Probability of police dogs detecting missing persons in search sectors

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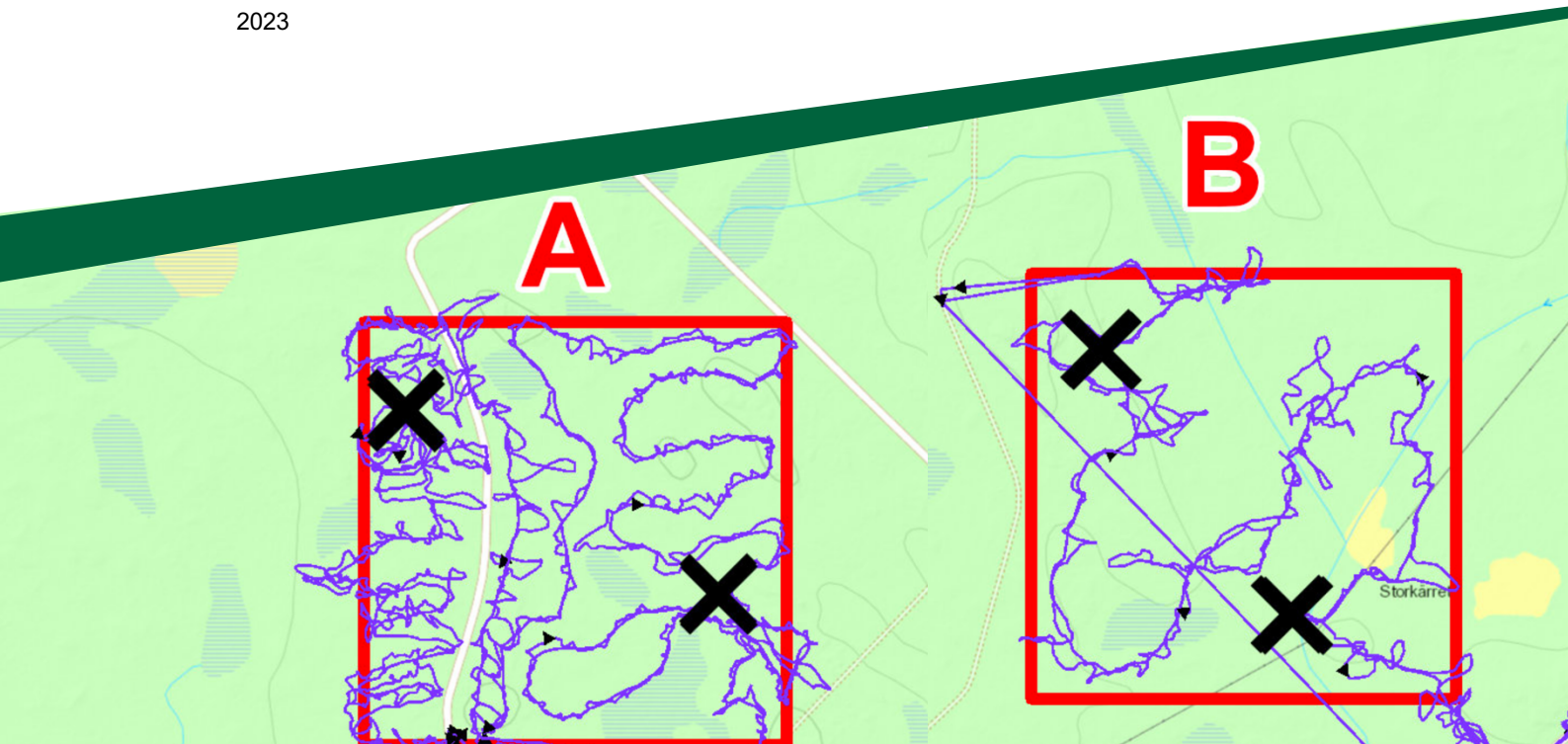
2023



Probability of police dogs detecting missing persons in search sectors

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Publisher: Department of Ecology, SLU
Year: 2023
Location: Grimsö
ISBN: 978-91-8046-880-0
Keywords: Working dogs, Search and Rescue dogs, Police dogs, K9.

Summary

Searching for missing persons is an important task for police dog teams. The purpose of this study was to investigate what proportion of missing persons are found during sector searches. The study was conducted as an exercise within the framework of the local weekly training structure (L406) for police patrol dogs in Police Region South during the winter and spring of 2022/2023.

A total of 23 dog teams participated over six weeks from December 2022 to April 2023. During the searches, 25 out of 26 (96%) of the deployed decoys were found, which means that a missing person is very likely to be found by the police dog teams also during real search and rescue missions. Interestingly, the dog teams that have used a total search-time below average have found decoys to the same extent as the teams that have used more total search-time. The group that has used less than 119 minutes and where the dog has travelled an average of 9.5 km has thus been sufficient to find the missing persons. This means that the teams that have searched longer than the average and where the dog has travelled a longer distance, have used more time than actually needed.

A total search-time of 119 minutes on average and a distance travelled by the dog of 9.5 km was sufficient to find all the decoys in an area of 25 hectares. A shorter search-time and shorter distance travelled would likely have been sufficient to find the same number of decoys, but based on the results of this study we cannot determine what time or distance would have been sufficient. This is however interesting to investigate further in future studies as it suggests that there is a possibility to cover larger areas in less time but with the same probability of detecting missing persons.

Content

Introduction

A patrol dog in the Swedish police has a wide range of skills and is trained in obedience, protection, searching for articles (crime scene investigation), searching for suspects in indoor and outdoor environments and searching for missing persons in terrain (Search and Rescue). They are also trained in tracking, both in urban areas on hard surfaces and off-road. The patrol dogs are divided into two levels of training, patrol dog level 1 and patrol dog level 2. When a dog is taken into service for the first time, it has been approved in all the elements that make up patrol dog level 1. The dog is then further trained by its handler and after one year it is tested for patrol dog level 2. The difference between the two levels is that the protection work is a little more extensive in level 2, which includes a courage test, an additional muzzle test and that the difficulty in the recall exercise is increased. Furthermore, the handlers must also be able to search with their dogs off-lead to be approved for level 2. Another difference is that the dogs in level 2 must also find and indicate smaller articles and articles that are hidden. In rescue searches, not only do the handlers have to be able to search with their dog off-lead, but the dog must also be able to search the terrain according to the handler's directions and come back to the handler when the handler calls the dog. In the rescue search, the dogs are to indicate humans and articles contaminated with human scent by barking. The tracks in patrol dog level 2 are both longer and older compared to the requirements in level 1.

