SINTEF F12273 Open

REPORT

Oil in Ice - JIP

Report no.: 14

Using dogs to detect oil hidden in snow and ice - Results from field training on Svalbard April 2008

Per Johan Brandvik (SINTEF) and
Turid Buvik (Trondheim Hundeskole)

SINTEF Materials and Chemistry
Marine Environmental Technology

Date: 22.06.2009

www.sintef.no

SINTEF

Preface

SINTEF has in cooperation with SL Ross Environmental Research Ltd and DF Dickins Associates LLC on behalf of the oil companies AGIP KCO, Chevron, ConocoPhillips, Shell, Statoil and Total initiated an extensive R&D program; *Joint industry program on oil spill contingency for Arctic and ice covered waters.* This program was a 3-year program initiated in September 2006 and finalized in December 2009.

The objectives of the program were;

- To improve our ability to protect the Arctic environment against oil spills.
- To provide improved basis for oil spill related decision-making:
- To advance the state-of-the-art in Arctic oil spill response.

The program consisted of the following projects:

- P 1: Fate and Behaviour of Oil Spills in Ice
- P 2: In Situ Burning of Oil Spills in Ice
- P 3: Mechanical Recovery of Oil Spills in Ice
- P 4: Use of Dispersants on Oil Spills in Ice
- P 5: Remote Sensing of Oil Spills in Ice
- P 6: Oil Spill Response Guide
- P 7: Program Administration
- P 8: Field Experiments, Large-Scale Field Experiments in the Barents Sea
- P 9: Oil Distribution and Bioavailability

The program has received additional financial support from the Norwegian Research Council related to technology development (ending December 2010) and financial in kind support from a number of cooperating partners that are presented below. This report presents results from one of the activities under this program.

Stein Erik Sørstrøm
Program Coordinator
(stein.e.sorstrom@sintef.no)

Funding Partners

R&D Partners

Cooperating Partners

SINTEF REPORT

SINTEF Materials and Chemistry

Address: NO-7465 Trondheim, NORWAY
Location: Brattørkaia 17B, 4. etg.
Telephone: +47 4000 3730
Fax: +47 930 70730

Enterprise No.: NO 948 007 029 MVA

Trondheim Hundeskole

TITLE

Using dogs to detect oil hidden in snow and ice
Results from field training on Svalbard April 2008

Project 5: Remote sensing

AUTHOR(S)

Per Johan Brandvik (SINTEF) and
Turid Buvik (Trondheim Hundeskole)

CLIENT(S)

Agip KCO, Chevron, ConocoPhillips, Shell, Statoil and Total

REPORT NO.	CLASSIFICATION	CLIENTS REF.	
SINTEF F12273	Unrestricted	Mark Shepherd, Marine Julliand, Eimund Garpestad, Gina Ytteborg, Hanne Greiff Johnsen and Ulf-Einar Moltu	
CLASS. THIS PAGE	ISBN	PROJECT NO.	NO. OF PAGES/APPENDICES
Unrestricted		800834	19/0
ELECTRONIC FILE CODE		PROJECT MANAGER (NAME, SIGN.)	CHECKED BY (NAME, SIGN.)
Dogs-Svalbard-ver7-Final.doc		Per Johan Brandvik	Svein Ramstad
FILE CODE	DATE	APPROVED BY (NAME, POSITION, SIGN.)	
	2009-06-22	Tore Aunaas, Research Director	

ABSTRACT

The main objective of this project has been to train dogs to find oil spills hidden in snow or ice. Previous tests performed during 2007 in a laboratory environment in Trondheim showed that dogs are able to detect and identify the smell of oil, both weathered crude and bunker fuels. Outdoor tests in the Trondheim area have also shown that dogs detect the smell of oil and can find point sources at an outdoor temperature down to -5°C. This was confirmed in phase I of this project.

Realistic tests conducted in April 2008 on Svalbard confirmed that dogs can be used to detect oil spills covered with snow and/or ice in Arctic environments. The dogs were able to locate single point oil spills and determine the approximate dimensions of a larger oil spill. The dogs also verified bearing to a larger oil spill (400 litres, on top of the ice covered in snow) in increasing distances up to 5 km away from the oil spill.

This fieldwork on Svalbard has shown that the dogs perform very well under harsh Arctic conditions. The trainers and dogs were able to work in temperatures as low as -40 effective degrees (below -20° C and strong winds) for long periods. The dogs also managed to keep their full concentration and operative sensitivity for several days even after being transported in cages while strapped on scooter sledges and exposed to bumpy rides and exhaust. The use of scooters for transporting the dogs makes it easier to cover larger areas.

This give us future possibilities in using specially trained dogs to search large areas covered with snow and ice to detect possible oil spills.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Oil spill	Oljesøl
GROUP 2	Dogs	Hunder
SELECTED BY AUTHOR	Detection	Deteksjon
	Pollution	Forurensing
	Arctic	Arktis

TABLE OF CONTENTS PAGE

1 Introduction 4

2 The team 5

3 Training elements 6

3.1 Transportation of dogs 6

3.1.1 Long distance transport in cabin of larger airplane 6

3.1.2 Transport by small airplane and snow scooter 6

3.2 Wind 7

3.3 Temperature 7

3.4 Experimental oil spills 8

3.5 Logging dog search patterns 10

4 Practical training of dogs 11

4.1 Basic detection of point source 11

4.2 Determining size and dimension of oil slick 12

4.3 Working with oil gradients 13

4.4 Sensitivity - long distance search 14

5 Conclusions and recommendations 17

5.1 Transport and logistics 17

5.2 Arctic working environment 17

5.3 Detecting and determining dimensions of oil spills 17

6 Recommendations 18

7 Literature 19

1 Introduction

All countermeasures regarding oil spilled in the environment assume that the oil spill itself is located and the polluted site is known. When working with oil spills in open water, a wide variety of remote sensing tools are available not only to locate the oil, but also to monitor the oil trajectory, the distribution of the oil and the film thickness of the oil on the sea surface. This is possible through a combination of sensors operated from satellites, airplanes, helicopters or boats. A comprehensive review of these methods is given by Fingaas and Brown (2000).

Today, no proven operational system exists for detecting oil spills covered by snow and/or ice or hidden under beach sediments. The technologies with the highest potential for use with oil in ice are the fluorescence detector, ground penetration radar and ethane detectors. However, a considerable amount of R&D work and field testing needs to be done to verify the operational usefulness of these methods in screening large areas to detect hidden oil spills. Another common feature with these methods is the high level of technology used in this equipment. This complicates the use of these methods in remote and challenging Arctic areas.

