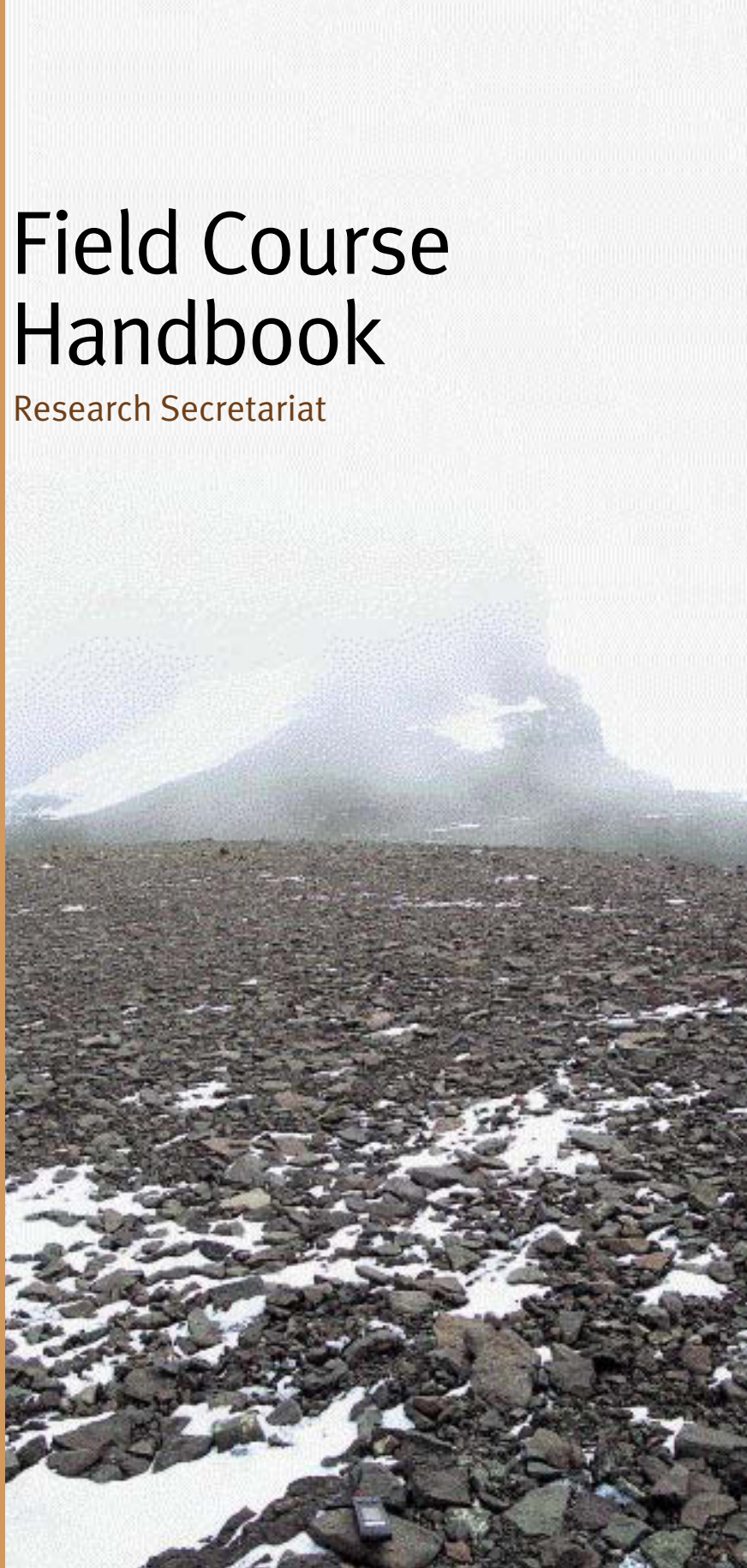
Field Course Handbook

Swedish Polar Research Secretariat



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Swedish Polar Research Secretariat

Acknowledgements During the preparation of this book, valuable comments have been provided by members of the Secretariat's Logistics Council and the staff of the Swedish Polar Research Secretariat.

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Print EO Print AB, Stockholm 2004
ISBN 91-975183-2-8

Foreword

The purpose of this book is to provide practical information to participants in polar research expeditions organised by the Swedish Polar Research Secretariat. It should serve as a complement to the Secretariat's field course which is a compulsory part of the preparation for all participants on polar expeditions.

This book does not replace practical training with an experienced instructor which is essential in order to attain the knowledge and skills necessary for safe travel and living in a polar environment.

Equipment, techniques, and knowledge improve over time and therefore this book is updated on a regular basis.

The Secretariat takes no responsibility for any injury or damage, to person, equipment, or property that might be caused by applying the contents of this book in any situation.

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Figure 1.1 The ice-breaker Oden.
PHOTO: KATARINA ABRAHAMSSON

1. Introduction

The field course and the handbook

The main aims of both the field course and this handbook are to familiarise expedition participants with some features particular to polar research expeditions and equipment that will be used, as well as to introduce safety principles and techniques that should be kept in mind while on the expedition. The field course is also a valuable opportunity for the participants to get to know each other in a setting that resembles an expedition.

On all polar expeditions there is inevitably an element of risk. It is important to recognise that the margins of error can be much smaller in the polar regions than at home. The weather may change quickly and become very violent. On glaciers, crevasses may be hidden under snow bridges that hold for the first and second person but not for the third. As for wild animals, a walrus may decide to investigate your Zodiac or a polar bear may look for food in your cooking tent. All such critical situations may come about quickly and unexpectedly. The risks are real and you should not add to them by neglecting them. The safety principles and techniques presented here and at the field course are adapted to the Swedish Polar Research Secretariat's expeditions and are constantly being reviewed and developed. It is likely that you will learn knew things even if you have attended field courses earlier, and you will definitely get an opportunity to refresh old skills.

Besides the basic field course, the Secretariat may provide extra training for some of the expedition members in topics of specific relevance to the expedition. However, it is important to recognize that you will not be a fully-fledged e.g. mountaineer after the field course or even after the extra training. Many of the techniques taught theoretically and practically take a lot of time and practice to master. Both in training and in the field, you should be realistic and honest about your knowledge and abilities, and not take part in activities where you are uncertain of if you can handle situations that may arise.

This handbook fills three main functions: as pre-training reading to prepare you for the field course, as a complement to the notes you make during the field course; and as a repetition to be read before and during the expedition. Before the field course, you will receive information on which parts that you are expected to have read beforehand. The handbook may cover topics that are outside of the scope of the expedition that you are to participate in. However, the Secretariat always tries to reflect each expedition's uniqueness in the form and content of the field course.

A general description of Swedish polar expeditions

As a general principle, the Secretariat organises three kinds of expeditions, each with its own characteristics: Antarctic, marine, and tundra expeditions.

Figure 1.2 The nunatakk Plogen, as seen from Wasa station. PHOTO: THE SECRETARIAT

ANTARCTIC EXPEDITIONS

Climate and environment What really characterises Antarctic expeditions is the inland ice that is the almost totally dominant environment in Antarctica. This kind of environment is very unfamiliar to most people. Through its immense size and vastness the inland ice may seem unchangeable, but actually it is a very dynamic environment. Just like water, the inland ice is affected by the Earth's gravitation and it "flows" from higher to lower ground. As it does so, the inland ice is affected by the topography of the underlying ground. In all areas where the ice is moving it is subjected to various forces, and since the ice is not perfectly plastic this results in cracks and crevasses. In general, the greater the height differences in the underlying topography, the more and the greater cracks or crevasses occur. Even in seemingly flat areas the ice may be subjected to forces that lead to cracking: the underlying topography may not be flat even though the surface is, and ice in areas quite far away may subject "the flat ice" to pressure. Both small and large cracks can be covered by snow (bridges). This may make it very difficult or impossible to detect crevasses even a short distance away.

Mountaintops jut out of the ice like islands out of a sea. These mountaintops go by the Greenlandic word "nunatakk". The Swedish station Wasa is situated on the nunatakk Basen, which measures approximately three by five kilometres. Basen has relatively large areas of bare ground. This bare ground consists mainly of stones and boulders, with a few, more or less temporary shallow

pools of melt water. The vegetation is very sparse and consists of mosses and lichens. These grow extremely slowly and are very sensitive to disturbance. Their abundance can locally be quite high. The other Swedish station, Svea, lies in the Scharffenbergbotnen that is part of a larger nunatakk system, the Heimefrontfjella. Here, most mountainsides are steep or very steep, and therefore quite inaccessible.

Even though Antarctica is the coldest, driest, and windiest of the continents, it should be noted that the Swedish expeditions go there during the austral summer. At Wasa, the mean summer temperature lies around minus ten degrees centigrade, and it rarely goes below minus twenty. The relative closeness to the sea makes the Wasa area prone to bad weather, with wind speeds reaching gale force. However, summer seasons at Wasa without any real storms do occur, even though they are rare. At Svea, the weather is more stable, due to the position further inland. The interior of Antarctica consists mainly of an ice plateau, ranging from 1 000 to 4 000 metres above sea level. The plateau begins just south of Svea, and here the summer temperature lies around minus twenty degrees, often going lower. The wind is almost ever-present in Antarctica, and the wind-chill effect should never be disregarded. Another important aspect of the wind is drifting snow. Although Antarctica has small amounts of precipitation, drifting snow can quickly cover even large items left outside, and the wind quickly packs snow into really hard drifts. Snow usually drifts rather close to the ground, up to two or three metres in height, and it can severely limit visibility. Another typical phenomenon in Antarctica is "white-out". This usually is caused by a thin cloud layer covering the whole sky, producing a diffuse but quite intense light that is reflected both from the snow and the sky. The danger with white-out conditions is that you lose all points of reference, which makes e.g. flying using visual means impossible.

Way of transportation The arrangements of transport services to and from Antarctica are as a rule done in co-operation with other countries. Until 2001, basically all Swedish expeditions were transported to and from Antarctica by ship. In that year Sweden, together with ten other countries, started an international co-operation with the aim of providing air transportation between South Africa and Antarctica, and within Antarctica. The framework for this co-operation is called Dronning Maud Land Air Network (DROMLAN). Some of the benefits of using air transportation are a potentially longer summer season, a more flexible scheduling of the season, and lower costs of transporting people. The most serious drawback is the limited cargo capacity of the aeroplanes, and ships still need to be used when re-supplying the stations with e.g. fuel and heavy equipment. Another negative effect, albeit less so, is that flying from a temperate-subtropical Cape Town straight onto the Antarctic inland ice creates quite a contrast, and it is important to try to mentally prepare oneself for this.

At times ships will still be used as the means of transportation when the Wasa station needs to be re-supplied with fuel, heavy equipment etc. In such a case, it may be the most convenient solution also to transport people this way. However, in the foreseeable future most such journeys with passengers will be one-way. Travelling by ship allows one to adapt more easily to the climate change, and on journeys to Antarctica a lot of preparations and training can be done on the ship.

During the expedition as such, tracked vehicles and snowmobiles, stationed the year around at Wasa, are used for overland travel. Helicopters and/or small aeroplanes may be chartered for specific science

Figure 1.3 In Antarctica, bare ground is generally covered with broken rock due to frost action. PHOTO: K. INGEMAR JÖNSSON

purposes; they are also used in the rare case of evacuation for medical reasons (MedEvac).

Living conditions The Swedish Antarctica expeditions are rather small, typically consisting of ten to fifteen people. As on all polar research expeditions, living quarters are of a limited size, and shared sleeping quarters is the rule. Depending on the activity, living quarters range from comfortable conditions at permanent stations to primitive conditions in tents. On Swedish expeditions everyday chores, such as cooking and cleaning, are generally shared between the participants. The food consists as much as possible of fresh and frozen goods, supplemented by canned food. In a long field season the fresh fruits and vegetables may not last the full period due to a lack of good storage conditions. At high latitudes the sun never sets in the summer and in a very white environment, such as in most of Antarctica, there is no great difference between night and day.

Figure 1.4 The top image shows an Ilyushin 76, a Russian-built four-engined jet aeroplane, used to transport people between South Africa and Dronning Maud Land. Above, an expedition is unloaded from a ship unto the sea ice. Tracked vehicles and snow mobiles, towing sledges, transport the equipment and provisions from the unloading site to Wasa.

PHOTO: THE SECRETARIAT, AND PETER DARTH, RESPECTIVELY

Figure 1.5 The ice-breaker Oden. PHOTO: JOHN JONSSON

Figure 1.6 Meteorological equipment on the sea ice. PHOTO: THE SECRETARIAT

This may cause sleeping problems in some people, but usually it is not a big issue.

Logistical and technical support and limitations Antarctica expeditions are technically and logistically complex operations. This is due to the combination of the continent's harsh climate and far away location, and the aim of providing good science platforms and comfortable living conditions. Everything that is needed at Wasa and Svea has to be shipped there in several stages, which takes time and thorough planning. When flying there, there are usually strict limitations on weight and volume of the cargo, mainly due to the capacity of the feeder flights within Antarctica. At the stations there is some office/laboratory space but there are no research facilities as such in place. All technical support requests need to be discussed beforehand with the Secretariat's logistics staff, as conditions may differ radically from home. For instance, the main power grids at the Swedish stations provide 12 V and 24 V DC only. Also, as the stations are self-contained, the care and maintenance of equipment are the responsibility of the expedition's logistics staff and do take some time.

Environmental issues Activities in Antarctica are strictly ruled by the Protocol on Environmental Protection to the Antarctic Treaty. The rules set up by the Secretariat, based on the Environmental Protocol, must be strictly adhered to.

MARINE EXPEDITIONS

Climate and environment The main characteristic here is, of course, that almost all activities are confined to a ship. The exception to this could for instance be temporary activities on the sea ice. In spring there can be sunny but cold days, while in the summer the sky is usually overcast and the temperature often lies around the more moderate temperature of zero degrees. In the high Arctic, gale winds are unusual in the summer, and once inside the pack ice the sea is very calm. Travelling through sea ice can be a very bumpy ride, but most people adjust to this quite quickly. Thick, multi-year sea ice and pressure ridges formed by wind and currents can lay obstacles to the journey, and reduce the possibility of fulfilling planned activities. In Antarctic waters, storms rather than ice are the main problem, with (long) swells often reaching heights of 10–15 metres. These storms break up most of the sea ice every year, and multi-year ice is common only in distinct areas such as the Weddell Sea. Closer to the ice-shelf the sea is usually calmer, and huge icebergs are common.

Means of transportation For Arctic expeditions the ship most often used to date is the Swedish ice-breaker Oden. Such expeditions generally depart from a Swedish port, in order to make the mobilisation and demobilisation more convenient. Oden is quite a unique ship in that she is an ice-breaker of the highest Arctic class and built

Figure 1.7 Mountainous tundra, and the more common, flatter tundra terrain. PHOTO: THE SECRETARIAT, AND ANDERS MODIG, RESPECTIVELY

so that she can easily be converted to a research vessel: the Secretariat had a consultative role when she was built. Antarctic marine expeditions are made in co-operation with other countries, and the ships and ports used vary. Work and storage space may be limiting factors onboard ships, particularly laboratory space.

Helicopters may be available onboard the ship for specific science purposes, however, this is totally dependent on the facilities available on the ship.

Living conditions Although space is always limited, most ships are very comfortable to stay on. The rule is that cabins are shared, and some people may feel a bit confined after a while. The status and availability of common rooms and other social facilities vary from ship to ship. The ship always provides meals, but other services such as the cleaning of cabins and corridors, and the washing of clothes are in some cases done by the crew, in others by the passengers. The ship's captain will decide on which areas that are accessible by the passengers and which are not. The food onboard is generally good, but on a long journey vegetables and particularly fresh fruits may not last the full period.

Logistical and technical support and limitations One of the great benefits of being on a marine expedition is that the ship always has a very competent crew. However, it should be kept in mind that the crew has the running and maintenance of the ship as their primary task, and the servicing of scientific equipment is always the researchers' responsibility. What media, e.g. water, gases, and electricity, and how much of them can be supplied to laboratories and work areas vary. It should be noted that the quality of electrical power is not the same as back home and that power spikes and cut-offs may occur; also, a ship has no true grounding plane. Furthermore, depending on where the ship comes from, the electricity provided has either 220V/50Hz or 110V/60Hz as the standard. The possibility of bringing onboard containers is very limited on some ships.

Environmental issues Activities onboard and away from the ship, e.g. on the sea ice, are ruled by the ship's regulations, based on national and international law. South of 60°, the Protocol on Environmental Protection to the Antarctic Treaty applies.

TUNDRA EXPEDITIONS

Climate and environment In general, tundra is the treeless nature type that occurs north of the taiga, and which is not covered with snow the year round. However, both patches with dwarf birch and Salix, and with permanent snow may occur. To the north, the tundra turns into polar desert due to little precipitation and melting. Permafrost,

Figure 1.8 Walking in mountainous tundra, the Canadian High Arctic.
PHOTO: ANDERS MODIG

Figure 1.9 Low clouds, sometimes even touching the ground, are quite common on the tundra. In the background, an MBB-109 helicopter.
PHOTO: THE SECRETARIAT

i.e. the ground being permanently frozen, is common in the tundra, and the surface layer that melts in summer is often quite shallow. In flatter terrain, with limited run-off of melt water, the impermeable permafrost layer causes large areas to become very wet. Large parts of northern Siberia and Alaska are very flat, while the Canadian High Arctic is generally hilly or mountainous. Summer is short on the tundra, often only lasting from mid-July to mid-August; the temperature generally lies above the freezing point, and the weather most days consists of overcast skies, a light wind, no precipitation, and a temperature around five degrees centigrade. However, really warm days as well as cold fog, and snow and sleet storms can occur.

Way of transportation The transportation into the field is almost always by helicopter, while the journey to the helicopter landing field may be by aeroplane, ship or even by train. Helicopters have strict weight and volume cargo limitations, which depend on the flight distance, i.e. on how much fuel they must carry. The makes and models of helicopter, and thus capacity, vary greatly depending on what is available at the take-off site. On some expeditions rubber boats, such as Zodiacs, are used for travel in the field.

Living conditions Tundra expeditions are tent based, often with two people sharing a tent. Field stations are few and far between on the tundra. Besides sleeping tents, most camps are supplied with a larger kitchen tent. Food is generally of the canned variety with a limited supply of fresh goods.

Logistical and technical support and limitations Being tent based, tundra expeditions have very little in the way of technical infrastructure. Electrical power is generally only supplied for maintaining communication. On some expeditions a change of camp sites at mid-season can be used for re-supply.

Environmental issues The activities on tundra expeditions are regulated by the national law of the area in which the expedition is done.

Personal matters

BEFORE THE EXPEDITION

From when you receive this book to when you leave for the expedition there are a number of preparations that must be done, both at a personal level and concerning the scientific equipment that your project is bringing along. During this period of preparation you will receive information and instructions from the Secretariat. It is critically important that you follow these, or if you cannot, that you contact the Secretariat immediately.

LEAVING

The time just before leaving on an expedition is usually quite hectic and filled with preparations, and you are probably quite excited about the whole thing. Some people get absent-minded and are "on expedition" weeks before actually leaving. For those staying behind, even if they are happy for your sake, you should remember that they are literally staying behind and will not participate in the things that cause your excitement. For their sake, do not be over-cheerful about the expedition, and a good idea could be to plan something nice for your homecoming, so that they also have something to look forward to. To prepare yourself, read about the area that you are going to visit and talk to people who have been there or in similar areas. Try to make a realistic picture of what you are going to experience. Even though you probably will enjoy quite fantastic experiences and beautiful views, you will also encounter (boring?) everyday chores and bad weather. With a realistic view there is less risk for your expectations not to be fulfilled.

ON EXPEDITION

During the expedition, some things can make the expedition "heaven" or "hell". One is your own mental attitude; another is your relations to the other expedition members. All participants will experience their own highs and lows. One thing that can make an expedition a really bad personal experience is poor planning of your project. A good way to avoid such frustration is to have a clearly prioritised list of things that you want to do. Consider all things that you get done on top of the basic minimum for the project as bonuses. In this way you can be happy most of the time and congratulate yourself for all the bonus work you get done. Furthermore, if things do not go as planned in your project, do not turn it too heavily against yourself, but use it as a lesson for future expeditions.

