

African swine fever and detection dogs for wild boar carcasses

This is part of a broader study on the possibilities for deploying detection dogs to locate wild boar carcasses in the event of an outbreak of African swine fever (by Hilde Vervaecke and Manon De Meester, Odisee University of Applied Sciences, Belgium; steering committee members: Uta Kielau, Ellen Van Krunkelsven, Kristof Baert, and Arno Thomaes).



Report 7. Durability of expertise of detection dogs for wild boar carcasses and alternative targets

What is the future of the trained African swine fever (ASF)-detection dog teams after African swine fever is gone? Information on how to maintain a durable expertise of detection dog teams was screened from various sources:

1. Scientific literature
2. Information from protocols, reports and related materials
3. Information from interviews and conversations with people with experience in the training, deployment or governmental management of detection dogs aimed at combating African swine fever.

The sources used in this work include both peer-reviewed scientific literature and grey literature (e.g. protocols, reports and consultations with experts). While peer-reviewed publications provide scientifically validated evidence, grey literature and expert input mainly offer practical and contextual insights and should be interpreted accordingly.

Citation: Manon De Meester & Hilde Vervaecke, 2025. Durability of expertise of detection dogs for wild boar carcasses and alternative targets. Report 7 for ANB (Agency for Nature and Forests).

Acknowledgements: Patrick D'Artois, Anouck Decors, Sophie Desvaux, Kai-Uwe Gries, Christina Jehle, Uta Kielau, Jürgen Scharf, Ellen Van Krunkelsven, Heike Wagner.

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Literature review of other targets for a public benefit

Training multiple odours

Training detection dogs for wild boar carcass detection is an investment in the future, even when the threat of African swine fever has subsided. Dogs can learn to discriminate up to 40 different odours, and some researchers estimate that their potential is even higher (Hayes et al., 2018; Johnston, 1999; Waggoner et al., 2022). Although some claim that specificity decreases as more odours are added to a dog's repertoire (Göth et al., 2003; Hayes et al., 2018; M. Williams & J. M. Johnston, 2002; Yin et al., 2008), Waggoner et al. (2022) demonstrated that specificity remained stable and that no increase in false positives occurred as the number of trained odours increased—even when the number reached 40. Higher numbers were not tested, so the upper limit of this potential remains unknown.

What was shown, however, is that even when an odour had not been trained for 12 months, accuracy remained high and stable, with some odours still detected with 100% accuracy. This stability was only achieved when the dog continued training on another odour in the meantime. In other words, the dog must maintain its discrimination skills, but does not need to rehearse every individual odour to retain it long-term. Training on just one odour is sufficient to maintain the entire repertoire of learned odours (Waggoner et al., 2022).

Similarly, a 2021 study by Lazarowski et al. showed that dogs were able to recognise and discriminate 10 previously learned odours after one year without training on them, simply by receiving occasional training on one other odour during that period (Lazarowski et al., 2021; Porritt et al., 2015; Thrailkill et al., 2018; Waggoner et al., 2022).

The ability to learn multiple odours without losing sensitivity is a major advantage. In fact, the more odours a dog learns, the less training it appears to need to acquire new odours (Waggoner et al., 2022). Additionally, dogs with prior experience in odour training—whether in recreational scent work or professional detection—perform better on new odour tests and generalise more quickly than dogs without such experience (Degreeff et al., 2018).

This information demonstrates that dogs previously trained to detect wild boar carcasses can be trained on additional target odours without losing accuracy for carcass detection. They can therefore be deployed for other projects between ASF crisis periods, and they may progress more quickly in training for new targets because each new odour requires less practice (as shown in Waggoner et al., 2022).

Broad application

Regarding the nature of potential follow-up projects, the possibilities are endless. Detection dogs have already proven their value in many different fields and for a wide variety of target odours. Examples include detection dogs active in police work, deployed by other emergency services, or used for military purposes such as detecting explosives, narcotics, missing persons, live humans in emergency situations such as earthquakes, and human remains in criminal investigations (Alexander et al., 2016; Clare Browne et al., 2006; Furton & Myers, 2001; Gazit & Terkel, 2003; Jones, 2011; Lazarowski & Dorman, 2014; Prada & Chávez Rodríguez, 2016; Settle et al., 1994; Sommerville et al., 1993; Williams & Johnston, 2002).

Detection dogs have also proven useful in medicine. They can recognise microorganisms such as bacteria and viruses (for example the SARS-CoV-2 virus) and can indicate the presence of cancer cells (Bomers et al., 2014; Bryce et al., 2017; Grandjean et al., 2020; Jendry et al., 2020; Jezierski et al., 2015; Koivusalo et al., 2017; Koskinen et al., 2017; Moser & McCulloch, 2010; Reeve & Koivusalo, 2018; Taylor et al., 2018). Dogs may offer higher accuracy, require less time, be cheaper, less invasive, and easier to apply than PCR tests for SARS-CoV-2 detection (Hag-Ali et al., 2021). Diseases such as

diabetes, epilepsy, and chronic wasting disease in cervids can also be recognised and indicated by detection dogs (Elliker et al., 2014; Gadbois & Reeve, 2014; Hardin et al., 2015; Mallikarjun et al., 2024; Reeve & Koivusalo, 2018; Strong et al., 1999).

