

## Breeding Station for the European hamster (*Cricetus cricetus* Linnaeus, 1785) at Opel-Zoo Kronberg

### Eine Zuchtstation für den Europäischen Hamster (*Cricetus cricetus* Linnaeus, 1785) im Opel-Zoo Kronberg

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### Summary

Once abundant throughout Western Europe, the population size of the European hamster has decreased dramatically in the last 40 years. It is now listed as critically endangered and urgent action must be taken to enable the survival of the species. Therefore, the Hochtaunuskreis (Hesse, Germany) started to take conservation measures in 2012 and initiated a reintroduction programme for European hamsters which started in 2020. The Opel-Zoo supports this initiative by breeding hamsters for release. We here describe the husbandry system developed at Opel-Zoo in which every hamster can be housed according to German regulations (“Gutachten über Mindestanforderungen an die Haltung von Säugetieren vom 7. Mai 2014”) in a relatively cost and space-effective way. Since 2018, over 165 hamsters have been born at Opel-Zoo of which 157 exceeded an age of 8 weeks. The medium litter size was 6. Until August 2023, 116 European hamsters were released in suitable habitats in cooperation with the federal agencies (Regierungspräsidium Darmstadt & Untere Naturschutzbehörde Hochtaunuskreis). It has been confirmed that some of them reproduced successfully.

**Keywords:** European hamster, *Cricetus cricetus*, breeding, conservation

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## Background

The European or common hamster (*Cricetus cricetus*) is a characteristic species for fertile lowland steppes and grasslands in Europe and Asia. It has a high reproductive potential (Eibl-Eibesfeldt, 1953) and used to be common in anthropogenic habitats as meadows and croplands (Banaszek et al., 2020). Due to its habit to feed on and cache large amounts of crops, it was long regarded as pest and persecuted intensively. Common hamsters were also hunted for fur trade (see Nechay, G., 2000 for a detailed discussion of the historical and current situation of hamsters throughout Europe). Combined with the effects of intensified agriculture and habitat fragmentation, this led to a severe decline of population size in Western Europe (Kryštufek, B., Vohralík, V., Meinig, H. & Zagorodnyuk, I., 2016). After an updated assessment of the population status in 2020, the species is listed as critically endangered by the IUCN (Banaszek et al., 2020) because the population trend is decreasing over the whole range, including Eastern Europe, Russia, and Kazakhstan. The assessors project this to result in extinction between 2020-2050 if the situation does not change.

In the European union, the common hamster is listed in Annex IV (species in need of strict protection) of the “habitat directive” (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). In Germany, it is furthermore protected under federal law (BNatSchG) since 1980. The three most western populations of common hamsters occur in France, in the border region of the Netherlands, Belgium and Germany and in the German states of Rhineland-Palatinate and Hesse (Banaszek et al., 2020, Nationaler Bericht nach Art. 17 FFH Richtlinie in Deutschland 2019), where the von Opel Hessische Zoostiftung (Opel-Zoo) is located. Because of the responsibility for these populations on the edge of the range of the species, the state of Hesse intends to preserve and strengthen the last populations of common hamsters. In 2018, the state of Hesse, the Opel-Zoo, the regional nature conservation authority (Untere Naturschutzbehörde Hochtaunuskreis) and the registered association “Landschaftspflegeverband Hochtaunus e.V.” signed a letter of intent concerning the protection of the European hamster which includes the establishment of reintroduction programmes. The goals of the reintroductions are to support and re-connect the remaining hamster populations in the region by establishing and populating suitable hamster habitats in geographically relevant areas. The Opel-Zoo supports the project with a breeding station, where European hamsters are housed, rehabilitated if necessary, and bred for reintroduction. To guarantee that hamsters are housed according to an official German expert report “Gutachten über Mindestanforderungen an die Haltung von Säugetieren vom 7. Mai 2014”, we developed a new husbandry system for the species, that we describe in this article.

