

Sus caledonia: Extinction, Myth & Reintroduction.

Allan David James Hunter¹

Evangeline Abigail Hunter²

Affiliations:

- 1) Haggis Guardian Institute of Study (H.G.I.S.), Balnagowan Woods, B9092, Nairn, IV2 7QX, Scotland.
- 2) Scottish Association for Marine Science, Oban, Argyll, PA37 1QA

Corresponding author: A. Hunter (H.G.I.S.), ahunter.bowhunterarchery@outlook.com

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Abstract

The Scottish Haggis (*Sus caledonia*) has historically been dismissed as folklore, resulting in limited ecological recognition and conservation action. This study evaluated whether a captive breeding and reintroduction programme could support population recovery of the Highland subspecies. Over a five-year period (2019–2024), 20 adult individuals were maintained within a semi-natural captive environment designed to replicate native habitat conditions. Behavioural monitoring was conducted using remote camera systems, direct observation hides, and thermal drone surveys.

Breeding occurred consistently in captivity, with a mean annual productivity of 25 offspring. Natural social structures, maternal care, and foraging behaviours were retained across generations. A total of 72 juvenile individuals were reintroduced to their original range at two years of age. Post-release monitoring indicated high adaptation success, with mortality limited to road traffic incidents (n=2) and respiratory disease (n=7). Ten individuals lost tracking collars, while the remaining monitored animals integrated into wild social groupings.

These findings demonstrate that captive breeding and structured reintroduction can be effective conservation tools for *S. caledonia*. The project provides a framework for future subspecies recovery and contributes to reintroduction biology in small endemic ungulates.

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Background

Scientific Classification

From the taxonomic classification (Wilson & Reeder, 2005), it can clearly be seen where the haggis evolved from. (Table 1).

Table 1. Taxonomic classification of *Sus caledonia*.

Scientific Classification	
Domain:	Eukaryota
Kingdom:	Animalia
Phylum:	Chordata
Class:	Mammalia
Order:	Artiodactyla
Family:	Suidae
Genus:	<i>Sus</i>
Species:	<i>S. caledonia</i>
Binomial Name	
<i>Sus caledonia</i>	

At the beginning of the project, it had been suspected that the haggis may have been a second species in the genus *Porcula*. (Groves & Grubb, 2011) Potentially a distant relation to the pygmy hog (*Porcula salvania*). This was discovered to be an incorrect hypothesis, and the haggis is more closely related to the wild boar (*Sus scrofa*) (Frantz et al., 2016) of the Northern Hemisphere.

The haggis (*Sus caledonia*) is a small and endangered species of “pig-like” animal. Endemic to Scotland (Figure 1), the haggis is a suidae native of the woodlands, coast, moors, mountains and glens of Scotland. Populations of haggis were once widespread throughout Scotland. As of 2024, 4 subspecies of haggis have been found, (IUCN SSC Wild Pig Specialist Group, 2017) ranging throughout Scotland. These subspecies consist of the Highland, Lowland, Island and Mountain haggis.

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Distribution & habitat of the haggis



Figure 1. Historical and current distribution of *Sus caledonia* in Scotland.

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Due to human encroachment and the destruction of the haggis' natural habitat, the species was thought to have gone extinct by the early 1960s. However, in 2000, a small haggis population was rediscovered. They were seen fleeing a wildfire, near the Moray Forth. Today, this original population of haggis still resides in this area of the Moray Firth. Since 2000 further populations of haggis have been rediscovered (Seddon, Armstrong & Maloney, 2007) all over the Scottish Mainland and Islands. Exhibiting subtle differences and adaptations for habitat, the haggis is an ecologically adaptable species.

Conservation

The population is threatened by habitat destruction (primarily through house building), fires and illegal hunting. With an estimated population of less than 500 mature individuals in the wild, the haggis is listed as an Endangered species on the IUCN Red List, (Figure 2), (IUCN Standards and Petitions Committee, 2022) and conservation efforts such as captive breeding and re-release programs are desperately needed to ensure their survival .



Figure 2. IUCN Red List threat classification categories (IUCN 3.1 framework).