In addition, detection dogs are highly capable of locating pest species or native species and can assist biologists in conservation projects by helping to map species distributions, identify species that are difficult to distinguish from similar species, and locate species that are very well hidden. Wildlife detection dogs can also contribute to combating the illegal trafficking of animals or animal products (Braun & Stuart, 2018; Glover et al., 2023; Grimm-Seyfarth et al., 2019; Hoyer-Tomiczek et al., 2016a; Hurt & Smith, 2009; Kerley, 2010; Matthew & Relton, 2021; Matthew et al., 2021; Smith et al., 2003; Stevenson et al., 2010; Wasser et al., 2004).

Deploying eco- and wildlife detection dogs

Examples of previously researched target species and their possible relevance for Flanders

The animal species that dogs have already been trained to detect vary widely and are not limited to specific taxonomic groups. Dogs have been trained to detect mammals, reptiles, birds, amphibians, and insects (Arnett, 2006; Beckmann, 2006; Cablk & Heaton, 2006; Glover et al., 2023; Homan et al., 2001; Lin et al., 2011; Matthew & Relton, 2021; Paula et al., 2011; Vice & Engeman, 2000).

Examples of mammals for which ecological detection dogs have been trained include wolves (*Canis lupus*) (Vervaecke et al., 2021), a species protected under the European Habitats Directive (92/43/EEC) and, in Flanders, under the Flemish Species Decree and Annex III of the Nature Decree (“Besluit van de Vlaamse Regering met betrekking tot soortenbescherming en soortenbeheer”, 2009; “Decreet betreffende het natuurbewoud en het natuurlijk milieu”, 1997; “Europese Habitatrichtlijn (92/43/EEG)”, 1992). More information is available at <https://www.natuurenbos.be/dossiers/de-wolf-vlaanderen>.

Other target species include grizzly bears (*Ursus arctos horribilis*) and American black bears (*Ursus americanus*) (Wasser et al., 2004), spotted-tailed quolls (*Dasyurus maculatus*) (Leigh & Dominick, 2015), the critically endangered riverine rabbit (*Bunolagus monticularis*) (Matthew & Relton, 2021), and the bobcat (*Lynx rufus*) (Clare et al., 2015).

Another mammal successfully detected by dogs is the European otter (*Lutra lutra*), a species for which a species protection programme has been established in Flanders (Ministerial Decree establishing a species protection programme for the European otter, 2022) (Demir, 2022; Grimm-Seyfarth et al., 2019; Oldenburg Jr et al., 2016). Dogs have also been able to detect primates, including the black crested gibbon (*Nomascus concolor*), the Indochinese grey langur (*Trachypithecus crepusculus*), and the stump-tailed macaque (*Macaca arctoides*) (Orkin et al., 2016).

They can also detect European beavers (*Castor fiber*), another species protected in Flanders and the subject of a species protection programme (Ministerial Decree establishing a species protection programme for the European beaver, 2024) (Demir, 2024; Rosell et al., 2019). Finally, there is the golden jackal (*Canis aureus*), a species that occasionally passes through Belgium but is not registered as native (Hatlauf et al., 2021).

Examples of amphibians include the great crested newt (*Triturus cristatus*), a species protected at the European level and also the subject of species protection programmes in Flanders (Ministerial Decree establishing a species protection programme for the crested newt, 2019) (Demir, 2019; Glover et al., 2023), and the American bullfrog (*Lithobates catesbeianus*), an invasive alien species in Flanders (Matthew et al., 2021).

Examples of insects include the larvae of the hermit beetle (*Osmoderma eremita*), a species listed under the EU priority Habitats Directive and classified as “near threatened” on the European IUCN Red List. The species has become extremely rare in Europe and may even be extinct in Belgium (Mosconi et al., 2017). <https://www.iucnredlist.org/fr/species/157901/5169119>

Dogs have also been trained to detect stoneflies, particularly the endangered alpine stonefly (*Thaumatoperla alpina*) (Rutter et al., 2021), as well as the Asian longhorn beetle (*Anoplophora glabripennis*), an invasive and harmful alien species in Belgium (Hoyer-Tomiczek et al., 2016b). Detection dogs have also been successfully used to improve estimates of wind turbine casualties, including birds and bats (Domínguez del Valle et al., 2020; Paula et al., 2011).

Brief comparison with other methods

According to several studies, detection dogs used for locating other species—whether endangered species or pest species—deliver better performance and results than other monitoring methods. These alternative methods include track plates, camera traps, hair snares, and human-conducted searches. The use of drones as a monitoring method has already been discussed in another literature review included in the deliverables of this ASF-control project (Eyes on the target: deploying drones to detect wild boar carcasses for ASF control and prevention, 2025). A structured comparison between drones and detection dogs, including their compatibility and complementarity, is also discussed elsewhere (Report 11).

Here, the comparison is briefly made with the more traditional methods mentioned above. Dogs appear to be better at finding rare species and multiple species spread across large areas. In addition, the use of dogs—and the resulting sample—would be less spatially biased, meaning they have a lower “spatial sample bias.” This is because camera traps, track plates, and hair snares are fixed methods that remain in the same location for long periods and therefore miss animals that do not pass by them (Gorman & Trowbridge, 1989; Hassler et al., 2024; Long et al., 2007a, 2007b; Long et al., 2012; MacKay et al., 2008; Tom, 2012; Wasser et al., 2004).

Detection dogs can therefore reduce sampling bias compared to other monitoring methods and require far less effort, time, and personnel than human searchers working without dogs (C. Browne et al., 2006; Duggan et al., 2011; Harrison, 2006; Mosconi et al., 2017; Paula et al., 2011; Wasser et al., 2004).