## Hamsters at Opel-Zoo

In June 2018, 5.5 European hamsters arrived at Opel-Zoo. 1.1 hamsters were adult and wild-caught by federal agencies because of necessary translocations. 4.4 were sub-adult and bred in human custody; 1.2 and 3.2 belonged to the same litter, respectively. Due to a lack of space at other facilities, the hamsters were brought to the Opel-Zoo before the breeding station was completed. Therefore, they had to be held in small cages temporarily in accordance with the responsible authorities. Presumably, this resulted in one female developing stereotypic behaviour patterns (circling, later pacing). Stereotypies are invariant behaviour patterns without obvious goal or function that may be a result of distress and can be an indication of poor welfare (Mason, 1991 a, b). Once established, stereotypic behaviours can emancipate from their causing stimulus so that individuals go on performing the behaviours even when the original aversive

stimulus is no longer around (Mason, 1991 a, b). This female displayed stereotypic behaviours throughout her life and never raised her litters. No other hamster in the breeding station was observed to display stereotypic behaviours.

In July, the hamsters were moved into the breeding station located in the house for European rodents at Opel-Zoo. It was officially opened on 10th of October 2018. Visitors can see hamsters in two outside enclosures (total area: 20 m<sup>2</sup>) that are equipped with sub-terrestrial windows (total size: 4.3 m<sup>2</sup>), so it is possible to observe burrowing.

## Breeding Station

The breeding area consists of a 32 m<sup>2</sup> room that can be heated and is lit by daylight (Fig. 1). It contains 14 commercial cages “SAVIC Suite Royal XL” that have been modified to fit the needs of hamsters and staff (Fig. 2). The furniture is accomplished by two “mating boxes”, a washbasin, a retractable desk, a mobile rack, various shelves, and installations to store tools. We tried to keep all interior mobile to facilitate working and make most use of space at any time of the year.



**Fig. 1:** Breeding station for European hamsters at Opel-Zoo. Sides and back: SAVIC Suite Royal XL hamster cages. Middle: mating boxes (covered and used for storage outside of breeding season). Photo: Opel-Zoo archive.

## Enclosures

As stated in an official German expert report (“Gutachten über Mindestanforderungen an die Haltung von Säugetieren vom 7. Mai 2014”), an adult European hamster has to have access to an enclosure with a base of 2 m<sup>2</sup>. Therefore, we installed additional floor levels in every cage, so cages reach a base area of 4 m<sup>2</sup>. Usually, one hamster has access to a whole cage. If necessary, cages can be divided into two compartments of 2 m<sup>2</sup> each, so that two adult hamsters can be housed. The “SAVIC Suite Royal XL” furthermore has the following advantages: a) it is placed on wheels, b) it allows sufficient ventilation at all cage levels, c) young cannot fall out thanks to the small gap between the bars, and d) the whole front consists of large doors, so all parts of the cages are easily accessible for the keepers.

Every enclosure is equipped with two or more sleeping boxes, a running wheel or “flying saucer”, a food bowl, a water bottle (drinking feeder), tubes for hiding, wood for gnawing, a box filled with a sand-clay-mix for digging and ladders that allow the hamsters to switch cage levels. We place thin wooden plates between cages to prevent visual contact. For sleeping boxes, we mostly use residual cardboard boxes of suitable size (~ 30 cm L x 20 cm W x 25 cm H or larger) as they can easily be exchanged if hamsters urinate into the box. For nesting material, we offer hay and straw and use commercial wood shavings as ground cover. We started using running wheels but changed to “flying saucers” which are made of washable plastic. Also, the largest available running wheel has a diameter of 30 cm, which seems too small for adult European hamsters. Because the “flying saucers” are too light and turn over under the weight of an adult hamster, we stabilize them by gluing them onto a wooden board of approx. 30 x 30 cm.