Predation

Humans are the haggis' main predator in most of its natural range. Anecdotal accounts suggest that small numbers are predated by Golden Eagle (*Aquila chrysaetos*) and White-tailed Eagle (*Haliaeetus albicilla*). (Watson, 2010; Love, 1983) There is little scientific proof to support this theory. The haggis has a long history of association with humans, having been classed as a game animal for millennia. During the Victorian era, considerable damage was done to the haggis population in Scotland. Many Victorian gentlemen travelled to Scotland from far and wide for the honour of trying to complete the "Holy Grail of game". For the skilled and wealthy adventurer, it was possible to start at Dawn fly fishing for an Atlantic Salmon. From here they would move to the hills and moorlands in an attempt to bag a brace of Grouse, stalk a Red Deer Stag and for those cunning enough 'chasse' a haggis, all before dusk. haggis were also bred for their coats. The haggis were sheared and the fur spun to produce a material more expensive and rarer than cashmere and Vicuña wool. This practice ceased in the early 1910's with the numbers of both wild and farmed haggis dropping to unsustainable levels.

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Method

For this research study it was decided that the “Highland” subspecies of the haggis would be used as the test subject for Phase 1. It was hoped that if the project was successful, it could be replicated for the further 3 subspecies of haggis. The project was subject to ethical review, focusing on animal welfare, (AWERB for research) licensing, (NatureScot) ecological impact, and community consultation, with a strong emphasis on the "3Rs" (Replace, Reduce, Refine) and detailed harm-benefit analysis to ensure minimal harm and maximum conservation benefit, especially for protected species.

Monitoring

Monitoring was to be carried out 24 hours a day with behavioural data recorded and first-hand observation taken. By ensuring that human interaction was kept to a minimum, the haggis were able to follow their natural behaviour. Importance was placed on the ability for observations to be taken without the observer disturbing the natural behaviours of the test subjects. In order to achieve this a wireless network of 250 remote cameras fitted with 360° motion sensors and night vision were placed throughout the location. (O’Connell, Nichols & Karanth, 2011) Drones with thermal imaging cameras proved to be a useful addition, following guidance set out by Schad and Fischer (2022) in their publication on the opportunities and risks in the use of drones for studying animal behaviour. (Schad & Fischer, 2022) Alongside these advanced technologies, 48 hides were built at strategically chosen sites. With the use of one-way mirrors these hides were able to offer 270° visibility. First-hand observation was undertaken between the hours of 06:00 - 18:00. Out-with these times footage was recorded remotely and reviewed on a daily basis.

Habitat

The project was designed over a period of two years. Computer models of the haggis and habitat were used to study and identify an optimal location for the captive breeding programme. It was important that our test site included a similar habitat vegetation %, prey availability and area per group as their natural environment offers. Habitat composition included approximately 60% woodland cover and 40% open moorland, reflecting regional ecological structure. It took a further 16 months to find and purchase a suitable location. Due to the suitability of the final site, it only took four months to secure the perimeter and finish the construction. This was done at an undisclosed location to ensure the safety of the haggis and prevent poaching. The habitat took into account all the needs of the haggis and tried to replicate their natural environment as closely as possible. The location consisted of 9 acres of mixed Scots Pine (*Pinus sylvestris*) woodland and heather (*Calluna vulgaris*) moorland. The site contained a small Lochan and several burns.

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Participants

A test population of 20 mature haggis were humanely captured before the beginning of the breeding season 2019 and relocated to the facility before the end of November. Initial founder size was constrained by ethical and population viability considerations. The group was made up of 14 females and 6 males. All subjects were trapped humanely and transported to the facility whilst under sedation, (IUCN, 2013) following the advice and information from the paper: *Trapping Wild Pigs: Techniques and Designs* written by Bethany Wight, Raoul K. Boughton, and E. Hance Ellington. (Bethany Wight, Raoul K. Boughton, and E. Hance Ellington, 2018) All of the mature subjects were trapped using a corral and were then sedated. During sedation each subject underwent a physical examination to ensure there were no visible injuries. At this point all subjects were fitted with a tracking collar and assigned an identification number. Transportation occurred under sedation, and all subjects were moved to the research location and released without incident. Tables 2 and 3 show the identification number, the date and time captured and an identification photo for each of the 20 subjects.