Dogs are also better than humans at finding species that tend to remain hidden. Humans rely heavily on visual perception, whereas dogs are superior in olfactory perception. As a result, they detect far more than humans can see. They are estimated to be 4 to 12 times better than humans at locating the target species (Arnett, 2006; Duggan et al., 2011; Glover et al., 2023; Goodwin et al., 2010; Homan et al., 2001; Hurt & Smith, 2009; Karp, 2020; Long et al., 2007a; Mosconi et al., 2017; Paula et al., 2011; Rutter et al., 2021).

Similarly, unlike humans, the accuracy of detection dogs is barely affected in densely vegetated environments. However, dense vegetation—such as brambles or thick shrubs where targets like feces are hidden underneath or between vegetation—can reduce the dog’s speed and efficiency. This effect also impacts human searchers, combined with their limited visual detection abilities (Domínguez del Valle et al., 2020; Hassler et al., 2024; Leigh & Dominick, 2015).

An example of a species that often remains hidden is the great crested newt, especially during its terrestrial phase when it shelters in burrows of other animals (Glover et al., 2023). Another example is the larvae of the hermit beetle (*Osmoderma eremita*). These larvae live concealed inside decaying tree trunks. One method to check for their presence is “wood mould sampling” (WMS), in which the decaying wood is manually inspected for larvae. This method can damage the larvae and is extremely time-consuming. Detection dogs, by contrast, appear to be a less invasive, more effective, and more efficient method for screening tree trunks for larvae. A major advantage is that well-trained wildlife detection dogs can give their alert from a distance, allowing the target species to remain largely undisturbed (Chambers et al., 2015; Hoyer-Tomiczek et al., 2016b; Mosconi et al., 2017).

Sensitivity and specificity

Another major advantage of detection dogs is their ability to achieve extremely high sensitivity. According to some studies, no analytical measuring instrument surpasses the sensitivity of well-trained

dogs (Buis et al., 2015; Bye et al., 2024; Concha et al., 2019; Hayes et al., 2018). They are capable of perceiving, recognising, and discriminating odours at very low concentrations. For example, in a study by Matthew et al. (2021), the scent of bullfrogs was diluted to 1:100,000 without affecting the dogs' sensitivity (Matthew et al., 2021).

Another example comes from Vyplelova et al. (2014), where dogs were able to identify individuals with 100% accuracy using cotton swabs. These swabs had never been in direct contact with the individuals. The individuals merely held their hand above the swabs for a few seconds, which was enough to transfer scent for the dogs to recognise.

Even when the target odour was part of a mixture of scents, or when it was masked by many other odours, dogs were still able to identify the target scent (Beebe et al., 2016; Domínguez del Valle et al., 2020; Hayes et al., 2018; Helton, 2009; MacKay et al., 2008; Matthew et al., 2021; Vyplelova et al., 2014).

In addition to high sensitivity, dogs also possess strong discrimination abilities, resulting in high specificity. In a study by Matthew et al. (2021), detection dogs distinguished the scent of bullfrogs from other frog species with 98.6% specificity. Dogs were also able to distinguish otter scat from mink scat with 95% accuracy under laboratory conditions (Grimm-Seyfarth et al., 2019), and to distinguish European beaver scat from Canadian beaver scat with more than 96% specificity (Rosell et al., 2019). Beyond using feces for species monitoring, Matthew and Relton (2021) showed that carcasses and pieces of skin could also be used to locate living individuals of the same species—in this case, the riverine rabbit (*Bunolagus monticularis*). Further research is needed to determine whether this method can be reliably applied in practice (Matthew & Relton, 2021).

It should be noted that during blank trials, dogs may be prone to false positives when the presented samples are similar to the target odour. This occurs because there is no reference odour, which can confuse the dog. Therefore, it is recommended to include sufficient blank trials. In field conditions, false positives may also occur when no target has been found for a long time. The dog may become demotivated and, in an attempt to elicit a reward, indicate other odours (DeMatteo et al., 2019; Gazit et al., 2005; Matthew & Relton, 2021; Porritt et al., 2015; Stanhope, 2015).

Further research is needed to optimise detection dog training so that issues with specificity during blank searches, motivation problems during fieldwork, and generalisation issues—when dogs memorise only individual samples—can be overcome. Nevertheless, these studies demonstrate that dogs are capable of remarkable performance and can make a significant contribution to wildlife monitoring and the screening of samples for microorganisms.

Project-ideas with potential relevance for Flanders

Early recognition of African Swine Fever-virus

An innovative project idea is research into early detection of the virus using detection dogs. This is a German project proposal called Früherkennung ASP, developed by Uta Kielau, Heike Wagner, Peter Kaul and Gerhard Holl from the Institute for Detection Technologies (IDT).

Translation of the project “Early recognition of the ASF-virus”

In September 2020, African swine fever (ASF) was officially detected for the first time in wild boar in the district of Spree-Neiße in the Federal Republic of Germany. Additional cases in Brandenburg and Saxony followed. In July 2021, ASF was also officially confirmed in domestic pigs in Brandenburg. ASF affects only pigs; other domestic and wild animals are not susceptible, and the disease is not transmissible to humans. The causative agent of ASF is a double-stranded DNA virus. Transmission in Europe occurs through direct contact with infected animals or their carcasses, as well as via indirect routes (vehicles, contaminated objects). The virus can remain infectious in the environment for up to

four months. After infection, animals develop very severe but non-specific symptoms within 14 days. The disease is invariably fatal. Due to the high mortality rate and international trade restrictions associated with outbreaks, ASF is of major importance.