One alternative to these hi-tech approaches would be to utilise the large potential in specially trained dogs to detect oil spills not visible to the naked eye or remote sensing detectors. It has long been known that dogs' ability to detect different odours is exceptional, and this ability has been used for many purposes. Specially trained dogs are used today for related purposes such as searching for bombs or drugs (K9, 2009, Fält, 1997), or for missing children (Buvik, 2003). These dogs are also used for pro-active searches and are capable of searching buildings or vehicles for drugs, or bombs, or for use in passive person scanning at airports. Mine detecting dogs have shown that dogs can work under harsh conditions and deliver reliable results. However, the methodology in which the dogs are trained and the quality of the training has a strong influence on the dog's work performance. It is also known that dogs have been used within the petrochemical sector for detecting gas leakages in refineries and onshore pipelines. Dogs have also been used to detect pollutants such as polyclorinatedbiphenyls (PCBs) and polyaromatic hydrocarbons (PAHs) in for example construction sites or old buildings.

Previous tests performed during 2007 in a laboratory environment and outdoors in Trondheim have shown that dogs are able to detect and identify the smell of oil, both weathered crude and bunker fuels. Outdoor tests in the Trondheim area have also shown the dogs can detect the smell of oil, and can find point sources at an outdoor temperature down to -5°C. This was confirmed in phase I of this project (Brandvik and Buvik. 2007).

The objective for phase II in this project was to develop a new and innovative method to detect oil spills hidden in snow, ice or beach sediments by using specially trained dogs.

The work described in this report has focused on detecting oil spills hidden in snow and ice with extensive field training performed on Svalbard in April 2008. A similar report exists on oil hidden in beach sediments, describing field work performed in September and November 2008 (Buvik and Brandvik, 2009)

2 The team

The team travelling to Svalbard consisted of three dogs and handlers, all of whom had been able to meet the selection criteria for this training in the Arctic environment. This selection was based on work performance as well as plasticity to environmental changes both for handler and dog. The project group consisted of a total of five handlers and seven dogs.

The Svalbard team consisted of:

Responsible for dogtraining Turid Buvik (Trondheim Hundeskole) and 3.5-year-old Border Collie Jippi. Jippi is in addition to oil also trained for detecting PAH and PCB and is also participating in a research project using dogs to detect human lung cancer. Jippi is also a trained herding dog.

Dog Trainer Reidun Mangrud (Trondheim Hundeskole) and 2-year-old Border Collie Blues. Blues is in addition to detecting oil a certified search and rescue dog

Project Manager Per Johan Brandvik (SINTEF) and Tara, a 3 year old Dachshund. Tara has been trained for 2 years detecting oil in this project, and is also used for deer and fox hunting.

3 Training elements

The ability to detect oil is only a small part of the skills needed by the dogs in detecting oil hidden in snow or ice. Both the dog and trainer need to be able to handle challenges regarding the climate and logistics in Arctic areas, which was a vital element in our field training on Svalbard in April 2008.

3.1 Transportation of dogs

The dogs must be transported back and forth to the search area in a safe and effective manner. This means that the working capacity of the dogs should not be reduced due to stress, the risk of any harm to the dogs should be minimised and the search time should be as short as possible. Cost is also an important factor. Helicopters are an option in some cases, but during this training large and small aircrafts were used together with crates on snowmobile sledges.

3.1.1 Long distance transport in cabin of larger airplane

We obtained special permission from both the Norwegian airway authorities and SAS (Scandinavian Airline System) to transport the dogs in the cabin of the plane. This was done to avoid extra stress by freighting the dogs in crates as cargo without supervision.

3.1.2 Transport by small airplane and snow scooter

On Svalbard the dogs were transported in dog crates by small airplane and by being strapped down on a scooter sledge (see Figure 3.1).

Figure 3.1: Transportation of dogs in crates on snowmobile sledge. The dogs had good insulation and wind cover in the crates due to the low temperature and high winds.

When the dogs were working outside in cold and windy conditions for several hours, even furry dogs needed an insulated crate and some kind of warming suit to keep warm in-between working sessions. Both Figure 3.1and Figure 3.2 show how the dogs were kept warm between the working sessions and during transport.

The snow scooters used were brand new vehicles with modern four-stroke engines to minimise exhaust fumes.

Figure 3.2: Tara resting in her insulated crate with wind cover. A: Outdoor temperature –25°C B: Temperature measured in her fur showing +30°C and C: Temperature inside under the top of the crate showing +1.2°C.

3.2 Wind

The wind is an important factor in this approach. The dogs usually search upwind easiest, but experienced dogs can also search downwind and crosswind. During the field work at Svalbard, we experienced unstable and rapidly changing wind conditions due to a rapidly passing low pressure front. Wind speed and direction for the actual period are given in the figure below:

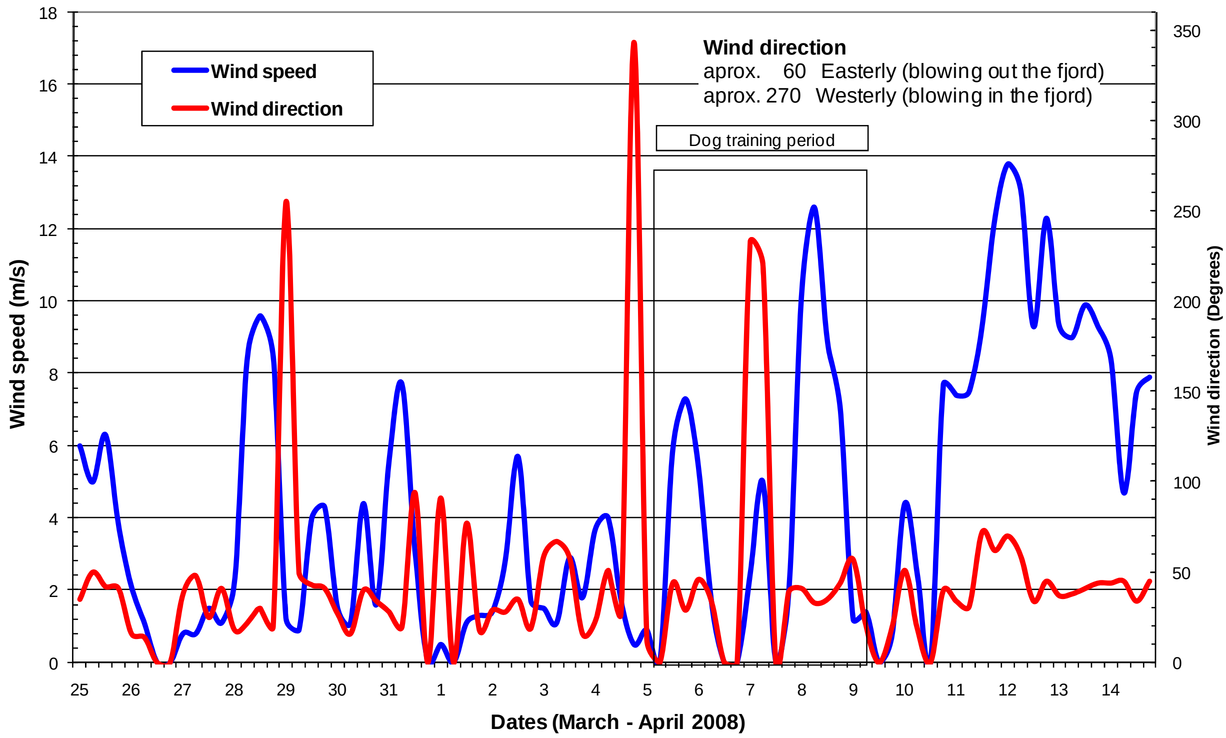

Figure 3.3: Wind (speed and direction) for the total Oil-in-Ice JIP field work in Svea April 2008. The dog training period is shaded.

Early in the period the wind was gusting to more than 10 m/s, but later changed direction completely over a period of a few hours due to a passing low pressure front. Several times the dogs gave the search team surprising directions to the training oil spills. However, after checking the weak and variable wind, the directions indicated by the dogs proved to be correct.

3.3 Temperature

One of the biggest issues for this Arctic training was to see how the teams (both dog and trainers) managed to operate in the cold climate. The temperature, in combination with strong winds, made the effective temperature below –40°C. The temperatures during the field work period are shown in the figure below.

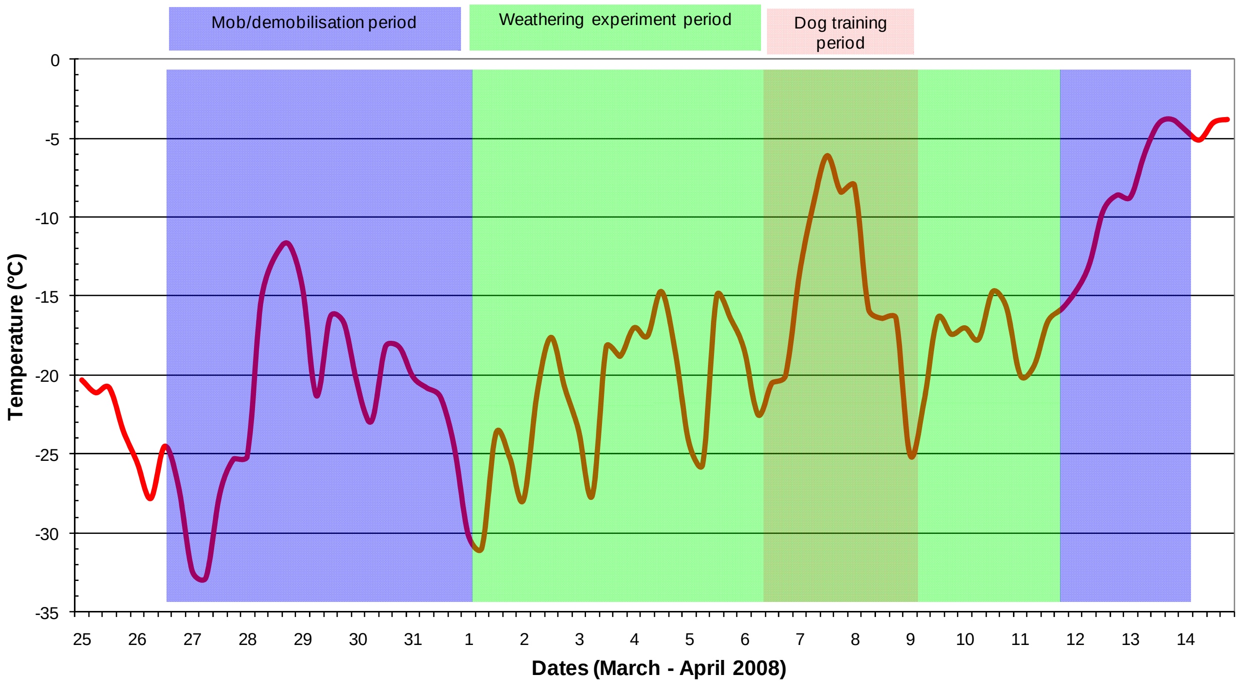

Figure 3.4: Air temperature for the total Oil-in-Ice JIP field work in Svea April 2008. The dog training period is shaded.

3.4 Experimental oil spills

The experimental oil spills were placed on the fjord ice one week prior to the arrival of the dogs. The spills consisted of one large 10 m^2 oil spill (400 litres) plus 16 smaller oil spills (400 ml). These smaller spills consisted of oil released into a hole in the ice (0.5 meter deep) and then covered with ice and snow (see Figure 3.5 below).

Figure 3.5: Small training oil spills used for the field training. A: 400 ml of weathered Troll crude (200°C+) in a 30cm hole in the first year ice. B: The hole is covered with snow and ice chips and marked with a small white cord.

All the samples were tagged with a small cord wire as shown in Figure 3.5. During the entire training period none of these cords were detected by any of the equipages (dog/trainer). No assistance in detecting the oil spills was given to any of the teams due to the visual detection of the cord wires by either the dogs or trainers. The sites were all tagged with GPS, which were used to find the locations for cleaning at the end of the field work.

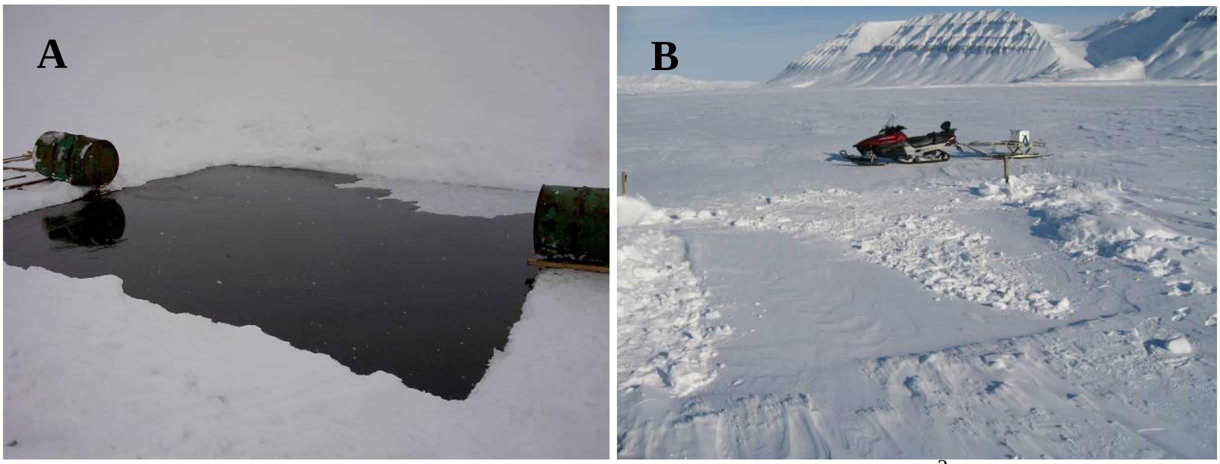

Figure 3.6: Larger training oil spill used for the field training. A: A 10 m^2 area covered with 400 litres of fresh Statfjord crude. B: Two days later, naturally weathered (evaporation) and covered with drift snow.