In the metropolitan regions (Region Stockholm, Region West and Region South), many of the patrol dogs are also trained to work in a group against crowds at for example demonstrations. In many of the Swedish police regions, the aim is for as many patrol dogs as possible to be trained to search for narcotics and firearms.

Of the 23 dog teams included in this study, 17 were German Shepherds and 6 were Malinois. Of the German Shepherds, 11 were males and 7 were females, and for the Malinois, the distribution was 5 males and 0 females.

Six of the dogs were approved in patrol dog level 1 and 17 were approved in patrol dog level 2.

A dog handler in the Swedish police is a graduate of the Police program. To apply as a dog handler, the applicant must have experience of working as a police officer and have good grades. Recruitment for dog handlers consists of two parts. The first part consists of physical tests integrated with problem solving, dog handling and an interview. If successful in the first part of the recruitment process, the applicant undergoes a trial period of at least 6 months and is assigned a dog. After passing the probationary period, the applicant must successfully complete an 8-week basic dog handler training course.

In this study, 15 of the dog handlers were male and 8 were female. Searching for missing persons is an important task for police dog teams. Dogs and handlers are continuously trained to improve their skills. The purpose of this study was to investigate what proportion of people in a forest area are found during a sector search with a police dog. An important aim was to obtain a reference measure of time spent and probability of detection to be used for adjusting the methodology and/or training and future follow-ups.

Method

The study was conducted as an exercise within the weekly training structure (L406) for patrol dogs in Police Region South during the winter and spring of 2022/2023. The terrain and sectors was unknown to the dog handlers. A total of 23 dog teams participated. 6 dog teams during week 49 in 2022, 8 teams during week 7 in 2023, 3 teams during week 9 in 2023, 4 teams during week 12 in 2023 and 2 teams week 15 in 2023.

All sectors included in the study have been searched in daylight. Weather and temperature have varied from -6 degrees Celsius and snowfall to snowy rain and a temperature around ±0 degrees Celsius to about 10 degrees Celsius and bright sunshine. As the searches were carried out in winter and early spring, there were no leaves on deciduous trees and bushes.

All sectors were searched with dog off-lead, with the exception of one dog handler who chose to search with his dog on a lead because the dog was still recovering from a previous injury.

Sectors

The sectors had a size of exactly 25 hectares and were measured and drawn in Poliskarta web. They were located in three different geographical locations in southern Sweden, in Höör in Skåne County, Rockneby in Kalmar County and Lammhult in Kronoberg County. The terrain consisted mainly of normally accessible forest terrain of mixed forest. However, there were elements of more difficult terrain such as dense spruce plantations, wetlands and fallen trees making it more difficult for a team to move through the terrain. The topography was relatively flat in Rockneby compared to Höör and Lammhult. The sectors in Lammhult were generally more hilly compared to the sectors in Höör.

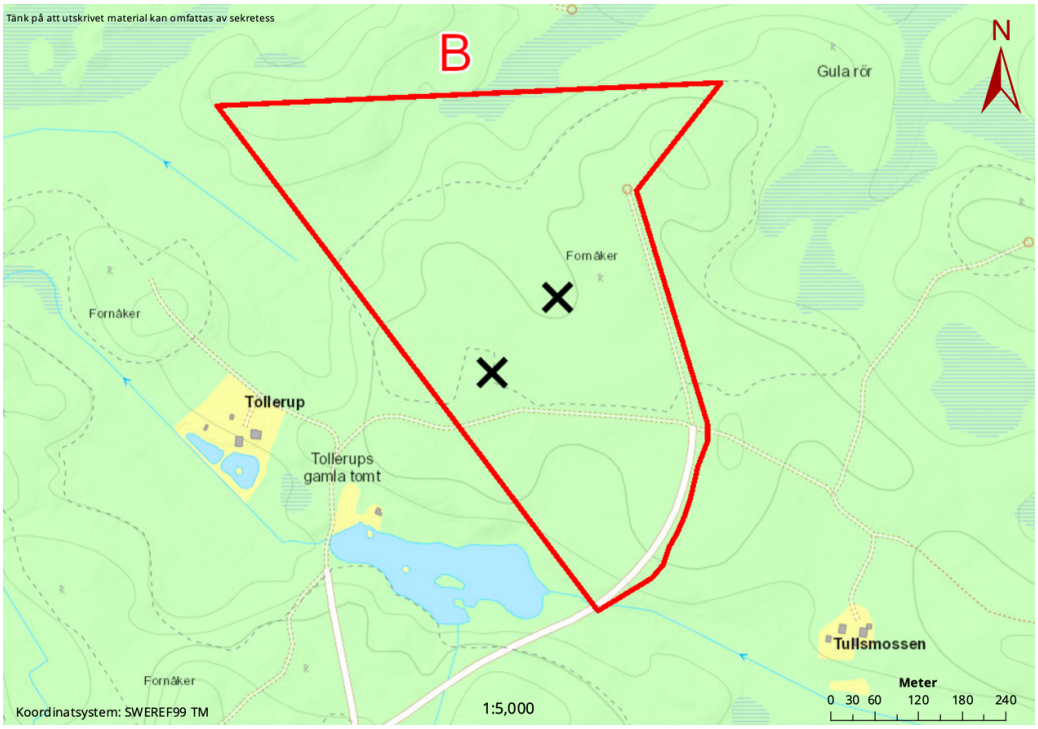


Figure 1: Map of sector B in Höör with the location of decoys.