As part of prevention and control efforts, several German federal states are currently establishing detection dog teams to search for carcasses. The use of dogs to search for missing or deceased persons, as well as for locating wounded game after hunting, has long been common practice. However, searching for carcasses is not straightforward due to the size of the areas that must be covered and the potential danger to both dog and handler. An additional disadvantage is that infected animals may have transmitted the virus to many other pigs before dying, and the carcass itself remains a source of infection until it is found. Early screening of the population would therefore be more effective for prevention.

Dogs possess an extremely refined sense of smell and can detect and distinguish even the smallest scent components. This ability is already used in the training of species-detection dogs. In such training, dogs learn to search for and indicate only the scent presented to them by the handler. The challenge is to make clear to the dog exactly which scent it is expected to indicate, since humans cannot determine which specific odour molecules the dog memorises and searches for. This method is successfully applied and taught by biologist Uta Kielau. Our approach is to determine whether ASF-infected pigs emit a specific scent and to isolate it. This method is already being investigated in another project (see IDT literature). With a chemically produced scent sample, dogs can be trained without working with infectious material.

Step 1 : Comparison of scent samples from domestic pigs, wild boar, ASF-infected wild boar, and “normally” sick wild boar, in order to isolate a scent component specific to ASF-infected wild boar.

Step 2 : Production of the scent sample and comparison of this sample, by dogs, with infectious material/carcasses.

Step 3 : Verification of the earlier results by searching areas with infected and non-infected populations.

Professors Peter Kaul and Gerhard Holl of the Institute for Detection Technologies (IDT) have developed a sampling method that makes it possible to concentrate scent samples from larvae of the Asian longhorned beetle on scent filters across larger sections of a tree. The researchers are working on reliably fixing the scent compounds. The method is based on the REST technique (Remote Explosives Scent Tracing), originally developed for detecting explosives using rats and now adapted for detection dogs.

[Source: Hochschule Bonn-Rhein-Sieg – Institute for Detection Technology](#)

Detection of species: combination of literature review and projects

Monitoring threatened species in Belgium

As described in the literature review, research has already been conducted on the use of detection dogs for monitoring endangered species. Many of the target species in these studies could also form interesting follow-up projects for Flanders. Consider, for example, the success reported by Glover et al. (2023) in their study on using detection dogs to locate adult great crested newts on land, hidden in burrows (Glover et al., 2023). Or the study by Rosell et al. (2019), in which a dog was trained to distinguish the feces of European beavers from those of the exotic Canadian beaver (Rosell et al., 2019). The same applies to the discrimination study on otter scat versus that of the invasive American mink (Grimm-Seyfarth et al., 2019).

Screening decaying wood for the presence of larvae also appears to pose no difficulty for well-trained dogs, and can make invasive methods such as wood mould sampling unnecessary (Mosconi et al., 2017). Examples of insect species and their larvae that are relevant for Belgium include the hermit beetle (*Osmoderma eremita*), as mentioned in the literature review, but also the stag beetle (*Lucanus cervus*) and the noble chafer (*Gnorimus nobilis*). Several dog handlers are currently training dogs on stag beetle larvae in collaboration with INBO (Arno Thomaes).

The ability of dogs to indicate from a distance is also a major advantage when searching for, for example, dome-shaped nests of endangered ant species such as the narrow-headed ant (*Formica pratensis*) and the red wood ant (*Formica rufa*) without disturbing the nest. A project on this topic is underway with Wouter DeKoninck (RBINS) and Noses for Nature detection dogs (including Guido Franssens).

Training dogs on the target species itself can also be useful for locating endangered amphibians such as the midwife toad (*Alytes obstetricans*), the spadefoot toad (*Pelobates fuscus*), the fire salamander (*Salamandra salamandra*), the European tree frog (*Hyla arborea*), or—as mentioned in the literature—the great crested newt (*Triturus cristatus*). Samples could consist of skin swabs collected with cotton swabs, as in the study by Matthew et al. (2021), although it is not yet clear how well dogs can transition from detecting skin swabs to detecting live animals in the field. This would be an interesting research topic, as it could eliminate the need to capture and temporarily hold amphibians as live training scent sources (Glover et al., 2023; Matthew et al., 2021).

Monitoring endangered mammals in Belgium by searching for species-specific feces can also help map their distribution. Examples of endangered mammals for which this could be useful include the European wildcat (*Felis sylvestris*), pine marten (*Martes martes*), red deer (*Cervus elaphus*), hazel dormouse (*Muscardinus avellanarius*), garden dormouse (*Eliomys quercinus*), and various bat species such as the greater and lesser horseshoe bats (*Rhinolophus ferrumequinum* and *Rhinolophus hipposideros*), the pond bat (*Myotis dasycneme*), the greater mouse-eared bat (*Myotis myotis*), and the grey long-eared bat (*Plecotus austriacus*). As mentioned in the literature review, this also applies to the European otter (*Lutra lutra*), European beaver (*Castor fiber*), and the wolf (*Canis lupus*). An otter detection dog is currently operational in a project in collaboration with INBO (Ellen Van Krunkelsven & Kristof Baert).

It is important that the species is not so rare that training samples become difficult to obtain. Sufficient training samples are needed to train for generalisation. When a dog is never able to find the species during fieldwork because no individuals are present in the search area, the motivation of both dog and handler can drop significantly. This occurred previously during the training of a detection dog for the European hamster (*Cricetus cricetus*) and its burrows as targets. The species has become so rare—along with its burrows—that training proved extremely difficult.