Table 2. Identification data for adult male Haggis captured for the study population.

Haggis ID Number	Capture Date & Time	Identification Photo
20	6 Nov 2019 06:30 UTC	
19	6 Nov 2019 06:45 UTC	
18	6 Nov 2019 06:45 UTC	
17	6 Nov 2019 08:00 UTC	
16	6 Nov 2019 08:45 UTC	
15	6 Nov 2019 09:00 UTC	

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Table 3. Identification data for adult female Haggis captured for the study population.

Haggis ID Number	Capture Date & Time	Identification Photo
1	7 Nov 2019 08:15 UTC	
2	7 Nov 2019 08:45 UTC	
3	8 Nov 2019 17:45 UTC	
4	8 Nov 2019 16:30 UTC	
5	8 Nov 2019 21:15 UTC	
6	11 Nov 2019 06:45 UTC	
7	11 Nov 2019 19:30 UTC	
8	15 Nov 2019 06:00 UTC	
9	15 Nov 2019 06:00 UTC	
10	15 Nov 2019 07:00 UTC	
11	15 Nov 2019 08:15 UTC	
12	15 Nov 2019 20:30 UTC	
13	16 Nov 2019 08:45 UTC	
14	16 Nov 2019 10:45 UTC	

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Assessments and Measures

Once the haggis were relocated to the facility, they quickly began to explore their new surroundings. From Day 1 data was collected 24 hours a day using CCTV and face-to-face observations. With the use of hides, cameras and one-way mirrors it was possible to keep direct human interaction to a minimum. All behaviours were recorded, allowing us to create a clearer picture of the day-to-day habits of the haggis. The following section will cover the results of these observations.

Social behaviour and life cycle

Over the past five years we have been privileged to be able to discern a far greater understanding of the haggis. So much knowledge has been lost over the decades, and the haggis turned into a mythical creature. With the completion of Phase 1, we are finally able to provide an insight into the life cycle and behaviours of the haggis.

Social Groupings

Haggis are incredibly social animals. They live in female-dominated groups, known as a cèilidh, consisting of barren older females and breeding females, called wifey's, with young. These cèilidh are led by one of the old matriarchs.

Male haggis leave their cèilidh at the age of 18 months, while females either remain with their mothers or establish a new cèilidh nearby. Males live in small groups called a stooshie, while elderly males tend to be solitary, preferring peace and quiet away from the wifey's and young.

(Jensen, 2017)

Reproductive Behaviour

Males reach sexual maturity at around 5 years old with females a year earlier at 4. The breeding season, referred to as the hochmagandy, runs from the 30th of November to January the 25th. Prior to mating, the males become argumentative and aggressive. The scrotum, locally known as the bawbag, of the male haggis doubles in size and glands secrete an effervescent orange liquid. Once ready to reproduce, males travel long distances in search of a cèilidh of wifey, eating little on the way, but with increased fluid intake. Once a cèilidh has been located, the male will attempt to drive off any males, below breeding age, and then begins to persistently chase the wifey. Once this stage has been reached, males of breeding age will fight potential rivals in a display known as laldy. A single male can mate with 6-8 wifey. By the end of the hochmagandy season, males are often badly injured, exhausted and can lose up to 28% of their body weight, with bite and hoof related injuries to the penis being common. (Fernández-Llario & Carranza, 2000)

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Gestation and Birth

The gestation period ranges from 60-70 days. Farrowing occurs around the beginning of April, with litter size depending on the age and nutrition of the mother. The average litter consists of 1-2 young, although 3 have been recorded during peak environmental conditions. The young haggis, or haglets, farrow in a nest, called a hoosie, constructed from heather, grasses and leaves. After four weeks the haglets are able to leave the hoosie and begin to follow their mother. Should the mother die prematurely, haglets are often adopted by the other wifey in the cèilidh.

