

Mine Detection Dogs: Operations

Case studies of operational systems

**Geneva International Centre for
Humanitarian Demining
Centre International de
Démunage Humanitaire - Genève**



The **Geneva International Centre for Humanitarian Demining** (GICHD) supports the efforts of the international community in reducing the impact of mines and unexploded ordnance. The Centre provides operational assistance, is active in research and supports the implementation of the Anti-Personnel Mine Ban Convention.

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Introduction

Background

The use of dogs for humanitarian demining purposes (mine detection dogs, MDDs) is a recent innovation that became an accepted technique during the 1990s. The earliest programme to become operational was in Afghanistan, where a nationally-run structure was implemented in 1993 following training by an American organisation (Global Training Academy, under contract to RONCO; Hayter, 2003). Summary descriptions of the main programmes in operation in the late 1990's can be found in Handicap International (1998).

Despite extensive research on specialist technical equipment, and the development of a large number of mine clearance machines, the most commonly used technique for clearing mines remains a person working slowly across the landscape using a metal detector and excavating the ground with some kind of tool. Arguments abound about relative costs and reliabilities (GICHD, 2003), but there is no doubt that a dog can inspect 100% of the ground at much faster rates than a human, including a human operating a metal detector (RONCO, 2003). An important reason is that dogs are not distracted by metal contamination, which can be extensive in battlefield areas and common throughout a landscape containing large numbers of humans and no mechanism for disposal of garbage. Dogs have two primary roles:

- to delimit the area in which manual deminers must work, either by a process of area reduction, or by locating the mines or UXO directly; and
- to provide follow-up QC checks of areas cleared using other resources, such as machines.

If mines or UXO are found, dogs are withdrawn and replaced by manual deminers, who conduct the excavation and clearance operations. Thus the role of dogs is to assist a clearance operation in which a variety of other detection and clearance tools will be used.

Currently, about 1,000 dogs are used by mine detection operations in more than 20 countries, and the use of dogs continues to grow¹. However, the methodology for best use of dogs in minefields is not standardised, and/or was usually developed by a process of trial and error rather than by careful experimentation. In some

¹ <http://www.gichd.ch/MDD/database/database.htm>

programmes, principles that define important operational standards may not have been developed or tested in any structured way at all.

To some extent, the above issues are addressed by the International Mine Action Standards (IMAS), which impose limits on the ways in which dogs are used, and on the standards that must be achieved. However, IMAS have limitations, first because they are necessarily generic, and second because adherence to them is voluntary. IMAS must be generic because the process of training a dog to search effectively and reliably for a mine is approached in many different ways. It is at a national level that the IMAS are adapted to local needs and local operational systems and may be adopted as legally binding regulatory instruments.

Operational diversity

Using 4 case studies of five systems, this report demonstrates wide variation in the operational systems used to deploy mine dogs. Each case study was of an operational MDD programme, which was therefore accredited in some formal sense at a national level.

All of the programmes described here were either fully nationalised (in that all operational, management and technical personnel were local people, or “nationals”), or were nationally-run programmes with some support from international technical advisers. In each case study, some comments are made about the educational standards likely to have been achieved by nationals recruited into the programmes, and also their likely attitudes towards dogs before being recruited. It is recognised that such comments are potentially controversial and open to argument and interpretation. However, they also represent useful background information that helps in the understanding of the potential for and limitations on MDD programmes in different contexts.

To give an extreme example, in a western culture (such as Switzerland) an agency recruiting dog handlers would require each short-listed candidate to have as a minimum:

- 12 years full time school education (graduating at age 17-18);
- a family history of keeping dogs as pets or as working animals (such as on a farm);
- direct training experience with dogs through working, showing or breeding; and
- a demonstrated interest in and enthusiasm for dogs.

Even with these criteria, the list of applicants is likely to be much longer than the number of available positions. In other words, the agency will be able to select candidates with a good education, a long history of contact with dogs, a demonstrated interest in dogs and at least some dog training experience. They will have had daily hands-on contact with dogs for many years. The candidates that actually get the jobs are likely to have a university or other professional education, have taken courses in the principles of animal learning, and have demonstrated a life-long involvement with dogs.

Nationals with the above backgrounds are not available in many of the countries in which MDD programmes are established for many reasons, including cultural perspectives and lack of educational opportunity. The relatively few people with an extended education are likely to want (and get) management and business positions, rather than jobs as dog handlers. In the Switzerland example, recruited personnel come into the job with a good education about principles, and an understanding of dogs built on years of experience. For many MDD programmes, all of that experience must be created using a training programme, which will be completed in a relatively short time. The eventual ability of a handler to work with MDDs will therefore be limited by the extent and quality of that training, as well as by their general sensitivity towards animals. The limits of those developed skills will likely limit the potential of the MDD programme.

The broad aim of this project was to provide a quantitative and qualitative description of operational MDD programmes showing the range of operational variation across the industry. The main aim was description, and not comparison. Thus, the report describes those aspects of each program that define its operational capacity and performance, but no attempt is made to compare these aspects between programmes. Factors that might be termed “best practice” can be drawn from the descriptions, but no attempt is made to draw those out here. Specifically, the study provides a broad description of a programme, and links that programme to the operational context in which it is deployed. The reader is encouraged to use those descriptions to identify issues such as best practice or operational potential, because, by doing so, a better understanding of options and constraints should emerge. But the GICHD does not presume to make such assessments.

Study methodology

Each study was approached in the same way. Initially, a request was made to the demining agency for the basic support needed to achieve the objectives of the exercise, and to allow the visit. An advantage for the agency was that the study represented a QA/QC opportunity at minimal cost, and all of the organisations studied were enthusiastic and supportive.

The general procedural approach is described in GICHD (2005), and is not given in detail here.

Methods: general principles

- The observer was to deploy with the MDD teams each day and to spend the entire day with them in the field.
- If the teams lived in a camp, then the observer also lived in the camp to be a part of non-work activities.
- While in the field, the observer made quantitative and qualitative measurements on the teams as they worked.
- Similar quantities of data were to be gathered on each dog working in the group to ensure that no one dog or team dominated the data.

- The programme should have at least 10 dogs so that variation among dogs in the programme could be documented.
- If the organisation had a group structure (e.g. a few dogs worked together as a group, and groups were deployed in different places) then at least two groups were studied.
- The observer deployed with the team(s) for a full work cycle (e.g. a 5-day working week), or if there was no clear cycle then for at least 5 days.
- The observer was to remain in the background as much as possible. Apart from the need to satisfy safety requirements, the presence of the observer could disrupt demining activities. For example, the teams might not behave normally while being observed, or the extra responsibility of a stranger in the minefield could be a distraction for the supervisors. Thus, observation distances were sometimes quite long and the observer moved about as little as possible. Binoculars and the use of safe vantage points ensured that quality data were obtained despite these restrictions. However, in a few cases studies were cut short because the presence of the observer created a problem for the teams.

All of the teams studied were remarkably tolerant of being observed. Once they began working, they concentrated on the job and mostly forgot, or at least ignored, the observer.

In practice, the above conditions were not always met. For example, some organisations had fewer than 10 dogs or did not have a group structure. However, in every case enough data were obtained to give a good overall picture of the operational structure.

Report layout and perspective

The study is laid out as four case studies of five organisations (two organisations in Croatia are described in one case study). A commentary is included in each case study as a discussion, and summarising comments are made in the final chapter.

Readers will recognise that each case study is essentially a snapshot of the operational structure of the organisation at the time that the study was done. Each study took about a month to complete (including report writing) and seasonal and other limitations meant that it took several years to complete the series of studies. In each case, the organisation used the results of these case studies to review and tune their operational systems. Thus, changes were frequently implemented a short time after the study was completed. MDD technology is still in development and all MDD systems are constantly being reviewed and updated. Several of the programmes studied here have undergone significant restructuring since the study was done. Thus it should not be assumed that the description here portrays the programme as it is today.

Case Study 1. The Mine Dog Centre, Afghanistan

Update

This study was completed in 2002. Since that time the Mine Dog Centre in Afghanistan has achieved the following developments

- A full technical review, conducted in 2003.
- Agreement in principle on introduction of a new training approach for new dogs and handlers, which is being introduced in 2005 (supported by GICHD).
- Retraining of older dogs and their handlers (supported by RONCO).
- More flexible operational procedures as a result of trials conducted in 2003, which identified environmental influences on mine dog detection.
- Introduction of a nationalised IMAS.
- Changes to procedures for operational deployment of dogs to improve the completeness of ground coverage.
- Considerable expansion of the programme, including establishment of new regional offices, new equipment, new management headquarters, and an increased number of dogs (about 300 in 2005).
- Considerable infrastructure development at the Training Centre in Kabul.
- Introduction of independent accreditation testing, and development of plans for an accreditation testing ground to be established by end of 2005.
- An international deployment, with establishment of a training programme in Yemen.
- An increased rate of attendance at international meetings.

Introduction

The Afghanistan Mine Dog programme has been continuously operational since 1989, and in 2005 is the largest dog programme in the world. At the time of this study in 2002, there were more than 130 operational dogs, and the programme has approximately doubled in size since that time. The Afghans have also expanded their sphere of operations by establishing a training programme in Yemen, and regularly contribute to international meetings. The programme reports to the UN-run Mine Action Centre, which supports ongoing development.

Background

Summaries of the situation in Afghanistan in early 2002 are provided in the Journal of Mine Action, Issues 5.3 and 6.1.

The Afghan people have endured almost continual warfare since the late 1970s. The arrival of the Russians in 1979 resulted in attempts to repel the perceived invasion, and prolific distribution of mines by both sides. After the Russian withdrawal in 1989, a destructive civil war began, which was brought under some control during the dominance of the Taliban from 1995. Some fighting between the Taliban and other parties continued until the rapid retreat of the Taliban before an international force led by the Americans in late 2001. In 2005, a national government is in place but some regional conflict continues. In earlier years, mine clearance agencies were generally left alone by the warring parties, but that situation has changed since extensive road building began in 2003. Some attacks on mine clearance agencies have occurred recently, and the problem may be escalating, restricting the deployment ability of the agencies and imposing higher security costs.

Contamination of the landscape by mines and UXO is extensive, and can be at such high densities that dogs cannot be used. In 2000, mine and UXO-related accidents were estimated at 88/month (ICBL 2001) and for 2001, 150-300/month (Sprinkel 2002). These estimates are based on information of low quality, but the most important point is that they are considerably lower than estimates from earlier years. The decline in accident rate continued until 2005.

A program of mine and UXO clearance began at the time of the Russian withdrawal, and continued throughout the civil war of the early 1990s and the uneasy peace of the Taliban period. The use of dogs was initiated in 1989 using 14 dogs donated by the Government of Thailand. The American-based company RONCO (through its contractor, the Texas-based Global Training Academy), provided training for several years, and the program was fully nationalised in 1993. In May 2002, there were 17 Mine Dog Groups (MDGs, 4 dogs each) and 33 Survey teams (2 dogs each), giving a total of 134 operational dogs.

The Mine Dog Centre, based in Kabul, runs an extensive breeding and training program in order to provide replacement dogs and handlers. During the expansion after the time of this study, about half the dogs were bred locally and the rest were obtained in Europe. Until 2002, the programme cleared up to 17 million m² of land per year, with reported clearance rates for MDGs (4 dogs) being up to 5000 m²/day (Mine Action Centre records).

In 2002, most of the infrastructure in Afghanistan was destroyed. There was no stable government, no exports, an unstable economy, little healthcare, education or other social services, and subsistence living was the rule. Extensive social problems were caused by a history of lawlessness, the prevalence of guns, breakdown of family structures (due in part to the death of many men) and economies (women have limited work opportunities), tribalism, production of drugs (opium, hashish) in some sectors, and population redistribution due to movements of refugees. Much of the food was grown by subsistence agriculture supported by primitive irrigation systems and supplemented by humanitarian aid organisations and some imports. Remaining irrigation systems were damaged by war and extensively mined. Much of Afghanistan is desert, and a drought had further reduced harvests for some years. Establishment of some political stability resulted in the return of large numbers of refugees, putting additional pressure on limited resources and infrastructure.

Most of the population live in small towns and villages, with a few larger centres. Local people tend to know where suspect or mined areas are in their region, and can avoid them. Two groups, returning refugees and the nomadic Goochies, do not have such local knowledge. In 2002, refugees were returning in large numbers, with the population of Kabul estimated to have risen by 500,000 in 6 months. The Goochies claim a population of some millions. As pastoralists, they wander widely across the landscape and are particularly at risk from low density minefields.

Afghanistan is a strongly Islamic culture, fundamentalist during the Taliban period. Dogs are considered unclean in many Islamic societies, and although there are many dogs, people do not regularly keep them as part of a family structure. Thus, people recruited as dog handlers are unlikely to have kept dogs as pets, or worked with dogs in any capacity. They would have little formal education, and no understanding of dog behaviour, training, socialisation, or healthcare. All of these skills must therefore be taught. Afghan dog handlers can eventually develop a strong bond with their dogs, to the extent that dogs have been taken home by the handlers when they grow too old to work.

Acceptance of dogs by both the handlers and the communities in which they work has improved through formal acknowledgement of dogs as a weapon in the war against mines.

Mine Action and MDC

The Administrative Structure

The Mine Action Centre (MACA) is a UN-run organisation that serves a variety of policy, liaison, and coordination roles, as well as providing technical support for the nationalised program (Sprinkel 2002). It moved to Kabul from Islamabad in June 2002.

The Mine Dog Centre (MDC) functions as an NGO, funded primarily by the German Government. The Head Office, breeding and training centres are all in one location in Kabul, having been amalgamated in 2004. Policy and national operational priorities are coordinated from those offices. The MDC training and breeding centre is an

excellent resource, with extensive training fields, breeding and housing kennels, and veterinary facilities.

Five regions were recognised in 2002 (north, south, east, west, centre), each with a Regional Mine Action Centre established in the capital of the region. Each region has a Site Office, which coordinates regional operations and provides local support. A vet, a paravet, and a dog trainer are based at each Site Office.

META (Monitoring, Evaluation and Training Agency) is an NGO responsible for quality assurance (including for work done by dogs), training on many aspects of mine action, and accident investigation. In 2002, accreditation of the dogs involved an internal test at the end of the original training at MDC, followed by regular 6-monthly tests conducted by MDC personnel at operational sites. META had no involvement with these tests.

No veterinary support is available at the field site, although the paramedic can provide emergency aid for dogs. Sick dogs may be brought to the vet at the Site Office. The dogs can be given excellent veterinary attention if they return to MDC after each 2-month deployment. At that time, the handler can also consult about any training or operational problem. Dogs deployed to remote locations across Afghanistan may not return to Kabul during the break between deployments.

The Operational Structure

A Mine Dog Group (MDG) consists of a Group Leader, an Assistant Group Leader, a Team Leader, 4 dogs each with one handler, 12 manual deminers, 3 drivers, a paramedic, a cook (total 24 men), and a few guards. Support vehicles are a bus, a truck (for the dogs), and an ambulance. Each MDG has radio support and is in daily contact with an administrative office, either regionally or centrally.

The ratio of 12 manual deminers to 4 dogs is a result of operational experience over several years. The number of deminers has been increased at least twice.

A Survey Team consists of a supervisor, 2 dogs and handlers, and a driver (total 4 men). A cook may be attached to the team. Members of the team are also trained as manual deminers. They use one double cab pickup truck, with the dogs travelling in the back. The main role of these teams is to support other (mostly manual) demining operations by delimiting the boundaries of minefields through a breaching process (i.e. survey). Survey teams were not visited during this study and nothing more will be said about their operations. However, the handlers and dogs receive the same training as for Mine Dog Groups, and they use the dogs in essentially the same way to clear 2-m wide safe lanes.

The following general comments are based on detailed observations of two MDGs, and general discussion with Head Office and MDC staff and international advisors. The background of training and requirements of the SOP mean that all teams operate in the same way when in the minefield, thus although the sample is small, it should be representative. The MDGs are routinely isolated from each other due to the remote locations of many minefields and the standard 2-month deployment (followed by 10 days leave). Thus each Group presumably develops its own culture outside the minefield, and some details may vary from the description provided here.

When deployed, a MDG is based at a camp in which the team lives communally and shares all facilities. The conditions are routinely primitive, with no electricity or running water, and housing in buildings that are partially destroyed. In 2002 there was no functioning communication network in Afghanistan and the men had little or no communication with family.

The dogs are housed in mobile kennels, separately from the men, and remain in those kennels except when working or in training. Each handler is responsible for the maintenance of his dog. As policy, dogs are not attended to or exercised by any other members of the team (such as manual deminers). In effect, the manual deminers have essentially nothing to do with the dogs.

The MDG works for 6 days per week, and does equipment and personal maintenance on the day off (Friday). Opportunities for making recreational visits to a local town will depend on the location of the camp.

The daily cycle proceeds as:

- Up at 0500, breakfast at camp
- 0545, team assembles in paramilitary formation prior to boarding vehicles
- 0545-0600, leave for minefield
- 0630 arrive minefield; assemble at assigned location at field base
- Prayer and short briefing from Group Leader
- Manual deminers prepare equipment; dogs given short walk, obedience routine, and taken into test minefield to find a mine (known location) as a tune-up exercise; medical base tent erected (an additional tent may be erected close to the worksite)
- 0700, march in loose formation to the minefield, deploy to worksites in teams
- 0710, dogs begin work; manual deminers may continue working on clearance sites not completed the previous day
- 1220-1230, complete work for the day (1220 or earlier if disposal is required); group assembles in formation before leaving minefield and walks out in formation
- Any required disposal completed
- Short debrief at field base; board vehicles; return to camp; debrief may occur at the camp; lunch at the camp; sleep
- In late afternoon dogs, receive short training session in a test minefield at the camp, beginning with obedience routine; manual deminers have no further work requirements
- Dinner; evenings free

The search procedure

A MDG operates as two loosely constructed teams, with two dogs and 6 manual deminers (who work in pairs). When working, a handler and dog are always under

close supervision, usually by the Assistant Group Leader or the Team Leader. The Group Leader supervises the entire operation, especially the manual demining work, and tends to leave direct supervision of dogs and the details of clearance to his assistants. In both the MDGs observed, the Group Leader was continually on the move in the minefield, checking up on his men and consulting with the supervisors.

For the first time in 2002, the manual deminers were issued with PPE, and new helmets and visors. The helmets are lightweight, and their main role is to support the visors which are the main protective equipment for the head. The body protection is almost full cover, with an apron, and fully protects a kneeling man except for the arms. Dog handlers wear no PPE. Until the new equipment was issued, helmets and visors were the only protection worn by the manual deminers.

Typically, two dogs begin work in separate areas. After 10 - 20 min, each is replaced by the second dog of the pair who searches the same area again. Thus, a maximum of two dogs is working at one time. If a dog gives an indication, there are two choices: either remove that dog and have the second dog search the same area up to the indication site (or beyond if it does not confirm the indication), or move the dog further along (5 m) and have it continue working. The second option was observed only once during 6 days observing two groups. On one other occasion, the first search dog was moved about 10 m farther along the baseline, and searched back to the indication site. In all other cases, the dog that gave the indication immediately stopped working, and the second dog was brought in for the second search.

An indication site is flagged by the supervisor after the second search. Whether or not the indication is confirmed, the second search allows the area leading up to the indication site to be declared clear, and the supervisor walks up to the site to place a flag. The flag is placed by eye in consultation with the handler.

For both the groups observed during this study, indications occurred at a fairly high rate. Thus it was possible for most of the six manual pairs to be working within 1-2 hours (aside from the possibility that some were already working on indications from the previous day). Thus, by about 0830, one or no dog was working for either or both of the reasons that: i) if another indication site was found, there would be no manual team available to clear it; and ii) the safety distance between operational teams (manual and dogs) was 60 m, and there was no space left along the front of the minefield for the dogs to work.

Manual deminers work in pairs doing 30-min shifts, clearing a 2 x 2 m area around the indication site using metal detector, prodding, and digging. If nothing is found, a dog is brought back to recheck the site. The time required for clearance of an indication site varies, but is a minimum of 1.5 - 2 hr and could be more in difficult ground. Once the manual team completes clearance of an indication site, it is possible for the dogs to continue working in the vicinity of that site, and there is usually a second work period for the dogs in mid to late morning. Clearance of indications from later in the morning is not usually completed on the same day.

In an open field site, there are no breaching paths, safe lanes, or zones delimited by strings or tapes. During road clearance, a safe path will be cleared along one side giving the deminers access to sites farther along the road (using the same breaching procedure as is used by survey teams). The edge of the safe area is lined with rocks

painted red (uncleared side) or white (cleared side) painted rocks which are moved as clearance progresses. Large red flags define the boundary of the minefield, and smaller red and white flags are used to mark current work areas (*Figure 1*).

Figure 1. The boundary of the minefield (large flag), and delimitation of work areas using smaller flags



All the dogs work on long leads. The handlers always attempt to work the dog across the wind, with the search lines moving down the wind, and the line direction may be adjusted with changes in wind direction (*Figure 2*). Search-line length is 8 m, and the cleared area is 7 m wide, giving a 1-m margin of safety. The length of a work area (effectively a “box” x by 8 m) varies, but x is usually 15 m or 25 m.

The distance between search lines is not measured, and is defined by the dog handler using one long pace, or 1.5 normal paces (1.25 - 1.5 m). Thus in a 25-m “box”, the dog should search 16 - 20 lines. The between-line separation was reduced from 2 m (2 paces) about 2 years ago.

The dogs are trained to search in both directions out and back from the baseline, and their behaviour on the search line is not highly structured. The effect was for each dog to have its own search pattern (details below).