There were 1-3 decoys deployed in each sector (1 decoy in 18 sectors, 2 decoys in 4 sectors and 3 decoys in one sector). The decoys, who were volunteers, were asked to come to the exercise in clothes they normally wear and to dress according to the expected weather. They were deployed approximately 2 hours before the dog teams started their search. The decoys were placed in such a way that they could not be visually detected by either the handler or the dog. On the very first occasion when a dog team searched sector A in Höör, the handler reported that she detected the decoy visually. The decoy was then repositioned in the next searches in that sector and was not visually detected by any of the subsequent dog handlers. In order to avoid the handler being able to visually detect tracks in the snow, all exercises were carried out on snow free ground.

Figure 2. Decoy placed among spruce trees in Lammhult.

Figure 3. Decoy placed among rocks in Rockneby.

Instructions given to the dog handlers

The police dog handlers were given information on how to get to a location that served as a command central during each trial. There they were instructed to use the terrain and weather conditions to tactically plan and search a sector in the forest terrain for missing person(s). The dog handler had the sectors downloaded to their Garmin Alpha 100 GPS. This allowed them to see where they were at all times during the search so that they could best orientate themselves within their sector and in relation to their tactical plan. The dog handlers were told that there could be between 0 and 3 persons in the sector. During the actual sector search, all communication between the command and handlers took place on the police radio system, RAKEL, which meant that all handlers could hear all radio traffic between the command central and other handlers.

At the command central, the dog handlers received both verbal and written information that before they began their search, they were to reset the trip log and track register on their GPS receivers for both themselves and the dog, and to report the start time to the command central.

Data collection

During the study, relevant data was collected and documented in Excel. Information collected from the dog handlers was:

- Time of day when the search started
- Time of day when a decoy was found
- Whether it was the dog that found the decoy on its own or if it was the handler who first discovered the decoy.
- Whether the dog was air scenting or whether the dog found the decoy by finding and following the track.
- Estimated distance to the decoy when the dog detected the windborne scent from the decoy.
- Whether the dog independently indicated the decoy by barking.
- The time of day when the search was terminated

After completing the search, the handler saved his own track as well as the dog's track on his GPS, after which the test leader saved them as GPX files.

Results

In the study, the dog teams found all the deployed decoys except in two of the sector searches. In one of these two cases, the dog handler's GPS did not work, which resulted in a larger and partly different area being searched. In the sector, three decoys were placed and the dog found one of the three figures. The parts of the sector where the other two decoys were placed was not searched at all due to the mishap with the handlers GPS. We have therefore chosen to exclude this dog team from the results of the study. For some dog teams, we have also not been able to obtain complete data, so the sample size varies slightly between the different variables.
Of the 22 dog teams that were included in the study and that searched their respective sectors, 96% of the “missing” persons were found (25 out of 26 possible). The average time spent by the dog teams to search the areas was 119 minutes (min: 68 minutes, max 182 minutes). Level 1 patrol dog teams spent an average of 130 minutes, while level 2 dog teams spent an average of 117 minutes, the difference was not statistically significant ($p=0.15$).

The average speed of the dog handler during the search was 3 km/h ($n=21$), but the variation was large, from 2.3 km/h to 3.7 km/h.

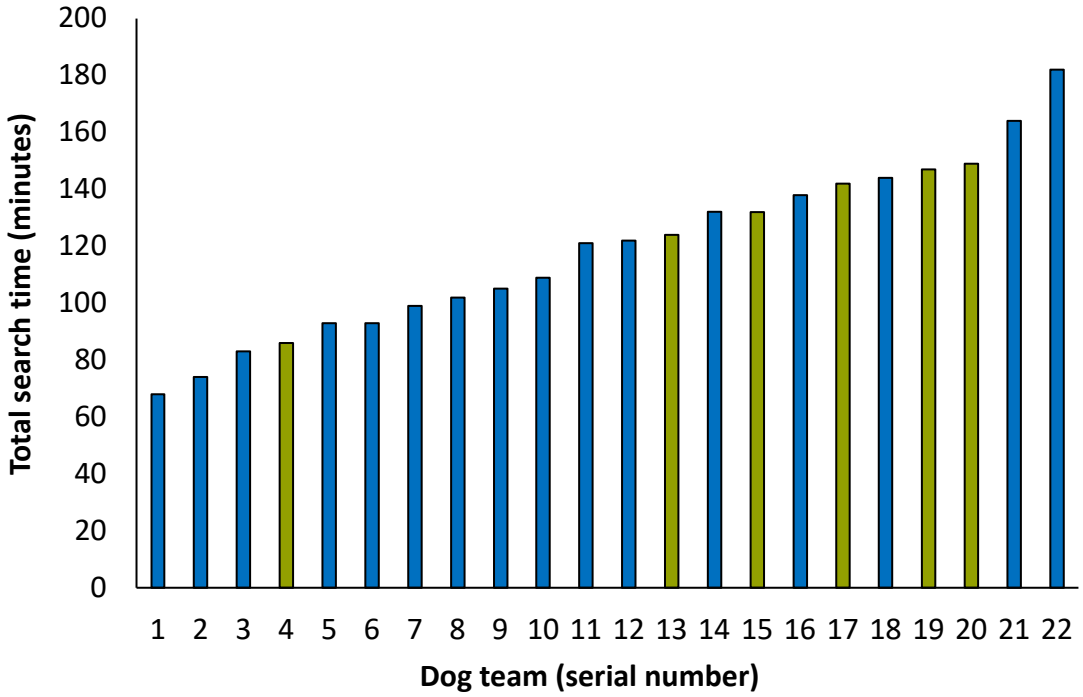
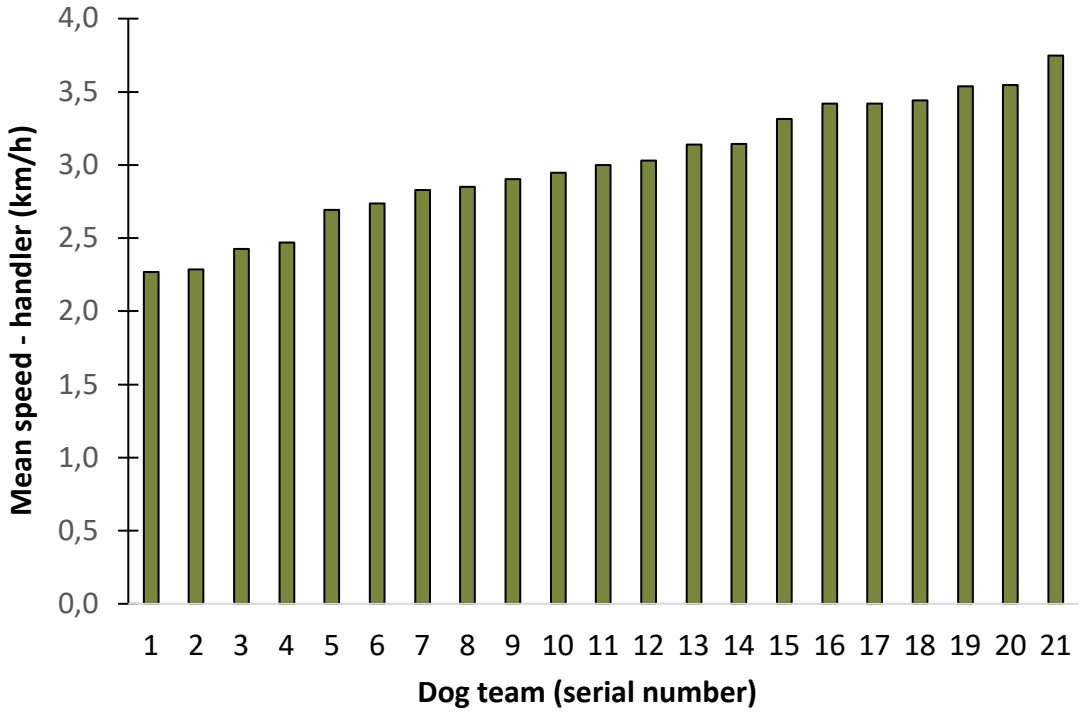