Be prepared for inclement weather or ice conditions that reduce your possibility to work. Going on an expedition is a risk project, and so far Mother Nature cannot be ruled over. If you cannot accept this, then you should not participate. You must also be prepared to

Figure 1.10 Leaving Gothenburg with the ice-breaker Oden.
PHOTO: MAGNUS AUGNER

take your share of everyday work. It is not always fun to wash the dishes of, say ten hungry people who rush out into the field straight after the meal, or to change the latrine drum at the research station. The Secretariat always tries to give the scientists the optimal research conditions that the resources allow and to be fair. However, in some cases the choice may stand between having an expedition where all members help out, or not having any expedition at all. If there is some chore that you really dislike, talk to the expedition leader to see if there are alternatives, or just see it as an experience that you have to go through (even if you never want to do it again).

Even though it sometimes may feel best not to have any contact with the ones at home, it is usually a good idea to have a regular contact, not least for their sake. Information "from the horse's mouth" is absolutely the best way to reduce worries. Try to be honest: if things are tough, or if things are great, say so. At times it may be difficult or even impossible to have decent communication with the outside world due to technical difficulties. This is something you (and your family) must be prepared for. No matter how much the Secretariat tries to plan to avoid such problems, unwanted things do happen on expeditions. The Secretariat cannot guarantee that you will have functioning communication with the outside world, but everything is done to provide it.

As for your relations to the other participants, nobody expects that you should, or even could, love and be loved


Figure 1.11 Everyday environments on an expedition: on the left, the main laboratory onboard Oden, and on the right, dining at Wasa station.
PHOTO: MAGNUS AUGNER, AND THE SECRETARIAT, RESPECTIVELY

by everyone. However, these are the people you have to live with whether you want it or not, and you can be sure that everyone has something interesting to teach you. A second thing to remember is that all human beings are deviant in one way or another. Some people may show peculiarities that you find very annoying, and the other way around – everybody must give the others some leeway. The longer an expedition is and the less actual space there is for privacy, the more tolerant everyone has to be. Everybody has some need for privacy, and it takes a lot of energy to be constantly surrounded by (at least initially) strangers. Try to have an open mind, and if there is something that really bothers you, then tell it straight to the person in question; be honest without becoming aggressive. Most times, it is enough if you can just get it off your chest, and the person at the other end may not have been aware that their behaviour had this effect on you. Do not be afraid of getting to know people: many a new friendship has started on expeditions.

COMING HOME

The homecoming after an expedition can be difficult in some ways. Close friendships formed during the expedition may dissolve, you may feel tired and in need of a rest, or you may be full of experiences and stories that you want to tell the whole world. Well, the world did not stop while you were away, and an expedition is a very different, and in some ways artificial, environment. If you live in the same town, you may continue to see your newfound friends. Just remember that being back in the normal world means that you again have everyday responsibilities and your old "nearest and dearest" to take care of; they have been forced to do all the work and have enjoyed none of the fun that you have. As for telling the world about all your wonderful experiences, well, some people will be very interested, others utterly bored. If you have a craving to talk about it, why not contact one of the expedition members? Only those who were there actually know what it was like, and emotional impressions can be very hard to put into words.

Safety and incidents

The Secretariat tries to plan and prepare for all possible emergencies, but unimagined and improbable things may happen. You must always use your common sense. To have expedition, camp and project leaders around you is no excuse for not using your brain. You must at all times be responsible, not only for yourself, but also for your friends and colleagues in the field. If something seems wrong or unnecessarily risky then you must say so. In this way you make people aware of risks they may not have thought of. For example, if you decide to turn back to camp or discontinue your work because of new, potential safety risks, then you are doing the right thing.

Table 1.1

Example of safety regulations

- Be responsible for yourself and for the other expedition members.
- Always follow the instructions given by the leader of the expedition, camp or group.
- Never leave the ship, station or camp area on your own.
- When leaving the ship, station or camp, inform others about where you are going and when you expect to be back.
- Always bring safety equipment when leaving the camp (radio, compass/GPS, gun, food, spare clothes, etc.).
- Avoid cooking in sleeping tents (fire and carbon monoxide hazard).
- Be aware of the potential (polar) bear and/or crevasse risk, in all activities, in the field or at the station/camp.
- You may deviate from regulations or set routines only after receiving permission from the expedition leader to do so.
- Keep to the communications routines.
- If a critical situation occurs, contact the expedition leader and/or camp leader as soon as possible. On marine expeditions, contact the ship's bridge.

There are no scientific data in the world that are worth a person getting injured, or worse. Remember that on all expeditions the main risk factor is human behaviour (Table 1.1).

Accidents are in general rare during expeditions. When accidents do happen they are mainly of the "everyday" kind, i.e. the kind that are common back home, while the more spectacular incidents such as people falling into crevasses or being attacked by polar bears are extremely rare. Many of the accidents that do occur happen outside of work, i.e. on time off. Since the medical treatment facilities are always limited in polar areas, you are not allowed to treat your time off as you would have back home. There are also risks that in practice only occur on your time off. For example, the only real risk of avalanches in Antarctica is if you go skiing, otherwise the expedition never moves in such terrain. In this context, alcohol should also be mentioned. On every expedition, the Secretariat decides if and how much alcoholic beverages that are allowed to be brought on the expedition, and when these may be consumed. On most expeditions, some festivities (with or without alcohol) are arranged to raise the spirits. However, it is totally unacceptable that anyone gets so drunk that they are unable to take care of themselves or to do their job in a professional way. Narcotic drugs are never allowed on expeditions, except for medical use as prescribed by the expedition's medical personnel.

On every expedition that the Secretariat organises, one person is designated as expedition leader, with the overall responsibility for carrying out the expedition. This task includes co-ordinating

- the safety of the expedition,
- the everyday work of the expedition so that common tasks are done, and
- the expedition's resources, so that all scientific projects are given the opportunity to be carried out in the best possible way. The expedition leader must see to it that the resources of the Secretariat are used in an efficient manner and that all activities are in line with the Secretariat's interests.

On smaller expeditions, a senior researcher may function as the expedition leader, while on larger expeditions this task is performed by the Secretariat's regular staff. If it is

the most efficient from the scientific point of view to split the expedition into different camps, then the expedition leader may delegate some of the responsibility for co-ordination to the camp leaders. However, the overall co-ordination responsibility is still the expedition leader's, and in matters affecting expedition safety or involving the expedition in general, the expedition leader must be involved in the decision making.

You should be fully aware that the time schedule for the expedition that is set up beforehand is an ideal one, one that will be followed if everything goes according to plan. However on expeditions to the polar regions, things rarely do go as planned, and there does not exist such a thing as a "guaranteed research day". All planning done and decisions taken in the field are part of a collaboration between the expedition leader and the different project leaders. However, sometimes decisions have to be made on the spot, e.g. due to bad weather or ice conditions. For the individual researcher this may cause frustration, especially if a change of plans means that you have to cancel part of your project. Please, try to be patient. Rest assured that the expedition leadership is doing everything it can to be as fair as possible to all the involved projects. The Secretariat's expeditions are never "overbooked", and care is always given during the planning stages to ensure, as far as possible, that each project is given enough time and resources to be successfully carried out.

Even if the expedition leader has the overall responsibility for co-ordinating the expedition safety, there are other specialists who make particular decisions. For instance, the captain of a ship or a helicopter pilot always has the last say on where their craft is going, and whether: their first priority is the safety of their vessel. The same goes for the doctor in medical matters. Individual members of an expedition should not enter a discussion with, e.g. a helicopter pilot about whether or not he should fly.

In case of emergency, a strict hierarchy of decision-making is necessary in matters concerning safety. For the same reason, in all situations involving more than a single person, one person acts as the leader, i.e. as responsible for co-ordinating the party's safety. This should be clear before any work is started, and the identity of the leader should be reported to the camp leader (expedition leader). Remember that nothing is more important than the overall safety of the expedition, and you must follow the expedition's safety regulations.

2. Clothes and field equipment

Clothes

Wind, more often than the cold, is the main source of ill feelings towards the weather in the polar regions (Figure 2.1). Irrespective of which of the polar areas you will visit, your clothes and equipment should be of good quality and something that you feel you can rely on: once you are in the field, it is not possible to replace "less functional" items. When going to the Arctic, you should plan for the equivalent of an advanced hiking trip with regards to both clothes and equipment. Even though the mean summer temperature is slightly lower than in the Scandinavian mountains, or similar places in North America, and even though you have to reckon with the odd snow storm, you should remember that the Secretariat's expeditions to the Arctic are usually done during the summer. If you are going to the Antarctic, even in the summertime you have to be prepared for temperatures down to –30°C, and for low temperatures combined with strong winds.

On most expeditions, the Secretariat will lend you a Gore-Tex jacket, a pair of Gore-Tex pants and a fleece sweater; and on expeditions to Antarctica, also a warm snowmobile overall. You must supply the rest of your clothing yourself (Figure 2.2). What you need is two sets of most things. Exceptions to this may be the outer shell (rain gear) and the sweater. The reason for having at least two sets is that you should have the possibility to change from wet to dry clothes and also to wash your clothes when they get dirty. Most likely, you will need more than two sets of underwear and socks. (For a suggested basic list of clothing, see Appendix I.)

Figure 2.1 Midsummer storm at Wasa station, Antarctica. The station's main building, some 50 metres away, is barely perceptible on the left-hand side of the picture. PHOTO: PETER DARTH

The perfect clothes for the polar regions have still to be invented. Cotton and other natural materials are very comfortable as long as they stay dry, but they do absorb moisture very easily. Wool is good since it insulates well, even when wet. However, one serious drawback with natural materials is that they dry very slowly. Natural materials are also comparatively heavy. A good thing with natural materials is that they are quite resistant to fire; in stark contrast to most synthetic fibres which may be quite inflammable. The positive side of synthetic fibres is that they are light, do not absorb water (dry

Figure 2.2
You should dress yourself according to the multi-layer principle, as it makes it easier to adjust the clothing according to the present conditions.
PHOTO: TAIGA

quickly) and are relatively resistant to wear and tear. The best choice is possibly a combination of comfortable camp clothes (natural fibres) and functional field clothes (synthetic fibres) – but you have to try out a selection of clothes that suit you personally. If you have to choose one kind over the other, synthetic materials are to be preferred, since they are easier to (keep) dry: cold rather than fire is the major hazard in the polar regions. One thing to keep in mind when packing your things is the weight – are you going to carry the things on your back, and if so, how much is comfortable for you?

Regarding footwear, you probably need two pairs of boots as well, both because they may get wet, and because they may break. It is absolutely necessary that your footwear is comfortable and well broken in. One thing in common for footwear and rain gear is that if they are perfectly waterproof, then you tend to get wet from the inside, and if they are not then you get wet from the outside. To some degree, the Gore-Tex type of materials may alleviate these problems, especially if you wear synthetic fibres with a humidity transporting capability as the innermost layer. Given the alternatives of being wet from the inside or the outside, it is usually easier to handle the former. You should not really have so much clothing on that you work up a sweat, and your socks should be changed regularly (after about four hours a

pair of woollen socks is saturated with humidity if they are worn in water-proof boots).

Wet socks and boots may cause serious injury to your feet even at moderately cool temperatures. "Trench foot" is a very serious condition (see Chapter 5). One way to avoid getting trench foot, or in more severe cold, frost-bitten feet is not letting the foot sweat get to your socks and boots. You can simply wear plastic bags as the innermost layer on your feet (shopping bags are excellent), and they will completely block the transportation of water vapour to your socks and boots ("fuktspärrar"). People who work in cold climates and who have to stay outdoors for long periods (e.g. mountaineers) always wear these. After a couple of days you get used to having wet (but warm) feet. To make it more comfortable, you can wear a pair of thin synthetic fibre socks inside the plastic bags. If you want to spend some more money, you can buy waterproof socks with inner socks in well stocked sporting goods shops.

Another item often brought up is "What brand should I choose?". That is a very tricky question. Generally quality costs, and the better the quality the higher the price. Most often, it is not a good idea to buy the cheapest clothes and equipment you can find. However, before you go out and buy the most pricey items, ask yourself "How often and how much will I use this?". The highest quality products are made in the perspective of very hard wear for long periods in the worst possible conditions, and they should last over several such seasons. Do you really need this? On most expeditions, items in the mid-price range are quite sufficient.

Personal equipment

Most often the Secretariat can provide some personal equipment, like lending you a sleeping bag, a sleeping bag liner and a sleeping pad. To some extent the Secretariat can also lend you other items. However, what can be lent to you depends both on your actual needs and on what other activities the Secretariat has going on. Other projects may be given priority.

On most expeditions a personal day pack is very useful. However, full size backpacks are only recommended if you are actually going to carry heavy equipment with you in the field. Weight and volume is usually not a problem for equipment transported by ship. However, flight operations may impose strict upper limits on the amount of personal equipment. (For a list of some useful personal items to bring, see Appendix I.) As long as your requests are reasonable, the Secretariat will lend you aluminium packing boxes which are quite light and very handy. It should be noted that all of the equipment that the Secretariat provides is to be handed back immediately after the end of the expedition – it is not economically possible for the Secretariat to give you any of it. Remember also that you are personally responsible for this equipment.

Field equipment

The Secretariat will provide the necessary, basic camp and safety equipment (see further the following chapters). The Secretariat may only purchase any special field equipment when it is felt that this is critical to your project and it cannot be supplied by the project itself. Note that it must be considered the exception, not the rule, that the Secretariat purchases any special field equipment for a project!

Scientific equipment

Equipment specific to the research project, or equivalent, is not an issue on the field course. However, it should be noted that the Secretariat must be informed well ahead of the expedition's departure of any equipment that the project wants to bring: usually the Secretariat will request such information, and all you have to do is to follow the instructions. There are several reasons why the Secretariat may need this information well before the expedition starts – transportation and/or Customs procedures may take a long time; there may be weight and/or volume limitations to what the expedition can bring; if the equipment needs to be supplied with media, e.g. electricity or gases, this needs to be organised and possibly tested etc.

Packing boxes for scientific equipment may be lent to you (given the prioritising of projects that may have to be done). You have to provide packing material yourself.

3. Field camps

Each field camp has one leader. The leader is responsible for co-ordinating the common duties and safety routines in the camp; every member must follow the instructions given by the camp leader in these respects.

If the camp is going to be used for more than a couple of days, it is well worth taking some time to plan the camp properly. To facilitate radio or satellite communication the camp should be located "high, free and wet", i.e. up on a hill, with no major objects blocking transmissions and with mesic to wet surroundings. A camp location somewhat higher than the surrounding area will also make it easier to find the way back to the camp and, on the tundra, to spot possible approaching bears. The plan of the camp should include the sleeping area, the cooking area, the place for garbage, etc. (see "Field hygiene" below and Chapter 7). If there is time, discuss the plan within the group before deciding on it. This may save time and aggravation if it prevents tents and equipment having to be moved later on.

Camp equipment

The Secretariat will provide the basic camp equipment and provisions (Figure 3.1). On tundra expeditions, usually there is one sleeping tent for two people. In many cases, a common, larger kitchen tent is also brought. Each camp has a kitchen box containing crockery, cutlery, pots, pans and kitchen utensils for all camp members. The camp is also equipped with communication equipment and power supply to this, as well as other relevant

Figure 3.1 Some field equipment that may be provided by the Secretariat. PHOTO: MAGNUS AUGNER

safety equipment. Other common equipment that may be provided is folding shovels, buckets, water jerry cans, a field toilet, etc. On Antarctic expeditions, field camps are most commonly made by sledge-mounted living modules. However, they can be tent based, or consist of a combination of modules and tents.

TENTS

Sleeping tents Most of the Secretariat's sleeping tents are of the model Saivo from Hilleberg (Figure 1.9). This is a 3–4-person tent, which is very comfortable for two people. It has a geodetic dome shape, which makes it very stable even in extreme winds. The poles are mounted from the outside and the inner and outer tents are erected simultaneously. It opens at both ends and has one large and one small abside.

Kitchen tent The kitchen tent was specially made for the Secretariat by Hilleberg. Basically, it is a Saivo tent increased by a factor of 1.75 (Figures 1.7, 1.9). It has no inner tent, no abside, and it opens at both ends.

Scott Polar Tent This tent is used only in Antarctica. It is made of heavy-duty canvas in a pyramid shape (Figure 3.2). It is extremely wind resistant and has four poles, one in each corner. The opening is tunnel-shaped to revent snow entering the tent. The tent can be used with our without the inner tent.

Tents vs. wind All the Secretariat's tents have storm mats added to them for increased wind resistance. Preferably you should not weigh them down by putting rocks on them; this will destroy the mats unless you are very careful! The mats only need to be used when there is a risk of strong winds, otherwise they can be tucked in under the tent. If the storm mats are used, they should be stretched and covered with soil, sand or snow: the purpose of the mats is to prevent the wind from getting in under the tent not to hold the tent down. What hold the tent down are the guy lines. In the rare circumstance of you having to camp on rocks only, you are allowed to place rocks on the storm mats. However, in such a case you must first stretch the storm mat, and then place rocks with soft edges all over the mat, so that they completely cover it. This way you achieve the same effect as having covered the mat with, e.g. soil.

Figure 3.2 Scott Polar Tent, used in Antarctica. PHOTO: ANDERS MODIG

Figure 3.3 Above, the interior of a living module. To the right, a sledge-mounted living module is towed by a TL-4 tracked vehicle.
PHOTO: ANDERS MODIG, AND MAGNUS AUGNER, RESPECTIVELY

It must be stressed that in windy conditions the pegs holding the tent's guy lines should be placed as far away from the tent as the ground conditions allow. The reason for this is that the more perpendicular the line is to the tent wall, the better the wind resistance.

LIVING MODULES

The living modules can be seen as comfortable "camping caravans", where the smaller two-person model is towed

by snowmobiles, and the larger 20-foot container sized model is towed by a tracked vehicle (Figure 3.3). The larger modules sleeps between two and six people in regular cots, depending on the configuration. All modules are insulated and heated by propane heaters. They are also equipped with cooking facilities and communication equipment.

COOKERS

For field camps the Secretariat usually provide kerosene or propane cookers. In the Arctic, the most common cooker fuel is kerosene, while propane is the standard in Antarctica. The fuel used depends on what can be provided in a given country and what can be transported out into the field. Most helicopter companies refuse to transport propane, kerosene or petrol on the same flights as passengers. However, since helicopters run on "kerosene" (Jet A-1), it is almost always possible to get kerosene flown out into the field.

All fuels are by definition fire hazards! There are some instances in which you have to be extra careful: when filling fuel containers, when transporting fuel, when re-fuelling cookers and when using cookers in tents (see further Chapter 6). Also, all fuels are more or less poisonous, and the liquid ones easily give food a very

unpleasant taste – do not transport fuel and food together, and keep their handling separate as well. The risk of propane gas poisoning is very low, because of its distinct and strong smell. However, there is always a very real risk of carbon monoxide poisoning when burning any fuel indoors or in a tent. Carbon monoxide and dioxide have no smell, and the symptoms of poisoning may vary considerably. Since carbon monoxide is a deadly gas, you must always have good ventilation when using cookers or heaters inside, even when the weather is bad!

Food and drink

With the exception of ship-borne expeditions, the expedition members will do their own cooking. In such cases, as much fresh foods as possible is brought. However, meat, fish etc. will be canned goods, as will most of the vegetables on longer expeditions. The reason is simply that you will not have any proper cool storage facilities in the field. The Secretariat tries to avoid freeze-dried foods as the staple diet. How you decide to handle the cooking in your group is for the group leader to decide. Before the expedition, the Secretariat will discuss the food and other provisions with the expedition leader, and in the case of larger expeditions, also with group leaders. It is impossible to make personalised diets for expedition members. Usually a large enough variation of foods is brought to allow for some personal preferences within the group. If you are a vegetarian or if you have any food allergies etc., you must let the Secretariat know well in advance. Even so, it may not be possible to provide a full supply of foods for you; it depends on in which country the food is purchased. In the worst case, it may come to pass that the Secretariat cannot let you participate in the expedition.