**Fig. 2:** Furniture of European hamster enclosures at Opel-Zoo. Photo: Opel-Zoo archive.

## Feeding

We use the following feeding plan (Tab. 1) to account for the varying energy requirements of hamsters in course of the year. To allow the hamsters to perform the natural behaviour of food caching, we provide more dry feed than required energy amounts. We check food caches on a regular basis and remove wet feed or the whole cache if it is moist or begins to go mouldy. Before hibernation, when the hamsters have already cached sufficient food, we reduce the daily amount of feed. During hibernation, amounts of dry food are changed once a week and vegetables are offered 2-3 times weekly. Because hamsters are mainly nocturnal, we use food consumption to check whether the animals are alive.

**Tab. 1:** Feeding plan of European hamsters at Opel-Zoo.

Frequency	Amount	Type of food
Daily (when not hibernating)	~ 100 g	Vegetables (beetroot, carrots, fennel, celery, parsnip...)
When hibernating: - Dry food: changed once / week - Vegetables: 2-3 times / week	1 branch	Foliage (hazel, beech, blackberry...) with wooden parts to allow gnawing
	If available	Herbs (dandelion, parsley, chive, chervil, salad burnet, sorrel, cress, borage...)
	Rarely	Fruit (berries, apple, dried rose hip, stone fruits without stone)
	~ 80 g	Dry feed Composition: - 55 % commercial parrot feed - 35 % whole grain oat flakes - 5 % commercial chicken feed - 5 % sweet corn
2x / week	½	boiled chicken egg
	25 g	commercial hedgehog feed (Claus Igelfutter Getreidefrei)
Daily for females when pregnant, lactating, or housed with young	Alternating	
	½ 25 g	boiled chicken egg commercial hedgehog feed
Before hibernation	occasionally	Peanuts, glans, beechnuts, chestnuts (in shell)
		Hazelnuts, walnuts (in shell but slightly opened)
For medication	½ teaspoon	Apple sauce, mashed banana, baby food

## Husbandry

As common hamsters are bred for reintroduction purposes in Opel-Zoo, it is vital that their natural annual and circadian rhythms are intact. Therefore, the breeding station is not heated until temperature drops below 10° C. Because the natural isolation effect under the soil surface is missing, heating is then implemented to prevent temperature from dropping too low, so that the hamsters are not killed by frost. The room is lit by daylight through ceiling windows which can be opened to allow airflow and prevent overheating of the room when necessary. Hamsters are not tamed (as this might negatively influence reintroduction process) but a good keeper animal relationship is hold up, especially with the breeding animals, to prevent chronic stress and increase breeding success.

We clean cages at least every 14 days. As some hamsters use one toilet spot very strictly and do not cache wet food items while others use their sleeping box for urinating and caching of all types of food, we vary cleaning depending on necessity. We clean toilet spots and remove wet food leftovers every day and exchange moist nesting boxes and food caches immediately. However, we try to minimize cleaning measures to reduce stress. If nesting boxes are clean, we do not remove them or the nesting material even if we clean the rest of the cage. To prevent disturbance during hibernation, we mainly stick to removal of moist spots and leftover food and only clean the whole cage if the hamster is awake. Usually,



hamsters wake up once per week. If no life signs (eaten food, urine, faeces) have been seen after 10-12 days, we check if the hamster is still alive. If we check, we are very careful as to not wake up the hamster. Hibernating hamsters are cold and breathe very slowly, a rose colour of the paws is a good indication of life. Hamsters might scream for several minutes while waking up.

Because of their sharp and protruding teeth, and to prevent stress and taming, we never take adult hamsters into hands. Instead, we use transparent tubes for moving and visual check-ups. Hamsters usually enter the tube voluntarily if it is placed in front of their snout (especially if the tube has been placed in the enclosure beforehand) and the handling person taps very gently on the tube with one finger. The tube can then be placed in a fauna box, so the hamster cannot escape (Fig. 3). Should the hamster try to leave the tube while not yet in the fauna box, a slight air blow on the snout will prevent it from climbing out on the front side while tilting the tube so the backside is lowered will prevent it from leaving there. This brilliant technique was introduced to us by Lisa Heimann and Marco Sander (Institute for Faunistic & breeding centre for European hamsters at Heidelberg Zoo). Subadult hamsters of up to about 140 g can be handled without the use of tools as they usually do not bite yet. We keep handling of young hamsters to a minimum as to prevent taming.