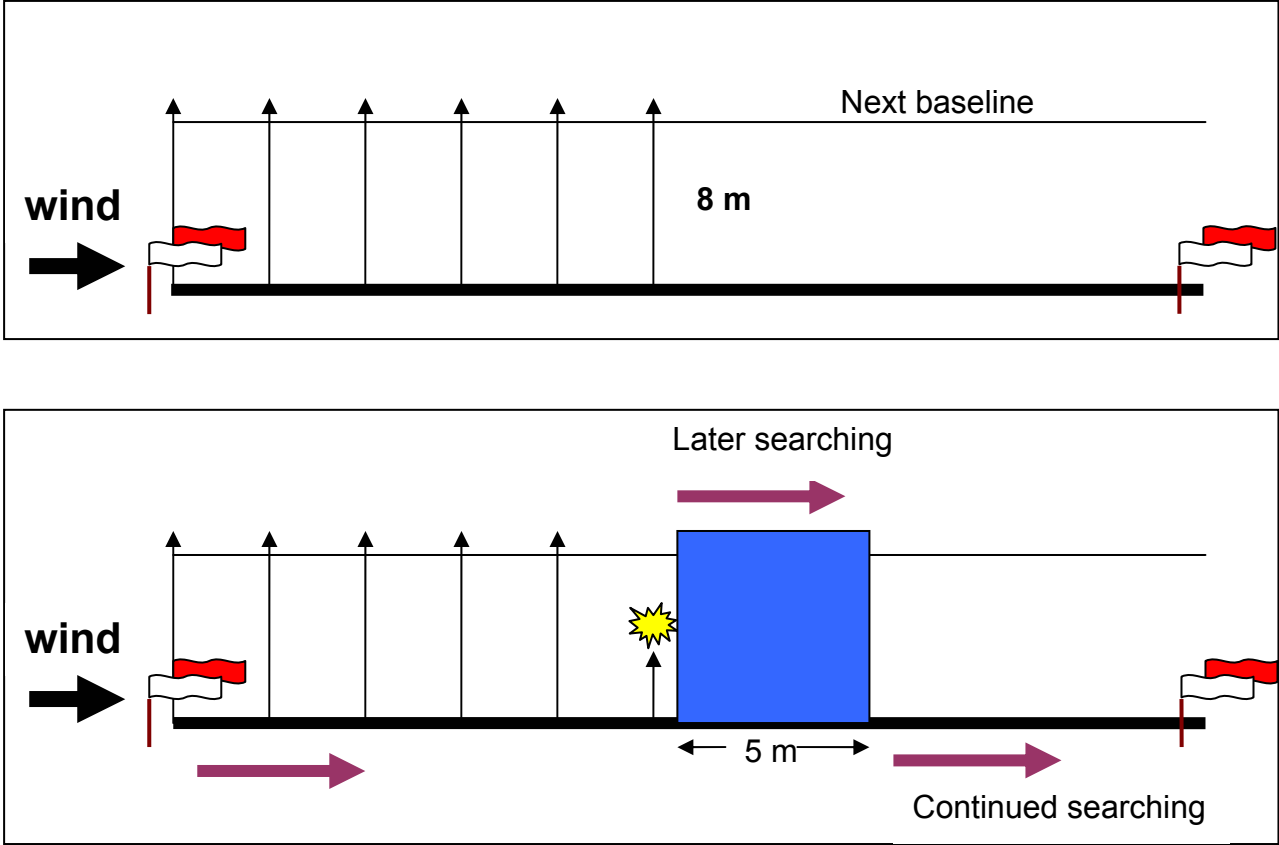
Once two dogs have searched an area of land with no indications, it is declared clear and marked with white-painted rocks. The deminers routinely walked across such land, demonstrating their confidence in the dogs and the operational structure.

At the end of each working day, the supervisors measure the amount of land cleared that day. The Group Leader keeps records of area cleared, items found, and disposal, and reports these values to the central administration office each day via radio. Formal records are not kept about which dog gave the indication and whether the site was confirmed on second search or missed on first search, although the Group Leader may keep notes on these details.

Weather

The study was done in late May 2002 in the Kabul region (altitude 1700 - 1800 m). There had been some spring rain that year, and the countryside was tinged green with light plant growth. In open plain areas, the growth was not extensive enough to be an impediment for dogs. Some prickly annuals (mostly nettles) restricted dog movement, but these plants were not at high enough densities to prevent an effective search. In enclosed areas or along irrigation ditches, some clearance of weedy growth was required.

Figure 2. The typical search pattern for dogs in Afghanistan (see text for details)

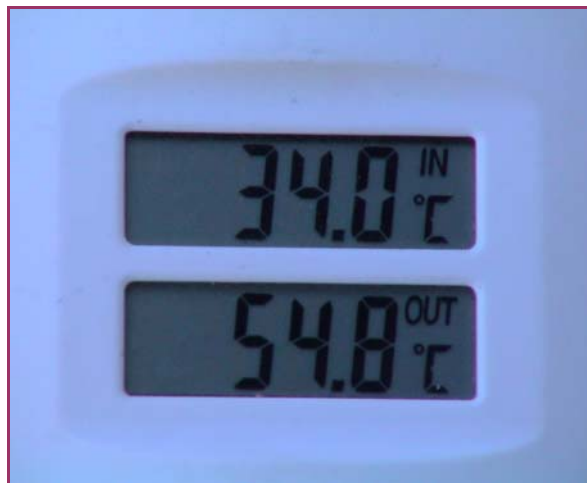


Air temperatures in the shade ranged from about 22°C at 0700 to 34-36°C at midday. Winds were light and variable through the morning. Wind and humidity tended to increase in the afternoon, sometimes resulting in dust and/or electrical storms from mid afternoon. Rain fell on one afternoon of the study period.

Soil-surface temperatures climbed rapidly through the morning from 17-20°C at 0700, to over 50°C by midday in open areas (Figure 3). In enclosed spaces with no wind, the soil-surface temperature climbed even more rapidly, reaching 50°C by 1030. At these soil-surface temperatures, dogs could be seen lifting their feet, and adjusting the search line in order to walk on vegetation. Dogs were only required to work for a

few minutes at a time under these conditions, and in some cases dog work was stopped completely.

Figure 3. Air temperature in the shade (above) and soil-surface temperature (below) in a minefield near Kabul at 1200 hrs on 28 May, 2002



Data Gathering

An observer worked in the field with operational MDGs from Monday 27 May to Thursday 30 May 2002 (MDG 10, full records were gathered from Tuesday-Thursday), and Saturday and Sunday, 1-2 June 2002 (MDG 14).

MDG 10 was working in an open plain environment just outside Kabul (near Chilsatoon Village) (*Figure 4*). The site had been a front line for confrontations between various parties, including most recently the Taliban (facing outwards from Kabul) and the Northern Alliance. A destroyed rocket launcher sat on the edge of the site, apparently from a confrontation some years previously. The plain had been subjected to ongoing clearance for some time by various groups, and the team was doing the last major area. ATC (Afghanistan Technical Consultants) were doing manual clearance on the steep hillsides bounding the plain. The area was grazing land, used by nomadic Goochies and local residents. Since clearance of the defined site began on 26 March, 2002, 9 AT mines, 27 AP mines, 15 UXO and 13796 fragments had been found. Two complete RPGs, one PMN2 mine and several large fragments were found during the four days of the study. The area was littered with bullets and fragments lying on the surface. Observation of the entire operational site was possible from one location, allowing all dogs to be monitored continuously through the working day.

MDG 14 was doing road clearance through a small village (Sabikhail) in Parwan Province, about 15 km from Baghram Airbase. The road meandered through the village and was contained by walls. Thus it was not possible to observe all the dogs at one time, and safety issues constrained observation opportunities (hence the shorter period observing this group). When the observer arrived, the group was

working on the road for the third day. One AT mine had already been found. A second AT mine, an AP mine and an entire Kalashnikov were found during the two days of observation. Paths used by the villagers passed over or adjacent to these mines (*Figure 5*). Villagers continued to use the road while clearance was in progress, although the MDG kept them away from working areas.

Figure 4. View looking across cleared area into the mine/battlefield lying between an erosion gully and a destroyed rocket launcher, near Kabul. The photographer is standing on cleared land (indicated by white rocks).



The observer chose one pair of dogs and recorded the details of the search procedure for entire search periods, until the dogs moved to a new area. The dogs moved regularly due to the requirement to stay away from manual-clearance sites, and frequent indications. It was not possible to equalise or randomise samples taken from each dog, and detailed observations were made of whichever dogs were nearest or most visible. All work periods of all four dogs were recorded throughout the working day on 3 days for MDG 10. Such detailed records were not possible for MDG 14.

Some video footage of searches was used to obtain the details of searching behaviour. However, the handlers were aware of being filmed, and the possibility of distracting them meant that filming was kept to a minimum.

Data recorded during each observation sequence were:

- Start and end time for the day
- Start and end time for each dog each time it worked through the day
- Role of the dog during a search (first search, second search, confirm indication, search boundary lines, etc)

- Number of lines searched in a sequence, including number of searches along the same line
- Exact time for each search (out and back, stopwatch)
- Notes about general search behaviour of the dog, including some video footage for detailed analysis
- General handler behaviour
- Relationship between dog and handler
- Temperature in air and at ground surface, and wind, about every hour
- Indications, including site, dog identity, whether indication was on first or second search, whether first search indication was confirmed by second dog, identity of first dog if indication was by second dog (i.e. first dog did not indicate the site)
- Result of clearance of the indication site (when possible)

These data allow calculation of total time spent searching by each dog (MDG 10 only), and estimation of total area searched. Other analyses are described in the results section.

Figure 5. Well-used village path passing over a type 69 AP mine, Sabikhail Village



Results

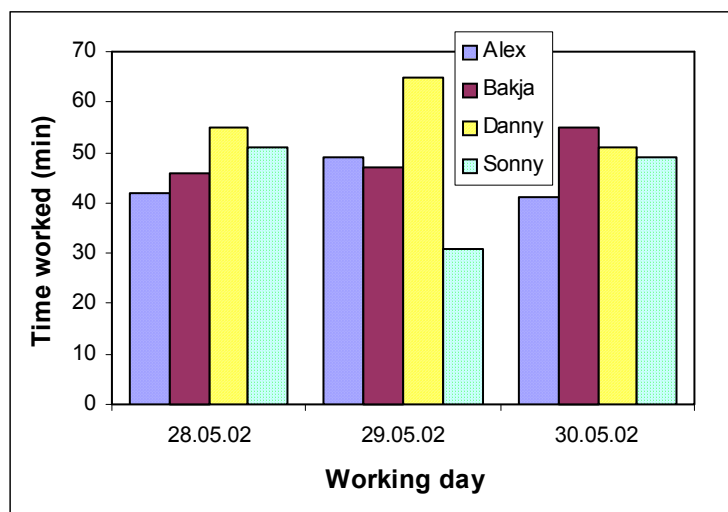
Most of the detailed results are for MDG 10. Additional details are provided for MDG 14 where possible. It was not appropriate to combine results for the two groups because of the different nature of the tasks they were working on. However, more general descriptions are given in a combined way.

Overall Search Statistics

Overall, the dogs of MDG 10 worked (i.e. searched lines in the minefield) for an average of 48.5 min, or about 15% of the 5.5-hr working day. This value is specifically for time spent searching lines. Because dogs work in pairs, they cannot work more than half of the 5.5 hrs, so this figure is more properly quoted as 30% of maximum potential work time. Some additional time is necessarily used for walking back and forth to the search site, drinking water, dealing with indication events, and resting (especially in the hotter part of the day). However, some potential search time was not used because clearance by manual deminers prevented the dogs from working. Equivalent detailed data were not available for MDG 14, but potential search time was similarly not used by that group due to manual deminers working on indication sites.

In the order Alex, Bakja, Danny, and Sonny, the dogs worked for an average of 44.0, 49.3, 57.0 and 43.7 minutes/day. Some variation in the length of time worked between days was found, but in most cases it was <20% (Figure 6).

Figure 6. Total time worked by each dog of MDG 10 during three working days



The area cleared each day was estimated from the number of lines searched by each dog, using a between-line width of 1.25 - 1.5 m, a line length of 7 m, and the assumption that all land is searched by two dogs (total area searched is divided by 2). A 1.5-m width gives the maximum estimated clearance, as most widths between lines were less than 1.5 m. Estimated values were compared with the values reported by the Group Leader based on measurements made directly in the field in Table 1. The match is remarkably close, although the estimates tend to be slightly below the reported values. The data show likely clearance rates under the search conditions experienced at that site (the landscape was ideal for working by dogs, indications were frequent, temperatures became too hot for work in the middle of the day).

Table 1. Reported and estimated (Est)* daily-area clearance by MDG10

Date	N	Reported m ²	Est (1.25 m) m ²	Est (1.5 m) m ²
May 30	20	1280	1019	1223
May 29	24	1200	961	1153
May 28	23	1100	992	1190

*Estimated values are given for two between-line separation distances. N is total number of searches conducted on that day

Length of the work cycle

A total of 86 work periods were observed during the 4 days with MDG 10, of which 31 (36%) ended with an indication. A total of 14 work periods were observed on one day for MDG 14, of which 11 (79%) ended with an indication and an indication was rejected during one more search. The very high rate of indications for MDG 14 appeared to be due to high levels of contamination (including fragments) on the road as well as several important finds (an AT mine and a Kalashnikov on the day of observation). Clearance was not completed for most of the indication sites when the observation period ended.

For the 55 work periods not terminated by an indication for MDG 10, the average period was 9.6 min (calculated as a grand mean of the averages in *Figure 6*) and the longest period was 22 min. The longest work period seen for MDG 14 was 11 min (terminated with an indication). Length of the 55 periods for MDG 10 was investigated in relation to time of day (*Figure 7*; the start time of a work period was used to assign values to a time category). As the day progressed, the length of each work period decreased, as is expected if the handlers are adjusting work periods to compensate for the heat and lower energy levels of the dogs. Sample sizes and ranges for the data were: 0700-0800: 18, 4-22 min; 0800-0900: 10, 5-21; 0900-1000: 7, 3-12; 1000-1100: 12, 1-11; 1100-1220: 8, 2-12.

Details of the Search

Some handlers ran their dogs several times on each search line, whereas others ran the dog just once for each line (*Figure 8*). A line was searched up to 4 times, and in many cases the dog may also have done additional circling while on the line. Note that the distinction between a run (one time out and back along a line) and a line is essential for understanding the figures. The main reason for additional runs on the line appeared to be that the dog had not searched the line properly when it returned to the handler (details below). Danny rarely ran a line more than once, Alex ran the line more than once slightly more often than Danny, and Bakja and Sonny ran most lines twice. Data in *Figure 8* are from 30 May (+29 May for Alex because of small N for him on 30 May). Number of search lines used to prepare the Figure were 31, 45, 48 and 57 respectively for each dog.

Figure 7. Length of each work period in relation to time of day for 55 searches not terminated by an indication for MDG 10. Bar is mean \pm standard error. N's in the text.

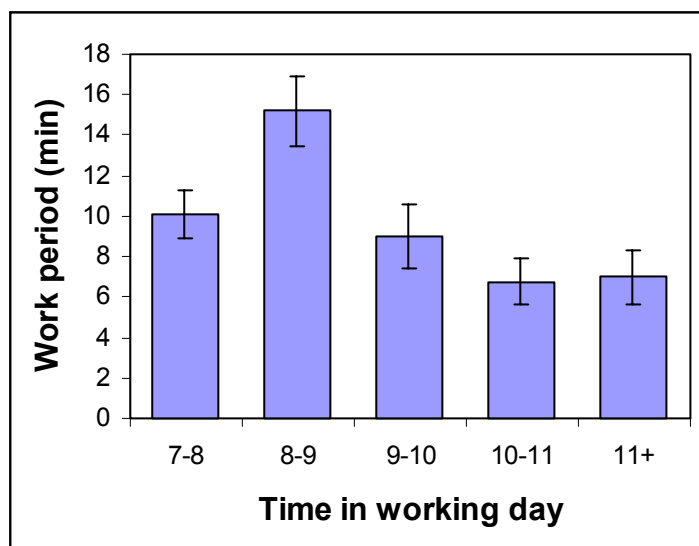
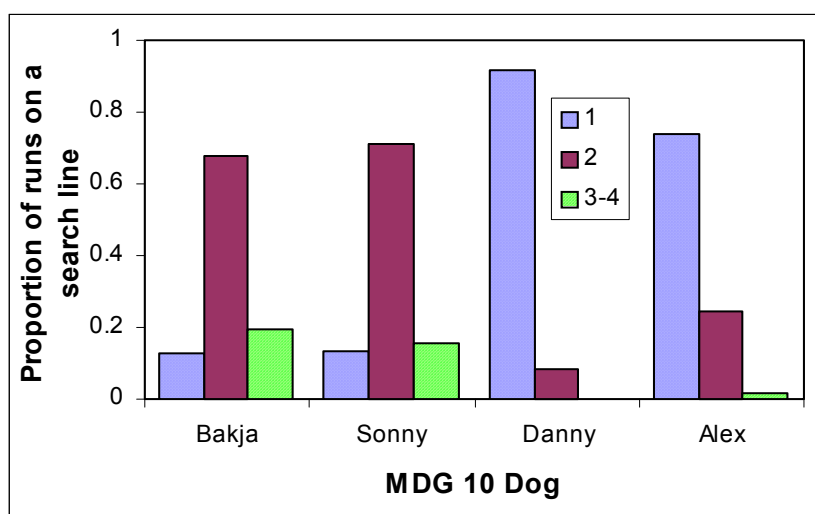


Figure 8. Proportion of runs on a search line for each dog. N's given in the text.

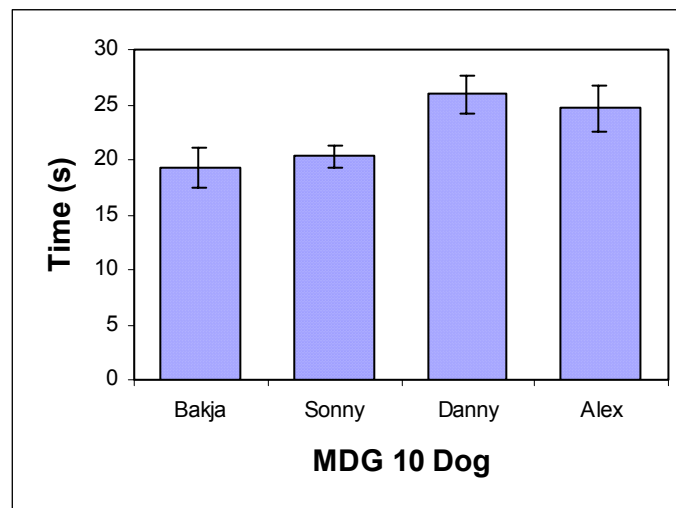


The time taken to make one run on the line varied between the dogs (*Figure 9*). Danny was the slowest and Bakja was the fastest (data as for *Figure 8*).

The time spent searching each line (*Figure 10*), and the mean number of lines worked by a dog/hr (*Figure 11*), were reciprocally related. Although the slowest searcher on a line (*Figure 9*), Danny completed lines at a faster rate and produced almost twice as many lines/hr as the other three dogs, because he only ran a line once. Three of the dogs worked at consistent rates on all three days. Alex was inconsistent, spending more time searching each line on May 29 than on the other

two days (*Figure 11*). However, the difference in search rate did not affect his productivity (*Figure 11*).

Figure 9. Time taken by each dog to make one run on a search line. N's given in the text. Bars are mean \pm standard error.



The MDG 14 dogs worked faster than the MDG 10 dogs, returning average line search times of 23 (N = 4), 18 (3), 21 (4), and 29 (3) seconds/line for Don, Bakja14, Azir, and Sheik respectively (similar to MDG 10 dogs Danny and Alex on 28 and 30 May). The average number of lines searched/hr by MDG 14 was considerably higher, being 105, 113, 127, and 107 (higher than all of the MDG 10 dogs; sequence and N's as above). The differences may have been due partially to slightly shorter lines being worked on the road (most searching was across the road).

Clearance rates for individual dogs

The clearance statistics used above to estimate overall daily area cleared by MDG 10 can also be used to estimate clearance rates for individual dogs. The following assumptions were used:

- For MDG 10, line length was 8 m
- For MDG 14, line length was 7 m
- Clearance was calculated for a 30-min search period. Although longer than the search periods observed, this time period is more useful for comparative purposes across MDD programs. The numbers are easily adjusted for any chosen time period.
- Separate calculations were made for a distance between search lines of 1.25 and 1.5 m.

Figure 10. Productivity, measured as number of lines searched per hour, for each dog in MDG 10. Total N's/dog: 12, 16, 10, 8 (range/day 2-6).