Figure 4. Total search-time for the dog teams (n=22). Level 1 patrol dogs in green and level 2 dogs in blue.



Figur 5. Mean speed for handler during the sector search (n=21).

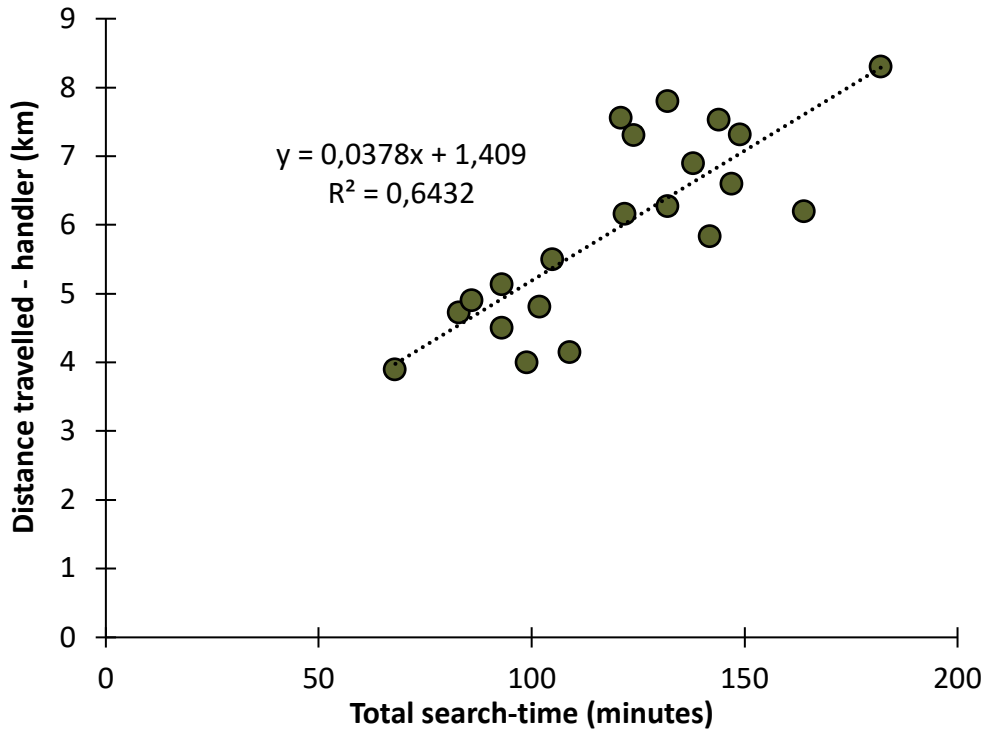


Figure 6. Handler distance travelled in relation to total search-time (n=21). The dashed line is a trendline and the R^2 value indicates how well the trend line describes variation of the data points.

