being investigated. Moreover, specific reasons for low breeding success of many animals are difficult to identify (Taylor & Poole, 1998). Notwithstanding, there seem to be strong indications that enclosure size and separating Wolverines from keepers during routine husbandry have an effect on breeding success. The results of this study can only pinpoint some general trends across the institutions participating in the Wolverine EEP programme that could explain their differences in breeding success. Further research on these topics is needed. We suggest that future research should focus on how the human–animal interactions affect breeding success by studying the procedures used to separate the Wolverines from their keepers during routine maintenance. This could be done in two ways. First, by sending more-detailed

questions to the institutions practising separation and identifying whether the process is related to training practices. Second, carrying out observational studies of the procedures and the behaviour of the Wolverines during separation from keepers. Two other aspects and their effect on breeding could be investigated in more detail. These are the possible effect of neighbouring species, and the usage and number of dens (both provided and self-made dens). In the survey reported here, the questions on these aspects were not detailed enough to exclude them as having an effect on breeding.

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PRODUCT MENTIONED IN THE TEXT

RStudio: integrated development environment (IDE) for R (Version 1.1.463, 2019), developed by RStudio, Boston, MA 02210, USA.

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APPENDIX 1

SURVEY FOR HUSBANDRY PARAMETERS IN CAPTIVE WOLVERINES (*Gulo gulo*)

This survey is sent to all holders of wolverines (*Gulo gulo*) included in the wolverine EEP Program of EAZA. The results of this survey will help identify factors (such as enclosure design, nutrition, human-animal interaction, health) that lead to breeding success in captive wolverines. Institutional and individual data will be processed anonymously.

The expected time to complete this survey is 15min, but there is no time limit to finish it. Answers are NOT saved if the user returns to the survey later without having it submitted first. Once it is submitted, answers CANNOT be edited. It is therefore advisable to have all the possible useful information available before filling in the survey. However, it is possible to go back and forward through the survey without losing the answers. Unless specified, questions are required an answer.

If you have any questions about the survey or if you have more useful information about your wolverines that you would like to share, please do not hesitate to contact Eva Andersson (EEP Coordinator Wolverine) via eva.andersson@nordensark.se.

Thank you very much for your collaboration, your participation is important!

Please, write the name of your institution:

[*enter short text*]

In which city and country is your institution?

[*enter short text*]

GENERAL

How are the individuals held/kept? *(you can choose more than one option)*

In solitary *In a pair* *In separated pairs* *In a group or family*

Other (specify)

Are the animals/breeding pair together all the time or only during breeding?

Together all the time *Only during breeding* *They are never together*

Other (specify)

When did your institution begin to hold the species?

Less than two years ago 2 – 5 years ago 6 – 10 years ago

11 – 20 years ago >20 years ago

ENCLOSURE

Outdoor

How many outdoor enclosures holding wolverines does your institution have?

[*enter a number*]

What is the size of the enclosure/enclosures (m2)? *If more than one enclosure, please specify the size of each enclosure.*

[*enter short text*]

Are the enclosures open top?

Yes *No* *Other (specify)*

What type of material is the enclosure MOSTLY made of?

Mesh *Fence* *Glass* *Wall* *Other (specify)*

Does the enclosure have electric barriers/wires?

Yes *No*

What kind of substrate does the outdoor enclosure have?

Natural grown *Grass* *Gravel* *Sand* *Woodchips*

Other (specify)

Does the enclosure have vegetation?

Yes *No*

If yes, what kind of vegetation?

[*Short answer*]

Approximately how much percentage (%) of the enclosure is covered by vegetation and/or substrate?

[*enter a number*]

Do they have places to hide?

Yes *No*

Do they have the possibility to climb?

Yes *No*

Is there a pond in the enclosure?

Yes *No*

If yes, how big is the pond (m2)?

[*enter a number*]

Indoor accommodation

Do the enclosures have indoor accommodations?

Yes *No*

If yes, how many indoor accommodations are there?

[*enter a number*]

What size are the indoor accommodations (m2)? *If there is more than one indoor accommodation, please specify the size of each enclosure.*

[*enter a number(s)*]

Are the indoor accommodations publicly displayed?

Yes *No*

What kind of substrate do the indoor accommodations have?

Straw/Hay *Dust/Sawdust/Sand* *Wood shavings/ Woodchips*

Rubber mat/ Rubber floor *Other (specify)* *None*

Other

Are there off-public enclosures and/or accommodations?