The oil spills were distributed in the inner part of the van Mijen Fjord just outside Sveagruva on Svalbard, see figure below.

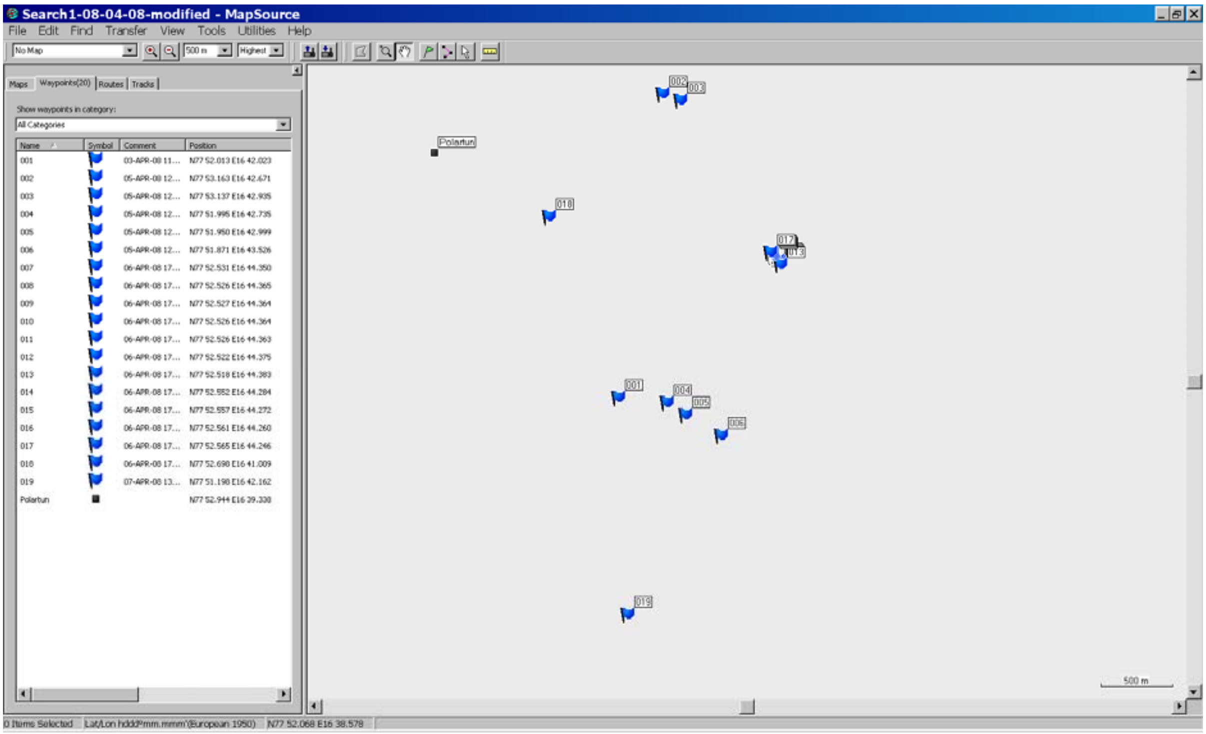

Figure 3.7: Overview of the positions for the training oil spills used during the field training 1 April 2008. Position 19 is the large spill (400 litres), the others are the small 400mL oil spills. The position of SINTEF's field research station "Polartun" is also marked on the figure.

3.5 Logging dog search patterns

The dogs were equipped with 2 different GPS positioning devices, a Trackstick and a Garmin 220 tracking device (see Figure 3.8). This was used to track the dog's search pattern and compare it with the oil spill positions, wind speed etc.

Only the Garmin system gave the necessary accuracy and updating frequency (1-3 meters, updating every other second). The Garmin system also offered real-time updating using a built-in UVF transmitter, while the Trackstick system only logged the positions in the memory stick. Originally the Garmin system was designed to give real-time tracking of dogs during hunting, while the Trackstick is mostly used to track vehicles.

This system made it possible to track the dogs during field training and to study each individual track in relation to oil and wind at the debriefing afterwards. Parameters such as distances, average search speeds etc. were displayed and calculated using the Garmin Mapsource software ver. 6.11.1. See examples of tracks in Figure 4.1.

Figure 3.8: A: Tara with the Garmin 220 system. Both the GPS receiver and the UVF transmitter are built into one compact unit. The positions are sent in real-time to a Garmin 220 hand-held map plotter. The UVF antenna is shown in picture B: The Trackstick unit with a built-in GPS receiver and memory stick for data logging.

4 Practical training of dogs

This chapter describes the different training elements used in field training on Svalbard in April 2008.

4.1 Basic detection of point source

The objective with this initial training (8 April 2008) was to show how the dogs were able to detect the smell of oil starting with an easy target (spill no. 18). All the dogs started from the shore, and went onto the ice in a straight line 90 degrees crosswind/downwind from oil sample no. 18. All three dogs gave a clear indication after approximately 400 meters that oil was upwind, as seen in Figure 4.1. Each dog has a separate colour (Tara: green, Jippi: yellow and Blues: red) on their track.

Note the small "tip" on both the green and yellow dogs half way out. All three dogs made small indications due to an "abandoned" scooter left on the ice half a kilometre upwind, which gave some fumes of oil in the air.