Field hygiene – general

Good hygiene in the field is extremely important, both for morale and medical purposes. It prevents infectious diseases and food poisoning, and common high hygiene standards and an orderly camp increases the comfort in the camp. In addition, it gives an important sense of well being to be clean and well, and to wear clean, fresh clothes. If you stay for more than a couple of days at a campsite, you should make a plan for the common hygiene arrangements (which everyone must follow); this is the camp leader's responsibility. The plan should cover food handling and eating, where to wash dishes, the handling of garbage, a place for personal hygiene, where to wash clothes, drinking water, and the latrine and where to urinate.

PERSONAL HYGIENE

Personal hygiene should be taken care of both on a basic daily level, and on a more extensive level every week or so. Since bacteria thrive where it is warm and moist you should wash your armpits, groin and feet every day. In cold conditions or bad weather you can get a long way with a washcloth and a small pot of warm water. You should also brush your teeth and comb your hair daily. It is definitely a good idea to make a distinction between work/field clothes and camp clothes and also to bring a second pair of boots, or if the circumstances allow it a pair of sandals or other light shoes to change into after work. This lets your work clothes dry between uses and allows your feet to "breathe" a bit. Continuous wearing of boots and protracted use of the same clothes may result in bad skin inflammations or infections. Every week you should try to wash your whole body (in bad weather, a wash cloth will once again help you a lot). If possible, dress up in fresh, newly washed clothes after the "bath"; it provides enormous comfort.

Try to keep your clothes and boots clean, dry and whole. Dirt makes textiles more fragile and gives them less insulation capacity. If you cannot or do not want to wash your clothes, then do not work up a sweat. Adjust your clothing to the temperature, and remember that wet clothes and boots can result in cold injuries even at temperatures above freezing. In the field, a large plastic bag functions perfectly well as a "washing machine". Just put the clothes in the bag, add warm water and some detergent, tie the bag up and knead it. In field camps, the drying of clothes and boots can become a problem. In general, synthetic materials dry much quicker than natural fibres. Make it a habit to take out the insoles of your boots every evening and to hang your clothes as

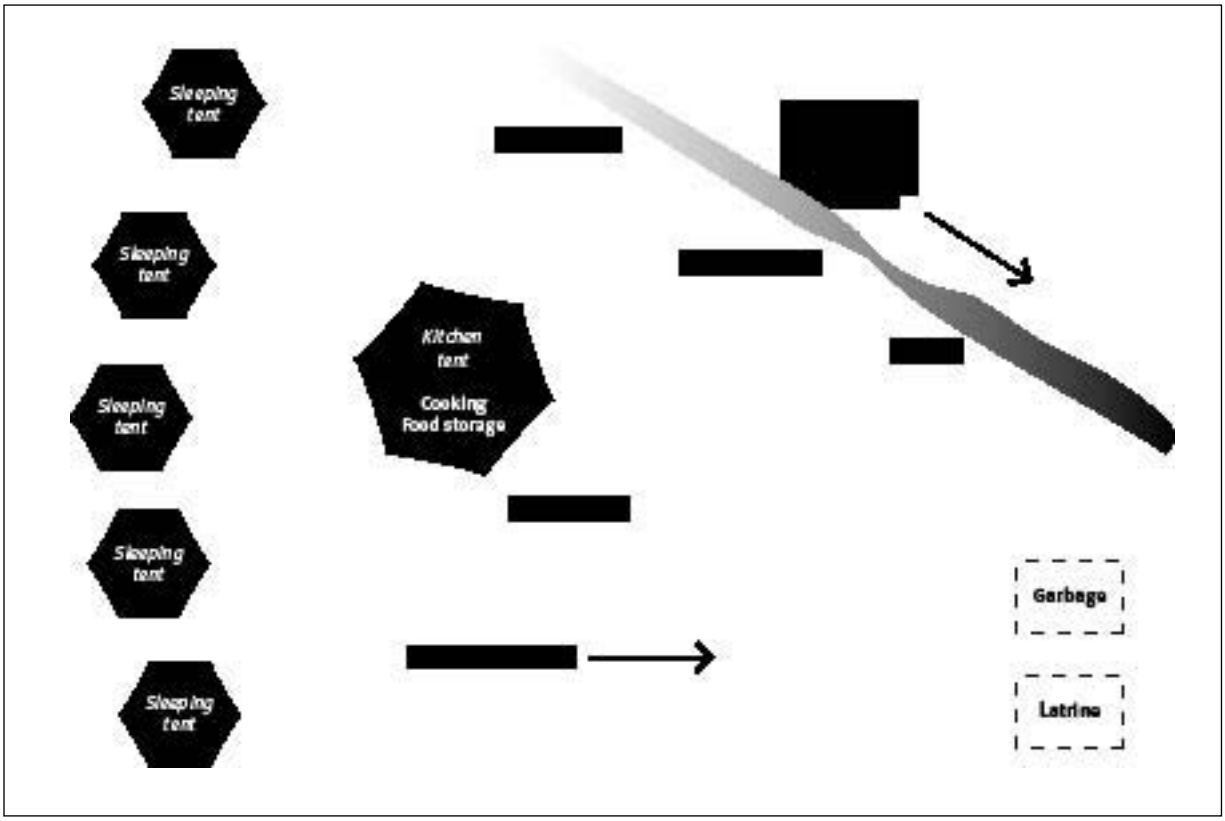


Figure 3.4 General principles of hygiene arrangements in a field camp.

airily as possible. If you are supplied with a kitchen tent, hang your clothes/laundry there while you are out in the field. Laundry hanging on lines outside, waving in the wind, may attract curious polar bears. Repair small holes and tears as soon as you detect them.

FOOD

The most important item here is to avoid being food poisoned. Food poisoning is the result of unwanted bacteria coming in contact with the food you are going to eat. Most of the potentially dangerous bacteria come neither from the food itself nor from Mother Nature, but from the people handling the food: we all carry literally millions of potentially dangerous bacteria on us.

However, food poisoning is actually quite easy to avoid:

- Never cook for others if you have any cut in your hand or if you have an (suspected) infection, e.g. a cold or stomach problems.
- Wash your hands before cooking and also during cooking if you handle anything that may be "unclean".
- Wash all dishes and utensils (with dish washing liquid) after each meal.
- Always store sensitive (fresh) food at refrigerator temperature (4–8°C).
- Separate the handling of fresh meats and other foods.
- Separate the handling of cooked and uncooked foods.
- Never save leftover food that has been cooked.
- Keep food in containers that protect it from birds and animals.

Field hygiene – tundra

For the common hygiene arrangements, it is important that all "smelly" places (garbage, latrine, urine) should lie well away from the camp, on the general downwind side, if there is a risk of (polar) bear visits (Figure 3.4, see also Chapter 7).

DISH WASHING

Dish washing should be done after each meal, and in a comfortable place close to the cooking area so that no-one feels inclined to put it off "just until tomorrow", e.g. because of bad weather. When you bring water for the cooking, bring enough for the dish washing too. End each cooking session by heating dishwashing water: the washing must be done in hot/warm water! The place where you do the washing should be such that it is easy to pour away the wastewater without it seeping into any tent or otherwise spoiling any equipment or provisions. Digging a shallow pit for this can help. Remember also to wash your pocket knife if you have used it with the food; it is as much a kitchen utensil as any of the regular ones.

GARBAGE

Garbage should have its own special place in the camp area, and all garbage should be placed in some kind of container so that birds and animals cannot get to it. You should make it a habit that after each meal you take all garbage from the cooking area to the garbage dump. All items that are brought in and which end up as garbage must be brought out when you leave. Smelly garbage should be kept in plastic bags. If you have supply flights or similar during the field season, try to have the garbage you have accumulated transported away.

DRINKING WATER

Drinking water should be boiled for at least 3 minutes, if you are not certain that the source is OK. Water should be taken from rivers or larger lakes, if possible. Examples of potential causes of unhealthy water in the Arctic are birds in lakes, dead animals upstream rivers, Giardia parasites (in North America and Russia), and human pollution. Drink at least 2–3 litres of (clean) water per day, more if you have done any physical work – this is especially important in cold environments with dry air.

LATRINE

The latrine should definitely have its own dedicated place in the camp area. If possible, have separate places for urine and for faeces: urine is in its normal state a perfectly sterile fluid with a high nitrogen content, while faeces consists almost only of bacteria that need nitrogen to grow. If you avoid mixing the two, you drastically reduce the smell. Human waste is sometimes brought back from the field, at other times it is buried after each visit to the "toilet": it depends on what resources are at hand and what is the most practical.

The latrine should lie below the camp so that rain etc. does not make the latrine flood into it. Also, the latrine should lie so that seepage does not pollute the place where you get your drinking water (see Figure 3.4). If there is a risk of (polar) bear visits, the latrine area must be visible from a distance and give a free view of any approaching bears. You should cover the latrine after each visit. The latrine must have some facility for washing of the hands after each visit, and overall it is important that the latrine is kept very hygienic. Anyone with stomach problems should have a separate latrine, to reduce the risk of stomach infections spreading.

If you plan to stay longer at the same site, decide at the beginning on several potential latrines, and use them one by one. As stated above, you should try to avoid mixing faeces and urine. If you dig a latrine hole, you should also dig a urine hole. A new hole should be dug every 20 "person-days", i.e. if there are ten of you then you should use a new hole every second day, mainly because of the smell. Take also these peeing holes into consideration when planning the different latrine holes. If you have portable latrines with you, then you should always bring the used plastic bags back to civilisation for proper disposal. You are not allowed to leave them in the field!

Field hygiene – Antarctica

The basic hygiene principles presented above apply to all field activities. Below, only the particulars of Antarctic field camps are brought up. All activities in Antarctica are regulated by the Protocol on Environmental Protection to the Antarctic Treaty. In Chapter 8, a fuller discussion on the ruling principles is presented.

DRINKING WATER

Drinking water is produced either by collecting snow (scrape off the uppermost layer, as it may be contaminated) and melting it, or by drawing water from internal melting layers in blue ice.

LATRINE

The latrine consists of a seat placed on top of an empty fuel drum with its lid off. The drum is usually placed inside a Scott Polar Tent. All human waste is brought back from Antarctica, after it has been freeze-dried for a year or more.

HANDLING AND DISPOSAL ROUTINES FOR FIELD CAMPS

Domestic wastewater and urine can be discharged to an ice pit or crack in situations where the transportation facilities are very limited and field camps in areas covered with snow and ice are of a temporary character, i.e. with less than 30 man-days in any one location. Sewage from large field camps (more than 30 man-days in one location) is to be transported back to a station or the expedition vessel for proper disposal. Any person working in an ice-free area away from their main camp is to carry appropriate containers to collect any human waste generated during the trip.

Domestic wastewater can be disposed of in ice pits. Wastewater from field camps in ice-free areas should be collected in appropriate containers (clean, not having been used for the storage of fuel or other inappropriate materials) and at convenience disposed of in ice-pits. Such pits shall be located on ice sheets that move out to ice-flow lines, which do not terminate in ice-free areas or in areas of high ablation. Under no circumstances must sewage or domestic liquid waste be disposed of in vegetated areas or in areas with discharge to fresh water.

Glass waste should be separated and placed in containers labelled for this purpose, and should be transferred to drums containing glass waste at the station. If separation is not practical, glass waste should be treated as mixed solid waste. Metal waste should be separated and placed in containers labelled for this purpose, and should be transferred to drums containing metal waste at the stations. If separation is not practical, metal waste should be treated as mixed solid waste. In field camps, food waste should be disposed of in separate containers or into the camp toilets. Always ensure that birds have no access to food waste. All remaining waste is to be placed in containers labelled for this purpose. Mixed solid waste is to be transported out of Antarctica and is to be delivered at reception facility for proper disposal.

RESPONSIBILITY

The leader of each scientific project has the full responsibility for compliance with the strategy and handling and disposal routines that apply in the field. This includes following up routine measures such as minimisation, separation, labelling and record keeping. Each person who produces waste of any kind must ensure the waste they generate is handled and disposed of according to the procedures laid out by the Swedish Polar Research Secretariat. Every person is also responsible for ensuring that the potential waste volume stemming from their activities are already minimised before departure to Antarctica.

It's a long way home from Wasa station.
PHOTO: MARGARETA HANSSON

4. Communications

Working communications are the main means of ensuring safety on all expeditions. No expedition is completely self-contained. In emergencies it is necessary to bring in resources from the outside, and the only way in which this can be ensured is always to have working communications. In addition, from a psychological point of view, contact with the outside world is extremely important for our well-being.

Means of communication

There are two basic ways to communicate over a distance during expeditions, either directly through radios or indirectly via communication satellites. Both methods have their pros and cons. HF radio ("short wave" radio) and satellite communication is used for long distance communication, i.e. for contacts outside of the expedition or between widely separated field camps.

The Secretariat's VHF radios are handheld sets used for short distance communication, such as the contacts within a field group, or even within an expedition. On some expeditions the members have one each, on others there may be one VHF radio for every 2–3 people. HF radios are placed in field camps, at stations and on ships. Nowadays, for voice communication, they are more and more being replaced by various satellite communication devices. The latter can be satellite phones that allow voice, fax, and/or data transmission, or devices that only allow e-mail traffic. Two things to remember are that all radio waves are blocked by large, dense objects, such as hills and buildings, and that also satellite telephones depend on radio wave transmissions (as GPS receivers do).

RADIO

In most instances only voice is transmitted by VHF and HF radios (Figure 4.1). However, there are modems that allow digital (e-mail/data) transmissions.

VHF (very high frequency) A major difference between VHF and HF (high frequency) transmissions is that the former are not reflected by any layer in the ionosphere, while the latter may be "bounced" against ionospheric layers. Thus, the range of VHF radios basically depends on the line of sight. The power output of the VHF radio (i.e. the number of watts) is of secondary importance to its active range. Since there is no real need for powerful transmissions and you do not have to find the frequency with the best "bouncing ability", the VHF radios can be made small and simple compared to most HF radios.

In theory you have to be able to see the other VHF radio to be able to reach it. By climbing, or even just by holding the radio above your head, you may increase the effective range. You can sometimes get a longer effective range in Antarctica than in other places. The reason for this is that ice does not block radio waves as effectively as, for example, rock does. A rule of thumb for how far you can transmit and receive at sea is:

$$\text{Transmission distance (km)} = 4 \times \left[\begin{array}{c} \text{the square root of the height of your antenna (m)} \\ + \\ \text{the square root of the height of the receiving antenna (m)} \end{array} \right]$$

Through an international convention the very high frequencies are divided into "bands". There are for example the marine band, the air traffic band, military

Figure 4.1 Some common kinds of radios used by the Secretariat.
PHOTO: MAGNUS AUGNER

bands, police bands etc. The Secretariat mainly uses VHF radios working on the marine band, i.e. frequencies between 156 and 174 megahertz (MHz). Most VHF radios use fixed frequencies, so-called channels. It has also been decided here, through an international convention, which frequency corresponds to which "international channel".

For VHF there are "simplex" and "duplex" channels. On a simplex channel the radio transmits and receives on the same frequency. On a duplex channel the radio transmits and receives on different frequencies. Duplex channels are used when you have repeater stations in the radio network. The repeater stations are used to increase the effective range of individual VHF radios, in that the repeater stations receive, amplify and re-transmits transmissions between the individual radios. Usually, repeater stations are equipped with high antennas and have a rather high power output.

HF (high frequency) Transmissions within the HF range (4–30 MHz) can be bounced against different layers in the ionosphere, and HF communication is truly global, at least in theory. However, the problem for long distance communication is to find a frequency that is reflected down to the correct reception area. As the radio wave bounces between earth and the ionosphere so called skip zones are created in between reception zones (Figure 4.2). For communication over short distances, VHF radios use direct transmission, just as VHF radios do.

The reflective ability of ionospheric layers depends on for example sunlight and sunspot activity. Sunlight thins out ionospheric layers when heating them up, and in this way reduces the reflectance; sunspot activity increases the electromagnetic radiation levels in the ionosphere, which increases the distortion of radio signals. The reflectance of ionospheric layers varies for different frequencies, and even if you can reach a station far away one day, it is not certain that you can do so the next. A rule of thumb is that the longer the transmission distance and the more sunlight over the transmission distance, the higher the frequency that must be used.

The high frequencies, 4–30 MHz, corresponds to

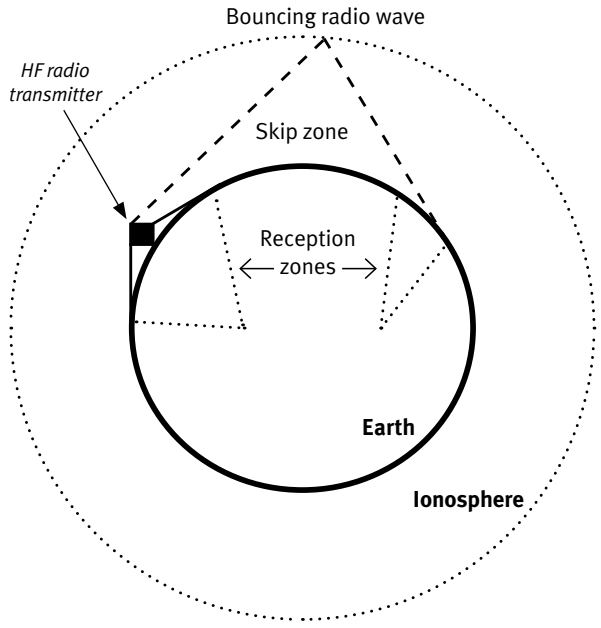


Figure 4.2 Since radio waves move in straight lines, from an HF radio you get a "ground wave", equivalent to a VHF transmission: If you can reflect the transmission against one or more ionospheric layers, you get one or more "bounce waves". The bouncing ability varies with ionospheric conditions and the radio frequencies used.

The reception zone on earth for the bounce wave is quite large. However, between the ranges of the ground and the bounce waves, you usually get a "skip zone" in which it is not possible to reveive the transmission. So the trick with long distance HF transmission is to find a frequency that lets you drop the hit zone over the intended receiver.

The reason why you rarely use fixed channels for HF radios is that you often need to finely tune the frequency to get good transmission (bouncing) conditions.

Figure 4.3 The Iridium satellite telephone is most commonly used on expeditions.

wavelengths between 75 and 10 metres. To get a good transmission the length of the active antenna must be a function of the wavelength for the transmission, e.g. a half, a quarter, an eight etc. of the wavelength. The closer you are to a full wavelength, the more powerful transmission you can have. This is the reason why large communication centres have huge arrays of antennas. It is also the reason why VHF antennas are quite large in comparison to VHF antennas (VHF radios work at much shorter wavelengths). Furthermore, to get a proper VHF transmission you often need an antenna tuning unit that makes the active antenna length correspond to the frequency you are using. If the antenna is not tuned, it does not matter how much power output you use!

SATELLITE

Satellite communications differ from VHF and VHF radio only in the respect that the transmission takes place with one or more satellites as "repeater stations". Some satellite systems allow only voice and low rate text transmissions while others allow high rate text/data transmissions.

Inmarsat The international maritime satellite system was developed for intercontinental and marine communication (Figure 4.3). It consists of four geo-stationary satellites placed over the equator. The position and height of the satellites, and the fact that radio waves move in straight lines, results in "dead ground" in the polar areas, with the result that above 70° latitude communication very much depends on the local topography. Different Inmarsat systems, e.g. A, B, C and M, provide different communications services.

Iridium This system uses orbiting satellites providing global coverage. The transceivers are about twice the size of an ordinary mobile telephone and are used in very much the same way (Figure 4.3). On the Secretariat's expeditions, Iridium is used mainly for voice transmission.

PREPARATION OF THE RADIO OR SATELLITE PHONE

When you set up any communication equipment for use, you should first check the power source and cables to ensure power supply. You must also check the antenna connection and cables to ensure a tight and correct connection to the set. You then connect the audio accessories and check the functioning of switches. You are never allowed to push the transmit button on any radio transmitting device if the antenna is not connected, as this may destroy the transmitter!

Communication language and procedures

When there are non-Swedish members on an expedition, the common communication language is English. However, calls that affect only individual members may be made in any language, and on expeditions with only Swedish participants the communication language is of course Swedish. Still, all expedition members must have a working knowledge of "radio English" in case of emergency or if contacts outside of the expedition must be made (see Appendix II).