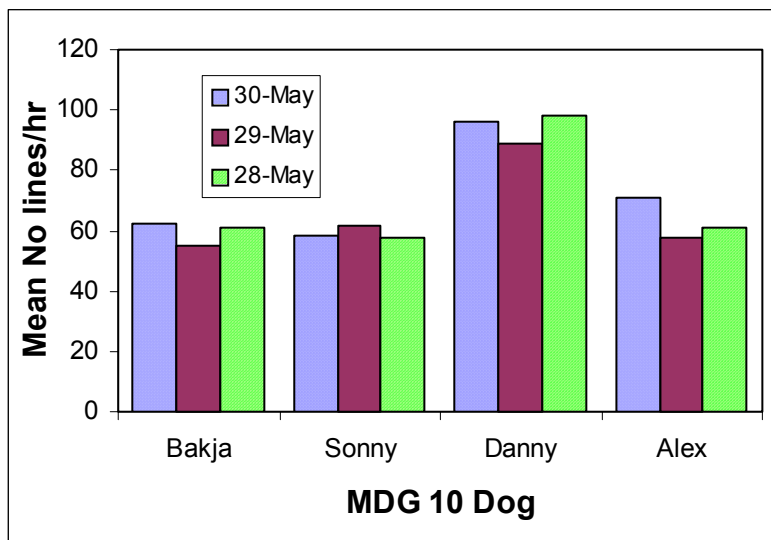
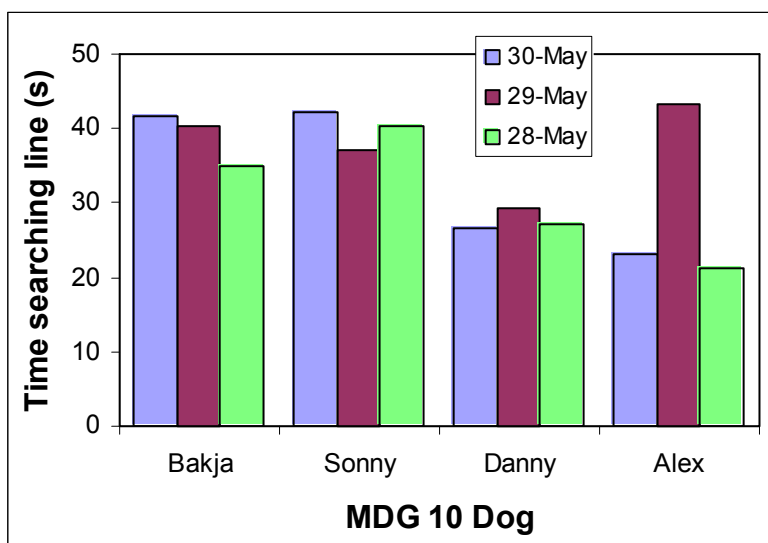


Figure 11. Time spent searching a line by each dog of MDG 10 on different days. N's as in Figure 10.



Area searched ranged from about 300 to about 600 m² per dog in 30 min (Table 2). MDG 14 dogs searched more area/unit time than MDG 10 dogs, even with the slightly shorter line length used in the calculation for MDG 14. Danny searched the largest area/unit time in MDG 10.

Table 2. Estimated search area/unit time for individual dogs of MDG 10 (above line) and MDG 14 (below line)*

Dog	N	Area/30 min (line separation 1.25 m)	Area/30 min (line separation 1.5 m)
Bakja	12	297.6	357.1
Sonny	16	297.0	356.4
Danny	10	472.2	566.7
Alex	8	316.7	380.0
Don	4	458.6	550.3
Bakja14	3	495.2	594.2
Azir	4	553.4	664.1
Sheik	3	466.7	560.0

*Assumptions underlying the calculation given in text. N is number of complete work periods used to make the calculation. Units are m².

Indications

Indications by a dog on the first search were usually confirmed by the second-search dog. If the first indication occurred on the second search, the MDG did not usually confirm that indication with a third search (seen twice). Indications are excavated whether or not confirmed by a second dog, so a third search would serve little purpose.

Of the 5 days for which complete or extensive observations were available, 7 of the 8 dogs gave indications in the minefield every day. Alex gave indications on only 2 of the 4 days he was observed. The dogs also give (usually one) indications in test fields at the beginning and end of each work day. Thus the dogs are given regular practice both on the odour of mines/UXO, and on indication behaviour. All indications were rewarded in the same way, by the handler giving a series of signals and giving the dog access to a ball. A small number of indications were not rewarded. In those cases the dog was recalled, then sent again to indicate a second or even third time, before being rewarded.

Behaviour of the Handlers

The handlers gave their dogs consistent positive attention during the routine process of searching, and offered water regularly. However, when not actually searching, the dogs were also subjected to occasional hard checks with the lead and shouted commands. Dogs that were not working well, and the poorer dogs, tended to be given more checks than others. In general the positive experiences far outweighed the negative experiences, and relations between handlers and dogs were good.

General Observations

Operational Structure

The operational structure was effective, efficient, and applied good safety principles. Field supervision was consistent and focussed – dogs never worked without a supervisor present. Movement of rocks defining boundary lines was closely supervised. SOP safety standards were adhered to rigorously, and visitors to the minefield were carefully monitored. Manual deminers stopped work if approached, and waited for the person to return to the safety distance before beginning work again. Entry to and exit from the minefield was done in formation, ensuring that all personnel arrived and left together. The mobile medical centre was placed as close to the working front as was practicable. Overall, the operational structure in the minefield appeared to be working well for both teams.

The MDG needed to work along a broad front in the minefield in order to ensure enough space for up to 6 manual clearance sites (at minimum 60-m spacing). The frequent occurrence of indications meant that dogs were constantly being moved to different sectors of that front. The dogs were always withdrawn after an indication, with the effect that the areas searched were not geographically structured (for example into precise 25 x 7 m blocks). New searches were begun at locations where there was room for dogs to be inserted between manual clearance sites. The effect was that the dogs searched random widths at random locations along the front of the minefield. As a result, there was a need for very careful marking to ensure that all land was properly searched (i.e. by two dogs). No mapping was observed, and assurance of proper clearance appeared to rely on the placement of red rocks and flags, combined with the memory of the supervisor.

Road clearance presented a different problem. Because the clearance site was 2-dimensional, ensuring proper clearance of all areas by two dogs was more straightforward. However, providing a broad front of operation was difficult because clearance effectively jumped down the road. When working, each dog worked as a second search dog for the first half of the area searched, and then as a first search dog for the second half of the area searched. This leap-frogging system worked well until an indication occurred. As the dogs were always withdrawn immediately until disposal had been completed, careful record keeping was required to ensure search by two dogs on the unsafe side of the indication, especially if one dog had already searched there.

Weather

The weather in late May was acceptable for humans, but temperatures approached the limits of tolerance for working dogs. Winds were mostly light through the morning, and along the enclosed road there was almost no air movement. When not working, dogs were usually placed in shade if some was available (from walls or landforms). However, towards the middle of the day that shade disappeared and dogs were often left in the sun. Such dogs were not heat stressed, but they were at the limits of heat tolerance when at rest. When asked to work, the extra activity caused them to become heat stressed almost immediately. The dogs would have been able to work

for longer periods in the late morning if they rested under shade on cool ground (i.e. on ground that was shaded from early morning).

General welfare

Due to language difficulties, only limited discussions were undertaken with the deminers about their jobs. However, those spoken to were enthusiastic and open. They liked their jobs, and had no complaints about operational procedures, equipment, housing or living conditions. The only negative comments, stated as facts rather than as complaints, were first, about the long periods away from family during which almost no communication was possible; and second, about the decline in value of salaries because of the changing economy.

Overall, the operational organisation of the two MDGs visited was impressive. Supervision was consistent and effective. Safety standards were carefully adhered to. The manual deminers were using the new PPE consistently and properly (although they found it quite heavy). There was considerable emphasis on team spirit in the daily briefings and debriefings, and good cooperation on daily tasks such as setting up and deconstructing the field base.

Productivity

MDG 10 produced about 1200 m² of cleared land/day, with considerable work time to spare. Presumably higher rates of clearance would have been achieved if the false indication problem with one dog was solved. Thus this clearance rate seems to be a fair indication of what is achievable using this search system. As each dog worked for only 30% of its potential work time, it seems likely that the clearance rate could be increased with a lower indication rate.

The dogs of MDG 14 gave estimated clearance rates about 1.4 times faster than the dogs of MDG 10 (Table 2). With equivalent lengths of time worked, MDG14 would give clearance of about 1680 m²/day. It would be valuable to explore further the reasons for such differences between MDGs, and the extent of that variation.

Acknowledgements

Thanks to all the members of MDGs 10 and 14, who supported this study with enthusiasm. The Group Leaders in particular were invariably helpful, supportive, and attentive to the safety and comfort of the observer, despite their busy work requirements. All personnel at the MDC Head Office and Training Centre assisted in many ways. In particular, I thank Shohab Hakimi, translator Anaitulla, and the senior management at the Training Centre, who organised vehicle and other support. It is a tribute to the openness of the Afghans that they supported this study, even though they knew that critical comments could be made about their operation. The study was supported financially by the Governments of Britain and the USA, and strategically by the United Nations Mine Action Centre of Afghanistan.

Case study 2. The Cambodian mine Action Centre

Update

Between November, 2001, when this study was conducted, and August 2005, the following changes were implemented:

- Responsibility for technical support handed over to Norwegian People's Aid in 2002.
- The programme is subject to regular (twice annual) review by a GICHD team, who evaluate different aspects of the programme on each visit.
- Changes to the training methodology and physical training procedures have been implemented, including introduction of a swimming pool.
- Accreditation (Test and licensing) of MDD's in compliance with IMAS is implemented.
- Long-leash MDD's have been introduced.
- Team structure and size has been adjusted to smaller teams to cut costs and increase mobility/flexibility:
 - A short-leash team consists of 9 staff, 4 dog handlers, 4 close markers (de-miners) and 1 Team leader. All transported in two cars with mobile kennels. An appointed Senior Dog handler becomes Acting Team Leader in the absent of the normal Team Leader.
 - A long-leash team consists of 3 staff, 1 Team leader and 2 Dog handlers. All are transported in one car.
- Total number of staff for the MDD program is about 110 local staff, 1 International consultant and 1 National consultant.
- In 2005, CMAC has 12 operational MDD Teams, 10 Teams working with short-leash MDD's and 2 Teams working with long-leash MDD's.
- The number of operational MDD's is 44, with more in training.

- CMAC have a joint cooperation with MAG Cambodia, who is renting/leasing two MDD Teams from CMAC.
- A cooperation agreement is signed between NPA Global Training Centre in Bosnia and CMAC.
- A trial for establishing dogs for EOD search has begun, with completion planned in first quarter in 2006.
- Productivity of individual dog teams has improved.
- The use of dogs as part of the demining toolbox is being conceptually improved.
- The dog programme is fully integrated within CMAC.

Introduction

The programme was originally established by the Swedish International Aid organisation (SIDA), with local responsibility held by the Cambodian Mine Action Authority (CMAC). It took several years to get the programme operational, and this study was conducted when new teams were still being trained and deployed.

Background

The Khmer people endured almost continual warfare from the early 1970's through the time of the Khmer Rouge (1975-1979), the invasion of the Vietnamese (1979), and the subsequent civil war which finally ended in 1992. Contamination of the landscape by mines and UXO is extensive, and in 2001 there were about 100 injury-causing accidents per month (Heng Ratana, pers. comm.). A program of mine and UXO clearance began during the 1990s, and the SIDA dog program was initiated in 1997. The first team (6 dogs) was accredited and became operational in June 2000. Subsequent teams became operational in late 2000 (Team 2), September 2001 (Team 3), and October 2001 (Team 4). By November 2001, when this study was conducted, a fifth team was under training for accreditation in March 2002, and 51 dogs were either operational or in training at the Mine Dog Training Centre (TC). Enough additional dogs and handlers were in training to create a 6th team sometime in 2002, although some of these handlers were to be deployed to currently operational teams after loss of handlers through either promotion (to supervisor or instructor status) or resignation.

Cambodia is extensively farmed for rice, and has a dense rural population. Educational standards tend to be low, but many children receive some school education and the ability to read can be used as a minimum recruitment criterion for dog handlers. The density of domesticated animals in rural areas is extraordinarily high, with very large numbers of cattle (oxen and water buffalo), fowl (especially chickens), and dogs, and fewer numbers of horses, pigs, goats, and geese. Typical farm animals are less common in the cities, but dogs are abundant and many are kept as pets. Animals frequently live in or under the houses of their owners.

The people care for their animals relatively well, for example, many cattle are washed regularly by hand. Thus, most Khmers grow up surrounded by animals, and have a generally positive attitude towards dogs resulting from a history of touching, petting, playing with, and perhaps even sleeping with dogs. However, Khmer dogs receive no training, little or no healthcare, and most fend for themselves by scavenging. Thus, while they are likely to have extensive experience with animals, recruited dog handlers will have little understanding of or knowledge about dog behaviour and the principles of training. They are unlikely to have a negative attitude towards dogs, or to be inclined to treat a dog harshly. But nor do they have any sense of what it means to socialise or train a dog, and they must be taught to care for and respect a dog.

The MDD program

The Operational Structure

At the time of this study, a team consisted of a supervisor (called an assistant supervisor), six dog handlers (each with one dog), six manual deminers, and three vehicle drivers (the assistant supervisor also had a vehicle). The drivers have basic first aid training and double as medics. The dogs work in pairs, thus each team contained three dog “sets”. Each set included two dogs, two handlers, and two manual deminers (called close markers). The personnel making up each set worked together consistently, but sets were routinely reconstructed using members of other sets (or other teams) if members were absent (e.g. through illness).

Each pair of teams had a supervisor with overall responsibility for field operations and liaison with the regional administrative authority for mine action (called the Demining Unit). The Demining Unit is responsible to the Cambodian Mine Action Centre (CMAC), based in Phnom Penh. Within CMAC, there is a Programme Manager for the dog program, who has overall administrative authority, and provides liaison with the sponsoring agency (SIDA, NPA). A varying (and reducing) number of Swedish Technical Advisors (TAs) have worked with the Khmer personnel since the beginning of the program. Their role is to assist with all components of the program (dog training, operations, management, administration, record keeping, accreditation, preparation of SOPs, etc). The aim was for most of the TAs to be withdrawn by end of 2002 (and that aim was achieved).

Together, two teams required 9 vehicles. Because of the warm and humid climate, vegetation clearance is a significant problem in Cambodia. During 2001, mechanical brushcutters were introduced with the aim of speeding up clearance rates by eliminating the need for clipping of vegetation by the manual deminers. At the time of this study, Teams 1, 2, and 3 were working behind a brushcutter, and Team 4 was working behind a large flail (deployed from Finland). Sponsorship of several more brushcutters (from Japan) was being negotiated. The flail was on loan and returned to Finland in February 2002.

In November 2001, the four operational dog teams were living in pairs near the towns of Bavel (Teams 1 and 2) and Sisaphong (Teams 3 and 4), in northwest Cambodia. In each case, they were working in minefields about 30-min drive from their accommodation. The Khmer people are accustomed to living in a relatively communal way in small family houses built on stilts because of flooding during the

wet season. Although some members of the teams had their families with them and lived in separate (but adjacent) buildings, most members of the teams lived communally. The dogs were housed in kennels inside the same buildings, either at ground level of a house (Teams 3 and 4), or at one end of a long shed (Teams 1 and 2). Thus, dogs and demining personnel slept in the same accommodation at night, and the dogs were accustomed to people coming and going. This accommodation style is first encountered by recruits at the TC, so is intrinsic to the operational structure from the beginning.

All supervisory staff were previously deployed as dog handlers, so were promoted from within the operational teams.

Most of the handler personnel were recruited from manual demining teams, so tended to have extensive previous experience in minefields. Difficulties with supervision of some of these older and experienced staff resulted in a change in recruitment strategy for Team 5, when advertising was open and only young people were recruited. Women were first recruited for Team 4, which had 3 women and 3 men as handlers in November 2001.

A standard working day has the teams up at 0500, on the road by 0600 (breakfast is taken at the worksite), and beginning work at 0700. The standard day involves working from 0700-1100, and 1400-1600 (mornings only are worked on Friday). Personnel have an early lunch, then sleep through the midday break. Dogs are fed and bedded down as soon as the teams return from work (1630-1700). Most dogs are given a quick evening walk before the teams go to bed. Each handler is directly responsible for the health and welfare of their dog. One of the two CMAC vets is assigned to the teams on a 5-week rotation, but visits by a dog trainer are only made if requested by the supervisor. The visitation rates of the TAs (who originally worked intensively with the teams) is being progressively reduced.

Once they are accredited from the TC, the dogs become operational and work a standard five-day week. They receive a minimum of one full training day each month – the primary objective being reminder training on the odour of mines. The full team returns to the TC for 3 weeks every 6 months for intensive training, and further accreditation. Dogs experience a “motivation” trial about once a day. A small piece of TNT is laid on a search line, the dog encounters the TNT and is expected to indicate its presence (by sitting or lying down), and is then rewarded.

Discipline is de-emphasised in the training program for these dogs. The principle applied is that the dogs are well socialised, they are worked on short leads, and they have an excellent relationship with their handlers (so wish to please the handlers). Basic “sit” and “stay” and “come when called” are trained, but are achieved primarily as a consequence of training for skills as a MDD, rather than being explicitly targeted as training objectives.

The Search Procedure

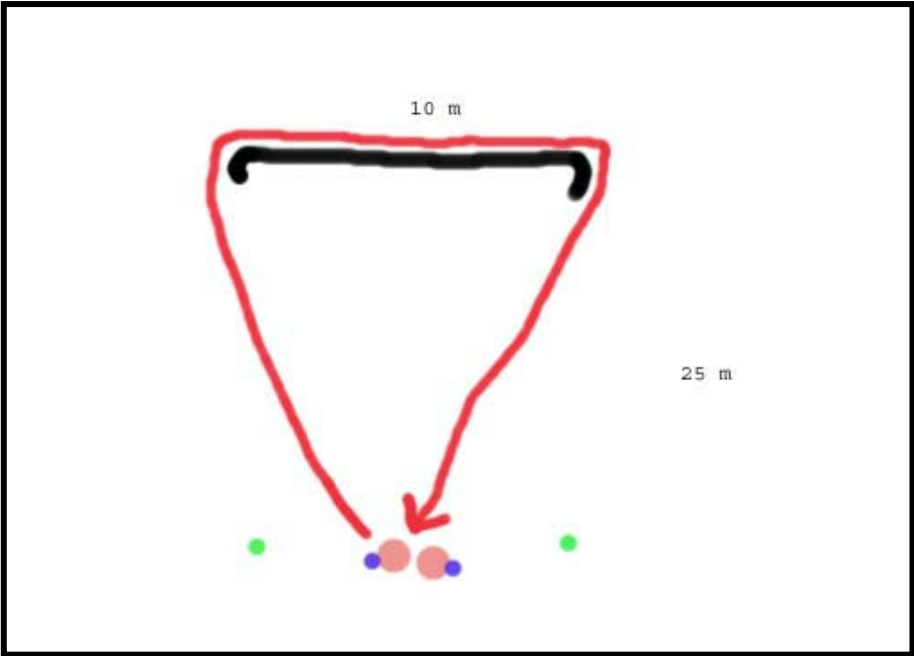
The search procedure begins when the two close markers (manual deminers) lay a 10-m rope along the edge of the safe lane (which is the previously-searched lane – there are no breaching lanes) (*Figure 1*). The dog then searches along the rope on a short lead, with the handler following on the safe side of the rope, and the dog

working on the unsearched side. The second dog follows the first dog and searches the same line. This line is then effectively declared safe, the two close markers move the rope a standard width (40 cm), and the two dogs search in sequence again. Handlers may ask the dog to search part of the line again if they are unhappy with the search, usually by circling the dog around and returning it to the line.

The rope provides the line along which the dog is to search, identifies the safe lane for the handler, and signals the beginning and end of the search lane for the dog. Both ends are curled back into the safe zone, so that the dog begins and ends its search in the safe area.

The teams work for 40 min in each hour. Short breaks may be taken frequently during hot weather to rest the dogs. The teams may work for longer than 40 min in one stretch during the cool morning hours.

Figure 1. The search technique indicating the typical positions of umbrellas (pink dots), dogs and handlers (blue dots), close markers (green dots), the search line (black) and the walk taken by each dog (red line)



In November 2001, the weather was cool in the morning, rising to 30-32°C in the middle of the day. November is at the end of the wet season, and November through January is the “cool and windy” part of the year, so is the best time of the year for the dogs to work. During the study there was no rain, winds were light and variable, and there was some cloud. There were only one or two afternoons in which the dogs

were clearly getting hot, and there were no delays caused by weather. The water table was high, with large amounts of standing water. Areas of the minefield that were set aside as too wet for searching in mid-November, were dry enough to be searched by the end of November.

The above description identifies many components of the search design that are potentially measurable. Thus, much of the quantitative data presented below are timed representations of components of the search procedure.

Dog Origins, Staffing, and the CMAC Training Centre

In 2001, the TC was staffed by a small number of administration and support personnel, one instructor, three dog trainers, and two veterinary staff (all these people are Khmer). More instructors were in training. Recruits for handler-training lived on site, and shared their accommodation with the dogs who slept in kennels in the same rooms as the recruits.

In November 2001, the 20 deployed dogs observed were 16 German shepherds, one Labrador, 2 Malinois, and one German short-haired pointer. A border collie was with Teams 1 and 2, but was not working because its handler was away. The dogs were a mix of whole and desexed males and females. Most of the dogs are purchased in Europe as young animals when 10 months to 2 years old, but some older dogs with previous operational experience in Sweden were in the teams. Some dogs held at the TC were purchased in Thailand specifically for training purposes to give handlers experience, and were not intended to become operational MDDs (at least one of these dogs, a Labrador, has become an operational dog).

Although fully established, the training program for new recruits was still evolving. The recruits for Teams 1 and 2 spent more than two years at the TC before deployment. Teams 3 and 4 spent about 6 months. Team 5 began training in October 2001, and was accredited in March 2002. An additional group of recruits (including three women) was being trained alongside Team 5. These people will be paired with new dogs, acquired at end November 2001, and may also be deployed to the operational teams if or when openings for handlers become available in those teams. Some reconstruction of Teams 1 and 2 was underway at the time of this study.

At the time of this study, the operational SOP was established. However, new ideas and suggestions were emerging as a result of operational experiences, and new technologies were becoming available. For example, the availability of a mechanical brushcutter in 2001 resulted in a need to investigate the effects of vegetation cutting on detectability of mines for dogs. That study was done during operations, and determined that the dogs should wait at least 12 hours before searching land cleared by the machine.

The TC was established on an old airfield, and the airfield land is used for training purposes. Extensive test minefields have been laid, and most of the training is conducted in those fields. Small pieces of surface-laid, pure TNT are used for training purposes. However, the dogs also search regularly for real mines laid at different depths.