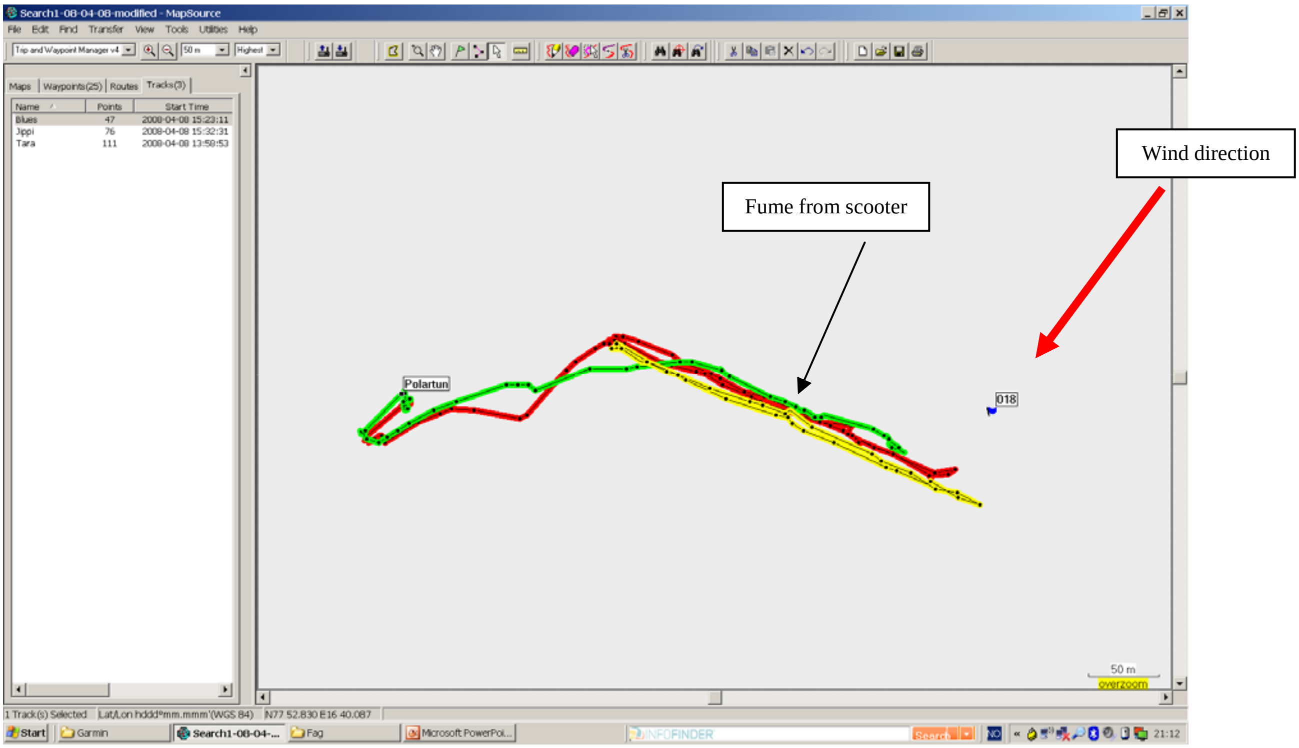

Figure 4.1: GPS tracks from the Garmin 220 system. Each of the three dogs – Blues (red), Jippi (yellow) and Tara (green) – have tracks in different colours. The oil sample is marked no. 18.

4.2 Determining size and dimension of oil slick

The main objective of this part of the field training (9 April 2008) was to find the dimensions or size of an oil spill by using dogs. For this purpose we used two series of small oil spills with a distance of 10 m to indicate a larger oil spill (oil spill no. 07-13 + 14-17, see Figure 4.2).

Triangulation is used to determine the range of findings and oil samples. In the search below an initial search was made downwind to find the start of the oil spill, entering from opposite sites to make indications of range.

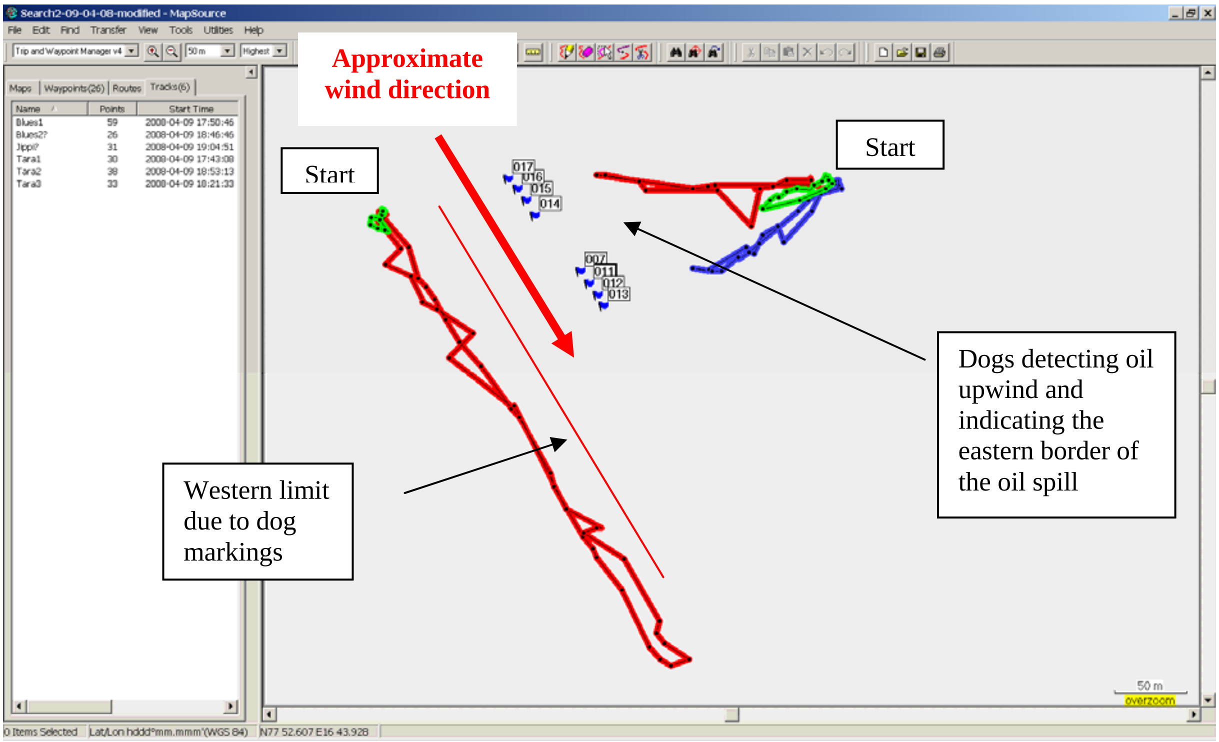

Figure 4.2: GPS tracks from the Garmin 220 system. Each of the three dogs – Blues (red), Jippi (Blue) and Tara (green) – have tracks in different colours. The oil samples are marked no. 07-13 + 14-17.

Using the wind, the west/east range of this oil spill is approx. 70 meters (the dogs are stopped instantly when detection oil, thus giving a "safe zone" to the oil spill of approximately 10 meters when there is little wind (longer distance when there are stronger winds). No north/south range limitations were performed for this test, but would have taken place if exact two-dimensional ranges would have been determined.