**Fig. 3:** Hamster secured in transparent tube and fauna box. Photos: Opel-Zoo archive.

## Breeding at Opel-Zoo

The hamsters are paired between end of April to middle of July depending on end of hibernation, oestrus cycle of the females, and, for the second litter, weaning of the first litter. The cycle duration is 4 days, gestation period is 17 days.

### Mating

Mating takes place in special “mating boxes” (Fig. 4) of approx. 1 m<sup>2</sup> which can be divided by a mesh and be easily accessed from above. The top can be closed so the animals can stay in the mating box overnight. Hamsters are introduced to each other as late in the day as possible to resemble their natural activity patterns, this is generally 4 p.m. or later, preferably after 6 p.m.

For introduction, we keep the mating box quite empty to have a better overview. First, the female is placed in one part of the box for approx. 5 min. Then the male is placed in the other part. After a brief orientation period, the male usually shows interest in the female at the mesh. If the female reacts very aggressively (jumping, eliciting grunts, attacking the male), the male is removed immediately. If the female reacts aggressively (grunting, short attacks), the animals stay separated for about 10 more minutes. As soon as there is only light aggression (grunting) or signs of interest (sniffing at the mesh), the separation mesh is remo-

ved. Should the female not show interest in the male, the male is exchanged. Some female hamsters are very picky and will only accept certain males (usually the heaviest). In case the female does not react to about 5 males, she is probably not in oestrus and the procedure is repeated the next day.

As soon as a pair is together, one keeper stays with the hamsters for at least 30 min to interfere if necessary (encounters can get very violent very quickly). If the male is interested in the female, he starts eliciting “pfffft” sounds that enhance in volume and duration. Normally, the female reacts to this with light signs of aggression and then starts to run away from the male. The male follows very narrowly while still eliciting “pfffft” sounds. Very often, the female turns every now and then to attack the male, who will continue to follow her afterwards. After a while, the male tries to mount the female. A successful copulation is indicated by both animals cleaning their genitals and resting for about 5 min. If the first copulation takes place within the first 30 min, the hamsters are left together overnight. If not, the pair is separated and let together the next night.

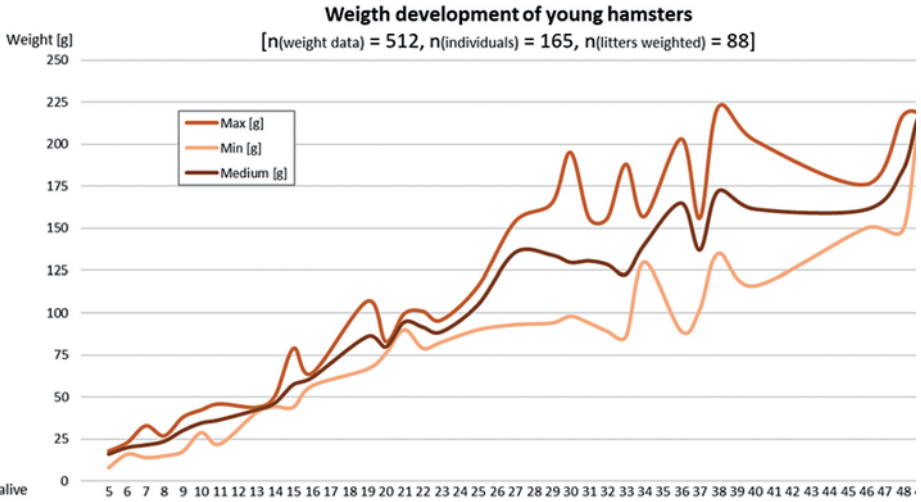
To prevent the hamster couples from fighting during the night, we offer several sleeping boxes, sufficient bedding, and sufficient food. We offer plenty vegetables but relatively small amounts of dry food, because some hamsters will try to carry it to their home cage and can get very stressed as they cannot leave the mating box. We separate the animals the next morning. To control whether mating was successful, the same pair is let together after four days. If the female is interested, the animals stay together overnight, again. If the female is not interested, the hamsters get separated and the control is repeated after another four days.