Data Gathering

An observer worked in the field with the operational MDD teams from Monday 19 November to Friday 23 November, 2001 (Teams 3 and 4; intensive data were gathered from Tuesday-Friday), and Monday 26 November to Thursday 29 November, 2001 (Teams 1 and 2). The observer also visited the TC for two days on 15-16 November to observe the training of Team 5.

Team 4 was working in an area cleared by the flail, and very little clipping of vegetation was required. Teams 1, 2, and 3 were following brushcutters, but were also required to do additional clipping of vegetation some of the time. Teams 1, 2, and 3 were working in fields containing some intensive agriculture (rice stands, banana plantations) and houses. Team 4 was working in open fields containing no intensive agriculture or houses.

The observer worked with each dog set for 1-2 work periods (up to about 100 min). The sets worked near each other (observing a minimum separation distance of 25 m), and they tended to be synchronised. So it was usually possible to switch from one set to another when both were on break. While gathering data, the observer sat quietly 30-50 m from the line being searched. The handlers were accustomed to being observed (by supervisors, technical advisors, and occasional visitors) and generally ignored the observer.

Data recorded for each observation sequence were: time of the work period (work time and break time), initial distance between the rest/wait site and the search line (termed the walk distance), number of search cycles (search by 2 dogs + repositioning of the rope), basic weather data (temperature, wind speed), and identity of the dogs and the set. The details of each search cycle were recorded as: time of actual search by each dog (i.e. nose down on the line), and total time for the cycle. Hand clipping of vegetation by the close markers was noted when it occurred, but was not timed.

Data recorded on an all-occurrence basis included reward patterns for the dogs, evidence that dogs were stressed or overheating, indications that the handlers did not respond to the dogs' needs or treated them harshly, any violations of the SOP, general behaviour of the set while search was underway, and behaviour of all personnel when the dogs indicated that a mine or UXO was present.

Searches were conducted in areas in which local people were living, and any activities of locals or their animals that might have disturbed the teams were recorded. Examples included locals approaching the teams either for conversations or to observe, domestic animals distracting the dogs, and domestic animals being driven through the search area. Searches were conducted as close as a few metres from houses, and it was not possible to evacuate locals. Locals routinely stepped over red lines while they went about their business, and could pass by within a few metres of a searching dog. The teams sometimes attempted to warn locals (especially children) away, but routinely gave up attempting to do so.

Three SOP "experiments" were carried out while the observer was present. These were situations in which the teams were trialing a different technique, or were

attempting to maintain operations in the absence of a set member. The experiments were:

- Searching a 20-m line (made by tying two 10-m ropes together)
- Using a deminer with a metal detector as the second dog (a dog was off sick)
- Using a dog handler to assist with moving the rope (a deminer was on leave)

Shorter distances than 10 m were sometimes searched if the local situation prevented use of the 10-m rope.

Terminology

The following terms are used in the description of results:

Close marker: a manual deminer who both moves the line and checks indications

Dog set: 2 dogs and handlers, and 2 close markers (= 2 dogs and 4 human personnel)

Dog team: 3 dog sets and a supervisor (called assistant supervisor)

Search cycle: a sequence of events which is repeated regularly when a dog set is working, including searches along a line by 2 dogs, and movement of the line 0.4 m by the close markers

Search line: the rope that defines the search line for the dog and safe lane for the handler

Search distance: the length of the search line (usually 10 m)

Wait site: the location (usually defined by umbrellas) at which members of the set wait when not working the search line

Search time: the time taken by a dog to traverse the search line

Walk distance: the distance between the wait site and the search line (usually 25 m)

Indication site: place at which dogs signal there is odour of explosives (by sitting or lying down)

Work period: time during which the set works continuously, doing search cycles

Break period: resting time between work periods

Time is usually expressed in seconds (s).

Results

Overall Search Statistics

Overall search statistics are in Table 1. The data are mean values for all measurements. The statistic for “search cycle” includes all times in which the dogs stalled (remained sniffing at one location), or cycled back to check part of the line, both of which are normal components of the search. The data include searches during the SOP “experiments”, searches in areas that had been flailed (Team 4) or brushcut (Teams 1, 2, and 3), search cycles including clipping of vegetation by the close markers, and searches along short (7.5, 5 m) or long (20 m) lines. Cycles were not included if an indication shut down the search sequence. Data sets were not always complete. For example, time was measured for 572 search cycles of a total of 644 observed, and the exact search time for each dog was not always obtained within a cycle.

The means are grand means obtained by first calculating the mean within a work period (e.g. across the 15 search cycles observed, or across the 13 line searches timed for one dog), and then obtaining the overall or grand mean of those means by calculating across work periods (e.g. if the dog was observed during 6 work periods, then its overall search time was calculated from the 6 mean search times available, although the number of search times measured for that dog might have been 62).

Sample sizes are given as the number of raw means used to calculate the grand mean, and the total number of measures available (means/raw counts, or 6/62 using the above example). Fewer complete work sessions (work period + break period) were recorded than work period only, because the observer sometimes moved on to watch another set (so did not measure the break time), or because there was no break between work periods (i.e. when work finished at 1100 or 1600 hrs). The proportion of time worked was calculated from just those work sessions in which both the work and a following break periods were available (N = 26).

Following an indication, the dogs withdrew and the close markers moved up to check the indication site. Such checks took an average of 610 s (N = 4). If that time was used as a break period by the dogs, it did not represent lost search time. However, if it was included in the work period, it represented lost search time.

The average search cycle of 165 s portrays overall productivity during the period of this study, as it includes all the factors (except indications) that were influencing the teams operationally. It is therefore a realistic portrayal of the expected periodicity of the search cycle.

The average search time of 25.6 s for one dog on the line portrays a statistic that was consistent for each dog, because each dog tended to search at a consistent speed on every search, although speed was quite variable between dogs. The fastest dog searched a line in about 15 s; the slowest routinely took about 120 s. Variation in the search time for each dog was related to variation in the length of the line (searches ranging from 5 - 20 m were observed), or if the dog cycled back to check part of the line. The factors introducing variability into these search statistics are investigated in more detail below.

Table 1. Search statistics for all data obtained from 4 MDD demining teams in Cambodia*

Item	Average Measure	N or calculation
Search cycle	165 s	44 / 572
No cycles/work period	14.6	44
Dog search time	25.6 s	86 / 1175 (20 dogs)
Dog prop. time worked	16%	25.6 / 165 s
Set work period	36.8 min [#]	44
Set work + break periods	55.5 min	26
Set prop. time worked	66%	26
Area cleared/work period+	58.5 m ²	14.6 * 0.4 * 10
Area cleared/day [@]	232 m ²	6 hr * 58.5 * 0.66

*The data are average values for each measurement, which can be of either a dog or a dog set depending on the measurement. The values for N are defined in the text.

[#]This value is <40 min because some work periods were short when it was hot.

+Each search line is 10 m long and 0.4 m wide.

[@]0.66 is the proportion of time worked.

Search time for individual dogs

Most of the dogs searched a 10-m line in 20 - 25 s (*Figure 2*), with variation in average search time ranging from 15 s to 37 s (ignoring one extreme case). The higher average of 25.6 s (Table 1) was caused by the extreme case of dog number 18 (a malinois, Sacha). Number 21 in *Figure 2* is a close marker working with a metal detector, and was not included when calculating the average search time. Searches as fast as 12 s along a 10-m line were seen, and this time (equal to a search speed of 0.83 m/s) represents the upper limit for search speed.

Sample sizes and identification of each dog are provided in Table 2.

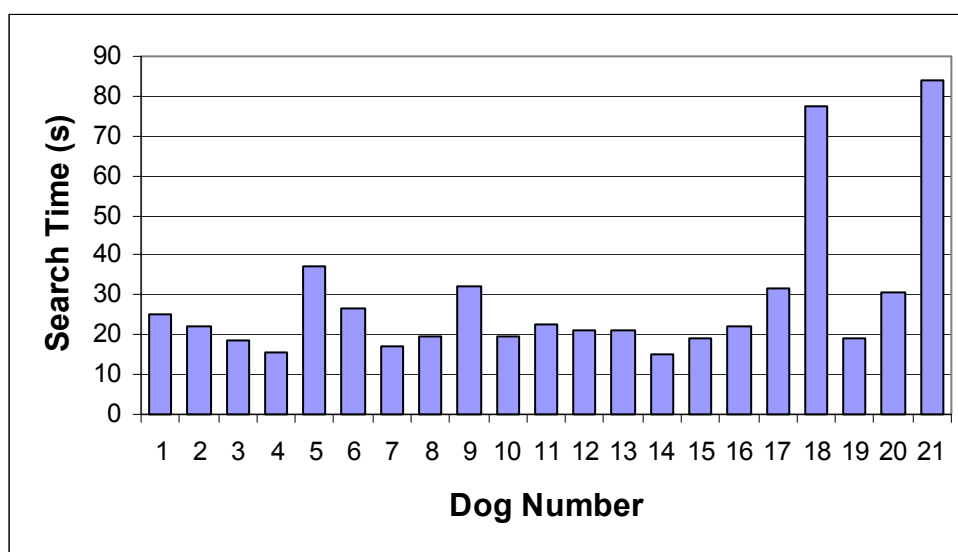
The slow dog Sacha was originally trained to use a different search technique than all of the other dogs, involving placing her nose at points forming a series of triangles along the search line. She still used that technique and it caused her to move much more slowly than the other dogs, who moved continuously. By chance, some of the data for Sacha were for her searching a 5-m line, and the 78 s reported in the figure is an underestimate of her typical search time on a 10-m line of about 120 s.

The proportion of time worked by each dog during the cycle (16%) does not include time spent walking back and forth between the wait area and the search line.

Morning vs afternoon search

The data were inspected for the possibility that dogs searched at a different pace in the afternoon compared to the morning (e.g. because they were hot or tired). No pattern was apparent, with some being slightly slower or slightly faster, but most worked at about the same pace.

Figure 2. Variability in search times along the line for individual dogs. Each bar represents a mean value calculated across all search times available for each dog (see Table 2 for N's and identification of dogs). Number 18 is a dog that searched using a different procedure (see text). Number 21 is a person with a metal detector.



Variation in length of the search cycle

Most sets produced a search cycle of between 120 and 180 s (*Figure 3*). Four sets per team are indicated in *Figure 3* because of mixing of pairs of dogs (in each case, the fourth set involves dogs that were included in the first three sets).

It appears that about 110 s is the minimum likely period for the search cycle on a 10-m line when the walk distance is 20 m+. A few cases faster than 100 s were recorded for the search cycle, but faster times were always associated with short walk distances (see below).

Two sets in Team 2 were unusually slow relative to the rest of the sets. The first of these (taking 300 s for a cycle) included the slow dog Sacha. The second included the close marker searching the line with a metal detector. Although a slow dog clearly slows the set down, there are many other factors influencing the length of time for the cycle. These are commented on in the discussion.

Table 2. Name and number (see Figure 2), breed, and sample sizes for N of cycles observed/searches timed for each dog in Cambodia*

Dog	Number	Breed	N
Alf	1	GS	1/21
Alma	2	GS	5/88
Amer	3	GS	4/60
Benny	4	GS	5/70
Bill	5	GS	3/26
Fitra	6	GS	5/67
Gin	7	G s-h pointer	4/41
Janett	8	GS	6/67
Jesse	9	GS	2/21
Jiquita	10	GS	5/88
Kelly	11	GS	5/88
Max	12	GS	4/73
Natten	13	GS	4/56
Petra	14	GS	5/65
Ricksa	15	GS	4/70
Ricky	16	GS	9/136
Rico	17	Malinois	5/34
Sacha	18	Malinois	3/25
Sassa	19	GS	2/28
Yellow	20	Labrador	5/39
MD	21	Deminer	2/13

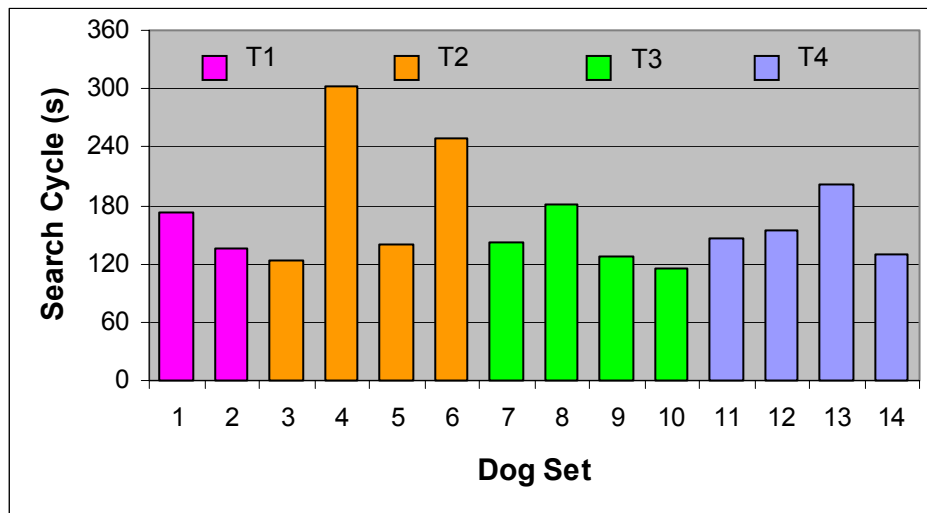
*GS = German shepherd, G s-h pointer = German short-haired pointer. N gives the number of work cycles used to calculate the grand mean for the dog, and the total number of searches timed for that dog.

Search Distance

The distance between the wait site and the search line was recorded at the beginning of each work period. The distance was quite variable, ranging from 5 to 30 m with an average of about 18 m (Table 3). The dogs searched about 15 lines (= 6 m) in 2400 s (40 min), so if the initial walking distance was 10 m, after 40 min it would be about 16 m.



Figure 3. Variation in average time for each search time for each dog set. Four sets are indicated for Teams (T) 2, 3, and 4 because dogs were moved between sets during the observations. Set 6 includes one dog and a deminer using a metal detector (doing the second search in place of a dog).



Walk Distance

The effects on the search cycle of differing walk distances between the rest site and the search line was investigated using those work periods for which the walk distance was recorded and a 10-m line was being searched. The effects are clear (*Figure 4*). Shorter walk distances resulted in a shorter overall time for the search cycle.

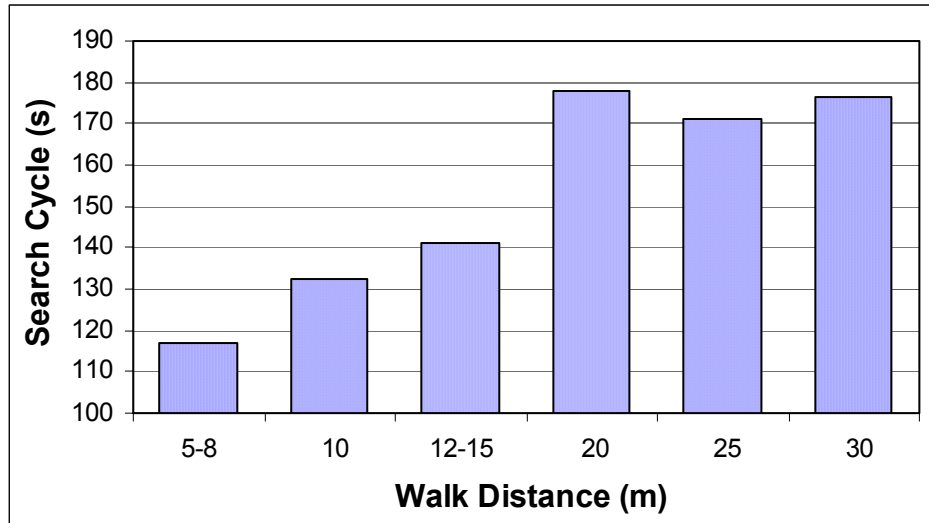
Table 3. Distance between the search line and the wait site (walk distance) at the beginning of each 40-min work period*

Distance (m)	N observed
5	3
6-10	6
11-15	6
20	8
25	17
30	1
18.5	Average

*N is the count for each distance (e.g. line 1: there were 3 work periods with an initial walk distance of 5 m).



Figure 4. The relationship between average walk distance and time of the search cycle. N's for X axis respectively: 3, 2, 4, 6, 17, 1.



This analysis ignores all other factors that potentially affected the search-cycle time (such as clipping, or differences in search time between individual dogs).

The SOP “Experiments”

Three experimental variations on the standard search pattern were observed.

Experiment 1: use of a close marker to replace a missing dog

The results are in *Figure 3*. The close marker was slower than a dog.

Experiment 2: use of a dog handler to replace a missing close marker

When a close marker is missing from the dog set, the set sometimes continued working by using one of the dog handlers to move the rope (i.e. to take the role of the missing close marker). This operational design is potentially more efficient than when two close markers are used, because walking time could be saved. However, the design presents the problem of what is to be done with the dog when the handler is moving the line. In the example observed, the handler tried all of the following possibilities: i) tell the dog to sit and wait and release the leash, ii) tell the dog to sit and maintain hold of the leash while moving the rope with the other hand, and iii) tell the dog to return to the umbrella on its own. The options of walking the dog back to the umbrella and then returning to help move the line, or of handing over the dog to the other handler, were not seen.

Unfortunately, the set in which a close marker was missing was not a standard combination of personnel, so it was not possible to compare the work-cycle time for this set under the two conditions of: two close markers and one close marker, because no data for the first category were available. Observations indicated that none of the options for dealing with the dog were effective, both because the handler watched the dog almost continuously and was therefore distracted from the task of

moving the line, and also because the dog itself was confused. In Option iii, considerable time was wasted while the set waited for the dog to return to the umbrella.

Overall, the cycle time under the experimental condition (dog combination of Natten/Benny) was relatively fast (127.4 s), suggesting that some time was being saved. However the combination of Amer/Benny using a normal cycle design (i.e. two close markers) was even faster (117.9 s). The combination of Natten/Jesse using a normal cycle design was relatively slow (201.8 s), in part because Jesse worked considerably slower than Amer (search times for Amer and Jesse were 19.4 and 32.3 s respectively). It appears that the option of using a dog handler to fill the role of close marker made little difference to cycle time, although the reason may be that this search design has not been properly developed and tested, and the dogs have not been trained to work to that search design.

Experiment 3: search along lines of different length

The data in *Figure 5* were taken from search situations in which dog sets were searching different lengths of line. Only data from the same individual dogs working in the same set are presented. However, some of the data were obtained during different work periods when the search conditions could have been slightly different. A curiosity is that both Sacha and Bill worked at very different speeds on the two occasions when they were observed searching a 10-m line. The cycle times for Sacha and Bill searching the 5-m line included vegetation clipping by the close markers on every cycle, presumably slowing the cycle time relative to the values for 10 m, when no clipping occurred.

Most dogs worked at about the same speed on any length of line, so the longer the line, the longer it took to search that line. Longer lines gave greater overall productivity (*Figure 5*), because the walk distances for each line length remained the same, hence, a greater proportion of the slightly longer cycle time was used for searching during longer line-length conditions, as opposed to walking to the search line.

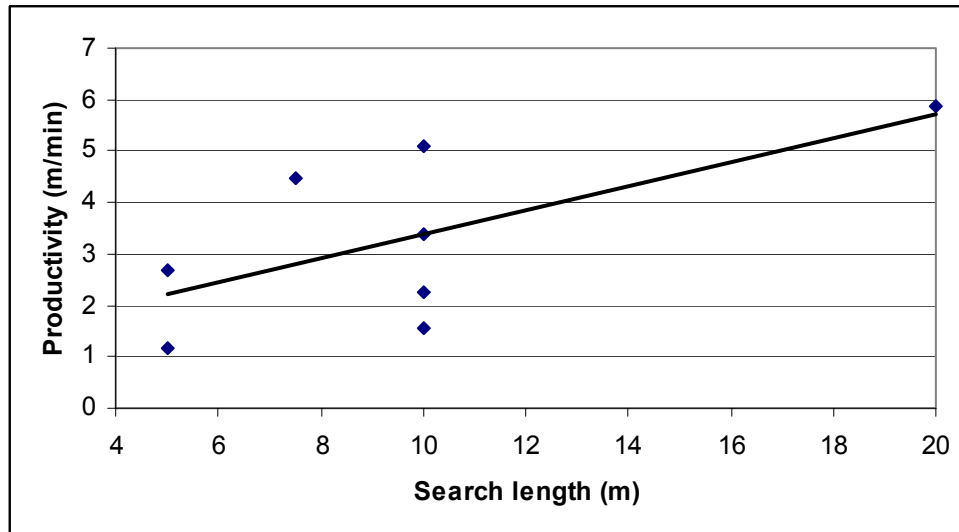
Clearance rates

The overall daily clearance rate of 232 m²/set/day (Table 1) includes data for sets working under all the operational conditions seen during the observations (including the set that used a close marker to search the line). The data can be broken down in a variety of ways.

The effects of clipping

The close markers were sometimes required to clip vegetation within the search cycle before the dogs could search a new line. Clipping of vegetation had the effect of increasing average time of the search cycle by 52.8 s, from 166.7 s to 219.5 s (*Figure 6*). The data compare cycles involving clipping with cycles not involving clipping, for one dog set within a work period. The time cost of clipping is 31.7% of the (no-clipping) cycle, and represents the time cost of clipping vegetation under the operational conditions at the time.

Figure 5. Productivity (metres searched per minute) as a function of increasing search-line length.



Productivity following the flail

During the observations, Team 4 worked exclusively in areas previously cleared by the flail, and did almost no clipping. They were working in flat fields with low grass cover and few trees, and were working under optimal operational conditions. The mean time for the 58 search cycles observed by Team 4 was 150.0 s (2 min 30 s). The median time for those cycles was 139 s (as is typical for calculations of the mean, a few large values biased the value slightly upwards relative to the median). Using these two estimates of the average time of the search cycle, one dog set cleared land at a rate of either 383.9 m²/6-hr day (using the mean), or 414.4 m²/6-hr day (using the median).