Before you get used to talking on the radio, it may feel very strange. However, there are some simple rules to follow, which ensure that all expedition members know how to send and receive basic messages. In Appendix II, examples are given of how a message can be sent in English and in Swedish. Table 4.1 presents you with a list that should be followed when reporting any kind of incident etc. A situation in which many people feel uncomfortable is when their radio station is a part of a radio traffic network, and calls are made from the main station to all other stations at the same time; in Appendix II you find examples of common network procedures.

When you are about to "go on the air", make sure no-one else is transmitting at the same time! This is one of the most common, and most frustrating, mistakes made during the Secretariat's expeditions.

You should make your message as brief as possible while still keeping it precise. You should not occupy the ether longer than necessary, as somebody else may need to pass on an urgent message. If you have a longer message to send, it is often a good idea to write it down first and read from your notes when transmitting. Furthermore, break the message into sensible passages with pauses in between, so that the receiver has a chance to write it down. When transmitting, try to maintain a high standard of articulation, a normal rhythm and moderate volume. Hold the microphone close to your mouth and do not shout (bad transmission conditions do not get better if you raise your voice). You should avoid excessive calling and unofficial voice procedures.

Table 4.1

List to be used as a guideline when reporting something important, e.g. an accident, or when leaving a travel note (färdmeddelande).

1. When it happened or the time when you leave and expect to be back.
2. Where it happened or where you are going.
3. How many people, vehicles etc. are involved.
4. Which people and/or types of vehicles.
5. What happened or what you intend to do.
6. Any other information.
7. Who is sending this report or leaving this note.

Within an expedition, the simplest possible call signs are used. Camps are called e.g. "Camp 1", or "Camp Blue", while persons are called by their names. Which call signs and frequencies or channels should be used is decided by the expedition leader. The official kind of call signs are used only in HF radio traffic.

When the transmission conditions are poor or when you need to be very exact, e.g. when giving a position, you should spell the important information to ensure that it is received correctly. When spelling something only the phonetic alphabets presented in Appendix II should be used. To enhance the correctness and speed up the handling of a message, procedure words (pro-words) could be used; a proword is a word or phrase that has been given a special meaning. The only authorised prowords are listed in Appendix II. [Kommentar: Vid signalering på svenska finns inte lika många "procedure words" som på engelska. Om du behöver ta till sådana är det enklaste att översätta de engelska.]

Table 4.2

Distress call (radio)

In an emergency, to ensure that you supply a listener with all relevant information: there is a format for such radio calls.

1 Start with the distress call: "MAYDAY, MAYDAY, MAYDAY", who you are and your call sign (three times).

2 After a short break, send the distress message. (If possible, write down the message beforehand, so that you send it correctly.)

If the battery starts to go flat, send the distress message after you have got a reply to the distress call.

Example:

"MAYDAY, MAYDAY, MAYDAY. From Swedish scientist Andersson, Kilo Lima Three, Swedish scientist Andersson, Kilo Lima Three, Swedish scientist Andersson, Kilo Lima Three."

[Short break]

"From Swedish scientist Andersson, Kilo Lima Three. Position 70 kilometers south of XYZ base, latitude 00.00.00, longitude 000.00.00. Our tent has blown away. No shelter for me and Swedish scientist Pettersson. Very cold. Require assistance. Over."

Communication routines and schedules

You should make a "radio check" the first time a radio is set up at a location, when the radio traffic has been down for some time or when you just want to make sure that you have working communications. You should never feel that you need permission from any other station to make this kind of contact: it is a useful way of telling the others on the net that you are on it (see Appendix II).

Every expedition has its own communication routines and schedules. These always include a main communication routine and a reserve communication routine. Added to this may be communication routines particular to the given type of expedition, e.g. a routine used when establishing a (new) field camp, a routine for patrols and out-parties, and/or an emergency communication routine. The Secretariat always tries to keep the routines as simple and logical as possible and to set the schedules so that the interference with other work is kept to a minimum. Every expedition's communication routines are found in the safety booklet ("benficksbok") that you will be given at the beginning of the expedition.

DISTRESS CALL (RADIO)

A distress call is a call for help in a (potentially) life threatening situation (Table 4.2). Anybody hearing such a call has to act on it, either by coming to the caller's aid or by relaying it to someone who can. The internationally established emergency frequencies are VHF 156,800 MHz (= channel 16), and HF 2182, 4125, 6215, 8291, 12290 and 16420 kHz. These frequencies are monitored by ships, aeroplanes, field stations etc. However, if you do not get a reply on an emergency frequency then try any other. There are no laws prohibiting you from sending an emergency call on any frequency. Get help, by any means possible!

5. First aid and medical care

Medical issues in the polar regions

It must always be kept in mind that the polar regions lie far away from the medical infrastructure that most of us have close at hand at home. In the places where most of us live, many lives are saved because patients can reach highly qualified emergency wards within 30 minutes of an incident. The situation is drastically different in polar areas, where it may take 30 hours rather than 30 minutes before a doctor can see the patient, and it may take several days before the patient reaches a real hospital! This means that some accident victims or ill people who could be cured under normal circumstances, may in the polar regions die due to the, relatively speaking, low levels of medical services and long transport distances.

Therefore, it is of the utmost importance that you only take risks that are really necessary, and try to keep a high level of risk awareness even in daily routines during the expedition. Also, you must fill out the medical questionnaire truthfully and not withhold any information to the medical examiner before the expedition. The medical officer's preparations are based on the information provided by the participants; with incorrect information, the preparations will be incorrect and this may cause unnecessary, serious aggravation of medical conditions.

Medical emergencies

If there is an accident and you are the first person on the scene, then you must first ensure that the damage is not increased and more people injured. You must also get an overview so that priority is given where it should be. People who can complain or scream are at least so well that they can complain/scream, thus it is the silent ones you should check first. If more helpers arrive, then you should already have a priority list in mind of what they should do. If you are not first on the scene, ask the person or people already there what you should do; do not rush into action on your own. If nobody is "in command", take command and follow the action list below!

Actions

1. Prevent further injuries: switch off engine, switch off electricity, pull people away from fire etc.
2. Check for more casualties. Talk to them and see if they answer! If not, check if they are breathing and have a pulse.
3. Take care of the worst case first – airway, breathing, circulation, disability.
4. When you have taken care of the worst injuries, call for help!

EMERGENCY TREATMENT

When you take care of an injured person, follow "ABCDE" – Airway, Breathing, Circulation (with bleeding control), Disability, Exposure. If you at any time during the treatment process loose track of what you should do, start again on "A"!

Airway If the patient does not respond to you/talks back, and if you are uncertain if they breathe by themselves:
1. Check that there is no foreign object in the mouth (food, vomit, false teeth etc.).
2. Raise the chin and stabilise the neck (never bend the head forward – in case of neck injury)
3. If the patient breathes now, put them in the shock treatment position (see below).

Breathing If there is no breathing, despite a free airway:
1. Check if there is any pulse! If there is no pulse and you have the proper training, you may apply CPR (cardio-pulmonary resuscitation), with two breaths followed by fifteen heart compressions (the "2–15 cycle"). Do four cycles and then re-check for pulse and breath. If there is still no pulse, do twelve cycles before re-checking. Even after the patient has got a pulse again you may have to continue giving mouth-to-mouth resuscitation. If you cannot get a pulse after 30 minutes of CPR, then you should give up the treatment as there is nothing more you can do to save the patient.

Caution: You are never allowed to do CPR on a hypothermic patient as it can be very hard to be absolutely sure that there is no pulse!

2. If the patient has a pulse, but does not breathe by themselves, give mouth-to-mouth resuscitation (normal, deep breaths; 12–15 per minute).
3. When the patient is breathing by themselves, make an assessment of the breathing (fast-slow, shallow deep; Is the chest leaking? Does the chest raise evenly on both sides?). Bluish lips and cuticles indicate that the patient does not get enough oxygen.

Circulation (with bleeding control)
1. Stop any major bleeding: Apply a bandage directly over the wound. Raise the position of the wounded part, except if it is a head wound (lowered position). If the wound bleeds through the first bandage, put a pressure bandage directly over the first one. Always apply a pressure bandage on wounds on the head or neck (push with the hand), and over thighbone (femur) fractures. Do not change bandages – put a new one on top of the old! Never remove larger foreign objects from wounds.
2. Check distal status: pulse (fast–slow, weak–strong), capillary circulation ("flushing"), skin (warm–cold, dry–moist, colour?). You must be careful so that a pressure bandage does not completely cut off circulation "outside" of the wound.
3. Check the blood pressure (wrist → groin → neck).
4. Check for shock symptoms: quick pulse and breathing; pale clammy skin; thirst; feeling sick and/or vomiting; troubled breathing; anxiety, confusion and sometimes aggressiveness. Lay the person in shock treatment position: If conscious – legs up! If unconscious – horizontal! Change the position every hour, i.e. alternate the down side. The motto when taking care of people in shock should be "Breathing, warmth, rest, carefulness".

Disability (with neurological symptoms) Check for symptoms of neurological injuries:
1. For the level of consciousness, apply AVPU (Table 5.1).
2. The pupils (size, reaction to light, differences between left and right pupil?).
3. Distal status (hands–arms, legs–feet: normal perception of touch in, ability to use and strength of muscles?).
If there are any signs of brain or neural damage, try to stop aggravation of the injury: stabilisation/fixation, never bend the head forward, use a slow and very careful "clothes lift" or "log roll" when moving the patient (one person to stabilise the head/neck), a patient with head trauma (risk of internal bleeding) should have the head in a raised position.

Exposure (depending on environment) Make a "head to toe" examination, to see if you have missed any injuries; is there any pain reaction (e.g. due to fractures)? Check: head → neck → chest → arms → upper abdomen → pelvis → lower abdomen → legs → back (use a "log roll" when turning the patient).

Table 5.1

Consciousness check list

Alert Fully conscious with a clear mind.
Verbal Reacts on sounds, but is incoherent (e.g. does not know what time or day it is).
Pain Reacts only to pain.
Unresponsive Does not react on anything.

Table 5.2

The approximate wind chill effect on unprotected, dry skin (degrees Celsius). There is a small risk above –20°C, and increasing danger between –20°C and –30°C, and a great danger below –30°C.

Calm 0 km/h	**Light breeze** (1.5–3.5 m/s) 5–15 km/h	**Moderate wind** (3.5–8 m/s) 15–30 km/h	**Fresh wind** (8–14 m/s) 30–50 km/h	**Strong wind** (14–21 m/s) 50–75 km/h	**Very strong wind** (21–25 m/s) 75–90 km/h
0	– 4	–10	–15	–18	–19
– 5	–14	–21	–25	–27	–28
–10	–20	–25	–28	–33	–36
–15	–23	–32	–36	–38	–43
–20	–26	–38	–48	–51	–52
–25	–28	–45	–56	–57	–60
–30	–33	–52	–63	–65	–68

It is important that the patient is not exposed to water or cold; the patient should be warm and dry. It is considered to be cold if the ambient temperature is below 28°C (the normal skin temperature)!

Follow-up When you have finished the "ABCDE" for all patients, you must continue to check their general status until help arrives: breathing (breaths per minute, quality), pulse (beats per minute, quality), blood pressure (wrist, groin, neck), and level of consciousness – just follow "ABCDE" again.

Cold related injuries

All cold related injuries are caused by exposing the whole or part of the body to temperatures so low that the body itself cannot compensate for them. Since the average skin temperature is 28°C, in most environments we must somehow protect the body from heat loss. Through physical work the body can produce a lot of heat, and the body can to a certain degree adapt itself to the physical conditions around it. However, since most expedition members are only temporary visitors to the polar regions and adaptation takes time, and since we cannot constantly carry out heavy physical work, potential cold injuries must be countered through our behaviour.

PREVENTIVE MEASURES

The motto is "dry, warm, and a full stomach". You should never allow yourself to become wet, neither from rain, from melted snow nor from sweat. Wet skin and wet clothes or boots are perfect conductors to lead heat away from your body. If any condition changes you must adapt your clothing, and you should not work up a sweat!

You must always have enough clothing on you and more than enough clothing with you. Naked skin is the most vulnerable, and wind, whether it is natural or man-made (e.g. by helicopters or snowmobile driving), drastically increases the risk of a cold related injury (Table 5.2). When taking a break, you must add insulation before it feels cold or even cool. Since the brain has a constant, high need for oxygen and energy, the blood flow to the head is not significantly reduced in cold weather. Therefore it is of the utmost importance that you protect the head from cold or windy conditions. A good saying is "if your feet are cold, put on a warm cap".

The body has a marvellous ability to produce heat. At rest, approximately 90 % of the calories we burn are used to produce heat. When the body's need for heat increases, we must produce it through using more calories. Shivering is a fast muscular movement with the only aim of producing heat: it can only be done with carbohydrates as fuel. In cold conditions the body's

craving for fat also increases, so do not fight this. It is better to gain a few kilograms on an expedition than to have to be hospitalised for any cold related injury.

Another effective way to help the body to keep its normal temperature is to drink hot drinks. Drinking as such is also important. In the dry air of the polar regions we lose more fluid from the body than under normal conditions, and because of the cold we may not perceive the body's signals for more water.

As we lose bodily fluids the circulation decreases. This may cause constriction of the peripheral blood vessels and consequently lead to less heat reaching the skin. You must eat and drink properly when in the camp or station, and you must always bring food and (hot) drink with you when you leave. You should bring so much food and drink with you that you always have some left when you return back to the camp or station (as an emergency reserve).

FROSTBITE

Symptoms White skin that is movable over the underlying tissues.

Treatment Thaw the injury with a warm hand/belly/armpit carefully until the symptom disappears. Do not rub or massage. Previous injuries are sensitive to renewed frostbite, so you must give them extra protection.

DEEP FROSTBITE

Symptoms Hard and deep-frozen tissues. Blisters, swelling, cracked or blackened skin.

Treatment Deep frostbites must receive medical attention. Do not thaw if there is any risk of renewed frostbite! Only protect it with a sterile dressing. Do not massage. Thawing is done by putting the injured part in warm (40–42°C) water. Do not let the water get cold as it transfers its heat to the injured body part. The thawing is completed when the tissue "flushes". The thawing process is usually extremely painful, so the patient definitely needs a painkiller. The injured area will swell a lot after thawing so it should be kept in a raised position and be protected against mechanical pressure. The patient should also be treated with antibiotics, due to the risk that the dead tissue becomes infected.

HYPOTHERMIA

At a body temperature below 35°C, the body stops the shivering mechanism, and below that temperature a person is hypothermic. The typical case for chronic hypothermia occurs in people who are lost in the mountains and who have not been eating and drinking properly. Acute hypothermia is caused by, e.g. immersion in cold water.

Symptoms Weakness, confusion, apathy, unconsciousness.

Treatment Seek shelter immediately and protect the patient from continued cooling. Insulate the extremities and the torso separately; the torso should be well insulated with sleeping bags etc. If the person is conscious they should be given hot (sweet) drinks and carbohydrate-rich food. When someone is unconscious due to hypothermia (body temperature below 30–32°C), warming must be slow and come from within the body. Quick re-heating (hot bath, electric blankets etc.) may lead to death!

Hypothermic patients should be kept in the shock treatment position. If the person is unconscious, the transport to a proper medical facility does not have to be treated as an extreme emergency evacuation since the patient is in a "metabolic deep freeze", but of course the patient needs qualified medical attention as soon as is safely possible. The surrounding temperature when waiting for transport and during transport should be kept at 20–25°C. You must avoid any extra heating of the body surface during the transport (see above on quick re-heating)!

A hypothermic person is considered alive until a medical doctor has decided otherwise; "no-one is dead until warm and dead"!

"TRENCH FOOT"

This is a condition that occurs at temperatures above freezing, typically in feet that have been wet and cool for a longer period. The wet and cold leads to reduced

circulation and slow tissue death, particularly of nerves and muscles.

Symptoms Swollen tissues, bad circulation and initially red later blue tissues. Pain.

Treatment Wash the affected part clean, and keep it dry in a raised position. Give painkillers and antibiotics if need be. Protect the injured part from renewed cooling. The patient should receive proper medical attention.

"SNOW BLINDNESS"

This is an inflammation to the eyes caused by too-intense (UV) light. In principle it is sunburn to the cornea, and it can occur even when the sky is overcast! It is a potentially serious and very painful condition which can easily be prevented. Just protect your eyes with good sunglasses when at sea or in areas with snow or ice covered ground. By "good" sunglasses we mean those that reduce the light by 85–95 %, that have UV-filtering ability and protection from light coming in from the sides, i.e. broad side-pieces. Preferably they should have mirror glasses as these reflect a lot of the light. Do not be unnecessarily economical when buying sunglasses for a trip to, e.g. Antarctica. Comfortable ones with a good light reducing effect will be much appreciated after a while.

Symptoms "Sand" in the eyes, flickering vision, pain.

Treatment Immediately protect the eyes against light. Keep protecting them until the problem has passed, which normally takes a couple of hours. If you develop severe problems, stay in a dark room, and take a painkiller if you need it. Just like sunburn to the skin, the retina is extra sensitive to renewed snow blindness, but in contrast to the skin, the cornea does not develop a suntan.

Other injuries

BURNS

Burns are extremely serious injuries and doubly so on expeditions. You must take every conceivable precaution to avoid burns by hot liquids, hot tools or open flames. Synthetic fibres have a very nasty quality in that they are more flammable than natural fibres, and they tend to melt, which can cause horrible burns.

Treatment Immediately cool the injured area with water, and keep on doing so for 10–15 minutes! The water used for cooling the injury should not be ice-cold, but any water with normal room temperature will do. At the initial stage, apply a protective bandage with wet compresses, to continue the cooling. However, keep in mind to protect the patient from becoming hypothermic. Call for help!

After the acute treatment is over, do not puncture any blisters as that increases the risk of infection: Just apply an airy, sterile dressing and keep the injury clean even if it is a small burn. There is a risk for shock if the injury is larger than 5 % of the body surface, where the area of one hand corresponds to 1 %. The injured person should drink a lot (if conscious) since burns always "leak" a lot of bodily fluid.

INHALATION OF FIRE SMOKE

In fires, it is much more common that people are injured through the inhalation of smoke than from the heat. Fire smoke is in general very toxic and may damage the lung tissue. People who have inhaled fire smoke should always be checked by a doctor.

Treatment There is no treatment for serious cases in the field; they must be evacuated immediately. Apply mouth-to-mouth resuscitation if the patient cannot breathe by him- or herself.

FRACTURES

Treatment The important thing here is to prevent the injury from getting worse. Stop any (heavy) external bleeding. If the thighbone is fractured, apply a pressure bandage on the fracture to reduce internal bleeding.

Check distal status (perception of touch, pulse, capillary "flushing"). If this is OK, immobilise the fracture by applying a supportive bandage with some kind of splinter: Fixate past the fracture over the joints above and below.

If the distal status is poor, you must try to pull the fractured bones into a better position (rough repositioning: pull-align-rotate). Check distal status again, and try to fix the position of the fracture that allows blood circulation. (Lack of circulation may produce severe secondary injuries below the fracture.) Give a painkiller if the patient is conscious and prevent shock. If possible, keep the fractured limb in a raised position. Get the patient to a hospital as soon as possible.

SPRAINS

Treatment Immediately put a very tight pressure bandage on the injury: if a fracture is suspected, contact a doctor. Leave the pressure bandage on for twenty (20) minutes even if the toes or fingers start to get blue (however, do not do this if there is a risk of frostbite!), then take it off for five (5) minutes. Repeat the process (20 minutes pressure bandage and 5 minutes off) three times. This reduces the bleeding and helps the recovery process very much. Apply a supportive bandage.

INJURED LUNG (E.G. FRACTURED RIB)

Any trauma to the torso can be or become very serious, and you should always contact a doctor.

Treatment If the skin is penetrated by a fractured rib, apply an airtight bandage, e.g. with the plastic cover of the first aid bandage, directly over the wound. Foreign objects that have penetrated the ribcage should be fixated to the chest. A conscious patient is placed in a half-sitting position, or what feels best. An unconscious person is put in shock treatment position with the wounded side down, so that the collapsed lung does not interfere with the uninjured one. Prevent shock.