It is therefore essential to set realistic goals, provide sufficient samples, and ensure enough field training opportunities with a reasonable chance of success to get the best performance from the dog teams. More information on species on the Red List in Flanders can be found here: <https://www.vlaanderen.be/inbo/rode-lijsten/#>, which was also used as a source for this text.

Monitoring of invasive species in Belgium

Monitoring endangered species is important, but mapping the spread of invasive alien species is equally crucial for taking appropriate management measures. Many of these invasive species are shy (e.g., non-native squirrel species), hidden (e.g., larvae of the Asian longhorn beetle *Anoplophora glabripennis*, the citrus longhorn beetle *Anoplophora chinensis*, or the New Zealand flatworm *Arthurdendyus triangulatus*), fast-moving or wide-ranging (e.g., Chinese muntjac *Muntiacus reevesi*),

or difficult to distinguish from native species based on feces (e.g., European otter *Lutra lutra* vs. American mink *Neogale vison*, or European beaver *Castor fiber* vs. Canadian beaver *Castor canadensis*). The literature review already described how dogs have been trained to recognise and distinguish the scent of American bullfrogs (*Lithobates catesbeianus*) from other frog species. In Belgium, this species is an invasive alien and therefore harmful to the ecosystem, competing with—or even preying on—native frog species (Matthew et al., 2021). Studies have also shown that dogs can be trained to discriminate between feces of similar species. For example, dogs were trained to indicate only the feces of European otters and not those of species with similar diets and body size, such as the American mink (Grimm-Seyfarth et al., 2019). The reverse approach is also possible: dogs could be trained not to indicate the feces of the native species, but instead to alert specifically to the feces of an invasive alien species.

In addition to the American mink, other fur-bearing species have entered Belgian nature through the fur trade, such as the raccoon (*Procyon lotor*) and the raccoon dog (*Nyctereutes procyonoides*). Their populations are still small, meaning there is still hope of eradicating them from the ecosystem—but rapid action is required. Detection dogs could assist by locating feces to map their distribution. Dogs could also potentially help locate nests, such as those of the Asian hornet (*Vespa velutina nigrithorax*). Since dogs have already proven capable of detecting aquatic target species—for example, the three-toed box turtle (*Terrapene carolina triunguis*) in wetlands, or locating whale feces at sea from a boat, such as that of the North Atlantic right whale (*Eubalaena glacialis*)—they could also be used to detect exotic crayfish species (red swamp crayfish *Procambarus clarkii*, spiny-cheek crayfish *Faxonius limosus*, rusty crayfish *Faxonius rusticus*, and signal crayfish *Pacifastacus leniusculus*) or the Chinese mitten crab (*Eriocheir sinensis*) (Rolland et al., 2007; Schwartz et al., 1974).

More information on invasive alien species in Belgium can be found on the website of Natuur en Bos Vlaanderen: <https://natuurenbos.vlaanderen.be/schade-en-overlast/schade-overlast-door-invasieve-exoten/invasieve-exoten-vlaanderen> and on Ecopedia: <https://www.ecopedia.be/exoten/invasieve-dieren>. These sources were also used to supplement the text.

Pre-screening of diseases (other than African swine fever): combination of literature review and project

Paratuberculosis

Paratuberculosis (also known as Johne's disease), a disease caused by infection with *Mycobacterium avium* subsp. *paratuberculosis* (MAP), leads to granulomatous lesions and damage to intestinal tissue. It is an intestinal disease with a chronic course and a poor prognosis. The disease occurs mainly in domesticated ruminants such as sheep, cattle, and goats, and often has a fatal outcome (Barkema et al., 2018; Koets et al., 2019; Sevilla et al., 2008). This has implications not only for animal welfare but also for the economy: affected animals produce less milk, many die, and farmers are often forced to cull their entire herd. PCR tests are very expensive and slow. In addition, infection rates are extremely high, symptoms are vague, and the disease has a long incubation period of 2 to 5 years. Many animals are therefore “invisibly” ill and spread the disease unnoticed, making control extremely complex (Benedictus et al., 2000; Clark Jr et al., 2008; Garcia & Shalloo, 2015; Kennedy & Allworth, 2000; National Research, 2003; Windsor, 2015; Woo & Czuprynski, 2008).

There is a strong need for fast, inexpensive, and reliable diagnostic methods, or methods for pre-screening samples that can later be confirmed with PCR. This would at least allow action to be taken sooner. Speed is essential to keep the disease under control and to prevent potentially contaminated milk from entering the production chain. A link has been found between contaminated milk and Crohn's disease in humans (Bastida & Juste, 2011; Honap et al., 2021; Schuiling & Groenvelde, 2005).

Detection dogs and detection rats could play a role in this rapid first-line screening. However, it must be taken into account that many other animal species are also at risk of infection, such as wild ruminants, wild boar, bears, camelids, non-human primates, crows, rabbits, mice, cats, as well as rats and dogs (Anderson et al., 2007; Beard et al., 2001; Kopečna et al., 2006; KuKanich et al., 2013; Manning et al., 2003; Palmer et al., 2005; Pedersen et al., 2008; Stehman, 1996; Whittington & Sergeant, 2001). For many of these species, it is not yet known whether they become merely carriers after infection or whether they develop disease—with or without clinical symptoms—and how severe that disease course might be. There is also no confirmed evidence of transmission between different species, although there are indications (Anderson et al., 2007; Over et al., 2011).