These values are very close to the maximum possible clearance rates achievable using this search system because that they do not include any productivity cost of lost time due to indications or clipping.

General Observations

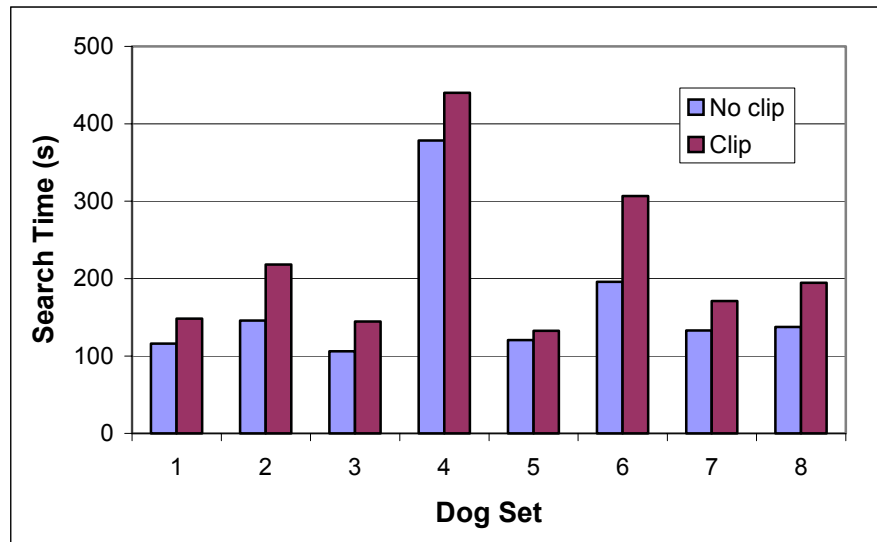
The following qualitative comments are based on general observations of and discussions with members of the teams.

Training and Motivation

The personnel were well trained and highly motivated. Discussions with handlers indicated that they had good basic understanding of dog training principles and medical requirements. Several close markers (who originally worked as manual deminers) indicated that they enjoyed working with the dog teams and did not want to go back to manual demining. The dog handlers indicated that they enjoyed the job and were enthusiastic about their future opportunities within the MDD structure.

Figure 6. The effects of clipping vegetation within a search cycle on the time taken for each cycle by individual dog sets within a work period (about 40 min).

Search time is the time required to complete a cycle, and the data are restricted to work periods in which some cycles included clipping and some did not. The dog set number is an arbitrary label.



Variation among the teams

Some variation in operational application of the teams was noted. Team 4 was the most recently accredited team, and it worked precisely to the SOP, with considerable dedication and attention to detail. This team contained three women dog handlers and there was some evidence that the culture within this team differed from the other teams. However, it was too early to separate the two competing explanations that differences in this team were due to either their very recent operational deployment, or to the presence of women.

Team 3 was the most erratic in working to the SOP. This team had been deployed for only slightly longer than Team 4 and included no women. Team 3 was otherwise consistently productive and dedicated.

Teams 1 and 2 worked reasonably consistently to the SOP, but some members of particular sets were very slow. The set containing the slow dog Sacha was additionally slow because all members of this set were slow.

Maintenance Training

Most dogs received a daily “motivation” event in which TNT was laid on the line during operations. Maintenance training involving exposure to real mines was required regularly, and was undertaken outside operational hours in a test minefield set up near the camp.

The Operational Structure

An operational dog set relies on six able bodies to be able to work. If just one of those bodies is lost for any reason, the five others potentially will have to stand down. For example, a handler who decides that a dog is not working well faces the prospect of stopping three other people and a dog from working if s/he places the dog off work for the day. Due in part to the high levels of motivation in the teams, there is consequently considerable pressure on all members to keep working, even if one member is marginally fit. The loss of productivity due to teams standing down because one is sick is a recognised problem in this program, for which a variety of solutions have been suggested. But a more subtle and possibly less recognised problem is that sets may sometimes keep working (or pressure a dog to keep working) when it would be better to stop.

The supervisors routinely (and sensibly) reconstructed dog sets when dealing with the problem of set members standing down.

The Operational Context and Safety

During the period of these observations, most of the teams worked in village areas in which people routinely went about their business within the minefield, such as moving animals, harvesting rice, or attending to plantations. Thus the teams were constantly faced with evidence that they were *not* working in a dangerous place, and clearly believed that the danger was low – some individuals stated this belief to the observer. Many minor SOP and safety violations seen during the field observations can be attributed directly to that belief. Discussions with members of the teams indicated that they were very safety conscious, and that they believed they did not violate safety requirements in any way. Unfortunately, the establishment of a belief that there is no danger leads easily to minor safety violations. If those violations are justified and/or ignored, then a new safety standard is established and safety is compromised. Internally, the staff will not even recognise that standards have shifted.

Resolution of this problem requires management intervention. The evidence of the villagers cannot be eliminated in this operational context, but it must be ignored. If the teams are constantly reminded that they work in dangerous ground, and that the evidence to the contrary is apparent rather than real, they will maintain consistently high safety standards. Field supervision allowing no sloppiness is essential.

Management of the dogs

The dog handlers were routinely gentle with the dogs, and almost no aggressive jerking on leads or other minor forms of punishment were seen. In most cases the handlers were responsive to the dogs' needs, or predicted them. Handler training about management of the dogs was clearly effective.

At base camps, dogs were housed in kennels within the living quarters of the demining personnel. This structure ensured very good socialisation with humans and a minimum of barking at night, so that the dogs awoke in the morning properly rested and ready to work. It also ensured that the dogs could not be ignored if they had a problem.

Discussion

At the time of this study, the MDD program in Cambodia was well into the operational implementation phase. Although some operational inconsistency was observed, the teams were highly motivated and in general terms were working well. Several of the supervisors were very newly promoted to their roles, and were still developing their skills. The role of the dog teams within the overall demining program in Cambodia was still being defined. It seems likely that much of the variability described here will stabilise as time passes, as the teams become more experienced, and as their role becomes better defined.

The primary value of this study is that it provides a background of information allowing the program to continue to improve its operational capacity. The data identify causes of variability within the teams, provide comparative assessment of operational alternatives, and can be used to optimise the operational structure. The following points are made with these objectives in mind.

The Operational Design

In 2001, the search design used in the MDD program in Cambodia was unique. Some other programs use short lead dogs and/or search along visual lines, but none construct a dog set in which two deminers are used to move the line. The concept was established before brush cutters were available to the programme and vegetation clipping was an essential component of the search cycle. Three potential costs or inefficiencies of the design are:

- the proportion of time spent working by each individual in the set is low,
- the set's operational capacity depends on the availability of 6 able-bodied workers, and
- 4 salaried human personnel (and two dogs) search about 400 m² in a working day under optimal conditions (no delays and little or no vegetation clipping).

The first of these costs also represents a potential benefit, as the operational conditions in Cambodia (routinely hot and humid) mean that dogs might not be able to work for greater proportions of time anyway. The human personnel are wearing heavy PPE, and could become similarly heat stressed (although they were having no difficulty with the very good conditions in November). The economic impact of the third cost on a program depends on local salary levels, which are relatively low in Cambodia.

A significant benefit of the design is that it avoids any need for establishing breaching lanes, which are time-consuming to construct.

Further development of the program

The SOP "experiments" described here represent ideas developed during operations that could be used to further improve the productivity of the program..

As an example, the data presented here indicate that searches along longer lines will give higher productivity. The costs of such productivity are a higher proportion of the work cycle spent searching by the dog (under hot conditions the dog may become

tired more quickly), and difficulties with moving the line (due to trees, or because it is heavy and must be dragged). Using an experimental approach, it should be possible to define the conditions under which dogs can work for a higher proportion of the cycle (e.g. below 28°C and/or with wind), a lighter line could be used, and there should be some clearance conditions (e.g. following the flail) when trees offer little impediment.

Acknowledgements

This study would not have been possible without the tolerance and support of the CMAC demining teams, who provided accommodation and logistics support as well as the opportunity to observe their operational deployment. They were a pleasure to work with. The assistance of the two supervisors, Sukhon and Sam Suchett, was especially important. Thanks also to the Khmer staff of CMAC and the Training Centre, who made themselves available to answer many questions. As the overall CMAC MDD project manager, Peng Horn facilitated the study in all ways. Conversations with Heng Ratana of CMAC were also valuable. Special thanks to the Swedish Technical Advisors, Claes Wolgast, Roger Malmgren, Rickard Andersson and J-O Widar. The study was supported financially through the Swedish Government (SIDA), and Daniel Asplund provided the local representation. H. Bach, P. Blagden and A. Goeth made comments which improved the written report.



Case Study 3. Norwegian People's Aid, Bosnia

Update

- The operational programme has been fully nationalised.
- A new training centre, called the Global Training Centre (GTC), was established in 2004. Responsibilities of the GTC include:
 - supply dogs for all NPA programmes;
 - breeding, selection, training and transfer of dogs;
 - monitoring, quality control and technical support of MDD activities in NPA, and also for some cooperating partners.
- The training principles and procedures have been formally described, and are available as a manual (GICHD 2004).
- Dogs are being used for survey as well as for searching minefields.
- Two new search procedures have been developed (not described in GICHD 2004)
 - Long-lead dogs have been trained to search on the return on a line.
 - Dogs have been trained for breaching in the case of medical emergency. The concept involves a preliminary long-lead search out to as far as 15 m (and back on the same line), followed by short-lead search where the dog leads the handler to the casualty.
- Procedures for introducing targets into training areas have been diversified, and include introduction of TNT contamination without the presence of targets.
- The carousel used for imprinting training of target odour has been improved, and now contains 20 arms.

Introduction

This study was conducted during a period when the programme had been fully operational for several years, and retained international TAs for both operational and training support. However, the programme was in the process of becoming nationalised.

Background

The recent war in the Balkans ended for Bosnia and Herzegovina (BiH) in 1996. During that war, large numbers of mines and large amounts of UXO were deposited across the countryside, and were especially dense in and around Sarajevo.

Although BiH was politically stable in 2002 (when this study was undertaken), the issues that caused the war were not yet fully resolved and the potential for political instability remained. International security forces that were deployed to BiH to maintain the peace were still in considerable evidence, although we noted a large number of tanks being railed out of BiH on 27 September, 2002. BiH is one of the poorest of the new Balkan states. However, rebuilding began quickly, and in 2002, Sarajevo was a rejuvenated city. Some other parts of BiH were recovering more slowly.

BiH is a westernised culture, with a relatively well-educated population. The schools and universities continued to function throughout the war and many of the population have a high school or tertiary education. The people are predominantly Moslem, but the society is relatively secular, comparable in terms of active religious participation to many westernised Christian cultures. Bars are common, bacon and ham are routinely eaten, and fashionable western clothing is the norm for women, who also participate actively in the economy by having jobs, driving cars, etc.

Although not comparable to Western Europe, salary levels are higher in BiH than in many countries in which demining is undertaken. Higher salary costs presumably affect the relative economics of different kinds of demining activity, potentially making the use of dogs attractive because of their higher clearance rates compared to manual teams. However, dogs must follow a clearance machine in BiH, whereas manual deminers can undertake clearance without following a machine. NPA keeps machine costs to a minimum by using a small flail (a Tempest D5) ahead of the dogs.

Small flails are reasonably effective in the predominantly flat to gently sloping agricultural grazing land in which most NPA work is conducted, but they cannot operate in some of the situations encountered in BiH, such as boggy ground or dense vegetation. Use of dogs is optimised because the ground ahead is cleared of booby traps, tripwires, and especially dangerous mines such as Proms. Relative cost comparisons are not a part of this study, and it is always possible that the current requirement for dogs to follow a machine will change in the future. However, when reading the results of this study it should be remembered that the dogs were working in minefields that were pre-cleared of vegetation and most mines/UXO, and so should be working at optimum rates.

Dogs are reasonably common in BiH, as working dogs (farm support and security) and as pets. Thus it should be possible to recruit dog handlers who have some experience with dogs, and a positive attitude towards animals. However, dogs kept as pets receive relatively little training, and there is essentially no readily available, structured dog training (such as puppy classes), as is common in other western societies. Thus, recruited handlers are unlikely to have much understanding of or experience with dog training principles, and these skills will need to be learned.

Administrative Structure for Demining

Demining activities in BiH are managed centrally by a Mine Action Centre, staffed by nationals and supported by the UN. The MAC coordinates, prioritises, and inspects all tasks, and conducts accreditation of dogs and some QA, among its other roles. In 2002, demining was a significant industry in BiH, generating considerable employment and also offering a training ground for administrative and management skills in the local population. About 15 organisations were using mine-detection dogs (MDDs), and demining was expected to continue as an industry for some years to come.

NPA Bosnia: background

Norwegian People's Aid (NPA) is a large humanitarian aid organisation with a long history and operations in many countries. In 2002, the organisation had field dog programs in three countries (Bosnia, Mozambique, Angola), was about to take over technical support of the CMAC programme (Case study 2), and operated a REST programme in Angola. These programmes developed relatively independently and all have had development and implementation problems, with some continuing to do so in 2002. Despite these experiences, NPA has persisted with dogs, trying a variety of options for acquisition and training, and exploring alternative uses.

In 2002, the training and operational deployment concepts for the NPA dogs had recently undergone significant re-development. That conceptual development continued after this study, leading to the establishment of the new Mine Dog School in 2004.

NPA established mine-clearance operations in Bosnia soon after the war ended in 1996, and eventually concentrated on the Sarajevo area. In 2002, its demining capacity was still focused on the immediate vicinity of Sarajevo, although with some winter deployment to warmer areas near Mostar. The minefield where the dogs were studied was within the city suburbs, about 10-min drive from the city centre. It was a grassy slope containing some rough ground and small patches of dense vegetation (*Figures 1, 2*).

In September 2002, the program in Bosnia was well-established and operating successfully, with 17 accredited dogs and a few more in training. Its relative success led to the suggestion that leadership provided from NPA-Bosnia combined with increased cooperation could improve all NPA dog programmes and perhaps lead to establishment of further programmes in the future. As a result, various exchanges of personnel have occurred, the support for Cambodia was initiated and the Bosnia dog school was eventually established.

Figure 1. A view across the minefield towards Sarajevo



Figure 2. Patches of trees and other vegetation within the minefield, which has been flailed



The Operational Structure

The minefield had a dog-team supervisor and a manual-team supervisor. These field leaders coordinated all activities and ensured proper record keeping. For the dogs, there were 1-2 observers and 2 trainers who doubled as handlers. The manual capacity was two teams of 8 personnel, each with a section commander.

The main support vehicle was a Toyota Landcruiser. The actual number of personnel and dogs carried in each vehicle was typically two or three (people and dogs), but was more or less on some occasions, and up to 4 dogs could be transported in most vehicles. Nine dogs were working in the minefield for most of the study period, and were transported using 4 vehicles. Additional vehicles and staff included two management vehicles (pickups – 1 each for the dog team and manual supervisors) and 1-2 ambulances (2 medics/ambulance). Manual teams usually travelled in 2 small vans (10 seater). All vehicles were 4-wheel drive, which will be essential under some operational conditions due to the variable weather in BiH.

The NPA-BiH dogs are not subdivided into structured teams. Nor are specific manual deminers attached to individual dogs. The system in the minefield is quite fluid, with variable numbers of manual deminers tasked to assist the dogs on any day. Before the dogs arrive in the minefield, manual deminers put in safe lanes and lay out the box system. Once the dogs are at work, the role of manual teams includes checking indications when called upon by a handler, adjusting the labelling system in the minefield as clearance progresses (tapes, red and white pickets), clearing safe lanes, and clearing small areas not accessible to the dogs. Depending on the size of the minefield, some of the manual deminers may be withdrawn and deployed elsewhere while the dogs do the bulk of their work, because of the requirement to maintain 25-m minimum safety distances. Depending on the complexity of the minefield, the manual deminers may have considerable follow-up work to do after the dogs have completed work.

It is up to the dog handler, sometimes in consultation with a supervisor, to decide whether a manual deminer is required to deal with an indication. Dog handlers are fully trained as manual deminers, and conduct some clearance checks themselves. During the observations, large numbers of fragments, bullets, and other debris were being indicated by the dogs, and it was routine for dog handlers to pick these off the surface without calling in a manual deminer. In some cases, the dog handler probed the indication site. Very few indications resulted in an extensive manual search, or in the dog moving elsewhere to continue working.

Dogs and their handlers work one hour on and one hour off, from 0800 until 1600 hrs (manual deminers work to a similar pattern). Weather may restrict the number of hours worked in a day.

The search procedure

NPA Bosnia uses dogs in two different ways: on long and short leads. The dogs work in boxes delimited with yellow tape, and surrounded by 1-m wide safe lanes (*Figure 3*). The boxes are established by manual deminers after the flail, and before the dogs begin work. Dogs are not used to make safe lanes.

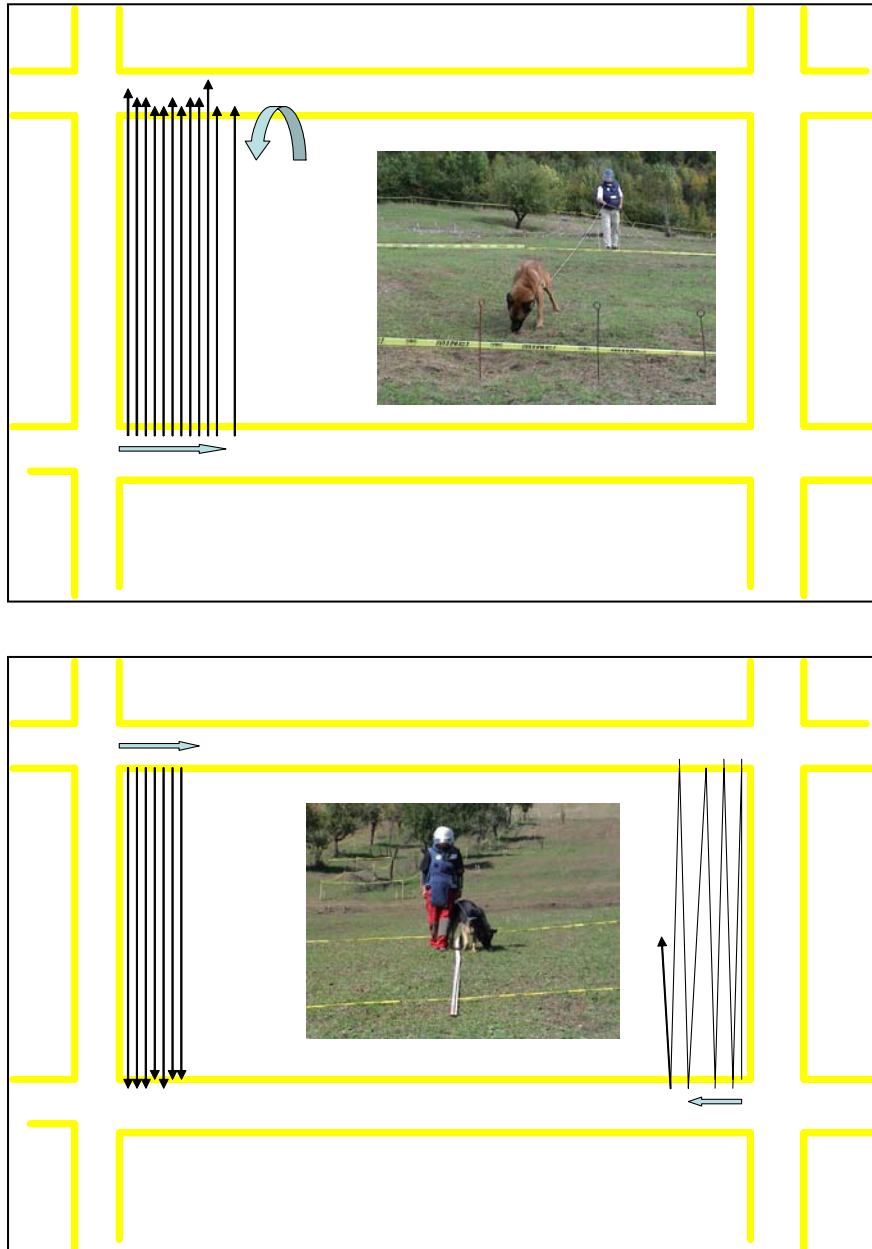
Each box is searched first by a long-lead dog, and then by a short-lead dog. As is standard for all long-lead dogs, the handler of the dog does not enter the box. The SOP requires that land be searched by two dogs before being declared clear, thus it is safe for the handlers of short-lead dogs to walk in the immediately preceding search lane. Handlers of short-lead dogs walk very slowly and take small steps, providing an effective (and impressive) QA through stepping on a significant proportion of the land in the box.

It would be straightforward to use two long-lead dogs to conduct a 2-dog search of one piece of land. NPA has also developed procedures for using two short-lead dogs in series. These alternatives to the long-lead/short-lead system were not seen during this study, and they would only be used if a surplus of one or other type of dog were available. Following a long-lead dog with a short-lead dog is the preferred procedure, because it is efficient (long-lead dogs work faster than short-lead dogs) and potentially increases reliability because the land is searched in two different ways.

Starting Work, Search Behaviour, and Rewards: General Description

There is no preliminary ritual such as a prayer or briefing, signalling that work is about to begin. In September, the time to begin work was determined each morning by the weather (primarily the wetness of the grass). Immediately prior to entering the minefield at the start of the day, the handlers put the dogs into a small test field established on the edge of the minefield where mine locations are known. Although the dogs work these test boxes every day, they always search with enthusiasm and do not simply walk to the mines. After locating a mine and being rewarded (about 5 min), the dog is taken to its work site. Full records of these daily tests are maintained and are occasionally inspected by the BiHMAC, and the test may be used to decide that a dog should not work that day.