4.3 Working with oil gradients

The main objective of this training was to differentiate between the different point sources and work in oil gradients. For this purpose we used point sources with larger distances (100–200 meters). The wind was very weak and variable during this training (10 April 2008, see Figure 3.3). The dogs, especially the more experienced Jippi, managed to identify the different point sources and search both down- and upwind.

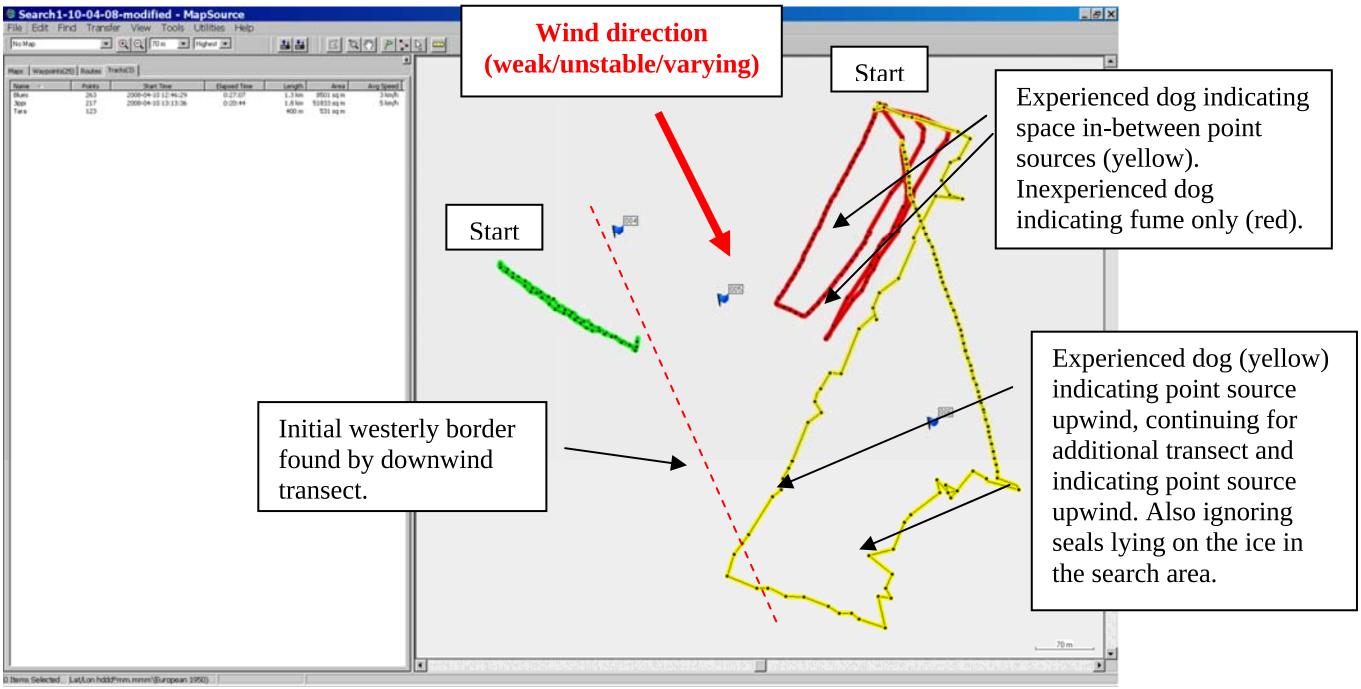

Figure 4.3: GPS tracks from the dog searches. Each of the three dogs – Blues (red), Jippi (yellow) and Tara (green) – have tracks in different colours. The oil samples are marked nos. 04, 05 and 06.

4.4 Sensitivity - long distance search

The main objective of this part of the training (9 April. 2008) was to see how far downwind the dogs were able to detect the oil. In this case, the large oil spill (10 m^2) consisting of 400 litres of Statfjord crude was used (see Figure 3.6). The team used the dogs at three different distances downwind (approximately 800, 3000 and 5000 meters) and at approximately 200 meters on the upwind side of the oil spill. The tracks are given in Figure 4.4.

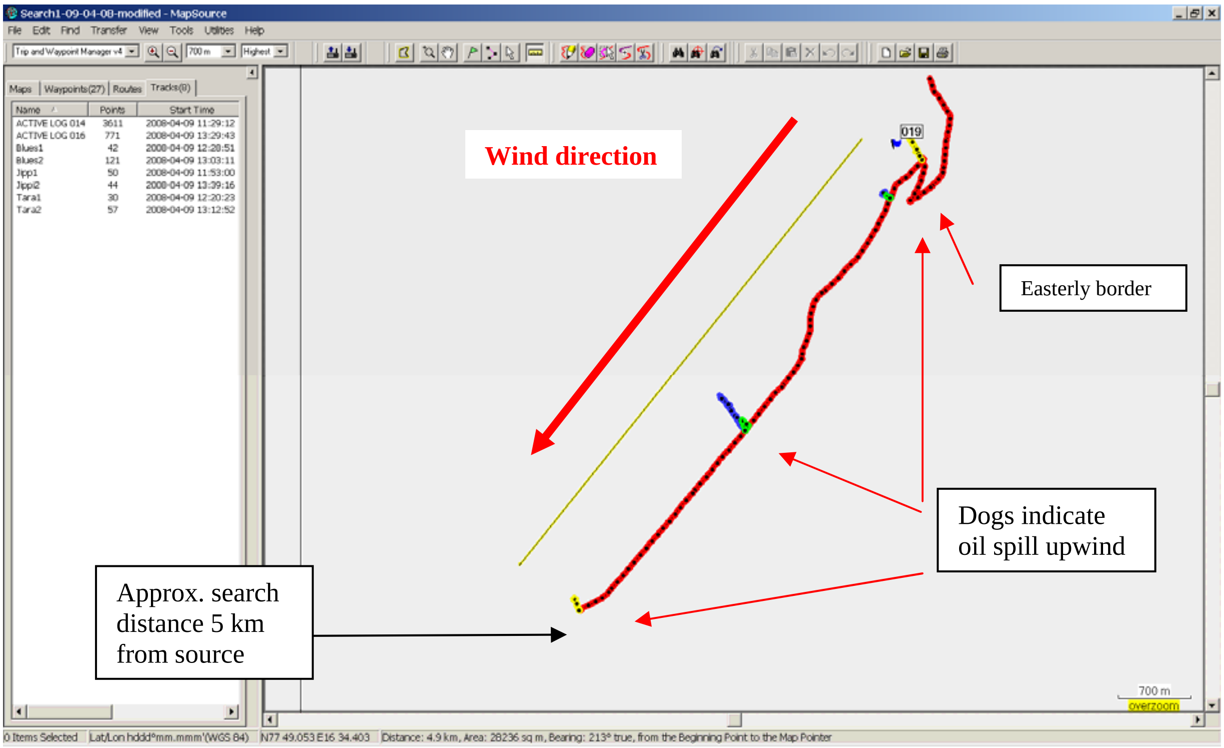

Figure 4.4: GPS tracks from the dog searches. The three dogs have tracks in different colours. Searches were performed at 0.8, 3 and 5 kilometres downwind and 0.2 km upwind.