In the case of rats, a study by Koets et al. (2000) found that none of the rats tested were infected with MAP. In contrast, Beard et al. found MAP in 3 out of 35 rats, although no characteristic intestinal lesions were found during autopsy. Rats may therefore be potential carriers without developing disease (Beard et al., 2001; Koets et al., 2000).

For dogs, a 2008 study showed that they may be potential carriers. MAP was found in the intestinal tissue of 8 out of 42 dogs (about one-fifth of the test population). Although these 8 dogs showed no lesions or damage in the ileum (typical for paratuberculosis), they did have a history of chronic gastrointestinal problems—problems not seen in the negative subjects. This suggests that dogs may not only be carriers but could also develop disease after infection (Glanemann et al., 2008).

A later study in 2013, unlike the 2008 study, found MAP in intestinal tissue of dogs that showed no gastrointestinal symptoms. This does not rule out possible disease development: these dogs may have been in the incubation phase, or some individuals may simply be less susceptible (KuKanich et al., 2013).

Given that the limited and somewhat contradictory literature suggests that rats likely do not become ill, while dogs possibly do, it is advisable to use detection rats rather than detection dogs (despite dogs' excellent pathogen-detection abilities) for screening this bacterium.

Rats have already proven to be excellent detection animals. The African giant pouched rat (*Cricetomys gambianus*), in particular, has achieved strong results through the NGO APOPO® as a diagnostic tool for pulmonary tuberculosis in humans in African developing countries (Mgode et al., 2012; Poling et al., 2017; Poling et al., 2011). With an accuracy of 94%, they are used not only for pre-screening but also for post-screening samples previously examined by light microscopy. These post-screenings resulted in 42% (2009), 43% (2010), and 39% (2014) more diagnoses in individuals who would otherwise have been missed (Ellis et al., 2017; Mgode et al., 2012).

Because of these strong results and the similarity between *Mycobacterium tuberculosis* and *Mycobacterium avium subsp. paratuberculosis*, Odisee alumna Manon De Meester launched a pilot study (bachelor thesis) in 2022 to train domestic rats (*Rattus norvegicus*) to discriminate positive colostrum samples (containing MAP) from negative ones and to clearly indicate them. The pilot study was promising: although only one of the four rats completed the training, that rat achieved an accuracy of 92.4% and found the positive sample within just 11 seconds in a setup of six samples. De Meester won the Bachelorprijs® 2022 and was an EOSprijs® finalist, showing that both the public and the Scimingo® jury recognised the potential of the research (De Meester, 2022).

Rats are small, easy to house, low-maintenance, and inexpensive, giving them an advantage over dogs. A disadvantage is their lifespan, typically two to three years. The rat that completed the discrimination training did so after nine months (with no prior detection-training experience from the trainer and no pre-selection of the rat for desired traits) and lived for three years and two months—leaving roughly two years of usable working time.

According to Weetjens et al. (2009), a single HeroRAT® (the APOPO® African pouched rats) can screen hundreds of samples per day. The Online Journal of Public Health Informatics (2024) includes an article by Jonathan et al. (2024), citing Mgode et al. (2018), stating that APOPO rats can screen about 100 samples in 20 minutes. In contrast, laboratory technicians require four days to microscopically examine

a culture. The rats work a total of six hours per day (in short 20-minute sessions with long breaks), allowing them to screen roughly 1,800 samples per day (Jonathan et al., 2024; Mgone et al., 2018). If domestic rats can achieve similar performance (since African pouched rats cannot be kept in Belgium), even 1.5 to 2 years of working life would be sufficient to screen a very large number of samples. This makes well-trained rats a cost-effective screening method. Continuing De Meester's 2022 pilot project could therefore hold significant potential for pre-screening colostrum samples from goats or other domesticated ruminants, reducing costs and increasing speed in farm-level disease monitoring.

Crayfish plague

As mentioned earlier under "Monitoring invasive alien species in Belgium," American crayfish species pose a serious problem for our freshwater ecosystems and the organisms living in them. In particular, our native European crayfish is a victim of the presence of exotic crayfish. This is because these American crayfish species are carriers of the water mould *Aphanomyces astaci*, which causes crayfish plague. This disease is responsible for high mortality rates in the European crayfish. The disease spreads through the release of zoospores shed by *A. astaci* carriers. These spores enter the environment, disperse through the aquatic system, and come into contact with other aquatic organisms (Strand et al., 2014; Svoboda, 2015).

In addition to detecting invasive crayfish themselves, dogs could potentially be trained to screen water samples from water bodies for the presence of *Aphanomyces astaci* spores, or to check captured individuals for the active fungus. It is important, however, not to train the same dog to perform both tasks—"searching for the crayfish species" and "searching for the water mould"—because the dog might then indicate both infected and non-infected crayfish of the same species, which is problematic if the goal is to detect only infected individuals of any species. The reverse approach is also possible: one could train a dog to search for a specific crayfish species, and the dog would then indicate any infected crayfish regardless of species.

Even when training on feces rather than live crayfish, those feces may contain spores from the environment. It is therefore advisable to clearly define the target in advance. Another option is to capture crayfish without distinguishing between species and only deploy the dog afterwards to screen the captured individuals for the fungus or its spores.

Whether these applications work in practice has not yet been tested, and no literature on the subject was found. However, given that dogs are successfully used for a very wide range of detection tasks and diverse targets, it is not far-fetched to assume that this could be learned and applied effectively in practice. Only further research or trial projects can determine this.