Yes No

Does your institution separate the animals from the keepers?

Yes No Other (specify)

Are the animals locked indoors during nights?

Yes No Other (specify)

If yes, what are the reasons for locking them in during nights? *(Not required)*

[*Short answer*]

What species are there in direct proximity to the wolverine enclosure?

[*Short answer*]

If possible, please upload photos or sketches that show if and where the following interior/items are located: *(Not required)*

Climbing apparatus, hiding places, caves, shade, bushes, trees, ponds, water and feeding troughs, dens, partitions, electrical points, service corridors, keeper exits and other furnishing designed to facilitate maintenance.

[*Upload image/document*]

NEST BOXES/DENS

Do they have the possibility to build a shelter/den themselves?

Yes No

Are there nest boxes/dens provided?

Yes No

If yes, how many?

[*enter a number*]

How are they designed? *(Not required)*

[*Upload image/document*]

Where are they located in the enclosure? *(Not required)*

[*Upload image/document*]

Is bedding material provided?

Yes No

NUTRITION

Describe the weekly diet sheet for one individual.

[*Long answer*]

Do you have special feeding routines?

Yes No Other (specify)

How often are they fed during a week?

Once a day Every second day Every third day Other (specify)

How do the animals get fresh water?

Bowl Stream Pond Water nipple Other (specify)

Is the food presented in an enriched way?

Yes, always No, never Only sometimes Other (specify)

ENRICHMENT

Which of the following types of enrichment are used? *(you can choose more than one option)*

Sensory (e.g. visual, olfactory, auditory, taste)

Foods / Feeding (e.g. task-oriented puzzle feeders)

Manipulative / Toys (e.g. balls, boxes, bags, barrels)

Environmental (swings, climbing structures, hiding places)

Behavioral/Social (interact with other animals, artificial decoys)

None

If enrichment is used, is it regularly changed/renewed?

Yes No There's never enrichment

If possible, could you upload any photo, video or documents showing the enrichment used? *(Not required)*

[*Upload image/video/document*]

TRAINING

Are the animals trained?

Yes No

If yes, what are you training? *(Not required)*

[*Short answer*]

If you train, are all individuals trained?

Yes No, only adults (>2 years old) No, only juveniles and/or cubs No, only males

No, only females *Other (specify)*

If possible, could you upload a video from a training session? *(Not required)*

[*Upload video*]

HEALTH

What are and have been the most common health problems?

[*Short answer*]

What are and have been the most common causes of death?

[*Short answer*]

Do the individuals or former individuals have or have had ticks?

Yes *No* *Maybe*

BEHAVIOR

Do the current individuals express any stereotypic behaviors?

Yes *No* *Maybe* *Other (specify)*

If yes, what kind of stereotypic behaviors? *(you can choose more than one option)*

Pacing *Head bobbing* *Somersault* *Other (specify)*

If possible, could you upload a video of the stereotypic behaviors? *(Not required)*

[*Upload video*]

Have former individuals expressed any stereotypic behaviors?

Yes *No* *Maybe*

If yes, what kind of stereotypic behaviors? *(you can choose more than one option)*

Pacing *Head bobbing* *Somersault* *Other (specify)*

If possible, could you upload a video of the stereotypic behaviors? *(Not required)*

[*Upload video*]

HUMAN-ANIMAL INTERACTION

This section is to determine whether visitors can have effects on mating behavior and birth of the cubs.

Is your institution open all year around?

Yes, all year around *No, only seasonally* *Other (specify)*

When is the high season for your institution? *(Specify answer in months: e.g. June - September)*

[*Short answer*]

How many visitors a day does your institution have on average during high season?

[*enter a number*]

How many visitors a day does your institution have on average during low season?

[*enter a number*]

BREEDING

Does your institution ever have successful breeding (live cubs born)?

Yes *No*

What do you think is the main reason for the successful/not successful breeding?

[*Short answer*]

Have the keepers ever seen courtship and mating behavior on the former and/or current breeding pairs?

Yes *No* *Only on the former* *Only on the current*

Has the institution ever have had cubs that died?

Yes *No* *Maybe*

If yes, what was the cause of death or what do you think was?

[*Short answer*]

[SEND]

Your response has been recorded. Thank you very much for your collaboration!

If you have any questions or comments, or if you want to send more information about your wolverines, do not hesitate to contact Eva Andersson (EEP Coordinator Wolverine) via eva.andersson@nordensark.se.