If the search track log mirrors both sides of the assumed centreline straight downwind, resembling the same search procedure performed on both sides (time limitations restricted this), an indication of the plume dimensions and direction of the spill location is possible.

The maximum distance during this training was measured to approximately 5 km with no indication of this being the maximal detecting distance. Time limitations prohibited further testing to determine the final limits.

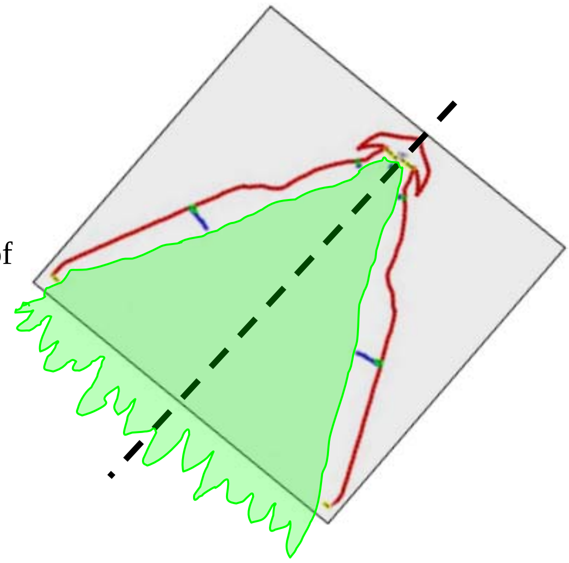

Figure 4.5: Indications of oil vapour plume dimensions by mirroring the search

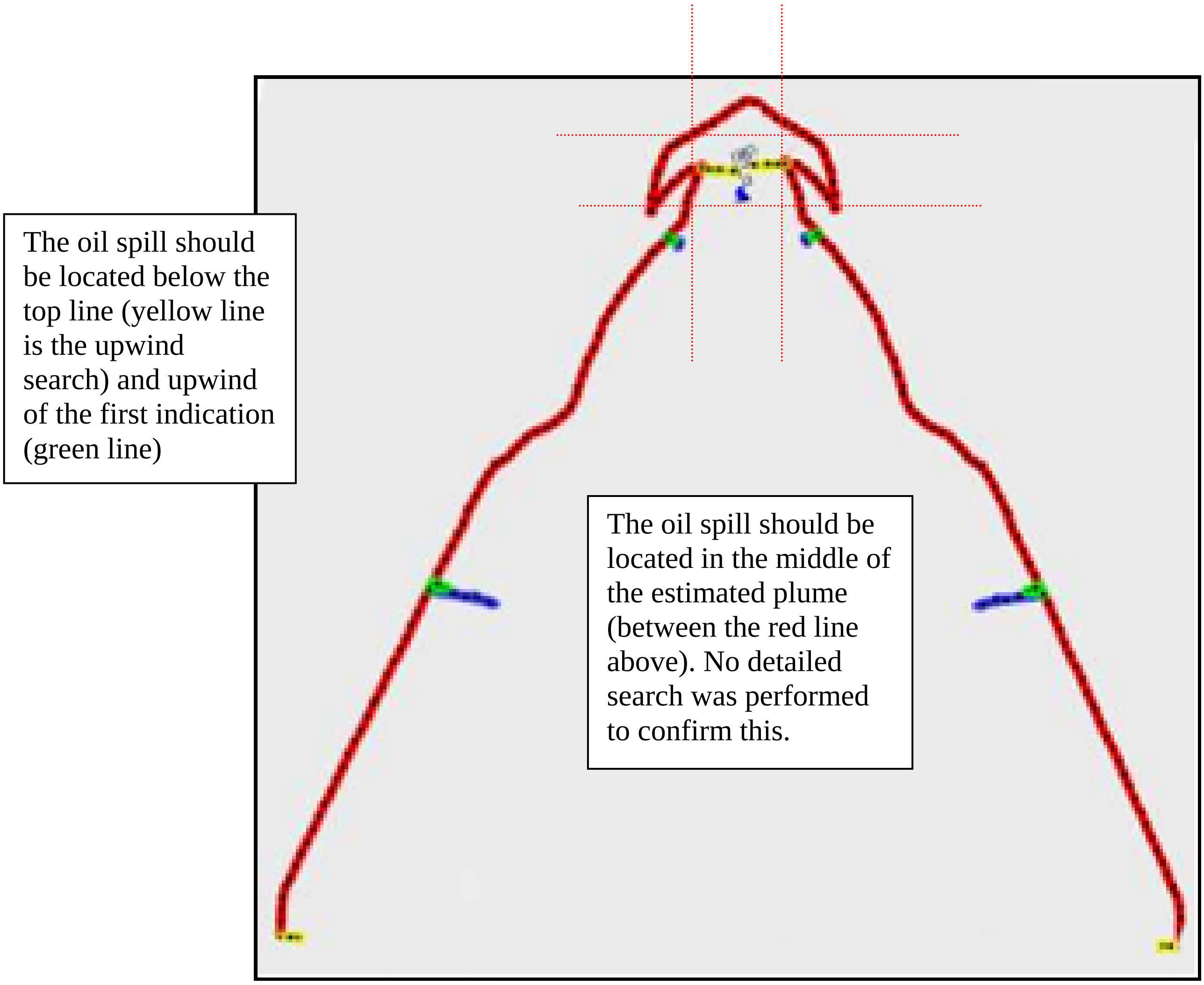

Figure 4.6: Indication of the location of the oil spill based on estimates of the oil vapour plume dimensions based on the dog search patterns.