INJURED ABDOMEN

If the abdomen is hard, suspect internal bleeding.

Treatment In the case of an open injury, apply a protective bandage with a pressure-relieving (bandage) ring around the wound, and with wet compresses if possible. Fixate any object that has penetrated the abdomen. Place the patient in a foetal position. Prevent shock. Do not give any food or drink. Get medical help as soon as possible!

EYE INJURIES

If a person has got any corrosive substance in the eyes, wash the eye with water or sodium chloride solution for at least 30 minutes (preferably all the way to the doctor). In the case of a wound to the eye, just apply a protective bandage and contact the doctor immediately.

CONCUSSION

Treatment If unconsciousness lasts more than a minute or two or if it appears some time after the injury, call for help. Put the patient in the shock treatment position. Do not leave the injured person alone, and be prepared to give mouth-to-mouth resuscitation. If you experience trauma to your head, inform the other expedition members since the symptoms of an injury sometimes develop only after some time. Trauma to the head can be extremely serious!

UNCONSCIOUSNESS

Treatment All unconscious persons should be placed in a horizontal shock treatment position (“framstupa sidoläge”). Check breathing and pulse continuously. Contact the doctor.

DROWNING

Drowning incidents in the polar areas are always combined with acute hypothermia.

Treatment Empty the patient’s lungs from water. If the patient does not breathe by themselves, give mouth-to-mouth resuscitation (1 or 2 breaths) to see if they start breathing. If not, check for a pulse and be prepared to give CPR (see above). Treat for hypothermia (see above).

Sicknesses

STOMACH PROBLEMS

Diarrhoea and vomiting are two ways for the body to remove toxic substances. You should therefore avoid taking anti-diarrhoea pills immediately when you get sick.

Treatment Drink a lot. Sweet tea can calm an upset stomach. Avoid food the first day. The second day eat white bread or crackers. The third day you can eat some rice and boiled fish. If you get problems again go one day back in the diet. Prolonged problems rob your body of water, salt, and energy – you must counter this by drinking warm, sweet drinks with a little salt added.

COLDS

At the beginning of expeditions it is quite common to get a cold: a lot of people, new to each other, are living close together and mixing their viral and bacterial floras.

Treatment Rest, warm drinks and possibly anti-inflammatory medication (aspirin). Viral infections may last up to a fortnight. If you suspect a bacterial infection (e.g. green phlegm, throat infection, ear problems), contact a doctor to see if you need antibiotics.

INFECTED WOUNDS

Even small nicks and cuts may become infected, and you should treat them carefully from the beginning.

Treatment Open wounds should be washed with soap and water, after which they should be kept as dry and clean as possible. A wound that is red, swollen and sensitive to light touch is likely to be infected. If the swelling is extensive and really painful, contact a doctor.

MUSCLE CRAMPS

If you start getting muscle cramps, it may be a sign that you have not provided your body with enough salt. In the polar regions, since a lot of the water is melt water it may not contain enough minerals. This is definitely the case if your water source is snow or ice. Also, in cool or cold weather it is easy to neglect the body's need for water. Salt deficiency in combination with hard physical work can quickly lead to a very serious condition.

Preventive measures You must eat "normal" food. Cookies, sweets and chocolate can provide enough energy, but usually they have a very low salt content. You should drink a least two litres each day, added to the water you get through your food. If you have snow or ice as the water source, you must add extra salt when cooking.

Treatment Rest. Drink a lot and add salt to your body. Make your own "sports drink" by adding salt and sugar to your regular drink.

THROMBOSIS

In connection with long flights, there is a real risk of thrombosis, i.e. blood clots in the veins. Thrombosis is a potentially very serious condition, and the action to take is prevention: Do not sit for prolonged periods during flights, but take all opportunities to move around. If the conditions forces you to stay in your seat, you should do regular exercise to increase your circulation, particularly in your legs.

Transportation of the injured

Injured people should only be moved if this can be done without worsening their condition, and when the moving is beneficial to their treatment. If camp is far away or transport is difficult, move the camp to the injured person! You can erect a tent, slit a hole in the bottom and in this way get patient inside without moving them.

During transportation you should protect the patient against heat loss (see below). As far as possible you should try to keep the patient's body straight in case there are any fractures or damage to the spine that you do not know of. You should always support the head and neck when moving a patient, both to secure free airways and because of potential spinal damage. If you need to pull someone, grip the injured person's clothes rather than the person themselves; you can hold clothes in a very tight grip without hurting the patient.

Protection against heat loss

It is of the utmost importance that you protect the patient against heat loss. Wet clothes are especially dangerous. So, change wet clothes to dry, or if this is not possible, limit further cooling by covering the body with wind- and waterproof material. You should also protect the patient from cold ground, especially at pressure points where the patient's body compresses the insulation material, e.g. the sleeping pad. You should also insulate well around the head and neck, since the flow of blood is very high to the head. It is your responsibility to ensure that the patient is not cold and does not become hypothermic.

Remember that it is considered to be cold if the ambient temperature is below 28°C! Injured people may have a much-reduced circulation and heat production compared with a healthy person. They may also be in pain and in shock, so that they do not feel the onset of cold. Add more insulation than you think necessary, at least in the beginning.

Severe emotional stress

In connection with serious incidents and accidents, even people who are not physically injured in any serious way may be affected by severe emotional stress. This is a condition that can be very debilitating both in the short and long perspective. Situations that can cause severe emotional stress are those involving (1) serious threats, (2) loss of friends and colleagues and (3) responsibility at serious incidents.

Mental preparedness drastically increases the ability to cope with emotional stress! Things can go wrong on expeditions, and because of the long distances to other helpers an expedition is very exposed and left to its own abilities. A necessary preparation is to discuss possible scenarios and what should be done if they occur, at least within the expedition leadership. The crisis caused by severe emotional stress is characterised by four phases: shock, reaction, recovery, and reorientation.

SHOCK PHASE

This phase may last up to three days and is a phase of (mental) self-protection, often characterised by denial. What you can do here is to give "emotional first aid" (see below). If you were involved in the incident or accident, do not be afraid of receiving this aid, and even to ask for it if it is not given to you freely.

You should never judge anyone's behaviour in a serious incident. The transitions from logical behaviour, to emotional, and instinctual behaviour are not conscious choices, but automatic reactions. One person may instinctively run away from a perceived threat, another may be paralysed, a third will just cry continuously, while a fourth may act fully rationally; all are "normal" reactions and they are not chosen by the people involved. You can never tell beforehand how a person will react in a given situation, not even if the person has been in similar situations before.

Emotional first aid The motto here should be "Hold the hand, shut your mouth and listen!", and you should try to give signals of safety, care and support to the persons involved in the incident or accident.

You should listen to what they have to tell you, but never talk about your own (similar) experiences. The patient has a need to talk, not to listen! Talking about your own experiences is an indication that you want to share, to be a part of it, but if you were not involved in this incident then "shut your mouth". The thing here is not to share experiences, but just to let the patients lighten their hearts.

You can also go closer than usual; physical contact may be comforting to many people. However, you must respect the other person, and if they shrug off the hand on the shoulder, it is still OK. Give the patient warm drinks, but no "drugs" (e.g. coffee to a person not used to it), and warm clothes to increase the feeling of comfort. Shocked people should be kept active with simple tasks, rather than letting them lie and brood. Let them have contact with their next of kin as soon as possible.

REACTION PHASE

This phase may last a week or so, and is characterised by feelings of guilt and ensuing distancing and avoidance. Because the person can feel terrorised by their memories and emotions they want to escape rather than to work them through.

The help that can be given in this phase is information, information, and more information about what actually happened. You should still listen and try to have an interested attitude. Give (constructive) advice and talk about what actually happened. If the patient is trying to isolate themselves, break the isolation.

RECOVERY AND RE-ORIENTATION PHASES

These phases will occur months or even years after the incident, i.e. after the expedition members have returned home.

INFORMATION

The Secretariat has incident preparedness plans, which will come into action as soon as information of an incident reaches the Secretariat. The Secretariat will help the expedition in any possible way, particularly as an information centre and to help mobilise external resources through channels that may not be available to the expedition.

The Secretariat will also arrange the contact with next of kin if participants cannot do so themselves, and with the media. If an incident or accident occurs, never hold back (factual) information from next of kin. If you are to talk to the media, prepare yourself and gather your thoughts for five minutes before the interview. All contacts with journalists should be arranged through the Secretariat!

To remember

To be able to take care of an injured person in a proper way, you must be in a reasonably good state yourself, i.e. you have to take care of yourself. After the initial emergency treatment of the injured person, you are probably in a state of (mild) shock yourself. Dress warmly and protect yourself against the weather. Eat something and try to drink something hot, this will make you think better. After the initial emergency treatment of the injured, contact the (expedition) doctor.

6. Protection against fire

The best protection against fire is prevention: you never have to fight a prevented fire. Fire is probably the single most serious danger at sea and in the polar regions. At sea you cannot easily get away from the burning object (the ship) without putting yourself in jeopardy (by going into the lifeboats). On land in polar regions, fire can be extremely destructive to equipment that you cannot easily replace; a destroyed sleeping bag or tent may put you in serious trouble. Furthermore, burns and smoke inhalation are among the worst injuries to take care of, especially in the field.

Fire prevention

SHIPS

The major fire hazards on a ship are in areas where you as a passenger have no say, e.g. in the engine room and in the galley. However, the ship's crew is at least as aware of the potential fire risks as you are. What is important from your side is that you must inform the crew if something in your scientific equipment may increase the risk of fire or pose secondary risks in case of fire. Also, you are never allowed to overload the electrical system or to connect any apparatus if you are not sure that it is safe to do so. If you smell smoke, burnt electrical wires etc. contact the crew immediately. You must strictly follow all instructions on board, e.g. concerning where smoking is allowed. If you need to do any work that may lead to an increased fire risk, talk to the expedition leader first.

STATIONS

At polar research stations like Wasa and Svea, you are in some ways even more vulnerable in case of fire than on a ship. Water is usually a scarce commodity and the fire extinguishers in place are not enough to put out a major fire. Furthermore, the dry air dehydrates materials very quickly, e.g. wood can be much more flammable here than at lower latitudes.Typical fire hazards are handling of fuels, the electrical power systems, cooking, and "hot" works, such as welding. In any station where you are staying, you should ask where there are smoke detectors or any other fire detection system.

As on a ship, you must follow all instructions for the station and if they are not handed to you, you must ask for them. The station manager or equivalent should have some kind of fire instruction and fire drill at an early stage, in order to organise the activities in the case of fire. If this is not done, ask the station manager to give (all of) you instructions. You must also inform the expedition leader if something in your scientific equipment may increase the risk of fire or pose secondary risks in case of fire. Check where there are fire extinguishers and what kind of fire they should be used against. Also, check the location of switches to cut the electric power, propane gas, fuel lines etc. If you smell smoke, something burning

or the distinctive smell of propane, you must immediately contact the nearest logistician. The same applies if you find any loose contacts, cables squeezed in doorways etc. Disconnect electric appliances that are not being used. Be extremely careful if you use candles or any other open flame.

FIELD CAMPS

In the field, the main fire hazards are connected to the handling and use of liquid and gaseous fuels. All fuels are by definition fire hazards! There are some instances in which you have to be extra careful: when filling fuel containers, when transporting fuel, when re-fuelling cookers and when using cookers in tents. You are never allowed to use candles in sleeping tents. The use of cookers in sleeping tents is only allowed in extremely bad weather: mere rain or snow does not qualify as extremely bad weather. Given this, the risk of fire is usually quite low in field camps.

Fire fighting

1. Save If you know or strongly suspect that there are people in the object on fire, you should try to save them. To humans the most dangerous aspect of a fire is the smoke: a couple of breaths and you may become unconscious. If the room starts to fill up with smoke, get down on the floor. There is always more oxygen and less smoke by the floor. If there are no people in the area on fire, close the door(s) to it.
2. Warn Any person close by who may be affected by the fire should be warned of it.
3. Alarm Sound the alarm, so that you can get help with putting out the fire.
4. Put out Try to fight the fire (see Figure 6.1), but do not take any unnecessary risks. Do not be afraid of using a fire extinguisher: it is much easier to put a fire out at the early stage than later on.

FIRE EXTINGUISHING

A fire needs oxygen and a fuel with a temperature above its flash-point; any reduction in these three factors will reduce the fire.

Smothering a fire, i.e. reducing the oxygen supply, can be done:
- by covering it, e.g. with sand, by pulling a blanket over a person with their clothes on fire or by putting a lid on a pot with burning cooking oil; or
- by reducing the amount of available oxygen, e.g. through halotron systems in generator rooms or through the use of carbon dioxide, powder or foam fire extinguishers.

The fuel supply can be reduced:
- by tearing down burning material; or
- by reducing the fuel supply, e.g. closing fuel valves.

The temperature can be reduced:
- by turning electricity off in case of a fire whose cause is electrical; or
- by cooling the fuel down, e.g. with carbon dioxide or foam fire extinguishers, or with water.

Water should only be used to put out fires in wood and paper – used on other fires it may be extremely dangerous (e.g. it can cause a steam explosion when poured on burning oil)! However, fine water spray can be used to reduce the heat radiating from a fire. Foam, carbon

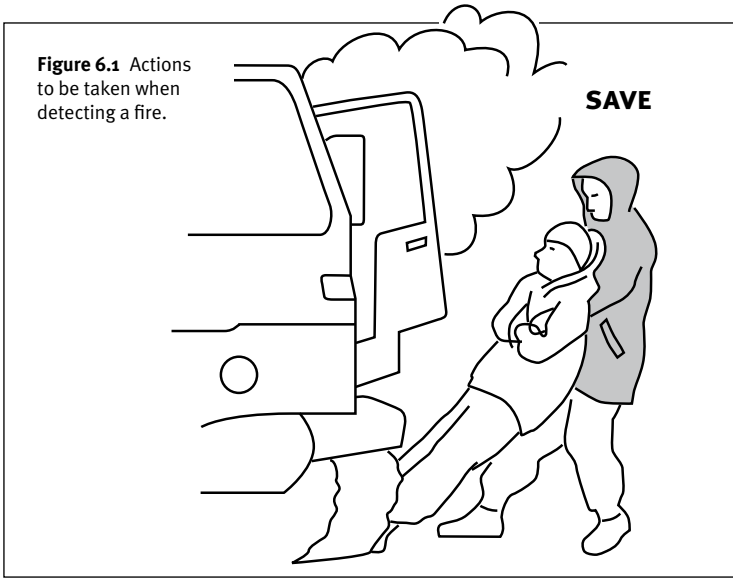


Figure 6.1 Actions to be taken when detecting a fire.

dioxide, and powder can be used for all kinds of fire, but if possible avoid powder for fires in electronic and mechanical equipment (the powder is very difficult to clean off afterwards).

Approach the fire carefully in a low position and aim the fire extinguisher at the base of the fire. Try the extinguisher first from some distance to see how (and if) it works. Make a decisive attempt to put out the fire and do not immediately stop putting it out when it seems gone. Fire extinguishers should always be treated with respect: the power of the pressurised contents, and the content itself may cause injuries if the extinguisher is improperly used.

SHIPS

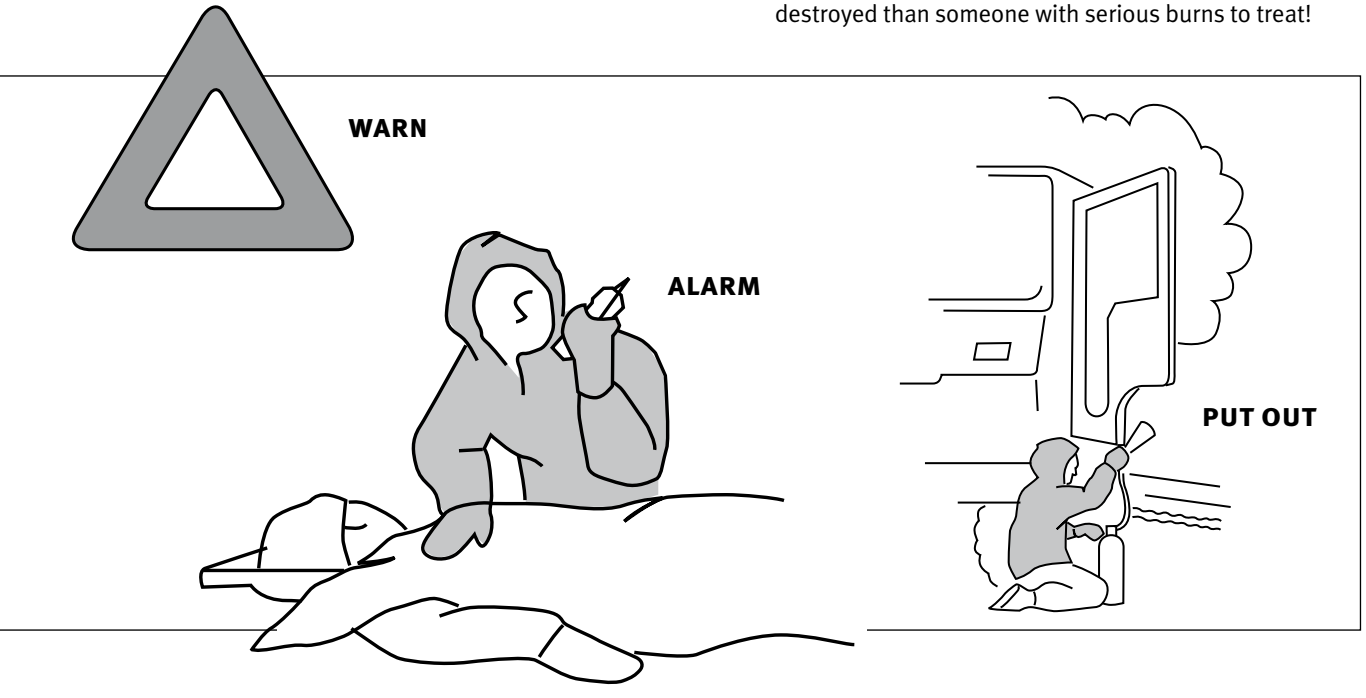
Since a ship is a very limited environment if there is a fire, you must follow the instructions given by the crew so that you do not obstruct the fire fighting. However, even if the crew have their own "fire brigade", you are not forbidden to put out a (small) fire yourself if you are the first one on the spot.

STATIONS

At stations there is usually no special fire brigade, so everybody must help out. The people staying at the station should be organised, but if you feel that nobody is in command, you must take command. If there is a fire in the electrical system, the propane gas system or any other fuel-fed system, you should cut the supply of the system in question. Extinguishing equipment is usually spread out at the station and placed at entrances of areas with a heightened risk for fire.

FIELD CAMPS

Most times in the field you do not have any special fire fighting materials. The exception to this could be e.g. when you are travelling with a tracked vehicle or other vehicles equipped with a fire extinguisher. If you do not have any special equipment, you have to improvise. A minor fire can usually be put out by smothering it with something. If it is really small you may even be able to stamp it out (not to be tried with burning fuels!). A pot, or even better a bucket, of water may help fight a fire. However, if you are not sure that you can master it, do not take any chances: it is better to have some equipment destroyed than someone with serious burns to treat!



7. Protection against wild animals

Most animals just want to be left alone and they get stressed if humans get to close to them. Animals in the polar regions have a hard enough life anyway, and they do not need people to add extra stress. As a general rule, you should never walk closer than 100 metres from wild animals, unless you are forced to do so. The taking of photographs for tourist purposes does not fall under the heading "forced to do so".

You should never feed a wild animal. Firstly, this may make it associate humans with food, and it can later become aggressive towards humans if they do not give the animal the food it wants. Secondly, you may actually make the animals sick; what is good for you is not necessarily good for them. All bites of wild animals should be treated as infected wounds, in particular carnivorous (meat eating) animals have dangerous bacteria floras in their mouths.