All haglets are born dark brown and fluffy to blend in with the surrounding habitat. After six to eight weeks their coats begin to gradually lighten. Newborn haglets weigh around 300-500 grams, bearing a single milk incisor and canine on each half of the jaw. There is intense competition between haglets over the milk-rich nipples, as the best-fed young grow faster and have stronger constitutions. It has been observed that dominant haglets will try and suckle from any lactating wifey within their cèilidh. The haglets do not leave the nest or hoosie for the first month of life. Should the mother be absent, the haglets lie closely pressed to each other or cover themselves with a warm layer of dried bedding. By two months of age, the haglets will be accompanying their mother on her foraging trips. Should danger be detected, the haglets hide or stand immobile, relying on their camouflage to keep them safe. The neonatal coat fades completely after six months, with adult colouration being attained by 1 year old. Although the lactation period lasts 6-8 months, the haglets begin displaying adult feeding behaviours at the age of 4-6 months. The permanent dentition is fully formed by 1-2 years. The teeth stop growing during the middle of the third year.

Sows are capable of attaining sexual maturity at the age of 4 years old, with males reaching sexual maturity a year later, however, oestrus more commonly first occurs around 5 years old in sows. Males will begin participating in the laldy at 5 years old. At this age it is unlikely they will be permitted to mate by the older males but will learn the techniques needed to eventually maintain a cèilidh of their own. The maximum lifespan of a haggis in the wild is 13-18 years, though few individuals survive past 10-12 years. It is hoped that haggis in captivity will be able to live for 20+ years, but this may only be possible with man's intervention.

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Results

The first-hand observations have been extremely important in terms of expanding our understanding of the haggis. This was a tertiary outcome though. The main aims of this project were to discover if two outcomes were possible with a captive population of haggis.

Outcome 1

Would haggis breed in captivity?

Due to the complete lack of recorded knowledge regarding the haggis, both farmed and wild, there was no means of knowing how best to facilitate breeding amongst a captive population. With only an ability to replicate, what we had previously observed to be, an ideal environment, the rest of the process would be down to the test subjects. From the following figure, (Figure 3) it can be seen that free-range, captive haggis, breed in similar numbers to those in the wild. This would be further confirmed by comparison to a control population. Unfortunately wild comparison data is limited due to endangered status.

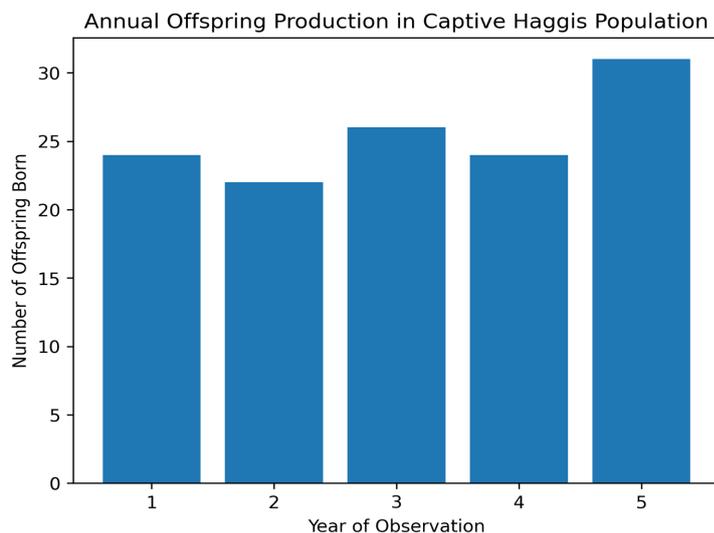


Figure 3. Annual reproductive output of captive *S. caledonia* population (2019–2024)

The test subjects adapted quickly to their new environment and returned to normal behaviour after only two days. For the five years of the project the number of offspring produced remained steady with an average of 25 young born per year and a total of 72 haglets over the course of the project. In a further paper, to be published in 2026, we will break down the individual offspring for each of the 14 female haggis and cover the secondary experiment conducted between years four and five. This experiment looked at the effect of nutrition on litter size and haglet health and built on research by Alexa Gormley et al. (2024) to explore the ‘Impacts of Maternal Nutrition on Sow Performance and Potential Positive Effects on Piglet Performance’. (Gormley A., Beom Jang K., Garavito-Duarte Y, Deng Z., Kim S., 2024)

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Outcome 2

Could any resulting offspring be reintroduced to the wild successfully?