**Fig. 4:** Mating box. Mesh lids (left) will prevent hamsters from climbing over the fence (right; risk of falling and escape) while allowing close monitoring of the animals. Photos: Opel-Zoo archive.

## Rearing

Young are born 17 days after a successful copulation. The first signs of young hamsters are soft squeaking sounds from the nesting box. We check (counting, weighting, visual check-up, Fig. 5, Fig. 6) the young after 7 days for the first time, as we try to avoid early disturbance. The control is repeated about weekly. During weaning, we try to reduce cleaning of the cage to an absolute minimum as young sometimes crawl around the substrate (probably because they are accidentally carried out by the mother while suckling). With eight to ten days, young hamsters start to actively leave the nest. After four weeks, we separate the young from the mother. In course of this, we check the sex and apply a transponder. If necessary, young can be kept together until 8 weeks old, but attention should be paid towards signs of aggression in the group.



**Fig. 5:** Weight development of young European hamsters at Opel-Zoo. Litters may have been weighted several times on different days.



**Fig. 6:** Young hamsters of 5 (left above and below), 10 (middle above, at belly of mother), 16 (right above), 25 (middle below while receiving a transponder and right below during sex determination) days old. Photos: Opel-Zoo archive.



## Breeding from 2018-2023

From 2018-2023, over 165 European hamsters were born in Opel-Zoo between the months of May and August (Tab. 2). The average number of young per litter was 6 ( $n_{\text{litters}} = 27$ ; litters excluded if no young were found at first check-up, as number of young remains unknown). Of the young that were present at first health check at approx. day seven, 95% ( $n_{\text{young}} = 165$ ) reached an age of 8 weeks (56 days). On 6 occasions (18%,  $n_{\text{successful pairings}} = 33$ ), no young that reached an age of 7 days resulted from a successful copulation. In three of these cases, young were heard after birth but could not be found on first check-up. Because the mothers had successfully raised young before, we increased amounts of animal protein in the diet (changes already included in Table 1), as vitamin B3 deficiency deriving from nutrition has been shown to cause infanticide in European hamsters (Tissier, M.L., Handrich, Y., Dallongeville, O., Robin, J.P. & Habold, C., 2017). In the other three cases, which involved two females, no signs of young were seen or heard. One of the females did not show behaviour changes prior to birth, so that keepers assume she did not conceive (Table 2). The other female changed behaviour, so that keepers assume that young were born but consumed by the mother. This mother is the same individual that developed stereotypic behaviours during temporary holding in small cages. The female is the only one which never raised young and the only hamster that developed stereotypies in Opel-Zoo.

**Tab. 2:** Breeding of European hamsters in Opel-Zoo from 2018-2023. Sex m = male, f = female, ? = unknown, Aug. = August. Litters of which not all young survived are highlighted in italics. Pairings from which no young reached the age of 7 days are highlighted in grey.