Figure 7.1 Polar bear mother and young, in their typical surrounding, the pack ice. PHOTO: ADMIR TARGINO

Bears

The polar bear is truly a marine mammal as its Latin name, Ursus maritimus, suggests. Its main habitat is the sea ice areas where seals come up to breath and give birth to their pups (Figure 7.1 and 7.2). Seals are by far polar bears' main diet. On beaches they may also feed on stranded whales. Polar bears normally follow the pack ice. Only in some areas do they regularly occur on land, and in such cases usually only on the beaches or in "bear corridors" between beaches.

The main habitat of the brown bear is the temperate coniferous forests, the taiga, but in places it occurs all the way north to the tundra of the Arctic Ocean coast-line, e.g. on the Kola Peninsula and on the western two thirds of mainland North America. The brown bear is the same species all over the Arctic. Humans are not part of the normal diet of bears. However, polar bears are carnivorous and brown bears are omnivorous ("all eaters").

Bears' most keen sense is smell and they can pick up and follow an interesting smell tens of kilometres away from its source, given the right weather conditions. Polar bears also have relatively good eye-sight, at least as good as ours, and for a hungry polar bear everything that moves is potentially food. However, humans are usually either avoided or ignored. Some bears are very curious,

Figure 7.2 Polar bears are excellent swimmers (right), and their broad paws function as snow shoes as well as paddles. PHOTOS: ADMIR TARGINO

and may approach anything they find interesting even when they are not hungry. When a bear finds something that seems interesting, the bear usually leaves once this has been investigated. Bears stand on their hind legs only to get a better view of something they are interested in; they do not charge in this position.

It is not always the case that bears are solitary creatures. Mothers care for their young for over a year, and by that time the cubs are quite large. Siblings may stay together to decrease their sense of insecurity and to help keep a lookout for food and other (potentially dangerous) bears. Furthermore, at places where food is plentiful, many "strange" bears can come together. Bears are only solitary in the sense that they do not like to share a limited resource with other bears, be it food or females to mate with.

To avoid unnecessary dangerous fighting, like most mammals, bears develop dominance hierarchies where the dominants take what they like and leave the leftovers to the lower ranks. This results in large, dominant animals having very little to fear at all and they can ignore all animals around them (including humans). If a bear is not sure of what rank it has in relation to another animal, including humans, it will use different signs to show off its own strength and it will look for signs in the other animal to try to judge how strong it is. These displays may consist of hissing, growling or snapping its jaws; slapping its paw against the ground, or forcibly tearing the ground; turning sideways to display its size; and looking directly at the opponent with a lowered head. If the bear is still in doubt it may fake an attack that ends abruptly a few metres from the opponent. In such contests, when the bear has established itself as the dominant, it will usually leave; an exception can be a dominant bear that may want to steal food from a subdominant animal, or what it perceives as a subdominant animal. Hunting bears will not perform any dominance displays but come straight at you in a very focused manner. An attacking bear is surprisingly fast and any bear within 30–50 metres is a potential danger.

Females with young have one main duty, to protect their cubs, and they do not want to take any risks that may involve the cubs. Therefore, the easiest bears to scare away are females with young, as well as young animals, low on the dominance hierarchy. In spite of this, the potentially most dangerous bears are females with cubs and bears that during the last year or so have separated from their mother, especially young males. If they feel cornered, females with cubs will do anything to protect them. As for young bears, they have not honed their hunting skills yet, and even if they succeed in a hunt an older, more dominant bear may steal the prey from them. Desperately hungry bears may take risks they normally would not take, e.g. attack humans; in this category of bears you find young ones and those stranded on land. Also, any animal that feels trapped or

threatened may defend itself. If you surprise a bear, its instincts may tell it to flee, to attack or to stand its ground. It is impossible to know beforehand how it will react. Bears that have become used to humans and associate them with food are also more dangerous than normal. Such bears can sometimes be found close to villages and stations where they have learnt to look for food at the garbage dump. At times, old males may become very bad-tempered, and they will not tolerate any larger animals at all around them. This is especially so in the mating season.

MEANS OF PROTECTION

Human behaviour Avoid all activities that may attract a bear's attention. This particularly applies to anything that produces a smell. Burning or burying the garbage is first of all not allowed on our expeditions, and secondly it is not enough, since (polar) bears have a very keen sense of smell and smelly (rotting) meat is a normal part of their diet. Once a bear has picked up an interesting smell, it follows it upwind. Therefore, you should keep an extra eye in the downwind direction. Polar bears may also be attracted visually, e.g. by flags or drying clothes hanging on a line, waving in the wind.

Always give the bear the right of way, and if you meet suddenly always give the bear a chance to leave (Figure 7.3). If the bear has noticed you or seems to be following your trail, try to get upwind of it or otherwise let it know that there is a human around, e.g. by talking in a normal to loud voice. You can also leave a piece of clothing or a backpack (not food!) on the trail it is following. Having investigated this, it will usually lose interest. Never try to outrun a bear as you will not make it, and never play dead when a polar bear is involved. If you see a bear, make a general call on the radio so that everybody becomes aware of it. You are not allowed to walk in areas where you may surprise a bear at close quarters, e.g. in narrow gullies or close to (sea ice) pressure ridges.

While you should try to avoid the attention of polar bears, a good way to avoid brown bears is to make noise to let them know humans are around. This is especially so in dense vegetation.

Guns In areas where you may meet (polar) bears, you are in general not allowed neither to leave the camp, nor to stay in the camp without a gun. Guns with enough calibre to kill a bear are the foremost protection against them (Figure 7.4). However, to actually shoot a bear must always be regarded as the very last resort: the Secretariat's policy is that both the safety of humans and the safety of bears must be considered when working in bear country. Still, human life has priority over a bear's life. If you do not have any flash-bangs or their equivalent with

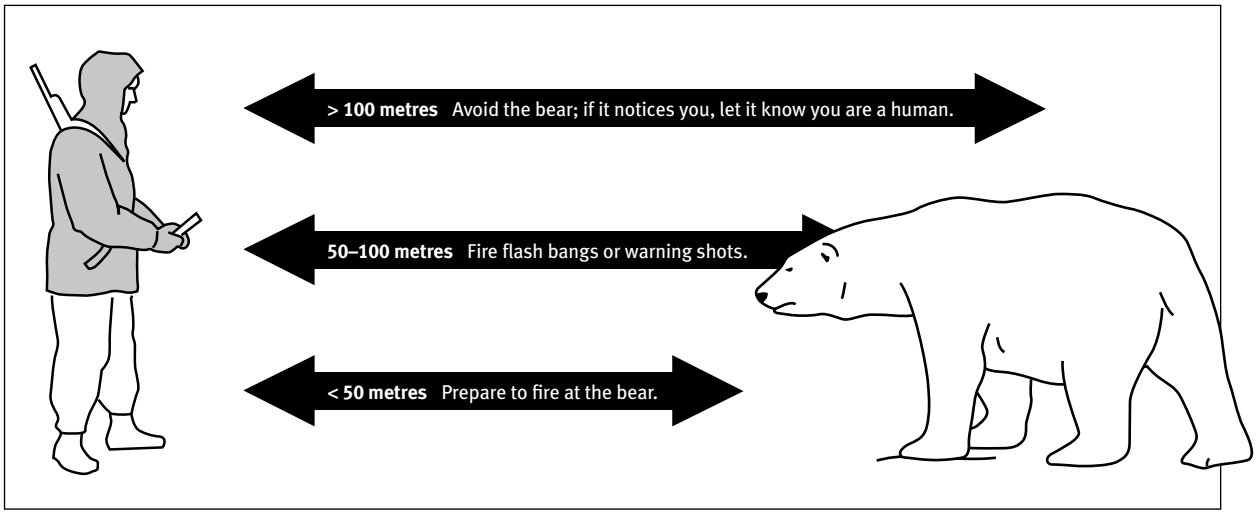


Figure 7.3 Actions to be taken at different distances when a (polar) bear is approaching.

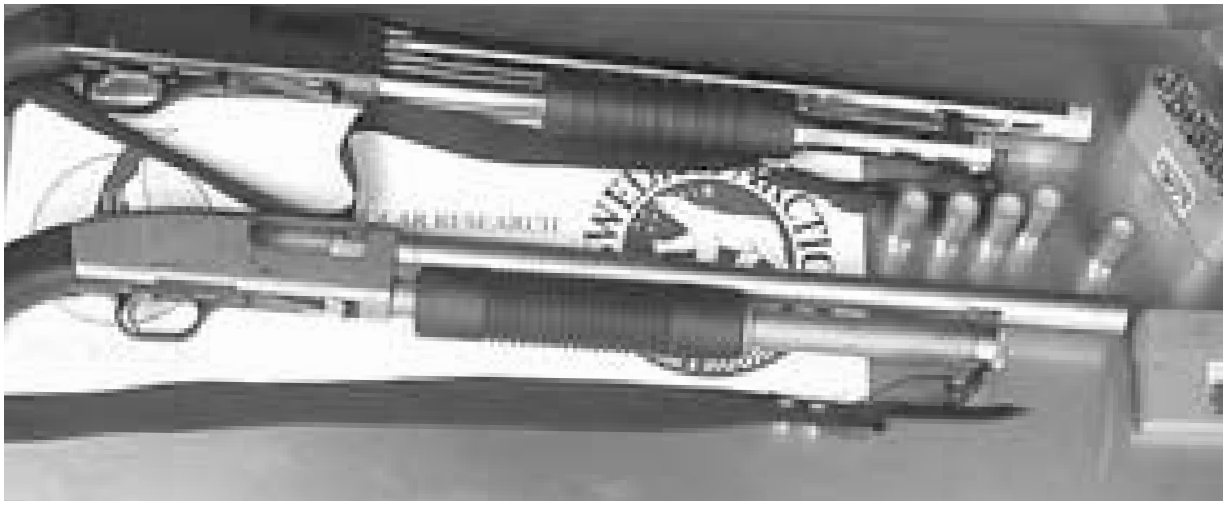


Figure 7.4 The gun most commonly used as protection on the Secretariat's expeditions is the pump-action shotgun. PHOTO: MAGNUS AUGNER

you, try to scare the bear away by firing some warning shots when it is about 100 metres away. Do not empty your gun completely when firing warning shots! If the bear is approaching slowly, reload the gun after each shot and try to walk away (perpendicular to the bear's path). If the bear is approaching quickly, do not shoot more than one or two warning shots, but save the ammunition in case you need to shoot at the bear. When shooting at the bear, aim at the centre of the animal. With the gun calibers provided by the Secretariat, any hit will stop or at least slow a bear down! Even if you get perfect hits, the bear may not fall down immediately: fire double shots and continue to do so until the bear is still or has moved out of range. If you have more than one gun, be prepared to give supporting fire. Any shot fired must be reported to the expedition leader!

Remember that a gun that can kill a bear can easily kill a human. Always treat a gun as the potentially deadly tool it is. Except in life-and-death situations, do not fire a gun if there may be people in the line of fire, not even if they are some distance away. When handling the gun, always treat it as loaded – you do not want to be responsible for someone being hit by an accidental shot! The main armament provided by the Secretariat is pump-action shotguns loaded with solid lead slugs. This choice was very carefully done, based on the robustness and reliability of the gun, its stopping power, and its "user-friendliness". On many expeditions, some participants will receive extra training in the use of guns. These persons are then lent guns as their personal equipment. Other members are not allowed to use the guns at will, but may do so only in emergencies, when the gun bearer is unable to handle the gun or when the expedition leader has given permission for this.

Camp layout Place the camp where you have a free view of any approaching bear at a distance of at least 200 metres. Bears can use very small shelters to hide themselves completely from view and they can move very quickly. All "smelly" areas should be placed downwind from the sleeping area (Figure 7.5).

You should have an unblocked view of the whole camp from all parts of the camp area, including the place for garbage and the latrine. When it comes to the latrine, safety definitely has priority over prudence! If there is a risk of bear visits, you are not allowed to bring food or anything else with a strong smell into your sleeping tent. The tents should be arranged in lines or semicircles so that there is always a way out for a bear entering the camp; a bear that feels trapped is extremely dangerous. If bear visits are likely you should always have a watch schedule among you. Knowing that someone is out there

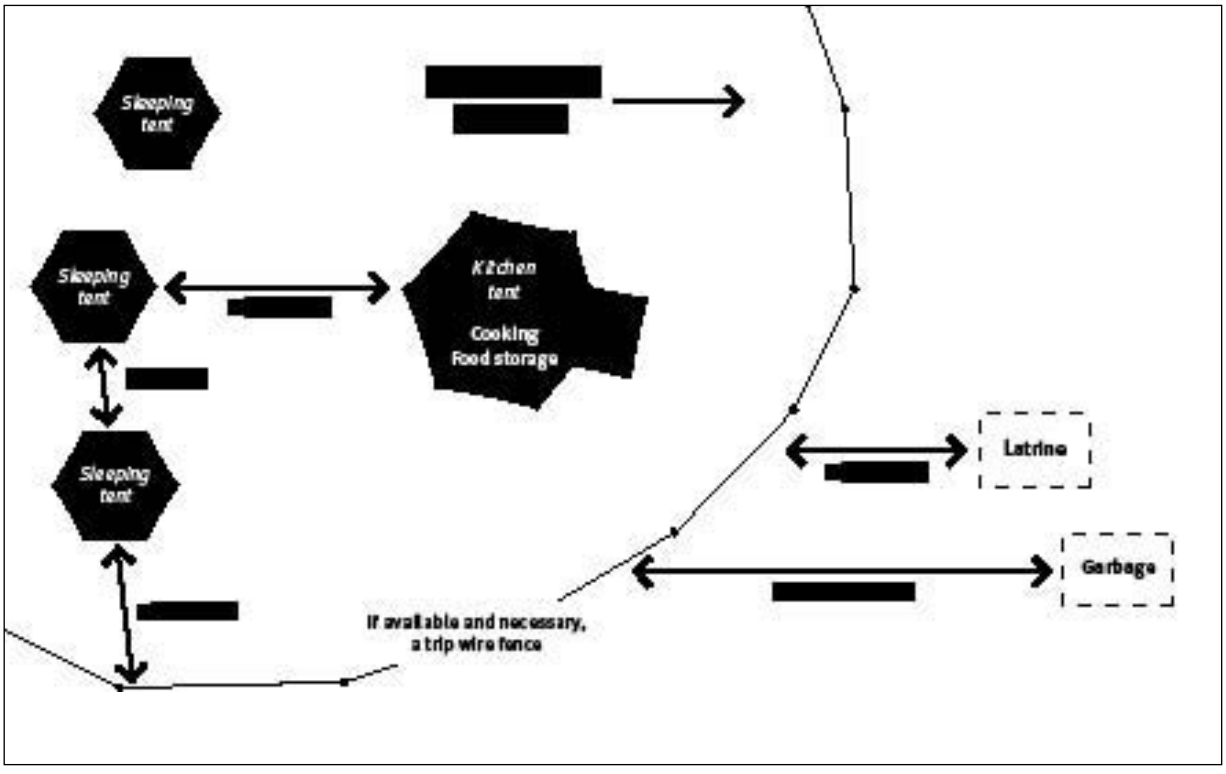


Figure 7.5 Guideline to camp layout and set-up of tripwires as protection against bear visits.

on watch is the best way to ensure a good sleep in "bear country". This may also reduce the risk of someone getting the "bear scare". This mental condition may become so serious that the affected person has to be evacuated before becoming a danger to themselves or to the rest of the camp.

Muskoxen

Muskoxen are social animals, living in herds (Figure 7.6). Older males that have been thrown out of herds by younger, stronger males live as solitary animals. Herds will defend themselves, and especially their calves, against any animal that is perceived as a potential predator and that ventures too close. As for most mammals, smell is the keenest sense, and muskoxen will flee from humans as soon as they are detected. However, older solitary males may have a very bad temper, and especially during the normal mating season they may attack even if they do not feel threatened. Muskoxen have a zone stretching some 25–50 metres around them, within which they will attack. When they do so they are very fast. In the summertime, muskoxen are easily overheated because of their fantastic insulation, and except for scientific purposes you are not allowed to approach them closer than 300 metres.

MEANS OF PROTECTION

The only effective means of protection is to stay away from muskoxen. If you meet one unexpectedly, move away as quickly as possible. Do not use flash-bangs or fire warning shots, as this will probably only aggravate them and may actually trigger an attack!

Figure 7.6 A herd of muskoxen in the Canadian High Arctic.
PHOTO: ANDERS MODIG

Figure 7.7 Elephant seals resting, Antarctic Peninsula.
PHOTO: ANGELA WULFF

Wolves, foxes and dogs

The only circumstances under which wolves and foxes are dangerous to humans are if they carry rabies, or are trapped or threatened. Avoid animals that seem to lack the normal shyness of wild animals, as this may be a sign of the later stages of rabies (where the brain is affected). You should never approach an inhabited den except for research purposes.

You should never approach sled dogs without their handler. Sled dogs may be very dangerous, in that they are used to humans but not trained to be pets. Even if they do not want to eat you, they may want to test the dominance hierarchy through fighting with you, and these dogs are very strong and tough.

Sea mammals

In the Arctic, the walrus is the only seal that can be dangerous to you at sea. A walrus may come up to investigate a small boat, or it may feel that its "territory" has been invaded by the boat. In both cases the boat may be destroyed and the people on board may be injured. These attacks may seem to be unprovoked. Give walruses at sea a wide berth. In the Antarctic, leopard seals is a potential danger when diving or staying close to the edge of sea ice. On land, seals are harmless most of the time (Figure 7.7). However, if you come upon them suddenly or during the mating seasons, seals may attack you. For shorter distances they may be surprisingly quick, and they are all predators with strong jaws. The main risk with seals on land is that you will disturb them. As with all other animals you should stay at least 100 metres away from them.

Whales may come up to investigate boats and rub themselves against the hull. When driving Zodiacs you may also collide with them. All these incidents should be considered accidental. You have nothing to fear from whales. However, do not disturb them and give them a wide berth.

Protection of wildlife

In Antarctica, the protection of wildlife is regulated by Annex II to the Protocol on Environmental Protection to the Antarctic Treaty. Based on this, on Swedish expeditions the rules of thumb are to never approach birds or mammals closer than 15 metres when travelling by foot, and not closer than 200 metres when travelling in a vehicle. The rules are even stricter for aeroplanes and helicopters, but that is the pilot's responsibility. In some cases, it could be that the animals become stressed at greater distances, and you should not disturb animals unnecessarily, e.g. just to take photographs. You are only allowed to approach animals more closely than the rules above stipulate, when doing so is part of the research you are conducting.

8. Protection of the environment

A key phrase in all activities in the polar regions is "protect the environment". The polar environment is often in itself very severe, and plants and animals often live at their (climatic) distributional limits. A small disturbance may destroy what has taken hundreds or even thousands of years to build up (e.g. moss and lichen communities), or even cause irreparable damage. You must therefore always give a little extra thought to what you are doing when visiting the polar regions!

The Arctic

The legal framework for environmental protection in the Arctic is quite complex. This is due to the fact that there are eight countries with territories there, all with their own laws, while the Arctic Ocean is protected by international law. It is therefore not possible to write even a brief summary of the rules and regulations that apply in every part of the Arctic in this book. However, most of the environmental protection strategies that apply to Antarctica also apply to activities in the Arctic. So even if you are not going to Antarctica, you should read through what is written below on waste management and oil spill response. Irrespective of whether an expedition goes to the Arctic or to Antarctica, the Secretariat's aim is to protect the polar environment as much as possible.

Antarctica

Only about one percent of the surface of Antarctica is bare ground, and the vast majority of all plants and animals are to be found there. Since the same holds true for most human activities, there is an obvious competition for space. Environmental protection in Antarctica is one of the main issues in the Antarctic Treaty System, which includes the Protocol on Environmental Protection (visit www.polar.se for more information). Every person visiting Antarctica (south of 60°S) is obliged to follow these rules. Furthermore, all Swedish activities in Antarctica are regulated by the Antarctica Act (Lag [1993:1614] om Antarktis). Following these rules and regulations, the three Nordic countries, Finland, Norway and Sweden, have developed a common *Nordic Environmental Handbook, Antarctic Operations*, which covers everything that participants in Swedish expeditions to Antarctica have to know about environmental protection during the expedition. Below some of the handbook's main provisions are summarised.