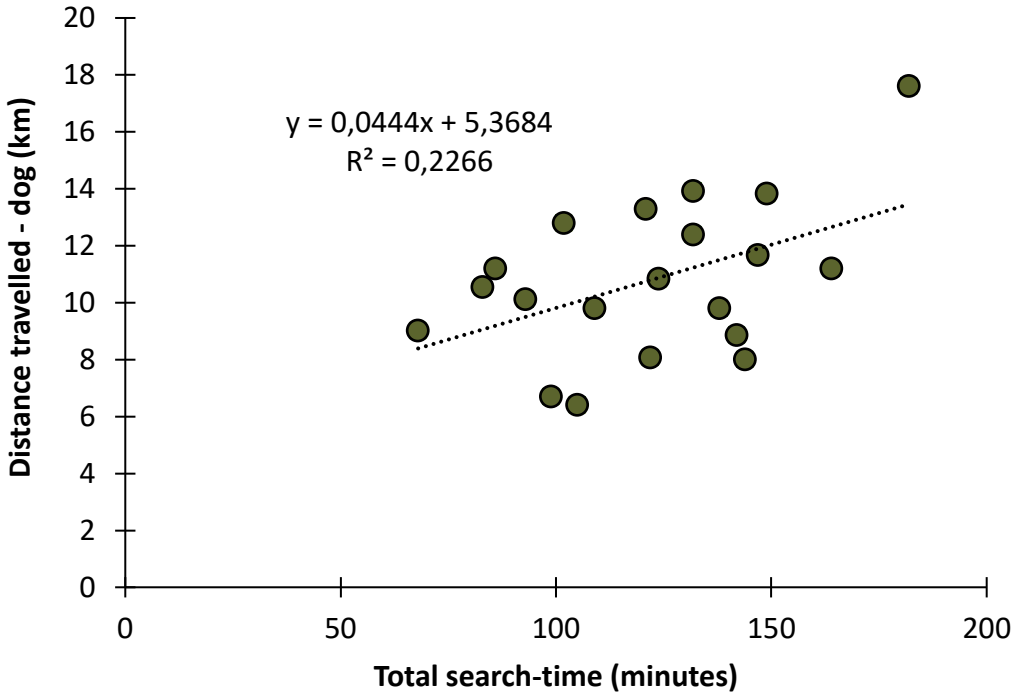


Figure 7. The dogs distance travelled in relation to total search-time (n=21). The dashed line is a trendline and the R^2 value indicates how well the trend line describes variation of the data points.

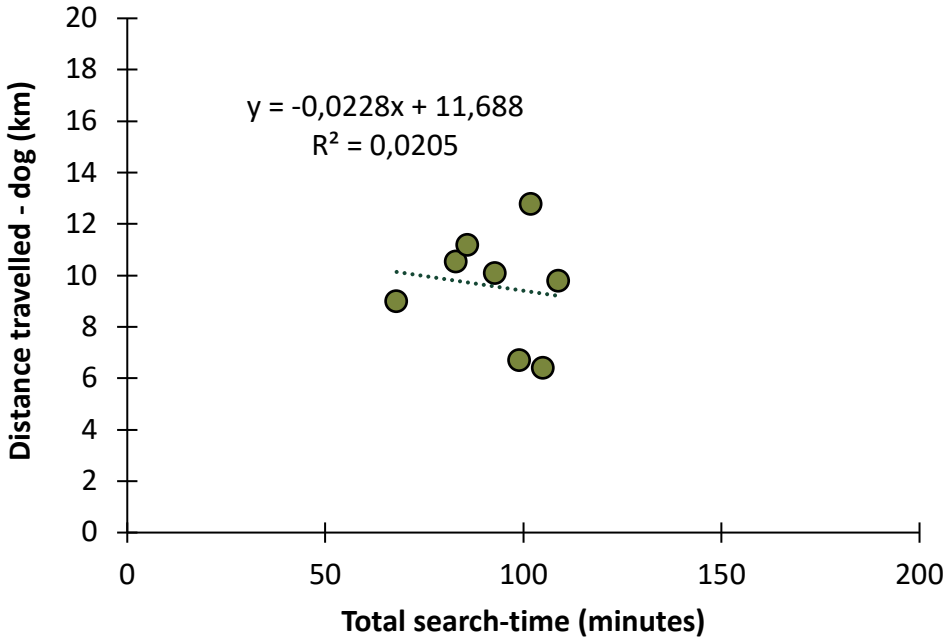


*Figure 8. Distance travelled by the dog in relation to total search-time in the dog teams that had a total search-time **below** the average of 119 min (n=8). The dashed line is a trendline and the R^2 value indicates how well it describes the variation of the data points.*

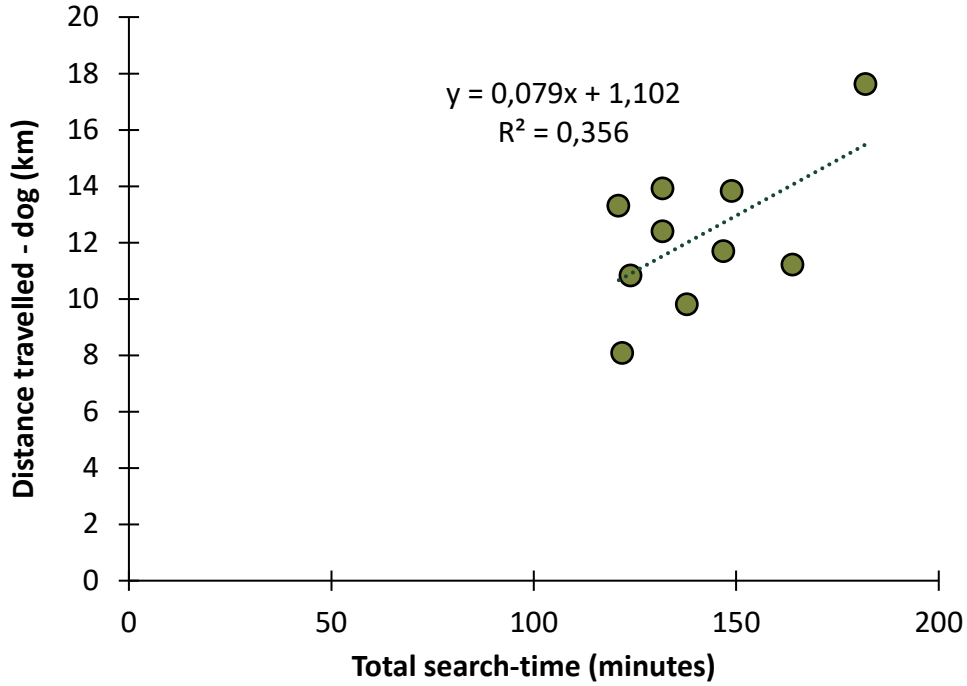


*Figure 9. Distance travelled by the dog in relation to total search-time in the dog teams that had a total search-time **above** the average of 119 min (n=8). The dashed line is a trendline and the R^2 value indicates how well it describes the variation of the data points.*