Hedgehog disease

In 2020, a very large number of reports were made in Belgium of sick hedgehogs (*Erinaceus europaeus*) being found. The hedgehogs all had wounds, abscesses, or other skin lesions on their heads and/or legs. The animals behaved as if they were ill, appeared during the day, lacked the ability to curl up, and staggered when moving. Secondary complications—such as the infestation of wounds by blowflies and their larvae, as well as severe inflammation—make this disease life-threatening. In some cases, the inflammation penetrated as deep as the skeletal muscles.

The exact nature of the disease is unknown, but it is thought to be triggered by bacteria naturally present in the hedgehog's oral environment, which, for some reason—possibly through biting each other or themselves—cause problems when introduced to other parts of the body. The suspected bacterium is *Corynebacterium ulcerans*, which can secrete toxins that cause skin problems. These toxins are also a possible cause of diphtheria in hedgehogs, but also in humans. This means the hedgehog disease is not only problematic for the conservation and welfare of hedgehog populations,

but may also have public health implications. Whether the skin disease is transmissible to humans remains unclear.

It is also uncertain whether the bacterium is the true cause of the disease or merely a secondary effect. It is possible that the bacterium proliferates more easily in animals with weakened immune systems, with another pathogen or underlying cause initiating the disease. The fact that the bacterium is so widespread and frequently found in animals showing these skin symptoms makes *C. ulcerans* a plausible primary cause (Martel et al., 2021).

To better understand the disease, more research is needed. For this, locating sick hedgehogs is essential. Dogs could potentially be trained to detect hedgehogs suffering from this disease. However, this is complex. Training a dog on the scent of the bacterium is not useful if the same bacterium also lives in the mouths of healthy hedgehogs and therefore has a commensal relationship with its host.

Training dogs on the scent of hedgehogs specifically affected by the disease (the actual target) could allow the dog to detect not only the bacterium but also the consequences of infection, such as the smell of abscesses and pathological processes in the body. The combination of all these odours creates a single, recognisable scent profile for the dog to imprint on.

However, this method requires multiple sick hedgehogs to collect scent samples using Getxent© tubes, Eppendorf© tubes, or cotton swabs placed with the animals long enough to absorb their scent and then used as training material. The question is whether the dog will generalise these scent-soaked materials to living hedgehogs.

The most reliable method would be to train directly on sick hedgehogs, but this raises animal-welfare concerns. Placing a sick animal near a predator is unethical, and because the disease is poorly understood, it is unclear whether it is transmissible to dogs.

Training dogs on the scent of live hedgehogs in general—including healthy ones—could also help, allowing the animals to be located and examined afterwards. However, this is an invasive method, as it requires bringing dogs into relatively close proximity to hedgehogs, which must then be handled for examination. The stress caused by this could weaken the immune system and potentially worsen disease. It is therefore important, if using this method, to train the dog to indicate from a sufficient distance, which also helps reduce any risk of transmission. Fortunately, dogs have previously demonstrated that distance indication is feasible with proper training (Mosconi et al., 2017).

Training on deceased hedgehogs that had the disease—using their bodies or infected skin as target odours—would make the method less invasive. However, this does not eliminate the potential risk of transmission from hedgehog to dog, so distance indication remains essential.

More information and further research are needed. Additional details on the hedgehog disease can be found at: <https://www.vogelbescherming.be/wildopvangcentra-vangen-veel-egels-op-met-egelziekte/> and <https://www.onzenatuur.be/artikel/sos-egels-kampen-met-mysterieuze-ziekte>, which were also used to supplement this text.

Conclusion

As shown in the literature review, dogs are already widely used, and many different fields rely on their sense of smell—with great success. Since dogs are capable of learning multiple odours and require less training for each new odour (Waggoner et al., 2022), and because continuous training and new objectives not only improve the quality of detection work but also help maintain handler motivation, it is sensible to deploy already trained ASF-detection dogs in new projects and involve their handlers as well. There are many themes and challenges in our country that could be addressed and investigated with the help of dogs, and in doing so, the application of detection dogs can continue to be refined and improved.

For although the dog's nose approaches perfection, the human factor still has considerable room for growth. Consider, for example, knowledge about scent imprinting, deciphering the dog's brain as a "black box," optimising training protocols, isolated odours versus full target odours, working with scent-absorption materials versus direct training on the final target, or transitioning between these methods during training, and how to maintain a dog's motivation when the target odour is absent. If

research can be conducted to address these questions and challenges, the use of dogs as a detection or diagnostic tool will only continue to improve in quality.

Although there is still room for development, dogs are not only reliable but also efficient as a detection method—especially compared to other methods such as classical monitoring techniques or diagnostic tools that require far more time (Hag-Ali et al., 2021; Long et al., 2007a). This was also discussed in the literature. Deploying dogs to monitor endangered species in Flanders, such as the otter or the stag beetle, to detect pest species such as the Asian longhorned beetle and the Asian hornet, and to screen for diseases and pathogens such as crayfish plague and the hedgehog disease, could be of great added value. To further expand the potential of biomedical scent detection, research into the use of domestic rats as a diagnostic tool—for example, for para-TB—would be an interesting avenue to explore.

Information from visits

Other potential deployment goals for already trained ASF-detection dogs (Information from interviews and surveys)

TCRH (Training Center Retten und Helfen), KUG, November 2025:

Eco-detection is a good alternative search objective once ASF has disappeared. Experience with an industry request to search for lithium batteries using dogs showed that this is currently not feasible in practice. Industry partners are asked whether they have useful questions or needs that can be tested with the teams, for example in cases of arson, gas leaks, etc. Medical applications are also being explored—for instance, dogs can detect prostate cancer up to two years earlier than laboratory tests. The TCRH trainer KUG will participate in such a pilot project in 2026.