Year	Number of pairing	Number of young at first counting (~ 7 days)	Number of young living up to day 56	Month of birth	Sex			Comments
					m	f	?	
2019	1	7	7	May	1	6	0	
2019	2	7	7	June	4	3	0	
2019	3	3	3	June	0	3	0	One young with missing leg
2019	4	1	1	June	0	1	0	
2019	5	0	0	June	?	?	?	Mother =
2019	6	0	0	July	?	?	?	stereotypic female
2020	7	7	7	June	3	4	0	
2020	8	5	5	June	3	2	0	
2020	9	3	3	June	2	1	0	
2020	10	6	6	June	2	4	0	
2020	11	2	2	June	1	1	0	
2021	12	8	7	May	4	3	1	
2021	13	6	6	May	4	2	0	
2021	14	5	4	May	1	3	1	
2021	15	0	0	May	?	?	1	Young heard
2021	16	7	7	May	5	2	0	
2021	17	6	5	May	3	2	1	
2021	18	5	5	June	2	3	0	

Tab. 2: Continued.

Year	Number of pairing	Number of young at first counting (~ 7 days)	Number of young living up to day 56	Month of birth	Sex			Comments
					m	f	?	
2021	19	7	7	July	3	4	0	
2021	20	5	5	July	3	2	0	
2021	21	6	6	July	3	3	0	
2022	22	9	8	May	2	6	1	
2022	23	2	0	May	?	?	?	<i>Mother had a tumor</i>
2022	24	7	7	May	3	4	0	
2022	25	0	0	May	?	?	1	<i>Young heard</i>
2022	26	0	0	May	?	?	1	<i>Young heard</i>
2023	27	9	9	May	4	5	0	
2023	28	7	6	May	6	0	0	
2023	29	9	9	May	2	7	0	
2023	30	9	9	May	5	4	0	
2023	31	9	9	May	6	3	0	
2023	32	0	0	-	?	?	?	Probably not conceived
2023	33	8	7	Aug.	4	3	1	
<b>Total</b>	<b>33</b>	<b>165</b>	<b>157</b>		<b>76</b>	<b>81</b>	<b>8</b>	

## Reintroductions

Experience shows that, to improve reintroduction success, European hamsters should have a minimum weight of 150 g, better 200 g, when released (Lisa Heimann & Marco Sander, Institute for Faunistic & breeding centre for European hamsters at Heidelberg Zoo, pers. communication). Therefore, second litters of a female born in one season stay in care during winter to be reintroduced early in the next year. As females from the first litter of a year can give birth in the same year, young females can breed in Opel-Zoo once and then be released after winter.

With the help of Frankfurt Zoo and Zoo Osnabrueck, which kept young hamsters born in Opel-Zoo until they were heavy enough for release, a total of 116 European hamsters were reintroduced at two different sites in Hesse to date (24 in 2020, 27 in 2021, 31 in 2022, 34 in 2023). The numbers include two wild individuals that were caught by authorities for translocation and were released after they had bred successfully at Opel-Zoo as well as three individuals born at Zoo Osnabrueck.

The two reintroduction sites are situated in different districts and therefore executed and controlled by different authorities. At one site, situated in district Darmstadt-Dieburg, the hamster population failed to thrive due to unknown reasons so that reintroductions were stopped. The other reintroduction site is situated in the Hochtaunuskreis and is supposed to connect the remaining hamster populations in the districts Hochtaunuskreis and Wetteraukreis. Camera-trap monitoring by the regional nature conservation authority (Untere Naturschutzbehörde Hochtaunuskreis) confirms that the reintroduced hamsters have successfully reproduced in 2022 and 2023 (Figure 7). Regular mapping of hamster burrows suggests that the number of reintroduced

hamsters born in the breeding station at Opel-Zoo is sufficient to keep the population viable (Untere Naturschutzbehörde Hochtaunuskreis, unpublished data). Monitoring of the population and evaluation of the project is ongoing.



**Fig. 7:** Young European hamster leaving the burrow. Camera trap at one of the two reintroduction sites in June 2023. Photo: Untere Naturschutzbehörde Hochtaunuskreis.