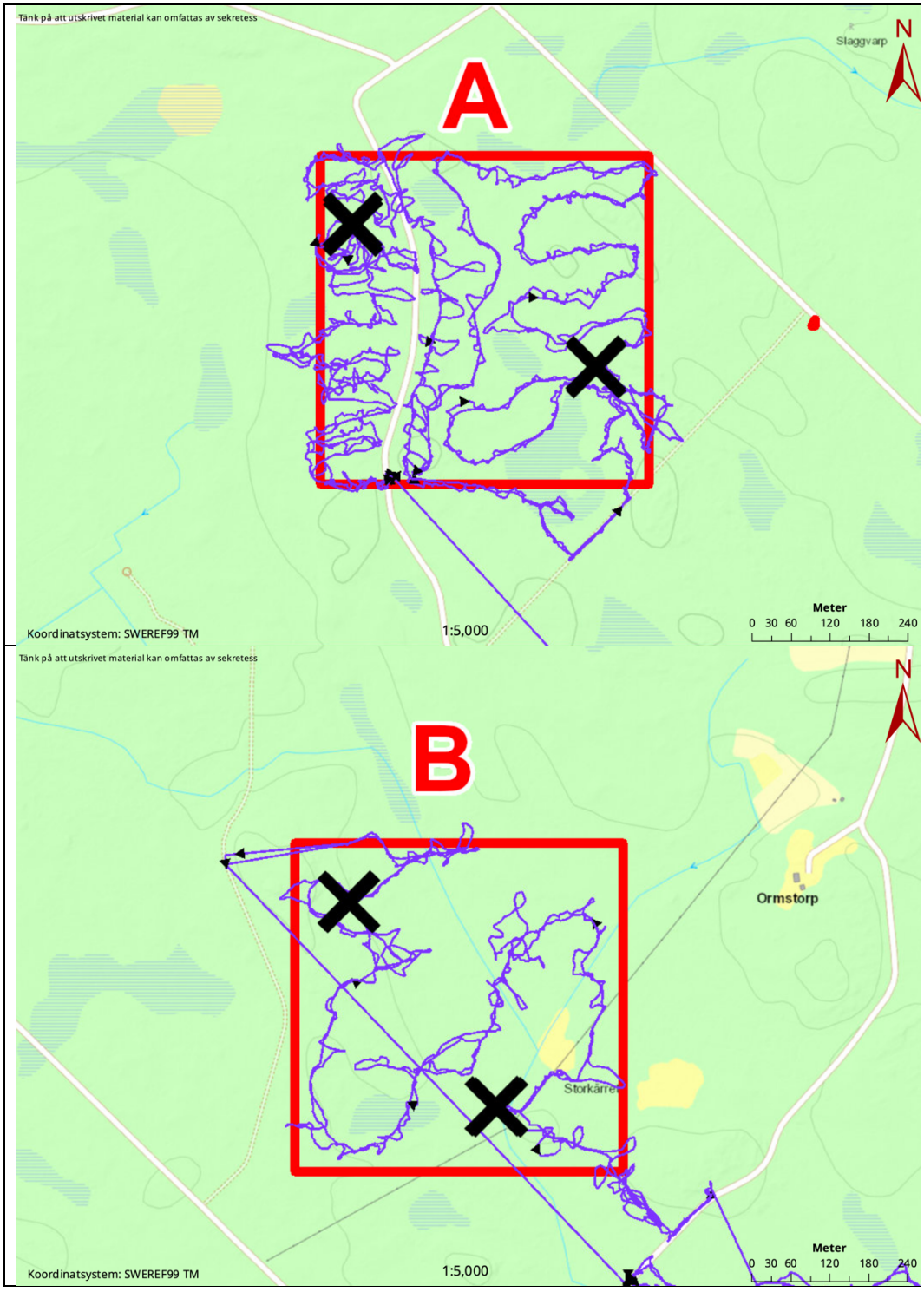


Figure 10. Sector A and B in Rockneby searched at the same time. Sector A. Search-time: 132 minutes, distance travelled by handler: 7.8km, distance travelled by dog 13.9km. Sector B. search-time: 68 minutes, distance travelled by handler: 3.9km, distance travelled by dog: 9.0km. In both sectors 2 out of 2 decoys were found.

In level 1 teams, the handler travelled on average 6.4 km (min 4.9 km and max 7.32 km) and the dog 11.5 km (min 8.86, max 13.82). The corresponding numbers for handlers of patrol dogs level 2 were 5.8 km (min 4 km, max 7.8 km) and 10.5 km (min 6.4 km, max 17.6 km). The differences in the distance travelled by the handler was not statistically significant (p=0.20). There was also no significant difference in the distance travelled by the dog between patrol dogs level 1 and 2 (p=0.23).