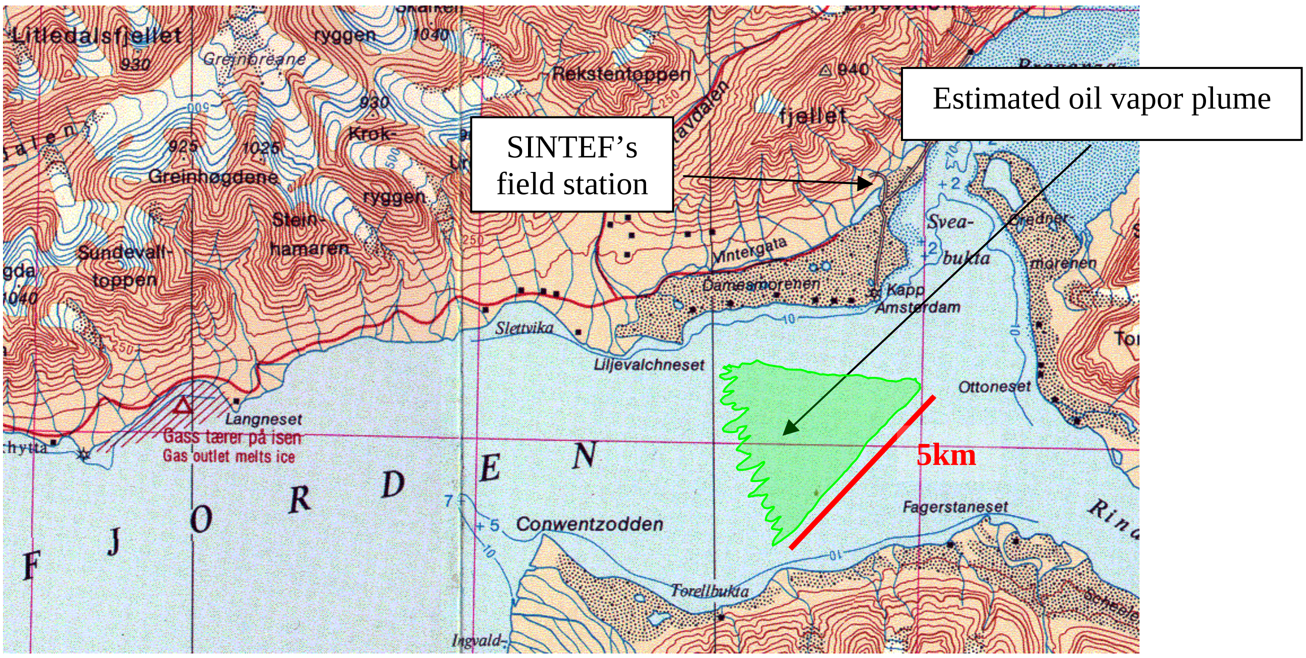

Figure 4.7: The search area projected on a map of van Mijen FjordSINTEF's field station and Svea are also shown on the map.

Figure 4.7 shows the search area projected onto a map of van Mijen Fjord. From this figure it can be seen that the dimensions of an oil spill in the inner part of the fjord can be estimated by specially trained search dogs. The search which forms the basis for Figure 4.7 took only 3 hours effective search time to perform with the transport by snow scooter accounting for most of this time.

5 Conclusions and recommendations

This chapter summarises the conclusions and recommendations for this fieldwork. Generally, the dogs performed very well, and more and better results than expected were achieved.

5.1 Transport and logistics

During ordinary passenger flights the dogs were able to handle the stress at check-in, crowds/queues and security check very well. They also coped well with lying under the aircraft seat for extended periods (2 x 1.5 hours), and during takeoff and landing.

In the small fixed wing aircraft (Dornier 220) the dogs were transported in their crates in the back of the cabin, together with the luggage. All the dogs handled this very well, with little stress and no complaints. There were no negative comments from the other passengers or airport staff.

It is important to stress the need for special permits (both national authorities and local airline companies) to transport the dogs in the aircraft cabin.

The transport by snow scooter sledge was challenging. The dogs handled the bumpy and noisy rides very well, without showing any lack of concentration or large stress response. However, the snow surface was rather smooth due to favourable snow conditions prior to this field work. Other more challenging snow or terrain conditions could make scooter transport difficult and create a possible need for helicopter transport. No helicopter training was included in this field work.

5.2 Arctic working environment

This field work showed that the temperature stress (10 m/s wind and -15°C) was manageable for both the dogs and handlers. The work was organised in two periods of four hours each, a total of eight hours per day. This could have been extended (due to 24 hours of sunlight), but time was also needed to evaluate the daily training and adjust plans for the next day.

The dogs also showed an ability to ignore the local wildlife. One search was performed with seals 20 meters away, and polar bear tracks were ignored. There were polar bears in the area, but prior training and motivation on-site helped the dogs to ignore the smell from other animals.

5.3 Detecting and determining dimensions of oil spills

The documentation of the results from this training (oil properties, GPS-tracks, video and photos) is extensive. The dogs managed to:

1. Pinpoint the exact location of smaller oil slicks (400 ml of weathered oil, 30 cm into the ice, covered in snow and left for a week before it was tracked by the dogs).
2. Determine the dimensions of larger oil spills by indicating the borders of clusters of smaller oil spills (10 meter spacing).
3. Find the location of a larger oil spill (400 L, on top of ice covered in snow) based on the triangulation of detected plume dimensions. The oil spill was clearly detected by the dogs up to 5 km downwind of the spill location.

6 Recommendations

The results from this field training have shown that dogs can detect even small amounts (millilitres) of weathered oil covered by snow and ice. Larger amounts (400 litres) can be tracked from distances of several kilometres.

If dogs are to be used in the future as an operational tool detecting oil spills hidden by snow and ice, the following tasks must be completed:

1. Discuss with authorities and oil companies if and how such dogs can be utilised as a part of the oil spill contingency plan.
2. Establish a standard for the training of new dogs and the certification of equipages.
3. Establish operational procedures for the use of such dogs.
4. Draw up agreements between the dog training institutes (such as Trondheim Hundeskole) and contingency organisations for operational use of such dogs.

This concept should also be utilised outside Norway. One possibility is cooperation with native communities in e.g. Alaska and Canada adding this capability to dogs already trained for other purposes e.g. search and rescue.

7 Literature

Brandvik, P.J. and Buvik, T., 2007: Oil-in-Ice JIP, Project 5 – Remote sensing, Oil detection by specially trained dogs. Memo with status and recommendations to the Steering Committee after ending phase I – Memo from Phase 1 feasibility study.

Buvik, Turid. "Training of Childsearch Dog", Training manual and report 2003 (in Norwegian), Trondheim hundeskole, Trondheim, Norway.

Buvik, T. and Brandvik, P.J.: 2009: Using dogs to detect oil hidden in beach sediments. Results from field training on Svalbard, September 2008 and on the west coast of Norway. (Fedje/Austreheim), June 2009. SINTEF report, Trondheim, Norway.

Fält, L. 1997: Hunden och luktidentifikationen. Polishunden, 1997, 1: 17-18

Fingaas Merv and Brown Carl (2000) A Review of the Status of Advanced Technologies for the Detection of Oil in and with Ice. Spill Science & Technology Bulletin, Volume 6, Issues 5-6, October-December 2000, Pages 295-302

US Bomb method: http://www.k9gta.com/Bomb-Dogs.html - The first to make a standard requirement for bomb dogs.