## Discussion and Conclusions

By intensive management, it is possible to breed up to 55 (and possibly more) European hamsters annually with only 7 breeding females and keep the hamsters in accordance with German regulations in a comparatively small breeding station (32 m<sup>2</sup> + outside enclosures for 2 individuals). While daily husbandry is relatively easy and quickly accomplished, mating is time consuming and requires experienced staff as well as detailed documentation. Keeping European hamsters in small mammal aviaries might have advantages for the animals as the ventilation is very good, and hamsters can have access to more space and options for vertical movement than in most traditional keeping systems. On the downside, this might reduce the numbers of animals that can be kept in a given space, potentially leading to a reduced number of individuals bred for reintroductions each year. Therefore, future studies should investigate if and how different husbandry systems influence the welfare of the animals, the number of births per litter, and the survival and growth rates of young in the stations and after reintroduction.

Survival rates of European hamsters in the weeks after release are low, but measures as electric fencing to prevent the predation by foxes can be taken to improve individual survival (La Haye et al., 2020; Vиллемey et al., 2013). The long-term survival of re-established populations is influenced by several factors related to habitat quality, as agricultural practices (La Haye et al., 2020; Ulbrich & Kayser, 2004; Vиллемey et al., 2013) and light pollution (Banaszek et al., 2020; Surov et al., 2016), as well as habitat size and connectivity (Ulbrich & Kayser, 2004). Therefore, detailed monitoring is vital to determine whether the number of individuals that are currently bred and reintroduced in Hesse is sufficient to establish self-sustaining populations.

This includes regular examination and possibly adjustment of habitat management and quality. In the project in Hesse, these complex tasks are implemented by the responsible federal agencies (Regierungspräsidium Darmstadt & Untere Naturschutzbehörde Hochtaunuskreis) and their partners. It will take several years until sufficient data is available to fully evaluate the project. Nevertheless, breeding success of reintroduced hamsters and numbers of active burrows at one reintroduction site indicate that with carefully chosen and well-prepared habitats as well as scientific monitoring, reproduction of European hamsters in breeding stations can play a vital role in the conservation of this species.

## Acknowledgments

We thank our colleagues of Heidelberg Zoo and the Institute for Faunistic, especially Lisa Heimann and Marco Sander for sharing their knowledge on European hamsters, and Lisa-Johanna Ebner for her vital input. Furthermore, we thank Zoo Osnabrueck and Frankfurt Zoo for their support in holding young hamsters until they have gained sufficient weight, which is important for reintroduction success.

## Zusammenfassung

Einst in ganz Westeuropa verbreitet, ist die Populationsgröße des Europäischen Hamsters in den letzten 40 Jahren drastisch zurückgegangen. Er ist jetzt gelistet als vom Aussterben bedroht und es müssen dringend Maßnahmen ergriffen werden, um das Überleben der Art zu ermöglichen. Deshalb hat der Hochtaunuskreis (Hessen, Deutschland) 2012 damit begonnen Erhaltungsmaßnahmen ergriffen und ein Wiederansiedlungsprogramm für den Europäischen Hamster initiiert, das im Jahr 2020 begann. Der Opel-Zoo unterstützt diese Initiative, indem er Hamster für die Auswilderung züchtet. Wir beschreiben hier das Haltungssystem im Opel-Zoo entwickelte Haltungssystem, in dem jeder Hamster nach den in Deutschland geltenden Regeln (Gutachten über Mindestanforderungen an die Haltung von Säugetieren vom 7. Mai 2014) relativ kosten- und platzsparende Weise gehalten werden kann. Seit 2018 sind im Opel-Zoo über 165 Hamster geboren worden, von denen 157 ein Alter von acht Wochen überschritten haben. Die mittlere Wurfgröße betrug 6. Bis August 2023 wurden 116 europäische Hamster in geeigneten Lebensräumen in Zusammenarbeit mit den den Bundesbehörden (Regierungspräsidium Darmstadt & Untere Naturschutzbehörde Hochtaunuskreis) in geeigneten Habitat eingebracht. Es wurde bestätigt, dass einige von ihnen erfolgreich reproduziert haben.

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