It was decided that no offspring would be reintroduced to the wild until they were two years of age. This resulted in the need to partition off part of the habitat to house the young male haglets. These subjects could then be trapped, sedated and returned to the wild after reaching two years of age. The female haglets were able to remain in their cèilidh until two years of age. This did create logistical issues when it came to capturing them. The solution of manufacturing a smaller corral with a significantly smaller gate, allowed the capture of only the haglets. Even the smallest of the wifey's were too large making capture of them impossible.

Once captured the haglets were returned to the original location that the 20 test subjects came from. All haglets were fitted with tracking collars which sent location data every 15 minutes. With this data we were able to monitor the range of the newly released haglets, and the GPS data enabled us to narrow down search areas when monitoring the haglets first-hand. Through the combination of GPS data and tracking of the haglets in person, we were able to monitor the 72 released haglets. Table 5 contains the outcome / incident report for the released haglets.

Table 5. Post-release outcomes of 72 reintroduced haglets.

Outcome / Incident	Number of Haglets	Notes
Released into the wild	72	Total number of haglets released
Tracking collars damaged or removed	10	Collars rendered non-functional. Collar loss represents a known limitation in wildlife telemetry studies.
Deaths due to disease (first year post-release)	7	Cause identified as lung disease, possibly silica dust exposure from nearby building site. Based on post-mortem lung pathology and proximity to construction sites.
Road traffic accident fatalities	2	Both incidents resulted in fatal injuries

Over the next two years the remaining haglets will be released back to the wild. They will continue to be monitored thanks to funding received from Bowhunter Archery Scotland. This funding will allow long-term monitoring to be ongoing. Releasing haglets has been a success so far. The haglets have been able to survive on their own and have managed to integrate themselves into groups of young males and cèilidh. To date there have been no signs that being raised in captivity has resulted in the haglets being unable to learn the needed behaviours and skills to survive on their own. This is partly due to the lack of human

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interaction during their time in captivity, but primarily because the wifey's are incredibly protective and capable mothers.

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Discussion.

This study represents the first structured ecological and behavioural investigation of *Sus caledonia* under controlled conservation management. The findings demonstrate that the species retains natural social organisation, reproductive capacity, and behavioural competence under semi-natural captive conditions. Comparable to other successful Scottish reintroduction programmes, such as the Eurasian beaver (*Castor fiber*), this work supports captive breeding as a viable recovery strategy for small, habitat-specialist mammals. (Gaywood, 2018) The observed post-release survival rate indicates that captivity did not result in behavioural maladaptation, a risk frequently associated with reintroduction efforts. (IUCN, 2013) Maternal learning and minimal human interaction appear to have preserved essential survival skills.

The next steps for Phase 1 of the project will be to continue using the current location to breed Highland haggis for reintroduction. The decision has been made to increase the number of mature haggis. This is possible due to the increase in knowledge regarding the area needed per cèilidh. Highland haggis do not range far and stay within an acre of land. This allowed us to concentrate the cameras and observers in the hides to an area of just under three acres. We believe this will allow us to comfortably increase the number of haggis from 20 to 50. Currently this will be possible for another three years and it is hoped further funding will be approved.

Phase 2 of the project is currently only partially funded, with the remaining funding being finalised by the end of July 2026. Once this funding has been secured a suitable uninhabited island of roughly four and a half acres has been donated to the project. The donor wishes to remain anonymous. The location of the island will not be disclosed to any parties outside of the project. This will allow us to replicate Phase 1 with the capture of 30 mature haggis of the Island subspecies. Due to differences in food source and cèilidh size from the Highland haggis, we believe it is possible for Phase 2 to begin with a larger number of test subjects. With the lessons learnt from Phase 1, we have been able to improve the processes from capture to release significantly. Over the next 5 years we hope to report a similar success story for the second subspecies of haggis to be bred in captivity and released back into their natural habitat. If this is the case it is hoped that the project will eventually cover all four subspecies of haggis.

If scaled appropriately across subspecies, this programme may enable population recovery sufficient to reassess conservation status within one generation.

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