Figure 3. The typical search pattern for NPA-BiH dogs (see text for details). Long-lead search pattern (above); short-lead search pattern (below).



The dogs, especially the short-lead dogs, work slowly with intense focus. As the boxes (25 m x 10 m) are all clearly laid out using markers and yellow tape, it was easy for the observer to estimate clearance statistics, width of search lanes, and other spatial details. In general terms, the dogs work lanes about 0.5 m wide. They are trained to indicate targets by sitting and focusing on precise location of the target. Thus many indications were checked very quickly, allowing the dog to continue working from the indication location within a few minutes or even seconds. There was little evidence of the dog being distracted by a previous indication site, which might be only 0.5 - 1 m away as it was passed.

Although there are supervisors and observers working in the minefield, each dog handler does not work directly with an assigned supervisor. The handlers effectively work independently, and makes most decisions about direction of search, quality of search, the need for consultation with a supervisor or calling in a manual deminer, and clearance requirements at the time of an indication.

Long-lead dogs search outwards only, and turn left (into the safe side) to return to the handler. They have been trained to search along straight lines until recalled, and will continue searching for many metres beyond the marked edge of the box if not recalled. The handler determines whether the dog searches the same line again, and the distance to be moved to the next line. The handler monitors progress and ground coverage using steel pegs placed at approximately 0.5-m intervals on the far side of the box (pegs are in alternating colours to minimise confusion).

Short-lead dogs work in either one or both directions, although current policy is to train for one direction only. A rope line is laid along the baseline of the search area, and the dog searches the unsafe side while the handler walks the safe side. The line is attached to steel pegs, which are moved by the handler after each search. Handlers that searched in one direction moved the peg at the far end, then returned to the beginning and moved that peg before beginning the new line. Handlers that searched both directions moved the peg at each end of the line as they turned to search back again, and so searched at slight alternating angles.

Rewards for indications are only given if the target can be seen by the handler. Thus indicating a buried mine would not be rewarded, but indicating a fragment lying on the surface might be. When something unseen is indicated, the handler simply removes the dog from the box and the dog either waits while the site is checked, or moves elsewhere to continue working. Rewards (the ball or kong, or food for one dog) were often given to the dog at semi-random moments (e.g. towards the end of a box, but before the box was completed), following the principle that appearance of the reward should be unpredictable for the dog. The link between the handler and the ball/kong was kept to a minimum by the handler tossing the ball in front of the dog, or by asking a supervisor to throw it. This procedure is followed even more rigorously during training to emphasise the link between the reward and the target, rather than the reward and the handler.

Weather

In September, the weather was warm and variable. Some days were foggy in the morning, usually clearing to a clear, warm, calm day by about 1030 hrs. Some days were rainy or fairly hot. There was little wind, but some stormy weather hung over the mountains on some days. Work was delayed most mornings because the ground was wet from overnight rain or morning fog. Rain stopped work early on one day and completely on another, and heat stopped work early on one day (the SOP requires the dogs to stop work when temperatures rise above 30°C).

Data Gathering

The observer sat near the edge of the minefield and observed one dog at a time (attempts to record all search details from two dogs at one time resulted in too many

recording errors, and were discontinued). Recorded, were start and end time, break times, searching time, exact time taken on each search line, number of times on each search line, all details of indications, and behaviour of handler.

Records were kept of all dogs working during each hour. Focal observations of each dog were spread through the day and across the 9 days of observation, with the aim of observing each dog about 6 times (Table 1). A total of 71 work-period observations were made. Thirty-four were of the entire hour of work for the target dog, including all rest periods. Thirty provided full details of search behaviour for part of the hour only, and the dog may have done other work during that hour. Seven provided precise records of start and end times and some other search details.

Table 1. Names and descriptions of the dogs studied, and number of observations made on each dog

Dog	Lead	No. Obs.	Full hour	Gender	Breed	Age (yr)
Argo	Short	6	3	M	GS	2.5
Axl	Long	9	3	F	GS	5
Calie	Short	5	4	F	Lab	7.5
Gnisi	Short	7	2	F	GS	8.5
Golda	Short	3	2	F	GS	8
Laik	Short	8	6	M	GS	9
Lotus	Long	9	4	F	Mal	4
Maia	Short	5	3	F	Mal	2
Tess	Long	10	3	F	Mal	3
Xingo	Long	9	4	M	Mal	4
Total		71	34	10		

Results

Observations were made from 9 to 17 September 2002, with quantitative data taken from the time dogs began working in the minefield on the afternoon of 9 September. September 18 was the last day of the 10-day work cycle, but the dogs had finished the minefield and were doing only QA on that day, so no data were gathered. Data were obtained from 10 dogs, although one (Golda) left the minefield on 13 September for a demonstration in Geneva. Details of the dogs and observations are in Table 1. Several of the dogs were reaching an age that sometimes limited their ability to work through the day, or for a full hour. Each dog had a separate handler, except for Golda and Maia, who both worked with the same handler/trainer. Maia was only recently accredited and was in operational training. Due to age, Golda was not usually able to work a full day and the handler split his time between these two dogs.

The working day

Due to wet ground and/or overnight rain, the teams were unable to begin work at 0800 hrs on any day, so it was impossible for all dogs to work their scheduled 4 hours. For the days September 9 to 17 respectively, start times were 1300 (the morning of Day 1 of the 10-day work cycle was spent on training), 0930, 1030, 1000, 0900, 0900, 0900, 0900, 0900, not known. Finish times were 1600, 1300 (hot), 1600, 1600, 1600, 1400 (hot – dogs taken to base for swimming), 1600, 1500 (rain), 1500 (minefield essentially finished). Half the dogs worked 4 hrs and half worked for 3 hrs on days that began at 0900 and ended at 1600. Some early finishing in the last hour was due to dogs being tired.

Details of search

The following calculations are made using only the 34 observations that represent the full hour of work for the dog. Between-dog variation is ignored in this analysis as the N for each dog was small, thus reported standard errors are calculated across the full data set of 34 measures. Data for long- and short-lead dogs were combined.

Within each working hour, the dogs actually worked (i.e. searched lines) for a mean of 35.6 min \pm s.e.2.0, range 10 - 52 min, N = 34 (59.3% of the assigned work hour). This result includes values of 10, 11, 17 and 19 min that were worked as short hours (usually the first or last hour of the day), but does not include one value of 0 for a dog that refused to work and was taken out of the minefield. Removal of the four low values gives 38.4 \pm 1.6 min, range 24 - 52, N = 30 (64% of the assigned work hour).

Rest time within the working period (including breaks for inspecting indication sites, to move pegs or to move between boxes) was 6.5 min \pm s.e. 1.1, range 0 - 22, N = 34 (6.5/38.4 = 16.9% of working time). The remainder of the hour (60 – (38.4 + 6.5)) = 15.1 min was not worked due to beginning late or ending early within the hour. Thus, with rest periods included within work-time, the dogs worked for 75% of their assigned work-hour. Most unused search time at the beginning of the hour was due to running the dogs in the test field at the beginning of the day, consulting with supervisors, and walking to the assigned box. Most unused work time at the end of the hour was due to dogs finishing a box near the end of an hour and stopping work rather than beginning a new box. In a few cases, dogs stopped early due to tiredness. Especially for short-lead dogs (which follow a long-lead dog), a new box might not have been available, forcing an early end to the work-hour.

During a full hour-long work-period (N = 34), average total area searched was 177.3 m² \pm s.e.11.0. (range 80 - 250); average total linear distance travelled (i.e. along the baseline of a 10 x 25 m box) was 18.6 \pm 1.0 m (range 8 - 25); average number of lines worked was 32.1 \pm 2.1 (range 13 - 68). The dogs therefore worked an average of 32.1/18.6 = 1.73 lines/m.

Although the largest searched area contributing to the data above was 250 m², a few instances of dogs working larger areas within an hour were noted as general observations. For example, the short-lead dog Argo was once seen to work about 350 m² in one hour. The box construction (10 x 25 m) was clearly an important psychological determinant of area searched within an hour. A few instances of a long-lead dog working more than 250 m² within an hour were seen, but more than

250 m² was rare, explaining why it was not recorded during the intensive observations of individual dogs.

Search Pattern

Long-lead dogs

No instance was seen of a long-lead dog turning the wrong way at the end of a line. Long-lead dogs only occasionally searched on the return. The search line was routinely straight, and long-lead dogs did not stop searching until instructed by the handler, even though they might pass several metres beyond the yellow tape on the far side of the box.

More than one search on a line was rare. In 22 work sessions, the four long-lead dogs repeated 4.4% of the lines (Table 2). Of the two dogs that repeated lines more often, Tess sometimes searched a little fast, and the repeats were either because the handler was not satisfied with her ground coverage or because the line was short. Xingo was having problems (see below), including refusing to search at all on some occasions, and his extra searches were due to short lines. In general terms, it appeared that the length and consistency of search of these long-lead dogs was so reliable that repeated searches on a line were essentially unnecessary.

Table 2. Proportion of lines on which searches were repeated by long-lead dogs

LL Dog	No. sessions	No lines searched	Repeats		
			2x	3x	4x
Axl	7	165	2	0	0
Lotus	5	142	2	0	0
Tess	6	204	14	0	1
Xingo	4	115	4	4	1
Total	22	626	22 (3.5%)	4 (0.6%)	2 (0.3%)

Most indications by long-lead dogs were immediate, and only rarely involved scratching, turning, or lengthy inspection of the site. The indication site was pointed by the dog's nose and the dog did not turn to look back at the handler, either for support when making the decision on whether to indicate, or in expectation of receiving the ball/kong.

Short-lead dogs

As the dog works in close association with the handler on a clearly defined line, the search pattern was generally straightforward and consistent. The handler occasionally turned the dog in a small circle to re-check part of the line, but otherwise the dog worked each line once only. Dogs that worked in both directions searched essentially continuously (with a few seconds break between lines). Dogs that worked

in one direction had a break from concentration as they returned to the start at a normal walking pace with the handler.

An important difference between long-lead and short-lead dogs is the effort required of the handler. Whereas long-lead-dog handlers stood or kneeled in one place much of the time, short-lead-dog handlers walked constantly at one of two speeds: very slow (while the dog was working) and normal (when returning to the starting end – for those dogs that worked one direction). Walking at a slow pace, and alternating different paces at short intervals, is extremely tiring, and by the end of the day short-lead-dog handlers showed as much evidence of tiredness as the dogs. Although very concentrated mentally, handlers of long-lead dogs did not make the same physical effort as handlers of short-lead dogs.

Adjusted data

The entire data set includes data from part-hours of working. Also, the proportion of an hour actually worked varied between work-periods for many reasons. Thus the following calculations of search statistics are converted to hourly estimates using only the time that the dog was working the search lines (i.e. excluding time spent resting, walking to the box, waiting for an indication to be checked, etc). Presentation is of means calculated for each dog. Calculations of variance are across these means, thus portray between-dog variation only.

Dogs worked at an adjusted rate of 60.1 lines/hr, range 45 - 90, N = 10, searching 320.5 m²/hr, range 250 - 460, N = 10 (*Figure 4*). Two of the four long-lead dogs worked more quickly and searched more area/hr than short-lead dogs, as expected. But two did not. Of the two poorer performers, one (Lotus) was a difficult dog to manage due to a variety of behavioural problems, and was only used because of a shortage of long-lead dogs in the programme. The other (Xingo) was described as normally an excellent dog, but was having motivation problems due to the presence in the team of two females in heat. The distinction between two good and two poor long-lead dogs can be seen in all of the following analyses.

For all dogs, the adjusted number of lines/hr was quite variable. The area searched by long-lead dogs was similarly variable, whereas the area searched by short-lead dogs was extremely consistent between dogs, with only Gnisi searching a somewhat higher area/hr than the norm of approximately 300 m²/hr (*Figure 4*).

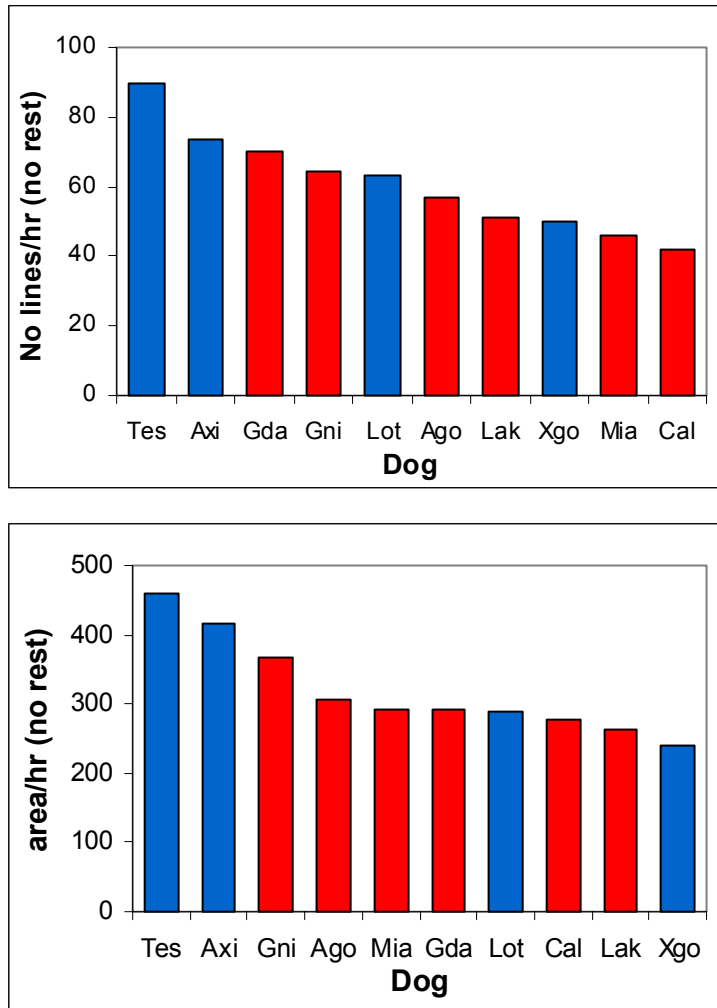
The search line

The following analyses include all data and have not been adjusted.

The time spent searching each line (*Figure 5*) was 41.2 s, range 26 - 55, N = 10, with two of the long-lead dogs being faster than the short-lead dogs, as expected.

The average number of lines worked was 1.86 lines/m, range 1.6 - 2.4, N = 10 (equivalent to 46.5 lines per 25-m box), and was below the program objective of >2 lines/m, in part because some of the short-lead dogs were working wide lines (1 - 1.5 lines/m) during some of the observations. Xingo searched the lowest area/hr because of extra time taken while the handler attempted to get him to work, and some repeats due to short lines.

Figure 4. Mean number of lines searched (above) and area cleared (below, in m²) calculated assuming dogs worked continuously for an hour. Differences in the distribution of dogs in the two graphs are due to varying intervals between lines for each dog (Figure 6). LL dogs = blue, SL dogs = red.



Proportion of time working on the line

While working on site, dogs spend some time taking breaks (down-time). The proportion of down-time was described above for full-hour work-sessions (16.9%), and this is the best absolute estimate available. However, the proportion of down-time can also be calculated from the full data set, allowing inspection of between-dog variability due to bigger sample sizes. The mean of 11.5% ± s.e. 2.0 (N = 10) is lower than for the full-hour data, because some of the data are taken from short working periods after which the observer switched to another dog without recording break-time (if there was one). The data are therefore presented as relative values to focus on comparison among the dogs (Figure 6). In general, the long-lead dogs had the greatest proportion of down-time, and most short-lead dogs had very little down-time. The bigger proportion of down-time for the old short-lead dog, Golda, is because she needed to be rested frequently on hot afternoons.

Figure 5. Mean time spent searching each line by NPA-BiH dogs (as mean + standard error). Bars are grand means calculated from the mean line-search time for a dog during one search period. A larger error bar indicates greater variability in search time between work periods (usually on different days).
LL dogs = blue, SL dogs = red.

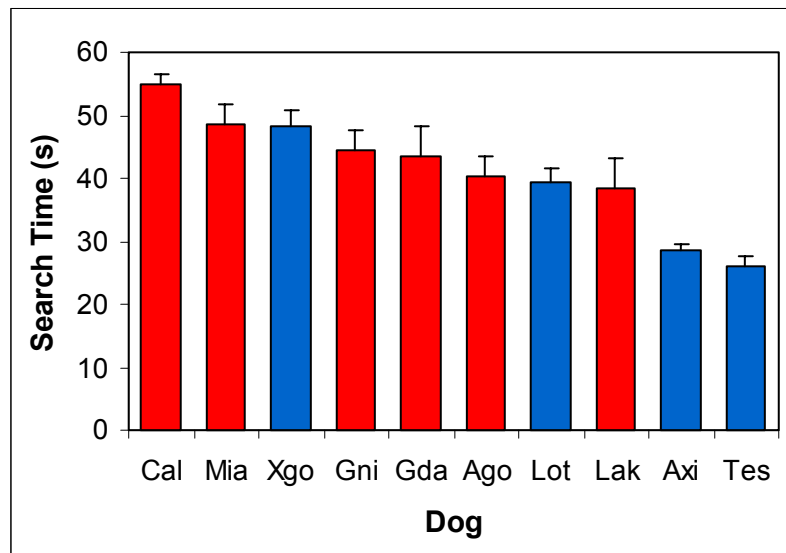
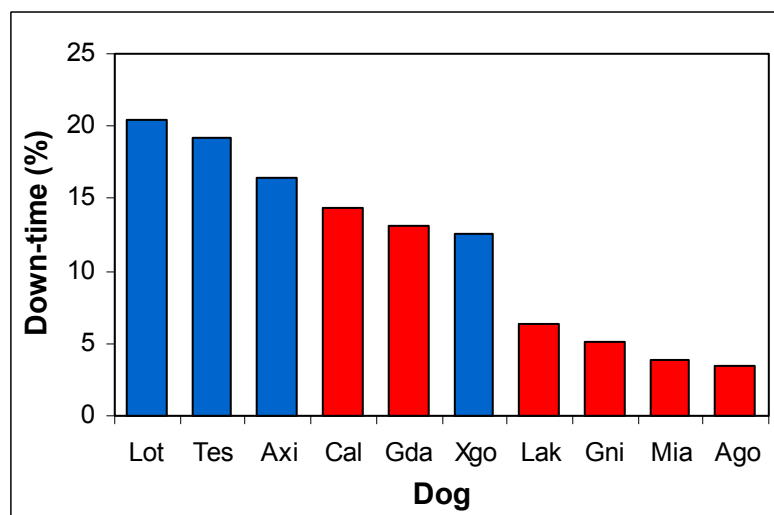


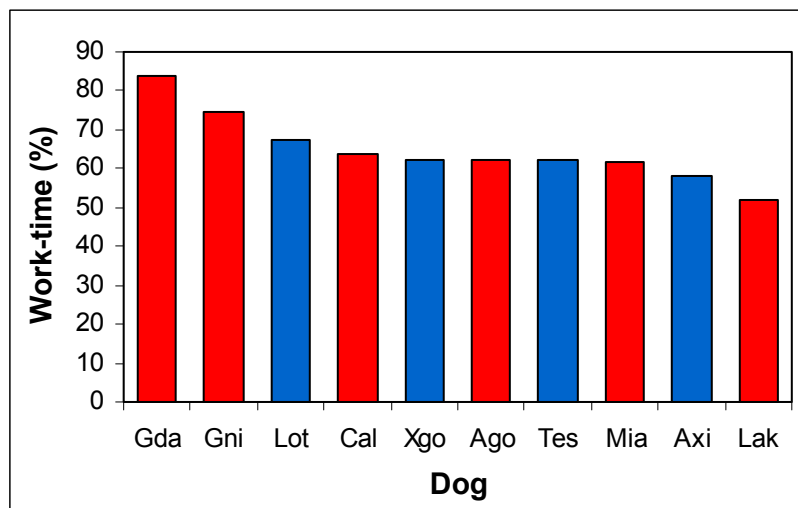
Figure 6. Proportion of work-time spent in down-time (i.e. resting, etc) for the full data set. LL dogs = blue, SL dogs = red.



While actually working, the dogs spent only a proportion of their time searching, due to the requirements to move between lines, return to the baseline, focus on the new search line, etc. This analysis excludes short breaks to move pegs (long-lead dogs only) or check an indication, but it includes the time needed to move the line (short-lead dogs only). The full data set was used to investigate variation in proportion of

time that the dogs searched while working (*Figure 7*). On average, dogs spent 64.8% \pm s.e. 2.8 of their work time searching (= 35% of work time spent not-searching). The dogs were remarkably consistent, and there was little difference between long-lead and short-lead dogs, except for two short-lead dogs that gave higher values (Golda and Gnisi) because they worked the line in both directions and lost very little time transferring between lines. Calie sometimes worked the line in both directions. When searching in both directions she lost little time transferring between lines, but when searching in one direction she was the slowest to transfer between lines. Her result matches the values for the short-lead dogs that worked in one direction only because the two effects in the data cancelled out.

Figure 7. Proportion of working time spent actually searching by NPA-BiH dogs. LL dogs = blue, SL dogs = red.