Waste management, Antarctica

Human impact in Antarctica must be kept to a minimum in order to preserve Antarctica as the world's largest pristine wilderness, with its unique environmental qualities. In Antarctica biological degradation is a slow process due to the cold and dry climate; all biodegradable

products should therefore be treated as non-biodegradable. Structures and equipment that are not considered essential for further operations in Antarctica should be removed after the conclusion of an expedition, as should all waste generated each given operational season. No open burning of waste is allowed. Some products have a larger potential for harming the environment than others and need special consideration during the planning of expeditions (Appendix III). A few of these products are prohibited, while others require a permit. Products and substances that have a potentially harmful environmental effect must be treated with special attention so that no emission or dispersal occurs.

As a general rule, the less waste produced the less waste needs to be handled and disposed of. Waste disposal has both environmental and financial costs that can be reduced by minimising the waste volume. Some rules have been set up with the aim of reducing waste production in Antarctica (Appendix III).

Nordic scientific activity in Antarctica, including logistics in support of science, is relatively speaking small, and large scale waste separation is not considered economical. However, a certain degree of separation and classifying is needed in order to handle the waste in a satisfactory manner. Waste should be separated into the following categories: combustible solid waste, glass, metal, sewage and domestic liquid waste, other liquid waste and chemicals including fuels and lubricants, and finally radioactive material.

HAZARDOUS WASTE

Hazardous waste cannot be handled together with other waste because of potentially harmful pollution, and must therefore be handled with care in order to prevent spills and dispersal in the environment (Appendix III). No labelling colour codes should be used for containers with hazardous waste. Rather, all such waste containers should be labelled according to content. Remove all old labels from containers in which hazardous waste is stored.

Different categories of hazardous waste should never be mixed together in the same container. If you are uncertain as to how a given category of hazardous waste should be handled, contact the Secretariat before departure. If problems arise during the expedition, contact the expedition leader. Remember that hazardous waste must not be left behind on an expedition. Oil-contaminated soil, water or fabric is to be stored in separate containers (labelled oil-polluted soil/water/fabric).

Table 8.1

Containers with non-hazardous waste should be marked with a painted spot, approximately 15 cm in diameter, on the sides and lid, according to this colour scheme.

BLUE Metal waste	**GREEN** Glass waste
ORANGE Combustible solid waste	**BLACK** Sewage and domestic liquid waste

All hazardous waste is to be returned to the country of the expedition's origin, or to the country of purchase, where it can be disposed of in an environmentally friendly way. All containers to be used for packing hazardous waste must be in good condition and the content must be marked according to international standards. The waste should preferably be returned in its original packaging. Ensure that containers are secured during transport.

RADIOACTIVE MATERIAL

Scientific research activities are the sole generator of radioactive waste in Nordic Antarctic operations. All radioactive material must be returned to the country of origin of the research project for proper disposal (Appendix III). All scientific personnel are to ensure that, if possible, all radioactive material is returned packaged in the same container in which it was transported to Antarctica, or that suitable containers (polythene bags, polydrums, etc.) are brought along for this purpose.

Solid radioactive waste should be packed separately from any liquid radioactive waste. Seal the contaminated waste in heavy-duty polythene bags. Bags should then be put in separate containers. Liquid organic and other aqueous radioactive waste should never be mixed.

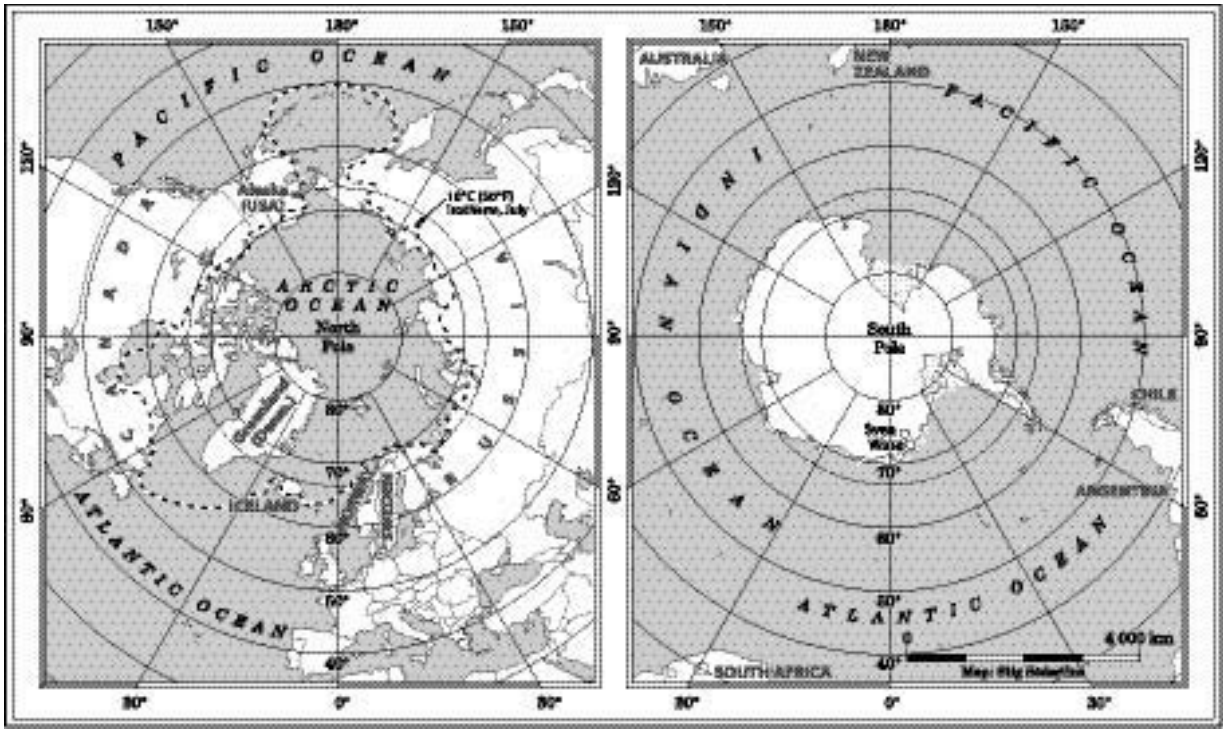


Figure 8.1 Maps of the Arctic and Antarctica, with the 60° S latitude.

Liquid waste should be poured into e.g. polydrums or other suitable containers. Containers must be thoroughly sealed. Do not overfill. Smaller items and containers should be put in separate, large containers.

N.B.: For both liquid and solid radioactive waste it is essential that the correct information is provided in the labelling of the containers. If you have any questions about radioactive waste disposal, contact the Secretariat before departure to Antarctica.

Oil spill response, Antarctica

In the case of any oil spill, after the safety of personnel is ensured, an initial assessment of the spill should always be made (Table 8.2). The general response strategy is otherwise to contain and recover oil spills where practical (Appendix IV). As much oil as possible should be removed immediately after the spill, and any remaining oil is left to degrade naturally. The use of dispersants and burning at the site is not allowed, and a large scale clean-up operation may cause more environmental damage than the oil itself.

Table 8.2

Initial oil spill assessment.

- Probable quantity of fuel spilled.
- Type of fuel.
- Location of the spill.
- Probable source and cause.
- Any risk of fire.
- Any risk of harm to human health.
- Any risk to the environment.

HEALTH AND SAFETY

The health and safety of personnel is paramount in the case of an oil spill. Emergency spill response actions should not be undertaken in extreme weather conditions or during periods of darkness, unless the situation has been fully assessed by the expedition leader and deemed safe.

Inhalation of hydrocarbon fumes can cause headaches and nausea: these are short-term effects. For spills of more than 200 litres, clean-up personnel should consider using facemasks, if such are available, until the fumes have disappeared. Fuel and oil can be a skin irritant. Severe reactions can lead to dermatitis. If possible, clean-up personnel should wear rubber gauntlets to protect hands and arms during clean-up operations. Drinking water would have to be highly contaminated by hydrocarbons for harm to occur. This is unlikely since very low concentrations of hydrocarbons alter the taste of water and make it completely unpalatable. The expedition doctor is to advise the expedition leader on likely health effects of an oil spill.

RESOURCES AT RISK

Snow- and ice-free ground If an oil spill occurs on impermeable ground, the oil will run off of rock and concentrate in puddles, and the ground will seem to be coated with oil. Oil spills in snow and ice-free areas will affect vegetation and micro-fauna in the area of the spill. Fieldwork taking place in particularly sensitive areas must adhere to specific guidelines given by the Secretariat in order to avoid oil spills and other negative effects on the biota.

Snow-covered ground Oil spills on snow-covered ground will seep into the snow. Due to capillary effects, the oil will also spread horizontally. The vertical spreading is always bigger than the horizontal, at least in the upper layers. If the quantities spilled are large, the oil will reach into layers of higher density until it reaches the ground or an impermeable layer of ice.

Figure 8.2 Fuel drums stored on a tracked vehicle sledge.
PHOTO: ANNE SWARTLING

Ice-covered ground Oil spilled on ice-covered ground is likely to remain on the surface and not penetrate much into the ice as long as there are no cracks.

SPILL RESPONSE EQUIPMENT

Stations and field parties must be equipped with sufficient materials and equipment to follow the response strategy for all spills. The equipment is to be stored in accessible locations, known to all expedition members. At stations there are oil-absorbing mats for refuelling sites, absorbent pillows and fabric for vehicles and field parties, plastic bags, protective masks and rubber gloves. Field parties should be equipped with absorbent pillows and fabric for vehicles, plastic bags and rubber gloves.

ATVs are used for heavy transportation in Antarctica.
PHOTO: THE SECRETARIAT

9. Movement and transportation in the field

Safety

There are four basic safety rules that you should follow when moving in the field:

1 Never go into the field alone.
2 Always bring the minimum equipment.
3 Always leave a travel note (färdmeddelande).
4 Keep to the communications schedule.

NEVER GO INTO THE FIELD ALONE

This means that you are only allowed to leave the camp, station, or ship alone, if you are given permssion to do so or when the standing procedures allow it. The reason for this is simply your personal safety: if you hurt yourself, e.g. twist an ankle, then you have someone with you to help out. If you are lost in fog, then you have someone to discuss the situation with, which reduces the risk that you act rashly. If your radio or GPS is broken, then you may have a second set with you. This rule of never travelling alone applies equally to vehicles: you should always travel with at least two vehicles of the same kind together, e.g. two snowmobiles, two tracked vehicles or two Zodiacs. If a vehicle gets stuck somewhere you must have another one to help tow it free, and if a vehicle breaks down there must be another vehicle to go back with.

ALWAYS BRING THE MINIMUM EQUIPMENT

This may vary depending on the location and extent of the expedition. Still, the idea is that you should be able to handle any situation that was not planned for, but that may come up. Basic items are a radio or some other means of communication, a map, a compass and/or a GPS. What constitutes the "minimum equipment" that you always must bring with you when leaving the ship, camp or station is regulated for each expedition. (See also Appendix V.) Do not improvise during your trip: if you do not carry the necessary regulated equipment with you, e.g. for climbing a glacier or fording a river, then you are not allowed to do so. If you are not sure whether or not you have the proper equipment then you must contact the expedition or camp leader.

ALWAYS LEAVE A TRAVEL NOTE

Before leaving the camp, ship or station, you should leave a message stating where you are going and when you are expected back (Table 9.1). If something happens, your life may depend on e.g. the search and rescue procedure commencing in time and covering the proper area. You should be aware of the fact that if you are missed by the others at the camp, e.g. if you are overdue for your radio call to the camp, then all other activities will cease and a search for you will be mounted. Furthermore, when someone is missing and an accident is suspected, people searching for the one(-s) missing will take risks that they normally do not. This means that if a search is mounted unnecessarily, you will have wasted precious research time for your fellow expeditioners and you may also have put them at serious risk! Camps and

Table 9.1

Information left in a travel note (färdmeddelande).

1. When you leave, and expect to be back.
2. Where you are going.
3. How many people, vehicles etc. are involved.
4. Which people and/or types of vehicles.
5. What you intend to do.
6. Other information.
7. Who is leaving the note.

stations have their own procedures for how to leave the travel note, while on ships the information should be passed to the officer on watch on the bridge.

KEEP TO THE COMMUNICATIONS SCHEDULE

Each group going into the field must be equipped with some means of communications, be it a radio or a satellite telephone. You must check that it works and that you bring enough batteries, or the equivalent, to last the whole trip (plus a reserve). You must do everything you can to keep to the time schedule for contacts that has been decided on beforehand. Missing contacts always lead to worries and the risk of unnecessary search and rescue operations. If atmospheric conditions make it impossible to keep an appointed contact time, the next one becomes even more important. If you do not have a valid reason why contact was not kept, you may be held financially responsible for any rescue operation that is mounted.

THE BOTTOM LINE

Do not take any risks unless you have prepared for the worst case scenario and are absolutely sure that you can handle it! Make sure that your actions follow accepted procedures and practices and comply with the expedition's safety regulations. It must be stressed that there are no scientific data in the world that are worth a person getting injured or worse! You must always make realistic estimates of how long the trip will take and of your own capability. See to it that you have margins, e.g. if the weather turns bad. These margins apply to both time and equipment.

Orienteering

MAPS

The Secretariat may provide overview maps for the expedition leader. These maps will be used only for organising the expedition and will be kept at the station, camp or ship. They may not be brought into the field by individual participants. The expedition members must

Figure 9.1 You use the compass as a direction indicator by first laying the long side of the compass along an imagined line from your starting point to your goal, on the map, with the arrow towards the goal. Adjust the help lines inside the compass house to be parallell to the north-south lines on the map, with the compass house's north pointing to the map's north. Without moving the compass house, turn the compass so that the magnetic north-south indicator falls within the compass house's arrow. The main arrow of the compass now points towards your goal.

themselves obtain any maps they need for their work. It should be noted that for the polar regions maps with a finer scale than 1:250,000 are uncommon, and updates can be few and far between.

COMPASS

For those not familiar with the compass, to use it you place the compass on the map with the long side of the compass along the course you want to take. The arrow should point in the direction of your intended course. While holding the compass steady, turn the compass housing so that "north" on the house corresponds to "north" on the map. You have guiding lines in the compass housing that should be oriented parallel to the north-south lines on the map. Lift the compass from the map and turn until the compass needle points to the compass' "north". The arrow on the compass (and the long sides of the compass) then points towards your goal.

In most places on earth "true north" and "magnetic north" differ. The cause of this may be (1) the fact that the magnetic north and south poles do not lie at the geographical poles and (2) possible local deviations in the magnetic field. On most maps the deviation between true and magnetic north is stated. It should also be noted that most standard compasses that you buy in Sweden cannot be used in Antarctica. The reason for this is that around the equator, the magnetic field is more or less parallel to the earth's surface, while the closer you get to a magnetic pole, the more perpendicular the field will become, i.e. its inclination increases. Regular compasses bought in Sweden have needles balanced for the inclination of the magnetic field there, while in Antarctica you need a compass balanced for that magnetic field inclination.

GPS (GLOBAL POSITIONING SYSTEM)

The GPS receiver is not to be used instead of, but rather as a complement to map and compass. It is especially convenient when travelling longer distances. The system consists of some 24 satellites circling the earth in six orbits. The satellites transmit radio signals to the GPS receiver, which uses the signals from several satellites to calculate its position in relation to the satellites.

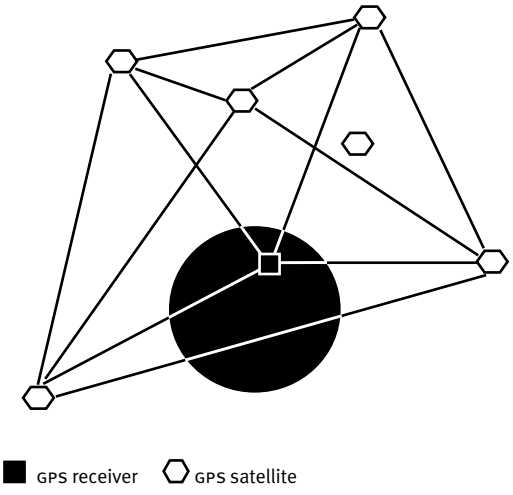


Figure 9.2 In this figure the GPS receiver receives signals from six satellites. If one draws imaginary lines between the receiver and the satellites furthest out on the receiver's horizontal view, and between the satellites outermost in space (in this case a total of five satellites), an imaginary polygon is formed. Here the polygon is delimited by eight planes, drawn between five satellites and the receiver (the sixth satellite lies within the polygone). The larger the volume of this imaginary polygon, the more exact the positioning of the receiver.

In principle, if you draw imaginary lines between the receiver and the different "visible" satellites, and also between the outermost satellites, you will get a three-dimensional polygon. The larger the volume of this polygon is, the more accurate the positioning (Figure 9.2). Thus the ideal condition is that you have the visible satellites spread over the sky above and around you. However, the satellite orbits never go above 55° latitude, which means that in the polar regions you will never have a GPS satellite directly overhead. Also, land forms or even human bodies that block the radio signals may further reduce the theoretical volume, and decrease the certainty in positional exactness.

The normal exactness of a GPS receiver is such that the deviation between the calculated position and the actual position should be less than 10 metres in 95 % of cases, and less than 30 metres in 99.99 % of cases. There are ways to increase the exactness, e.g. through

Figure 9.3 The undulating tundra terrain can be very confusing when travelling overland. PHOTO: THE SECRETARIAT

Figure 9.4 The wind may carve out deep channels in the snow, particularly at the edge of nunatakks. Here a wind channel close to the Svea station. PHOTO: THE SECRETARIAT

differential GPS, but such systems are quite expensive and less versatile than the regular hand-held receivers. The GPS receiver is mainly a tool for determining your position. If you are travelling at some speed, e.g. in a boat, on a snowmobile or in a tracked vehicle, it can also be used to determine the direction you are travelling in. However, when travelling by foot it should not be used as a direction finder: you should use a compass instead.

You can use both pre-programmed way-points or enter them as you go along. The way-points can be incorporated in routes. If you calculate a way-point from a map, this way-point may differ slightly from reality. The reason for this is basically that the map is a two-dimensional approximation of a three-dimensional reality. At the beginning of the expedition, you will be instructed in how to operate the kind of GPS receiver that you will be using during the expedition.

Land transportation, tundra

ON FOOT

One striking characteristic of the polar regions is that the normal visual perspective is not applicable. Things that you normally use as points of reference, like trees or other vegetation, are absent, and because of the clear air hills may seem to be much closer than they actually are. It usually takes a week or two before your mind has adjusted itself. Even after this, it is easy to get lost when travelling into new areas; suddenly the terrain looks the same in all directions. When you move out of well-known areas, always use a map and compass, and preferably also a GPS. Do not think "I am just going for a short stroll, so I do not need to bring anything extra." Also, in the polar regions, the weather may change very quickly for the worse, and you must be prepared for this.

VEHICLES

In general, the use of land vehicles on the tundra is strongly discouraged by the Secretariat. Although they may be handy, the ground cover on the tundra is generally very sensitive and susceptible to damage. Also, the use of light vehicles, such as motorbikes and ATVs (all terrain vehicles), may increase the risk of injury many times; and transportation of the vehicle and its fuel into the field may be both difficult and costly.

Land transportation, ice and snow

AREAS THAT DESERVE EXTRA CAUTION

In certain areas, particularly close to hills and mountains, the wind will carve out wind channels. These come in all

Figure 9.5 A tracked vehicle traverse, transporting equipment from the unloading site "Rampen" to the Wasa station. The nunatakk Basen, where Wasa lies, is seen at the horizon. PHOTO: ANDERS MODIG

shapes and sizes and often have an overhanging wind drift at the top. Around Basen, the nunatakk on which the Swedish station Wasa lies, there are several wind channels, both where you would expect them, e.g. on the south-eastern side by the steep cliff sides, and where you might not expect them, e.g. on the low slope in the direction of the neighbouring nunatakk Plogen.

You are not allowed to go skiing or driving a snowmobile in areas that have not been reconnoitred and deemed safe by the expedition leader. Wind channels are particularly difficult to spot from the slope below and in flat terrain. If you see a hole in the snow before you, you are not allowed to approach it without taking appropriate safety measures (see Chapter 10), as the hole may be a deep wind channel or a deep crevasse with a weak overlying snow bridge. Where the glacier ice meets a bare rock face there are often cracks and crevasses caused by the sun warming up the cliff and melting the ice, and here again the cracks and crevasses may be bridged over by snow. You must therefore be very careful when moving between ice and rock.