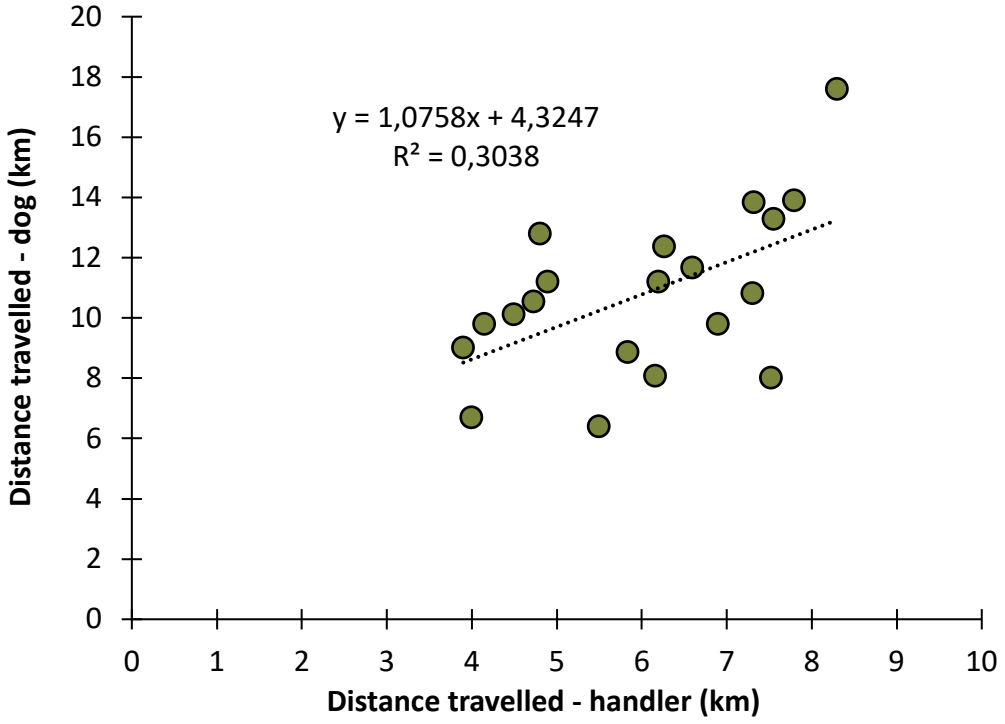


Figure 11. Distance travelled by the dog in relation to the distance travelled by the handler. The dashed line is a trendline and the R^2 value indicates how well the trendline describes the variation of the data points.

A patrol dog level 2 was on-lead during the study due to rehabilitation from a previous injury. Therefore the dog was managed by the handler before it had the opportunity to indicate the found person by barking. Of the 16 decoys found by level 2 dogs, all but one indicated by barking. Of the 8 decoys found by level 1 dogs, 5 were indicated by barking. This means that 62% of the level 1 dogs performed barking indications compared to 94% among the level 2 dogs. The difference is not statistically significant ($Z = -1.936$, $p = 0.524$), but there is a clear tendency that level 1 patrol dogs are less likely to indicate missing persons with a barking alert.

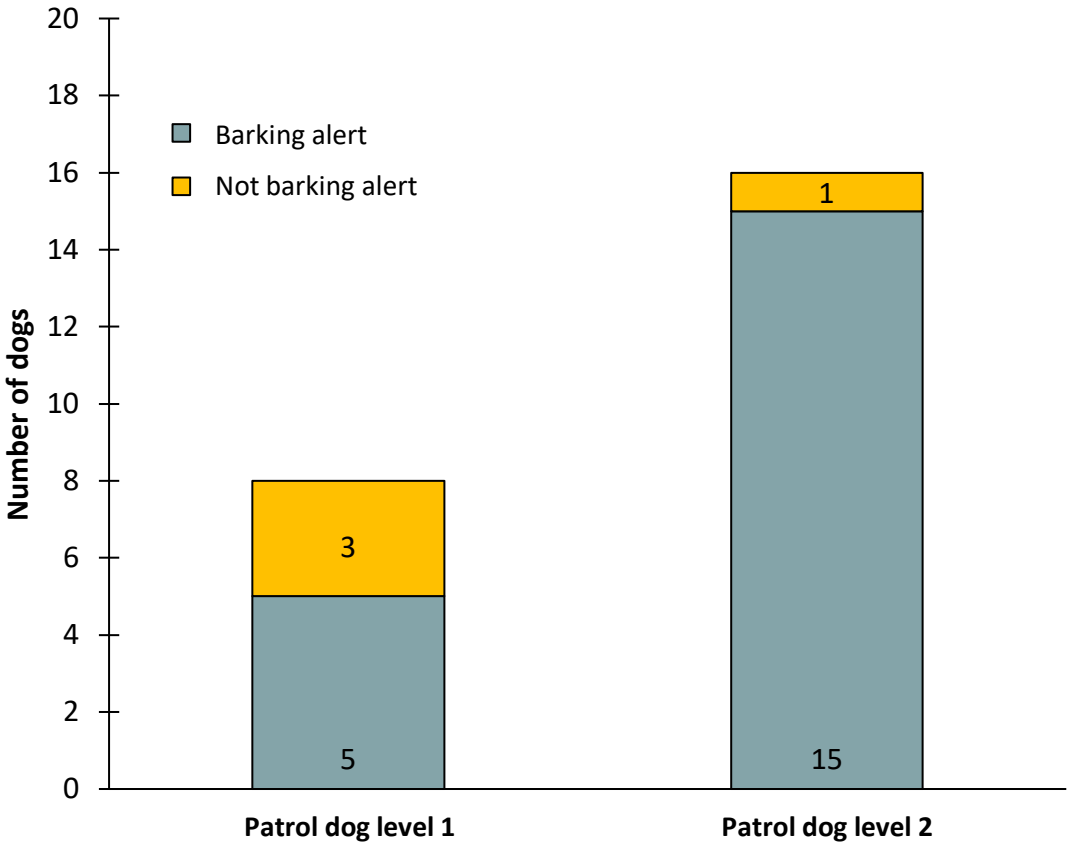


Figure 12. Number of times the dog indicated the decoy with and without barking alert for patrol dogs in level 1 and level 2. The dashed line is a trendline and the R^2 value indicates how well it describes the variation of the data points.

Discussion

The searches has largely been carried out in the same way as in operational searches and they provide a realistic view of the expected reliability in police dog teams searching for missing persons. During the searches, 25 out of 26 (96%) of the deployed decoys were found, which means that a missing person is very likely to be found by the police dog teams also in live searches, where the terrain consists of normally accessible mixed forest (as in this study). Even if the searches themselves have been conducted in a way that corresponds to a live rescue search, it is reasonable to assume that the fact that in these trials all handlers and dogs were well rested, full of energy and with a high expectation to make a find. In a real operation, the handler may have been about to finish the shift and go home when being ordered to a rescue search 250 kilometers away. The handler's expectations may also be expected to be different during a real operation. During this exercise, the handlers were informed that there could be 0-3 finds, so they probably had a quite high expectation that they will find a person in their sector. In a real operation, there is usually a total of only one find in a large number of sectors to be searched, where many sectors have a very low probability of finding a missing person. This can potentially lead to the dog handlers acting somewhat different in a real operation, compared to how they have acted in this study.