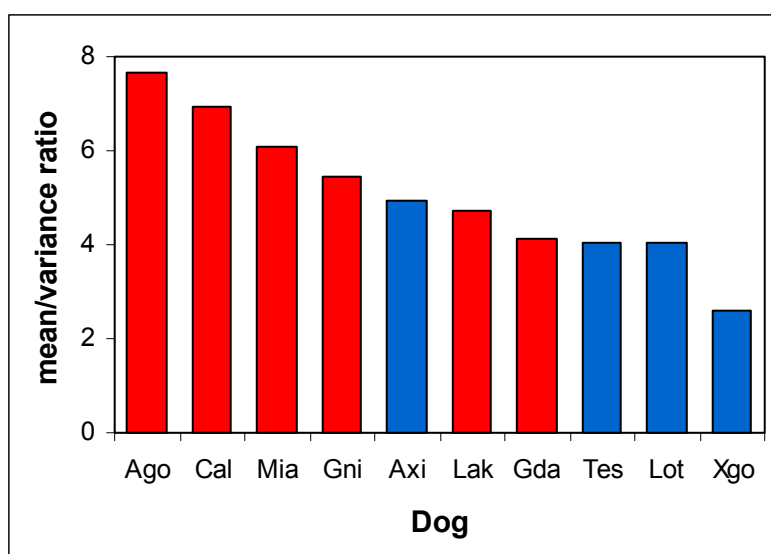
The combination of the two analyses above indicates that, in general, short-lead dogs spent more time actually searching than did long-lead dogs.

Within-dog variability

The variability between dogs has been emphasised in the above graphs. However, within-dog variation can also be calculated and used to portray consistency or reliability in the search behaviour of each dog. Within-dog variation was calculated using the time spent on each search line, because large sample sizes were available for this measure. First, the mean and standard deviation were calculated for time searching on the many search lines recorded within a work-period. These calculations gave a small number of mean and variance values (N indicated by Column 3 in Table 1) for each dog. Then the mean/variance ratio was calculated for each mean and variance available for the dog. The average of those ratios is in *Figure 8*, which portrays variability in time-on-the-search-line for each dog calculated across work-periods. Higher values indicate greater consistency of search behaviour, and the figure shows clearly that short-lead dogs worked more consistently on the line than did long-lead dogs, with Xingo showing very low consistency. The other

difficult long-lead dog (Lotus) showed similar consistency as the two good long-lead dogs. The least consistent short-lead dog (Golda) was an old dog for which only three measures were available, two of which were recorded in the afternoon when she was hot and tired. The most consistent dog was the short-lead dog, Argo.

Figure 8. Mean/variance ratio (calculated as mean/standard deviation for each search period) for line-search times for NPA-Bosnia dogs. Bar is a grand mean calculated across work periods. Height of bar provides a relative index of consistency in search behaviour, with higher bars indicating greater consistency. LL dogs = blue, SL dogs = red.



Indications

Indications were frequent, occurring on 36 of the 64 work-periods for which full data were available. Up to 8 indications were given during one work session, although 0 - 3 was typical. For long-lead dogs, indications were necessarily treated as significant and potentially requiring clearance, as the handler could only inspect the indication site from the edge of the box. For short-lead dogs, the handler could check the indication site directly. Most indications were of fragments on the surface, such as bullets, cartridge cases, and pieces of plastic or metal (including pieces of broken up mine). Thus, full clearance was required in only a few cases. More typically, the dog was delayed for only a few seconds while the handler picked up the fragment, or for a few minutes if manual checking was required. In a few cases, the dog moved on to a new box because a dangerous item was found.

The time cost was calculated for 31 indications seen on 14 - 17 July. Distribution was:

- **<1 min:** 23 events,
- **1 - 2 min:** 3 events,
- 1 event each of 4 and 8 min,

- **moved to new box** (delay of few min): 3 events.

As observations were made from distances of about 50 m, it was only possible to determine what (if anything) had been found for some indication events. However, it was possible to document the reward pattern for indications in relation to the operational policy of giving no reward in the minefield unless an object was known to be found (Table 3). For all indications where nothing was found (i.e. either a false indication or a hidden object), no reward was given. A reward was given in 21 of 23 indications where the handler identified the indicated object immediately. Only 1 of 20 indications were rewarded for situations where the observer could not determine if anything was found. Thus the policy was being implemented consistently by all handlers.

Table 3. Pattern of rewarding in relation to presence or absence of identifiable targets at the time the indication was given, for NPA-BiH dogs

Found	Count	Rewarded	Not Rewarded
Nothing	6	0	6
Fragments	21	19	2
Grenade	2	2	0
Unknown	20	1	19

Dogs were usually given the ball/kong at some point during a work-period. For 56 work periods, the kong/ball (or food for Golda) was given at the end of the work-period 20 times, before the last line 4 times, after the last line (15 m from the box) once, and no reward was given 31 times. Work periods in which an indication had occurred in the last 10 lines were rejected for this analysis, as the handler may not have given the reward at or near the end because it had been given previously for the indication.

Behaviour of the Handlers

The handlers were consistently gentle with the dogs. Few harsh jerks on the lead or other harsh treatment were seen, and the dogs were given plenty of positive attention. Some play with the dogs was observed. The handlers were also sensitive to the needs of the dog, giving water regularly and giving them breaks in shade as they tired or overheated. The handler of Xingo was particularly impressive, in that while attempting to put pressure on the dog to work, he did not use harsh words, shouting, or other typically aversive/dominating behaviours often seen in such circumstances.

Discussion with all the handlers indicated that they were proud of their dogs, and enjoyed working with them. Some of the handlers of the older dogs indicated that they might take them home when the dog was retired.

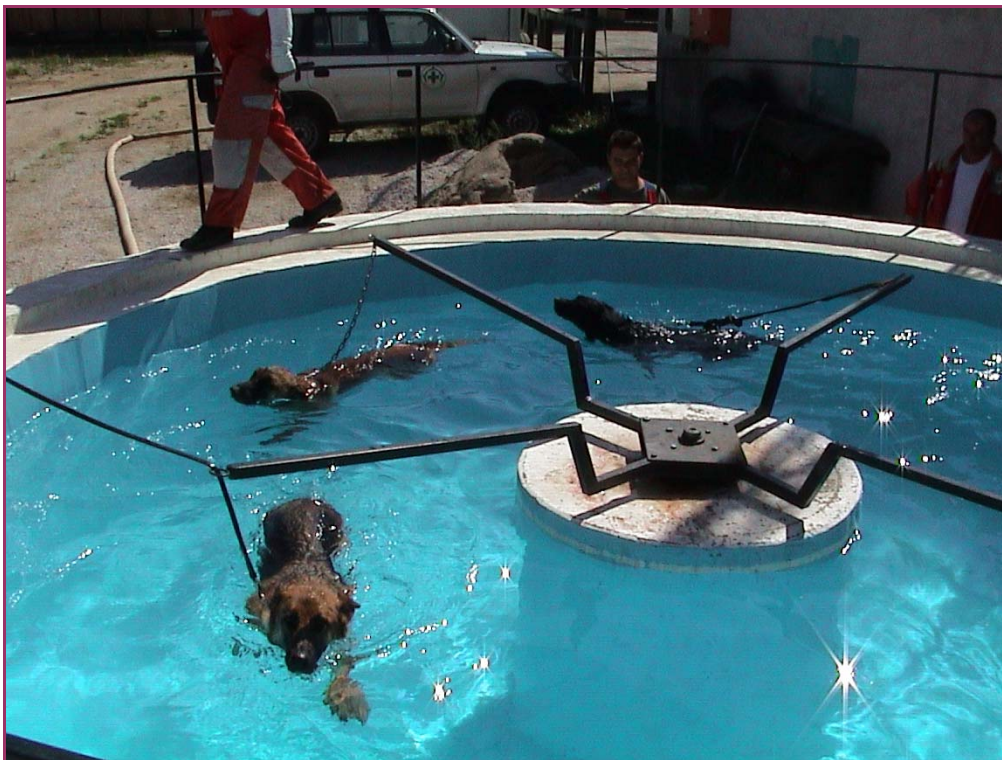
Welfare, fitness, and socialisation of the dogs

Kennelling was typical for a MDD operation. Veterinary services are provided locally by a professional vet, and the programme does not employ a vet. As the dogs are housed and work close to Sarajevo, this consultancy is cost-effective and fills all requirements. Most basic health treatment is done by NPA personnel.

To maintain fitness, the program originally ran the dogs using bicycles. Recently, a swimming pool was built and the dogs are swum several times weekly for up to about 45 min (up to 4 dogs can be swum at one time, *Figure 9*). The manager reports clear effects on fitness, and improved stamina when working. There are likely additional benefits in terms of minimising long-term impact of exercise on the axial skeleton, especially for the bigger dogs. Water in the pool is not treated, and is changed twice a week.

All the dogs, apart from Lotus, were well socialised and demonstrated no aggression towards a strange person such as myself, or towards each other. Lotus represented a difficult management problem in all contexts, but these were known and recognised.

Figure 9. Swimming pool for dogs





Discussion

A significant feature of this program is the regular innovation and fine-tuning of training procedures. Both with respect to the original training, and maintenance training of operational dogs, procedures are designed to establish and maintain the dogs at very high fitness and skill standards. Adjustments to the operational procedures are also routinely considered, although implementation may require the approval of BiHMAC. Trainers work as handlers in the minefield, thus are available for immediate consultation. The field supervisors have both dog training skills and experience as handlers, and maintain a close watch on the dogs. The international staff are readily accessible and frequently visit the field site. They are also directly involved in the training of all dogs, so know them intimately and are able to respond quickly to training problems, if needed. The combination of careful attention to the background of training of the dogs, and accessibility of experienced training personnel, are key features supporting a high degree of confidence in the consistency and reliability of these dogs.

Features of the program

- The consistency of search by each dog
- The relatively narrow search lines ensuring complete covering of the ground by the dog's nose
- The high motivation of the dogs
- The ability of the dogs to work consistently for an hour, and to work up to 4 hours in a day
- The emphasis on fitness of the dogs
- The alternative search techniques, potentially giving more reliable clearance overall
- The consistent application of training and operational policies in the minefield
- The reward principles
- Record keeping of maintenance training events
- the QA by the short-lead-dog handlers

Issues to consider

The standard box size of 250 m² appeared to impose a psychological barrier on productivity. The data suggest that the dogs could achieve an additional 50 m²/hour, suggesting a box size of 300 m². If the program wished to retain the psychological objective of completing a box within an hour for short-lead dogs, then box size should not be much bigger than 300 m². The adjusted data suggest that the long-lead dogs could achieve 400 m² in one hour if they worked more consistently through the full hour, but it is unlikely that the short-lead dogs would regularly achieve more than 300 m².

Although some of the data support the belief in the programme that long-lead dogs work faster than short-lead dogs, overall, they did not work faster during this study. The reason was greater down-time for long-lead dogs while working, possibly as a result of a tendency by the handler to work towards the psychological objective of completing one box within an hour. However, it is also possible that long-lead dogs require more rest time than short-lead dogs because they search lines at a faster speed. Exploring these alternatives would require discussion with the handlers combined with some careful experimentation. In many programmes, long-lead dogs lose productivity because they search a line several times, but that was not the case in this programme.

An alternative perspective on the above comments is that some short-lead dogs were working wider lines than recommended, possibly also because the greater line-width allowed completion of a box within an hour. When those handlers reduced their line-width, their hourly productivity declined. However, it was noteworthy that some short-lead dogs consistently searched a full box within an hour without working wide lines, achieved by taking little down-time within the hour. The largest area seen cleared by any of the dogs within an hour was about 350 m², achieved by a short-lead dog (Argo). This dog was a young German shepherd that was able to work for a full hour without a break. However, its high productivity was also a direct effect of the efficiency of movement by the handler, who always moved the line using a fluid turning movement and wasted no time walking back to the start line. It would be worth having the other short-lead-dog handlers copy the technique used by Argo's handler.

The policy of working bitches in heat had an effect on productivity (although for a male dog, and not for the bitches themselves). Although this problem was managed by separating the difficult male from the females, he was still unable to concentrate on searching and had to be withdrawn from work on several occasions. As general comments on this issue, some programmes always spay females at an early age as policy, and some dog trainers believe that unspayed bitches have lower odour sensitivity. There is no evidence supporting the latter belief, and the former policy appears to be designed to minimise potential management problems (such as was seen here) rather than because of detection issues.

Other Comments

Although not obvious from the data presented here, it appears that long-lead dogs should have consistently higher productivity than short-lead dogs by about 25%. Short-lead dogs are easier to train, and the approach in this program is to attempt to train all dogs as long-lead dogs, then to use the dogs that fail to develop a consistent search pattern as short-lead dogs. In a relatively small program it will always be difficult to optimise the ratio of the two types of dog, and the two operational concepts potentially introduce a slightly higher resource requirement for training. However, the benefits in terms of diversified search pattern and QA are probably substantial and should be balanced against those costs. Three potential additional benefits are: i) it could take less time to produce an operational short-lead dog than a long-lead dog, ii) maintenance training requirements for a short-lead dog could be lower than for

long-lead dogs, and iii) the short-lead option allows use of a failed long-lead dog that might otherwise be lost from the program entirely.

The greater consistency of the short-lead relative to long-lead dogs while on the search line was presumably due to the more direct control available to handlers of short-lead dogs. Despite the lower values, the long-lead dogs showed impressive consistency because they matched the lower range of the short-lead dogs.

The handlers have clearly learned to work their dogs with care and respect, an extreme example being the handler of Xingo who continued to work carefully and gently with the dog despite extreme frustration. One handler was having trouble slowing down a long-lead dog while on the search line. Training support was called and arrived within minutes, ensuring that the handler received good advice, and the dog did not become progressively worse as a result of the problem.

Acknowledgements

NPA-Bosnia and Herzegovina provided local support throughout the period of the study. The tolerance and friendship of the dog handlers and field supervisors during what is (for them) a fairly invasive exercise, is recognised and acknowledged with thanks. Their willingness to share experiences and to monitor the safety of the observer at all times greatly facilitated the overall result. Thanks also to all local management staff, especially Terje Berntsen and Kenan Muftic, who facilitated this and earlier visits to this program. This study forms part of a broader assessment of MDD operational systems, supported financially through the GICHD MDD research program by the European Union, and the governments of Norway, Japan, Sweden, the United Kingdom and the United States.



Case study 4. Mustela and Piper, Croatia

Introduction

For reasons of diversity, and completeness, the fourth case study was of two commercial companies. Unlike most post-war countries, most demining in Croatia is conducted by commercial companies. The two commercial companies described here have developed unique approaches to the use of dogs for demining. The case study was conducted in October 2004. As it was conducted recently, no update is provided.

Background

During the Balkan war in Croatia from 1991-1995, a front line extended down through the middle of the country resulting in a band of mines and UXO that is still undergoing clearance. However, much has been done and it is anticipated that the bulk of mine clearance will be completed by 2006-2007.

After the war, the economy of Croatia recovered relatively rapidly compared with many countries suffering similar experiences, and mine clearance was initiated quickly and efficiently. Some international sponsorship of mine action is still taking place, but much of the funding is now sourced internally and is distributed by the Croatian Mine Action Centre. Most of the demining work is done by commercial operators, some of whom are government linked, whereas others are fully independent. The two companies described here are both fairly small independent companies, set up after the war by senior officers in the Croatian army.

In Croatia, animals are routinely kept as pets and are seen commonly in and around houses. Dogs are common, and are kept as pets as well as for other typical uses such as guarding and hunting. Most children grow up with dogs, and many family dogs receive basic training, which will be a component of the children's experience with dogs. It should therefore be possible to find people to work as dog handlers who have a broad background of experience with dogs, who are accustomed to living and working with dogs, and who have a basic knowledge of training principles.

Administrative structure for demining

The central administrative body for demining in Croatia is the Croatian Mine Action Centre (CroMAC). Most commercial operators work under contract to CroMAC, who are responsible for prioritizing and distributing tasks. Testing and licensing of dogs is another of CroMAC's responsibilities. There are many commercial companies now operating in Croatia and the need for demining is diminishing, thus competition for contracts is high and cost structures have changed. For example, demining agencies pay €1000 per dog as an annual licensing fee – we believe that Croatia is the only country where such an administration charge has been implemented.

In Croatia, dogs cannot be used as the first demining method. A machine such as a flail (Mustela and Piper used a Bozena or Scanjack) must first be used on the suspect land. After the machine, manual deminers clear safe lanes from which the dogs and dog handlers work. The land can be declared safe after search by two dogs. QC is conducted by the organization on 5-20% of the cleared land.

Mustela and Piper both employed their own manual deminers, who cleared safe lanes, investigated indications by the dogs, and did QA.

Mustela and Piper: General Description

Both Mustela and Piper are commercial companies, with about 20 operational dogs each. They work closely together, sharing expensive resources such as flails and other equipment. However, their systems for using dogs differed and will be described separately. For both companies, one handler worked with two dogs. A strong emphasis on discipline in the training allowed handlers to take both dogs into the minefield at the same time (*Figure 1*). One dog waits at a designated place while the other works.

Mustela was set up by Boris Katić and Piper was set up by Željko Romić after the Balkans war of 1991-1995. Most of the staff employed by both companies fought for Croatia in the war. At the time of the study, Mustela employed 30 people, including a 10-person field-dog team with 20 dogs. The demining section of Piper was a similar size.

Piper has a well-developed training centre at Požega, about 2 hours east of Zagreb, with teaching rooms, motel-style accommodation for trainees, and a well-designed kennel for housing and breeding dogs (*Figure 2*). There is 45,000 m² of land providing extensive areas for setting out training fields. We did not visit the Mustela training centre.

Figure 1a. Two Mustela dogs waiting to work, with minefield markings



Figure 1b. Two Piper handlers, each with two dogs in the minefield



Figure 2a. Piper training centre: offices, teaching, and accommodation in foreground, kennels in background



Figure 2b. Piper training centre: exercise area on right and training boxes on left. The kennels are immediately behind the photographer.



The typical transportation for a dog team for both companies was a small 2-seater Citroen van towing a specially-designed trailer that doubled as transportation and kenneling of the dogs (*Figure 3*). The unit transported 2 teams (one team = a handler and 2 dogs). Although quite expensive (about US\$4,000), the trailers were insulated and aerated, were light enough to be towed by the small vehicle, and the dogs were clearly happy in them. Because of the excellent roads in most areas, these efficient units were suitable for accessing most of the locations at which demining was needed in Croatia.

Mustela used a mix of breeds, including German Shepherds, Labradors, and Belgian Malinois. Wherever possible, a male and female are worked as a pair. Dogs were only sterilized if there were behavioural problems.

Figure 3a. Piper vehicles and trailers/kennels



Figure 3b. Mustela vehicle outside bombed-out building in Gospić



Piper used only German Shepherds, and preferred females. Piper believes that females are more easily trained and are behaviourally more stable than males. Piper also has a small number of Labradors, used for other purposes.

Mustela uses a long-lead system, with the dog working a semi-structured pattern in 10 x 10 m boxes laid out in the minefield using tape (*Figure 4a*). The handler moves around the safe lane, working the dog first along the edges of the box, and then towards the centre. The search pattern varied for each dog, including for the two dogs worked by one handler. Some dogs worked lines about 5 m long and 0.5 m apart. Other dogs worked in circles or in figure 8 patterns. It was up to the handler to decide when the box had been fully searched. Handlers usually worked several boxes with one dog before switching dogs. The resting dog could be either in the minefield, or in the kennel trailer.

Piper did not use a lead. The dogs were trained to follow the end of a stick (*Figure 4b*). According to Piper, the stick offered two primary advantages:

- The handler could direct the dog's nose very precisely
- The nose was always right at ground level

There was also one important disadvantage. The search technique is similar to a short-lead system in that the handler always walks close to the dog. For the first dog searching, the handler was therefore walking on land that had been searched by only one dog. Piper regarded the risk as acceptable because of the combination of low risk following a flail and the quality of the search technique and the dogs. If the dog was to be used for first search (without the flail), Piper would put in safe lanes at 5 m intervals so that the handler could remain in the safe lane while working the dog back and forth on each side of the lane.

The search pattern was consistent for all Piper dogs. The dog searched continuously back and forth along short lines of about 5 m, working parallel to the baseline and moving approximately 0.5 m forward for each line. Boxes were up to 50 m long and 10 m wide. The handlers worked one dog for 5 - 10 m, and then the second dog for the same 5 - 10 m.

Figure 4a. Mustela dog working on long lead. Handler follows dog around box from the safe lane, seen in foreground.



Figure 4b. Piper dog following stick. Handler works close behind dog and inside box. Safe lanes were originally present but some tape was removed.



Living and working conditions for the deminers and dogs

Most of the deminers lived in local hotels or in short-term private boarding situations while deployed in the field. Living at home and commuting to the workplace occurred if the task was within commuting distance. They worked 7 days a week until either the job was completed or they had worked for 22 days, after which they had a break to complete the month.

According to the companies' SOP, and CroMAC regulations, staff and dogs should work for up to one hour and then take a 10-min break with a maximum of 5 hours worked per day. In late September, when the observations for this study were made, dawn was at about 0630 hrs. Mustela was beginning at 0800 and Piper was beginning at 0700. In the afternoons the dogs were exercised and trained for up to several hours. Training was in small, local test fields set up close to the minefield. All of the dog handlers were ex-military and enjoyed being fit, so the dogs were regularly taken for runs of 5 or more km.

While deployed, the dogs lived in portable kennels (the dog trailers in which they were transported). When on leave, the dogs generally lived with their handlers and families (Mustela) or at the breeding centre (Piper). All of the dogs of both companies were extremely well socialized and were friendly towards strangers.

All dogs were very healthy, well-conditioned and with clean coats. We observed frequent grooming by handlers, including both before and after work. All dogs had a good relationship with their handlers, and the handlers also seemed to enjoy being with their dogs. The dogs were extremely motivated to work, and worked enthusiastically even during long periods with no rewards. Both companies placed occasional targets in the minefield for the dogs to find in order to give rewards.

Mustela dogs were worked on either harnesses or choke chains, but the handlers did not exert pressure on the lead at any time. Handlers spoke to the dogs in a calm and quiet tone of voice – a raised voice was never heard. Dogs were often off-lead in the minefield, but if on-lead they walked quietly – no jerks or other control through the

lead was required. Outside the minefield, the dogs were obedient, alert, and well-socialised. After work had finished for the day, handlers were seen playing with the dogs, with several dogs off-lead in a safe area playing and chasing the kong (*Figure 5*). No between-dog aggression was observed.