During the visit to TCRH Mosbach, the importance of continuous, frequent, and high-quality training after ASF crisis periods became clear. This is not only to maintain the skills of the dogs and their handlers for future outbreaks, but also to ensure they can be deployed for other purposes in the meantime. The broader goal and philosophy of TCRH Mosbach is therefore not only to produce qualified ASF-detection dog teams, but also to ensure a high level of knowledge and expertise among both trainers and dog teams, enabling them to participate in future projects. These projects would involve other public-interest objectives defined by governmental institutions. Examples include detection of ion batteries, locating missing persons in disaster scenarios, ecological detection for control, monitoring or conservation purposes, deployment in disease control (such as during the COVID-19 pandemic in airports), and other forms of biomedical scent detection. The possibilities are nearly endless.

It is important to adopt an open and dynamic policy from the outset. Crises such as ASF do not respect political or national borders. These boundaries must therefore be crossed in the response. Cooperation within and between regions and policymakers at all levels is crucial. This concept must be coordinated at a high level from day one.

(Source: Report of the visit to TCRH Mosbach, 12-06-2025)

During a conversation with the head trainer of the ASF dog team in Wallonia, it became clear that Stéphanie Desvaux and Anouck Decors in France aspire to establish a platform for the training of detection dogs—not only for African swine fever detection, but also for other purposes such as poison detection (Conversation PA 27-06-2025). In an interview with them, they described their goal as the creation of a brigade of “maîtres-chiens administratifs,” meaning dog handlers employed in public service. They would be made available within a network led by a coordinator appointed specifically for this purpose. The idea is to have dog handlers with different specialisations who can be widely deployed, including in cooperation with the police. At present, there is no funding or structural support for this initiative.

(Interview 16-09-2025)

Effect of training for other purposes on quality and motivation

A centre such as TCRH, with well-trained detection dogs and motivated, experienced handlers, is highly valuable. It provides dog teams with a place where they can be trained, follow additional courses, maintain their knowledge and skills, and update their expertise so it can be applied when needed. This ensures not only quality, but also engagement, motivation, and commitment.

At TCRH, out of 320 teams, only 15 eventually dropped out and 5 were no longer welcome. If these regular training sessions were to disappear, the organisation would lose sight of the teams' skill levels and whether they decline without training. From the perspective of the dog teams, the organisation and the work itself would also fade from view. With fewer contact moments, people lose their connection to the organisation and the work, and with that, their motivation to remain involved. Engagement is crucial—not only to maintain quality, but also to maintain motivation, because low motivation leads to dropout.

Not only regular training, but also a meaningful purpose is important. Training sessions after ASF crisis periods without alternative goals may give handlers the feeling that the training is pointless. Some people need to feel productive and feel that they are making a difference. This sense of “added value for the greater good” is an important source of motivation for volunteers. For this reason as well, deploying dog teams for other purposes is a good idea, ensuring not only the long-term quality of the teams but also their motivation.

(TCRH Mosbach 12-06-2025)

German trainer (Uta Kielau):

“In the German federal state where I live, they want to start a project next year on invasive species for our dogs. Our dogs started years ago as wolf-detection dogs and were later trained as species-detection dogs. Now people realise that the dogs can handle multiple species, and our ministry is very interested and supportive. They are currently seeking funding and want to continue with invasive species. For example, we have problems with the hornet *Vespa velutina*. So we are going to try to deploy our dogs for more and more different species. There is also the organisation ‘Wildlife Detection Dogs Germany’. It is a non-profit association that has developed assessment rules, published with an ISBN number. These will soon be available on their website, also in English. We already have several target species for which we have developed assessment protocols, but we can include others as well. If someone asks us to work on a specific species, we simply adjust the rules and can then provide an assessment for that new target species. Because we keep our dogs very flexible in terms of target species, and the ministry has now discovered what the dogs are capable of, they are very curious. Whenever they have an idea, a species, or a sample, they call me to ask whether we can test our dogs on it. We are doing a lot of experiments at the moment, and that is actually very enjoyable: it allows us to try things out and be prepared for whatever comes, because we never know what next year will bring.”

COVID-project, Belgian Federal K9 Unit & University of Ghent (EVK): When it was COVID, financing was available to train dogs on COVID. In three months, a professional training method was established with great results. Unfortunately, it was temporal and it stopped after the COVID-pandemic. After having proven that it is possible, there was no continuation. That is a pity. In crisis, there are peak moments in which the dogs are urgently needed, and then later on the interest and finances are gone. It would be really useful to create something that stays.

At Odisee, University of Applied Sciences, Belgium, a research project will run from 2025-2027 to address the feasibility of questions on diverse targets for detection dogs, focusing on eco-detection. A feasibility protocol will be developed based on international expertise addressing technical,

economical, legal, operational and social aspects. Two focus species will be invasive flatworms and crayfish. The project deliverables will be shared.

Conclusion

Long-term deployment of trained, professionalised volunteers for ASF detection, as well as professional handlers and trainers, can benefit society thanks to the wide range of possible applications. A platform/centre is needed where people and organisations can turn to for detection dogs for specific purposes. Steps should be taken to develop and gather the available expertise in a dedicated centre in Belgium.

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