The correlation between search-time and the distance travelled by the handler is almost proportional, i.e. if the total search-time doubles, the distance travelled by the handler also doubles. The correlation between search-time and distance travelled by the dog does not show the same pattern (Figure 7). The dog teams that have a total search-time below the average show no correlation at all between total search-time and the distance travelled by the dog. However, when the total search-time is above average, we find the expected relationship where increased search-time is correlated with increased distance travelled by the dog. The sample size in this trial is too small to for any conclusions about what lies behind this pattern, but it should be followed up in future studies as it suggests that the total time spent on a search is not decisive for how much area the dog will cover.
What is also noteworthy is that the dog teams that have used a below average total search-time have found decoys to the same extent as the teams that have used more above average total search-time. The dog teams that used less than 119 minutes and where the dog has travelled an

average of 9.5 km has thus had sufficient time and area coverage to find the decoys with the same probability as the dog teams using more time and distance travelled. This means that the teams that have searched longer than the average and where the dog has travelled a longer distance, on average 12.5 km to search the same sectors, have used more time and distance than needed to be successful.

An average search-time of 119 minutes and an average distance travelled by the dog of 9.5 km was sufficient to find all the decoys in an area of 25 hectares. Probably an even shorter search-time and an even shorter distance travelled would have been enough to find the same number of decoys, but based on the results of this study we cannot determine how short a time or distance would have been sufficient. However, this is interesting to investigate in future studies as it suggests that there is a possibility to cover larger areas in less time but with the same certainty. If we could quantify the threshold for when the total search-time and distance travelled starts to affect probability of detection, it would be possible to cover more sectors with the same resources and thus save more lives.

In the search where a decoy was not found, the dog travelled 17.6 km compared to the average distance of 10.1 km. According to the GPS, the dog has at its closest been about 46 meters east of the decoy, 12 meters south of the decoy, 11 meters west of the decoy and 30 meters north of the decoy (sector A Höör 16/2-23). The decoy was located in a small depression a short distance into the eastern edge of a dense spruce forest. The sector has been searched on a total of 4 occasions where the location of the decoy has been the same and on the other 3 occasions the dog teams have found the decoy. On two of the occasions, the handler and dog walked straight into the areas where the decoy was hiding and in one case the handler reported that the dog got wind from the decoy at 40-50 meters distance, and in the other case the handler saw that the dog caught wind of the decoy at approximately 30 meters away.
We cannot determine why one of the dog teams did not find the decoy. The wind may have been unfortunate and caused the dog not to get a scent, the nature of the terrain where the dog passed may have made it difficult for the scent to reach the dog, based on the location of previously found decoys in his career, the dog may have had a low expectation to search and find a person in a very dense forest. To reduce the risk of dogs not finding persons in future missions, it would be desirable to conduct studies on the extent to which the terrain affects the dogs' probability of finding persons.

The fact that deployed decoys were found in 25 of 26 cases may be partly due to the fact that the decoys were deployed about two hours before the handlers started the search. Since the dogs are trained to pick up tracks that are up to three hours old, in some cases the dogs may have caught scent of the decoys track and followed it to the place where the person

was hiding. This is a potential source of error in our study and if several dogs have found the decoy in this way, it could theoretically mean that the probability of finding missing persons is lower in cases where a person has been missing for more than two hours.

Training dogs to be sent left and right from a transect (such as a footpath or road) involves extensive training. Currently it is a requirement for level 2 dogs to have this skill. Level 1 teams however found the decoys to the same extent as dog teams that have achieved level 2. Thus, being able to send the dogs from a transect does not always mean a higher probability of finding missing persons. However, we suggest that there are several occasions when the ability to send the dog from a transect provides increased efficiency. For example, at the beginning of a search when the area around paths, trails and roads (transects) is searched first. Or in areas where there are sections of terrain with very dense vegetation. Under such conditions, our hypothesis is that dog teams that have the possibility to send the dog from a transect will have a higher probability of finding missing persons in a shorter time than dog teams that are restricted to the technique where dog and handler move together over a sector. It would be interesting to investigate this further in order to give the dog handlers a basis for better determining under which conditions each technique can be expected to be more or less effective.

It is clear that level 1 dogs does not have the same skills as level 2 dogs in terms of barking alert. This may be a factor to take into account when searching for missing persons or locating suspects. It is likely that the level 1 dogs has not been given the opportunity to generalize the barking alert, which means that in some situations they does not bark when they have found the decoy. On two of the four occasions when the dog did not bark, the handler saw that the dog was tracking the last meters before reaching the decoy, and on the third occasion the decoy started talking to the dog when it had found her. These are not unrealistic situations in for real searches and should be considered in a revision of training plans for barking alert.

The fact that the dog handler whose results we chose to exclude from the study because the search was mostly conducted outside the designated sector had problems with the GPS indicates that we currently rely heavily on technology in rescue searches. The importance of functioning equipment and relevant training in handling the equipment in order to carry out effective searches was clearly illustrated in this case.

Although the total search-time, distance travelled and average speed varied greatly between the different dog teams, the probability of finding a missing person was constant and at a very high level. From this fact it can be concluded that the dog teams' training prepares them well for the task of searching for missing persons. With a 96% probability of finding a missing person, there is currently not much room for improvement in this

respect. However, since the dog teams that spent just over an hour searching the 25 hectares had the same probability of finding a missing person as the teams that spent more than twice as long searching the same areas, there is room to increase efficiency. In theory, the faster teams would have been able to search two 25-hectare sectors in the same time as the slowest teams searched one 25-hectare sector. The teams that have spent the most time have also been those that have travelled longer distances in the sector; this has not had any effect other than that the search has taken longer time.

After a real operational search each dog handlers is expected to report with which probability they would have detected a person if it was present in their sector. Results from this study provides support for individual dog handlers when doing this assessment. Further knowledge about how the speed, distance travelled and density between transects under different conditions affect the probability of finding missing persons has the potential to lead to missing persons being found faster without the need for more resources being allocated.

Thank you!

Many thanks to the dog teams that participated, the managers of the police volunteers in the Police Region South and all the police volunteers who acted as decoys during the study.