Figure 5. Dog leader throwing kong for dogs after work day, and immediately adjacent to the minefield, which is to the left of picture. This safe area was demined on a previous contract.

Weather

Croatia experiences two general weather patterns. Near the coast, the weather is Mediterranean, with warm winters and hot dry summers. In the interior the winters are cold, and summers are hot and humid. Thus demining work with dogs is preferentially conducted in the interior in summer and near the coast in winter.

The week prior to the study was characterized by considerable rain, with limited work opportunities for the dogs. The weather during the week of the study was cool overnight, with heavy mists in the morning clearing by about 1030, after which the day was clear, warm, and calm. About half the observations were recorded during heavy mist.

General Methods

Dog teams from Mustela were observed for two partial days (2 observers) when they were doing QC, and for one full day (one observer) and one partial day (2 observers) when they were working new areas. The Piper teams were observed for two partial days (2 observers the first day, one observer the second day).

The minefield at which Mustela was doing QC was 25,000 m² of flat agricultural land adjacent to a village near Karlovac, about 60 km from Zagreb. The QC search was treated as a normal minefield search, allowing us to obtain data on the typical Mustela search pattern. This contract was completed in 10 days, including the time required for flailing. Mustela was also working a flat area around a bus station in the village of Lički Osik, 3 hours from Zagreb. On the first day there, we arrived near the end of the working day for the dogs (the Božena continued working through the afternoon). On the second day one observer watched the full morning's work.

Piper was working an area of about 300,000 m² near the village of Čovići and about 40 min drive from Lički Osik. The area was old agricultural land on one side of a valley and was mostly flat. Piper expected to complete the contract in about 35 days. All estimates for number of days for a task include the time taken to work the flail.

Dogs were worked on the day immediately following the day on which the flail cleared an area.

The observers chose a safe and inconspicuous place from which to watch the dogs working. A simple data-recording sheet was used to record the activities of the dog teams and their durations. The following were recorded:

- Date
- Location
- Time each dog started working in a box
- Area searched
- Number of lines completed by the dog (where possible)
- Length of any breaks taken during the search
- Type of reward(s) used
- Timing of reward(s)
- Dog's name (where possible)
- Dog's sex and breed
- Pattern of the search
- Number of indications
- Time each dog finished working in a box
- Additional comments where necessary

When working in one place, the two members of the observation team watched different dog teams.



Results: Mustela

The Search Procedure

The working style of each dog was idiosyncratic and the handler decided which pattern of search best suited each dog. One dog worked on a 10-m lead while the handler and second dog remained in the safe lane. *Figure 6* illustrates the four different search patterns observed. Dogs worked in lines of up to 10 m either i) parallel to the baseline (*Figure 6b* and *Figure 7*), or ii) at right-angles to the baseline (*Figure 6a*); iii) some dogs worked in a circular pattern, leaving the baseline and completing a circle to come back to the handler (*Figure 6c*); iv) some dogs worked 3 sides of a box before beginning a free-search pattern through the rest of the box (*Figure 6d*).

Figure 6. Types of search pattern used by dogs and handlers

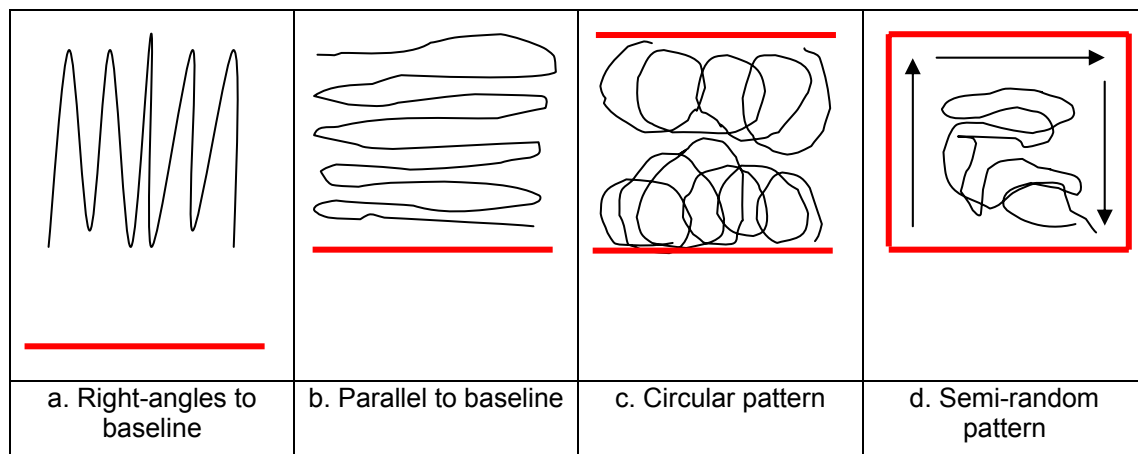


Figure 7. Mustela dog and handler searching minefield in village near Karlovac using the parallel search procedure

Starting work, search behaviour, and rewards: general description

The start and end time for work each day depends on environmental conditions. In the summer, the teams begin work earlier to avoid working the dogs in the hottest part of the day. In the cooler seasons, the teams generally arrive on site at 0800, and begin work at 0830.

A test field is created on site. Every morning a mine is laid (sometimes there is no mine and a blank test is conducted) and the dogs must find the mine before they start work. As soon as the dogs pass the test the teams begin working. There are no obedience drills before work begins.

The main reward used was a kong. The dogs also received praise, patting, play, and food from the handlers. It was policy to reward all indications in the minefield.

Productivity

The start and end time for each search (minus time spent on breaks, e.g. if an indication was being checked by a manual deminer), and the area covered by each search, were used to calculate the average search speed in terms of area of land searched per minute. This search speed was calculated for both locations where observations took place (Lički Osik and Karlovač) as well as for all searches by both sets of teams.

Overall, one Mustela dog searched an average of 22 m²/min (*Figure 8*), therefore taking about 5 min to search 100 m². The average search rate of 17 m²/min for the dog teams at Lički Osik was significantly slower than the 29 m²/min searched by the dog teams at Karlovac². The difference in search speed could have been caused by the different search patterns used in the two locations, or because the teams at Karlovac were doing QC and were therefore moving more quickly. In Lički Osik, the dogs were all working in a semi-random pattern in 10 x 10 m boxes. In Karlovac, the dogs worked lines either parallel or at right-angles to the baseline, or using a circular pattern.

Search rates of individual dogs

Search rate for individual dogs ranged from 13 to 41 m²/min (*Figure 9*). However, the sample size of search periods for individual dogs was small (ranging from 1 to 7). Thus the apparent variation should be viewed cautiously. The sample size for Una (6), Ara (6), and Clara (7) were big enough to suggest that these dogs search consistently at the measured rates.

Search time, Indications, and rewards

Excluding break times, dogs worked for an average of 8 min 19 sec (\pm standard error 1.0 min, range 1 min 52 sec - 34 min, N = 39). The longest period that a dog worked without a break was 12 min.

A total of 15 indications were seen, and many of the breaks excluded in the calculations above were caused by indications. The dog was rested nearby while a

² Independent-samples t-test, $t_{37} = 4.0, p < .0005$

manual deminer checked the indication, which in most cases took only a few minutes. For indications, dogs were rewarded with the kong 7 times and patted 5 times and no reward was recorded for 3 indications. The dogs routinely received physical attention when moved between boxes or when they finished work. A food reward was seen given on one occasion when a dog finished work.

Figure 8. Mustela: average search rate overall and average for two locations separately, measured as m²/min. Error bars show mean ± standard error. Data are averages of measurements from all dogs working at Lički Osik (N = 24) and Karlovač (N = 15).

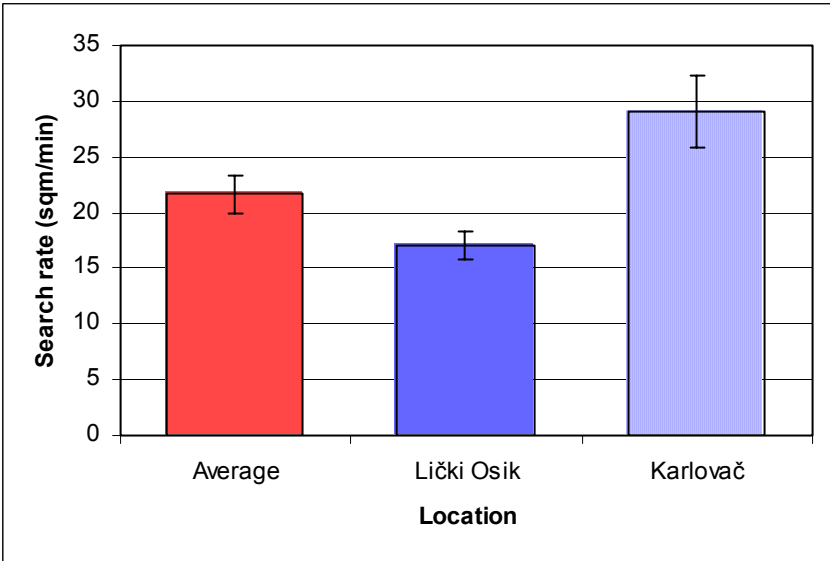
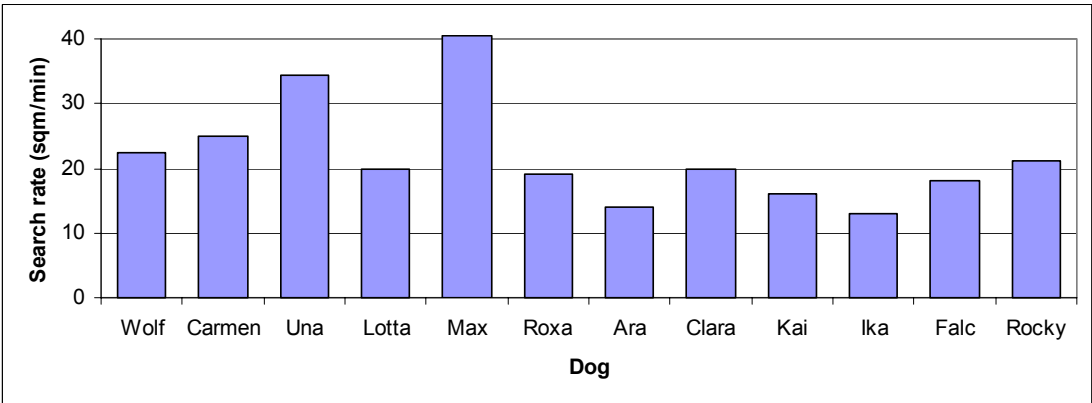


Figure 9. Search rates of individual Mustela dogs



Welfare, socialisation, and fitness of the dogs

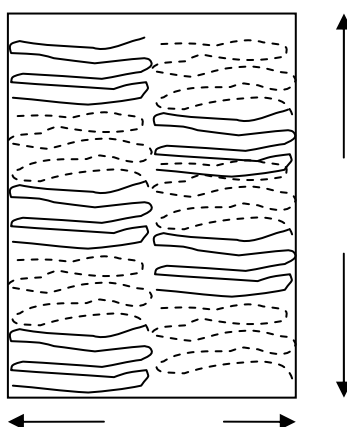
All dogs were in excellent condition, fit and well groomed. No aggression between dogs was seen. The handlers communicated with the dogs using quiet voice and hand signals, and no lead checks or other disciplinary actions were seen. Dogs worked on lead, but were often left off lead in the minefield.

Results: Piper

The Search Procedure

All dogs worked in the same way. Two dogs were used consecutively to search 5-m lines parallel to the baseline (*Figure 10*). Each dog worked between 5 and 10 m down the length of the box and then rested while the second dog searched the same area.

Figure 10. Search pattern for two dogs in a 10 x 50 m box.
Solid and dotted lines indicate the sequence of searches by the pair of dogs.



Starting work, search behaviour, and rewards: general description

The dog teams arrived on site at 0700. A test minefield was laid out on site and each morning a mine was planted somewhere in the test box. Each dog must find this mine before being allowed to work. In the event that a dog fails the test, it is not used for work that day.

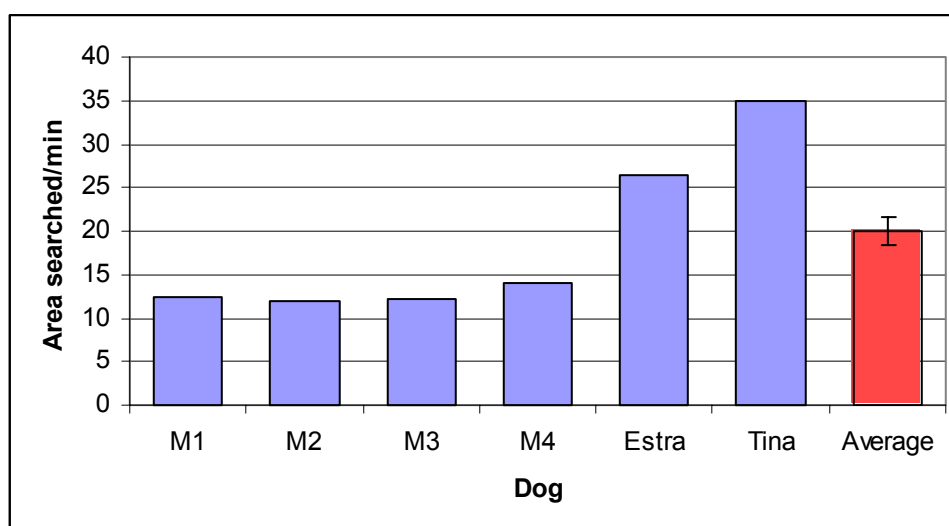
Work commenced immediately after the dogs passed the test. Both dogs were taken into the field and one rested while the other searched. The most commonly-received reward was food, although the handlers frequently patted and praised the dogs. Food was given at the end of each search for each dog. Occasionally a ball was used, especially for indications on test mines, but this was not a common reward. Rewards were not always given for indications in the minefield.

Productivity

The start and end time for each search, minus the time spent on breaks, and the area covered by each search was used to calculate the average search speed in terms of area of land searched per minute. Piper was observed at one location on two days, and not all dog names were recorded.

In *Figure 11*, the dogs named M1-M4 are all male German Shepherds and the other two are female German Shepherds. The average rate of search across the 6 dogs from which data were recorded was about 20 m²/min. The four males searched at very consistent rates. The two female dogs searched at faster rates than the four male dogs. Overall, the average search rate and variation among dogs was very similar to that measured for Mustela.

Figure 11. Search rate (m²) and overall average for individual Piper dogs.
Sample size per dog ranged from 5 to 12, and for the average was 52.



Search time, Indications, and rewards

Search sequences were generally short, because the handler alternated dogs every 5 -10 m. Thus, although the dog searched continuously, it was also regularly rested. Search sequences were an average of 2 min 36 s (\pm s. e. 8.2 s, range 43 - 277 s, N = 54). Dogs searched an average of $4 \pm$ s.e. 0.8 lines/min (N = 32 sequences in which the number of lines was recorded). Lines were 5 m long.

One indication was seen. The dog was patted and removed to 25 m while a manual deminer checked the site (10 min). When nothing was found, the dog was brought back to recheck the site.

Of 54 search sequences, food was given at the end of 41. A pat was given at the end of 23 sequences. For 12 of those 23 sequences, both food and a pat were given. No food or pat was given at the end of 3 sequences. Immediately after receiving the reward the dog was told to drop/stay. In effect, the drop location of the first dog marked the end point for the search by the second dog, although other cues were also available to the handler.

Welfare, socialisation, and fitness of the dogs

Unlike the dogs at Mustela, the Piper dogs do not go home with their handlers each night. While operational, the dogs sleep in their trailers when they are not working. The dog handlers exercise their dogs each afternoon, often running up to 8 km each day, as well as grooming the dogs. The dogs were all in excellent physical condition. When the dogs are not operational, they are housed in the Piper training facilities. The kennels available there are among the best that the observation team has seen anywhere.

The dogs were well socialized, friendly, and extremely obedient. As an example, during one of the breaks during operations in Čovići, a wolf ran out of the forest and came within 20 m of two of the dogs before it saw the dogs. The dogs had seen the wolf and rose from a lying to a sitting position, but did not make any moves to leave the positions they had been told to wait in. The dogs were not leashed and were 20 m away from their handler.

Discussion

The key features of the operational structure for these commercial companies were extremely well-trained dogs, and high productivity on a unit-time basis. Because each handler worked two dogs, the handlers could work continuously while one dog rested. Because the dogs were extremely well trained, management of two dogs in the minefield was straightforward – the dogs were no threat to either themselves or the handler.

An additional feature of these operations was the quality of management of the dogs, with careful attention and considerable investment given to fitness, grooming, housing, travel comfort, and socialization.

Acknowledgments

We thank the management and staff of the two companies, Mustela and Piper, for their support and tolerance of this study. We especially thank Boris Katić, Jasmina Musić and Željko Romić for their time and for the open way in which they answered our questions. GICHHD research on mine detection dogs, of which this study is a part of the study of Operational Systems, is funded by the governments of Norway, Sweden, the UK, Japan and the US, and the United Nations.

Summary and Conclusions

Afghanistan

The Afghanistan Mine Dog Programme is currently the largest, and the longest running in the world, and has been expanding in size for some years. It is a central component of the overall demining programme in Afghanistan, delivering a significant portion of demining productivity.

However, at the time of the case study there was considerable variation in both the productivity of different MDGs, and in the search abilities of individual dogs. A strong emphasis on discipline and on relatively harsh handling of dogs in the programme created difficulties with some dogs, and caused some of the between-dog variation. The variability suggested the need for adjustments to training and operational procedures for both dogs and handlers, and these changes are currently being introduced.

Many of the difficulties can be attributed to the working conditions experienced by demining programmes generally, and demining personnel specifically. Living conditions are primitive, personnel spend long periods away from home, and security is volatile. The dogs are necessarily housed in primitive conditions, and tend to be poorly exercised and poorly socialised. The handlers have no experience of handling or training dogs before entering the programme, and tend to have a low standard of education generally relative to other programmes. Thus everything must be learned within the programme.

Unfortunately, the realities of living and working in Afghanistan are unlikely to change in the near future. Such a large programme also contains enormous inertia, making the introduction of change difficult. However, improvements are being made. Considering the working conditions, it is a remarkably successful programme and there is much to be learned from its successes.

Cambodia

At the time of the case study, the mine dog programme in Cambodia was still under development. Much innovation and experimentation was taking place, which was leading to ongoing improvements.

The original design of the demining procedures in Cambodia emphasised simplicity, combined with the requirement to clear vegetation. As was also noted by NPA-

Bosnia, short-lead dogs are easier to train and work than long-lead dogs. Thus the emphasis on short leads and on following a line keeps things simple. However, the requirements of working to safety distances and vegetation clearance resulted in relatively low productivity for the dogs. Adjustments made since this study have improved productivity, and include introduction of vegetation cutting machines and reduction in required safety distances in the SOP.

Since this study, technical support for the programme has been taken over by NPA, and many of the innovations seen in Bosnia have been introduced, particularly to the training procedures. The MDD programme is still expanding, and is now an integrated component of the CMAC demining programme.

Bosnia

NPA's mine dog programme in Bosnia is highly developed and organised. The use of short- and long-lead dogs takes advantage of the difficulties faced in the training of long-lead dogs, and the combination of these two ways of using dogs provides impressive search and clearance reliability.

The details of the training procedures for NPA dogs are now described and published, and are available on order from the GICHD (GICHD, 2004).

Commercial Companies, Croatia

Both commercial companies observed in Croatia had impressive standards of dog management and welfare, with well-socialised and well-trained dogs, and a minimum of emphasis on discipline. Innovative and flexible search procedures were a feature; for example, Mustela dog handlers adjusted the search style to individual dogs, rather than requiring the dog to search in a standard way. Piper is the only company to use the "follow-the-stick" search technique, which certainly gave handlers very precise control over the dogs' search pattern. Productivity in both companies was high, and the single handler, 2-dog system, introduced valuable operational efficiencies.

Overall

A few common comments emerge from these case studies:

- The requirement to use two dogs (IMAS 09.41) when preceded by mechanical-ground preparation, essentially doubles search time. In both Cambodia and Afghanistan, dogs were used as the primary clearance tool and it makes sense to use a minimum of two dogs. However, where dogs follow machines (as in the Balkans), there are likely to be situations where the 2-dog search involves unnecessary redundancy, and reduced productivity. Adjustments to IMAS 09.41 are currently being considered in relation to these comments.
- The ability and willingness of demining agencies to adapt and pursue innovation in the field is likely to lead to ongoing improvement in their programmes. Both IMAS and the national administrative structures must be able to respond quickly to such proposals for improvement.

- Procedures for making time-and-motion studies, such as those undertaken here, have now been described by the GICHD in a guide (GICHD, 2005). These studies are relatively easy to undertake, generally requiring 1-2 personnel working for 1-2 weeks. They allow demining agencies to explore the details of their programmes, providing opportunities for fine-tuning procedures and testing new ideas. The GICHD encourages demining agencies to use time-and-motion studies as a regular part of their routine, and supports any request for help in undertaking them.



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Glossary of acronyms

BiH	Bosnia and Herzegovina
BiHMAC	Bosnia and Herzegovina Mine Action Centre
CMAC	Cambodian Mine Action Centre
CroMAC	Croatian Mine Action Centre
GICHD	Geneva International Centre for Humanitarian Demining
IMAS	International Mine Action Standards
MAC	Mine Action Centre
MACA	Mine Action Centre Afghanistan
MAG	Mine Action Group
MDD	mine detection dog
NGO	non-governmental organisation
NPA	Norwegian People's Aid
SOP	Standing Operating Procedure
UN	United Nations
UXO	unexploded ordnance