On slopes covered with ice, snow or loose rocks, you must be extra cautious. You must be observant of the fact that the slope and the surface conditions may change as you move! If there is a real risk of crevasses you should follow the instructions that apply to moving on glaciers. However, if this risk is small you should change your tactics so that if someone slips then the

whole team will not follow. The ground's slipperiness is not only determined by the angle of the slope but also by the condition of the surface: a hard, smooth surface can be extremely slippery even at small angles, as in blue ice areas.

Blue ice is formed where the glacier ice has a negative mass balance, i.e. more ice is melted and evaporated by the sun than is accumulated by snow and drift. Blue ice is just what it says, ice, and the surface is very slippery. Here, quite large cracks can be covered by thin layers of ice, corresponding to snow bridges over crevasses, and even if the risk of you falling into a crack is small, you can still twist an ankle or break a leg.

Even if the precipitation in many areas of Antarctica is at a desert-like level, there is snowfall and the wind can locally accumulate large amounts in a short time. The wind can also pack snow very hard. This is noticeable e.g. in the low sand-dune-like formation called by the Russian name *sastrugi*. Sastrugis as such are not dangerous, only a nuisance, but driving fast over sastrugis can damage equipment.

Another phenomenon caused by wind is the drifts that form in the lee of any object, and which can bury the object quite quickly. Snowdrifts are also formed on the lee-side of slopes. After storms there can actually be a marked avalanche risk, and you are not allowed to move in such lee slopes until they have been checked by the person responsible for the expedition's alpine safety.

In general, all areas with loose snow should be avoided as they are difficult to walk in and vehicles easily get stuck there.

ROUTES

Over the years, a number of transport routes have been reconnoitred over the Antarctic inland ice. The main reason why all transports should use these known routes is the safety of personnel and equipment. Before a route is recognised as such, it has been subject to thorough reconnaissance work with the aim of placing the route away from crevassed areas. Also, by limiting travelling to established routes, the negative effects on the environment are concentrated to as small an area as possible. To be allowed to travel outside of the established routes you must have the expedition leader's permission in each individual case.

The reconnaissance of a new route is, if possible, initially done from the air to get an overview of the terrain and to identify dangerous areas (mainly crevassed areas). During these flights, the helicopter/aeroplane may also land to allow reconnaissance on foot in tricky areas. In seemingly safe areas and on previously used routes, the reconnaissance is usually done from snowmobile and on foot. During the reconnaissance a number of way-points are determined using GPS receivers. The way-points are positioned at each place where the route changes direction. These are the GPS way-points that should be used for navigation! To provide a confirmation that the navigation has been correct, the way-points may be marked; if and how this is done on any given expedition is decided by the expedition leader.

Along some routes you may find stakes in between the way-points. You should always think twice before following such stakes, as they can be quite old and the ice may move as it flows "downhill". From a distance it may also be impossible to determine whether a stake has been placed as a route marker during some previous Swedish expedition or if it has been placed there for some other purpose. In other words, unless you are completely sure that they have been set up during your expedition, do not trust stakes or other route markings.

On more difficult tracks, e.g. over the sea ice in connection with off-loading and loading of ships, the route is marked more closely with stakes. In such cases the stakes are placed so that they can be used for navigation even in poor visibility. These route markings are temporary and taken down when the activity is finished. When travelling along a route it is of the utmost importance that you do not deviate from it! Reconnaissance of new routes and any deviation from established routes must be approved by the expedition leader.

DRIVING OF VEHICLES

All driving of vehicles brings about the use of fossil fuels and pollution by exhaust fumes. Therefore all driving should be minimised as far as safety allows. When driving a vehicle the following regulations apply:

- You must have permission to use a vehicle from the expedition leader or someone designated by the expedition leader.
- Which vehicle you can use is decided by the logistics manager, or by someone designated by the logistics manager.
- You must always leave a travel note.
- You must bring along a radio or equivalent, and emergency equipment as per the expedition instructions.

If you need to repair something on a vehicle you should use the proper tools (like the vehicle's own). You are only allowed to use multi-tools when proper tools are unavailable!

SNOWMOBILES

The Secretariat's snowmobiles are very stable, heavy-duty work machines. They are used for shorter trips or when smaller groups of people are involved. They are also used for reconnaissance work and as service vehicles on journeys with tracked vehicles. Two people can travel comfortably on them. They can tow a sledge with a cargo weight of up to one ton in Antarctica. They can also tow a two-person living module, basically a small, comfortable caravan. Besides emergency equipment, they carry some tools and spare parts as standard equipment.

TRACKED VEHICLES

The Secretariat's tracked vehicles are Hägglunds TL-4, with a very good cargo towing capacity. They are used for long or heavy transports and when large groups of people are involved. They seat 4–6 persons in the cabin, depending on the exact model. The tracked vehicles can normally tow two sledges, each carrying a 20-foot steel container or the equivalent. With their high cargo capacity the tracked vehicles are self-sufficient with regard to fuel and other supplies, even on month-long journeys. On such journeys at least one large living module is part of the cargo.

Water

ZODIACS AND OUTBOARD ENGINES

At present the Secretariat has some five Zodiacs. These inflatable rubber boats can carry between 800 and 1 200 kg of cargo. They weigh around 100 kg each, and are powered by outboard engines. For safety reasons, rather weak engines have been chosen; high speed driving of boats significantly increases the risk of accidents and there is never a need for speed boating in the cases where the Secretariat provides the boats. For a full season expedition, not more than two persons can realistically travel in a Zodiac, when including all the necessary equipment.

SURVIVAL SUITS AND FLOTATION DEVICES

The Secretariat will decide for each given expedition which flotation devices will be provided, based on an estimate of actual risks. Life jackets and flotation overalls can be sufficient in situations where immersion hypothermia will not be a serious problem, while in others survival suits are brought.

One reason why full protection survival suits are not always used in connection with open boat sailing and work on sea or lake ice is that they are sometimes too impractical. If the risk of falling into the water is deemed low, or if the consequences of falling into the water are considered not very serious, then people may start

Figure 9.6 Zodiac travel in south-west Greenland.
PHOTO: CHARLOTTE JÖNSSON

Figure 9.7 Sampling of sea ice pore water and sea water. PHOTO: PAULI SNOEIJS

Figure 9.8 Unloading onto the shelf ice, Antarctica. The largest dark objects on the shelf ice are 20-foot containers. PHOTO: PETER DARTH

wearing the suit in an inappropriate way, e.g. with open zippers. A tight fitting survival suit is both cumbersome and can become very warm to wear, but a survival suit worn with open zippers etc. can become a death trap! Furthermore, when working on sea ice, such as when unloading a ship in Antarctica, it may be more important to be able to move quickly, and a survival suit may be so cumbersome that it actually increases the risk of injury.

The expedition leader will decide from situation to situation what kind of flotation device you must use. You must always wear your flotation device in the proper way, i.e. it must be fitted, all straps must be secured and all zippers must be closed. If you fall into (cold) water, your movements will increase the loss of heat. The best position to conserve heat is to crouch into a foetal position, making your surface exposed to the water as small as possible; and try also to protect bare skin. How long a person can survive immersed in cold water depends on so many factors that it is impossible to give any reliable "degrees-hours"-chart.

SEA ICE

Sea ice is a dangerous environment and you are not allowed to walk or drive onto sea ice without the expedition leader's permission. You should not travel on sea ice thinner than 75 centimetres. Weather and currents constantly affect the sea ice and the forces involved are incredible. Even a quite light swell may cause sea ice to break up and it can happen rather quickly.

When walking on sea ice you must be aware that cracks and seals' breathing holes may be covered with snow and impossible to detect. You not only run the risk of ending up in the water, but also of breaking a leg in such holes and cracks. The expedition leader will decide whether or not you have to wear a survival suit when on the ice, and you are never allowed to be on it alone. In the Arctic, you must also be aware of the risk of meeting polar bears, especially in areas rich in seals and along pressure ridges and other places where the bear can lie in ambush (its common way of hunting).

Driving on sea ice should only take place along reconnoitred routes, away from cracks, on ice that is thick enough. In general, only the driver and possibly the co-driver are allowed to be in the cabin of a tracked vehicle. The reason for this is that if you get stuck in a crack, all the people in the vehicle must be able to leave it quickly and without any risk of panic.

When driving on sea ice the main risk may not be that the whole vehicle and the people in it sink into the sea, but rather that because of cracks the vehicle and its cargo get stuck on an ice-floe without any possibility of retrieval. All operations on sea ice must therefore be

as quick and as smooth as possible. They should be planned well ahead by experienced people.

Another danger in connection with walking or driving on sea ice in Antarctica is the route between the sea ice and the shelf ice. The sea ice is frozen seawater while the shelf ice is glacier ice formed inland and floating out into the sea (the actual coastline is usually tens of kilometres "inland" from the shelf ice's edge). The outer edge of the shelf ice drops down quite steeply to meet the sea ice. The risk of going over the edge should be taken seriously since the drop may be tens of metres high even in low shelf areas. In poor visibility you must be extra careful in your driving when you are close to the shelf edge. When walking in such areas, you must apply safety techniques (see Chapter 10), both because the slope may be steep and slippery, and because there are often cracks close to the edge. When driving vehicles between the sea ice and the shelf ice, a natural ramp is often used. This ramp consists of wind driven snow and should not be treated as if it had been built in concrete; there may be hollows, weak snow bridges, areas with loose "powder" etc. Furthermore the tidal movement of the sea creates cracks between the sea ice and the ice shelf that should always be considered as fresh cracks. Every passage over the ramp must be done with the utmost caution, and should be supervised by an experienced person.

Air

Air transportation in polar regions most often means that you go either by helicopter or by cargo aeroplane. In both cases you will experience a lot of noise, and it could be a good idea to bring some ear plugs to protect your hearing. The noise may be very stressful, especially when you are being picked up by a helicopter. Many people make the mistake of thinking that everything around a helicopter pick up or drop off must be done in a hurry. It is actually the other way around: the pilot prefers that you take your time so that the equipment is stored, the people have buckled up and the doors and hatches are closed, all in a calm and proper way. Even in a medical evacuation situation you should act carefully so as not to cause any delay during the flight due to rushed actions when loading the helicopter or aeroplane.

It is the pilot alone who decides if a mission can be done. The pilot's priority order is always (1) the safety

Table 9.2

Basic rules for helicopter transport

Information needed at request of transport

- Your exact position (preferably map references, as well as latitude, longitude, and altitude) and distinct landmarks.
- Number of people to be transported and how much cargo (weight and volume).
- How you will arrange the landing spot (markings etc.).
- Light, visibility, wind conditions and cloud-base height.
- Ask the person who receives the information to read back the information (to ensure that it is correctly received).

Preparation of the landing spot

- Check that the ground will take the helicopter's weight.
- Remove loose objects within a radius of 50 metres.
- Mark the wind direction (a flag, a fire etc.).
- Stand well clear of the landing spot.
- If you have a radio, call the helicopter when you hear it.
- Stand with both arms raised, with the wind from behind you (and stand still until the helicopter has landed!). The rest of the group and the equipment should be behind you.

When the helicopter has landed

- Stay away from the tail rotor.
- Do not approach until the pilot gives the OK sign.
- Approach from the front, keep eye contact with the pilot and, if it is a small helicopter, keep low to avoid the main rotor.

of the helicopter or aeroplane, (2) the safety of any crew and (3) the mission. Even if things look OK to you, the pilot may have misgivings and choose not to go through with it; that is the pilot's privilege. Unless given specific permission to do so by the expedition leader, no expedition member may order a flight. Even in a potential medical emergency you should try to contact the expedition leader before calling out for a flight (Table 9.2): there may be circumstances that you do not know of that affect the overall situation.

N.B.: In an acute life threatening situation there is probably not time for a helicopter or aeroplane to come to your rescue and you must do your utmost to help yourself and your colleagues!

During any flight you must bring along equipment so that you can cope with unexpected delays and landings. This is especially important in Antarctica, where extra warm clothes, a sleeping bag and a sleeping pad are usually mandatory. It is also good to bring some food, something to drink and warm clothes in case the weather turns bad. The helicopter or aeroplane is usually only carrying extra equipment for the pilot(-s). When flying longer stretches over open water, a flotation device must sometimes be worn: it is the pilot who decides if this is the case.

Unexpected situations and emergencies

Do not take any risks unless you have prepared for the worst case scenario and you are absolutely sure that you can handle it! It is worth stressing again that there are no scientific data in the world that are worth a person getting injured or worse! You must always make realistic estimates of how long the trip will take and of your own capability. See to it that you have margins, e.g. if the weather turns bad. These margins apply to both time and equipment.

EMERGENCY BEHAVIOUR

It can be very difficult to accept that you actually are in a situation where you need help, e.g. to accept that you are lost, and decide to start acting according to this. When something unexpected happens, you have a prolonged delay or an emergency occurs, follow "STOP":

S Stop, do not rush your actions.
T Think, instead of doing something rash.
O Orientate yourself. Try to find out where you are, or what has really happened.
P Plan. Decide what actions you are going to take, then carry them out in the right order.

Never hesitate to bring out the emergency equipment: you should rather consider it as "unexpected situation equipment". Put up the tent and get some warm food in time. You can easily pack the tent again and the food is replaceable – you are not!

To decide what you should do once you have stopped and calmed down a bit is not always easy. You may feel embarrassed about setting up camp and waiting for help when the camp may just be "beyond the hill over there". Once you are in a situation where you need help, do not move from that place unless this will, with 100% certainty, improve your chances of getting help. When people start looking for you they will follow the information in your travel note, they will not start looking "beyond the hill over there". Remember that if you cannot get in contact with the rest of the expedition, you will sooner or later be missed – nobody is left behind when the expedition leaves. However, this "sooner or later" can be drastically reduced if you follow some simple instructions: leave a detailed travel note, and keep to the communications schedule!

If you are missed beyond the time limit specified in the expedition instructions, a search operation will be mounted. Given the normal circumstances for polar expeditions, the only available personnel for this are the other expedition members. Thus the search teams are rather small for the task of looking for someone in a large area. The more specific information you give in your travel note and the less you deviate from it once out in the field, the greater the chance that you are found sooner rather than later. You must do everything you can to keep to the schedule for radio or satellite contacts that has been decided on beforehand. Missed contacts always lead to worries and the risk of unnecessary search and rescue operations. Since a search operation involves all expedition members, an unnecessary such operation will steal valuable research time from your colleagues.

Figure 9.9 Established symbols of distress are, e.g.
1 SOS
2 a triangle
3 a cross
4 standing with both your arms raised.

Furthermore, in search operations people tend to take risks that they normally would not take. This means that unnecessary search operations may put people's lives in jeopardy when there is no reason for it.

DISTRESS SIGNALS

When you think that people have started looking for you, you can make their work easier by making distress signals (Figure 9.9). Distress signals should be *high, clear, and in contrast with the background*. The signals or symbols should be at least 3 metres high and placed where they are as visible as possible. You can create a contrast with the background by creating shadows, e.g. by trampling snow or by laying bushes. A person is signalling distress by standing with both arms raised imitating a "Y", meaning "Yes". (*N.B.: A person standing with only one arm raised means that all is well; imitating an "N", meaning "No".*) Other conventional signals of distress are three of something, likes whistling signals, shots, fires etc. Remember that you can blow a whistle for much longer than you can shout! Also, all shiny materials can act as signal mirrors, and flashing lights will always attract attention. You do not need to shake your hand: the normal trembling of a hand is enough to produce a blinking light. Just aim the sun's reflection in the general direction where you think help may be. You should do all you can to increase your visibility, like spreading things out and moving about, since everything "unnatural" is more easily spotted. If you can, make a fire (smoke). If you have flares or signal rockets then use them, but only when you think somebody is looking for you or when you hear a helicopter or aeroplane (do not fire at the vessel!).

EMERGENCY EQUIPMENT

The equipment you need to bring for "unexpected situations" is such that you can keep yourself "warm, dry and with a full stomach". Exactly what this is depends on the circumstances (see e.g. Appendix V). If you venture outside the camp, the absolute minimum to bring is a radio with spare batteries, a compass, extra clothes so that you can cope with deteriorating weather and some food and (hot) drink. The further off you plan to go and the longer you intend to stay away, the more equipment you must bring. In Antarctica, each snowmobile and tracked vehicle is equipped with "emergency boxes" for two and four persons, respectively.

EMERGENCY BIVOUAC

If you have to be stationary in a given place, you should always protect yourself against any weather condition that may affect you negatively, e.g. against the wind, the cold and the rain: always prioritise the worst (Table 9.3)! Of course at most times the best and easiest way to protect yourself is to erect your tent, light the stove and snuggle down in your sleeping bag. However if you find yourself without this equipment or if it is broken, you will have to improvise.

There are different emergency bivouacs that you can build (Figure 9.10). A lean-to basically consists of a back wall and two side walls that can be made of anything that protects against the wind. If you do not have enough waterproof material, the angle of the back wall has to be at least 45°. You should make an effort to draught-proof

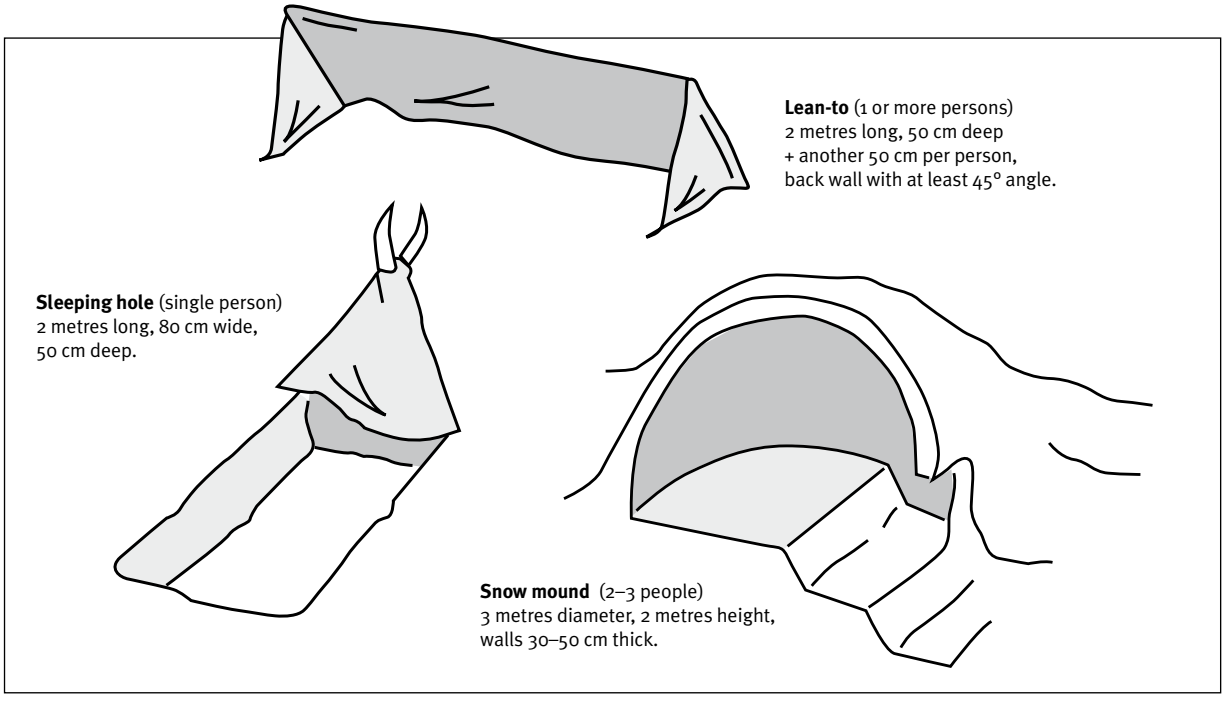


Figure 9.10 Emergency bivouacs.

the base of the walls (up to sleeping height) with windproof material. Use your imagination!

You start making a sleeping hole by trampling or digging down. Then you insulate the walls and the floor. Finish by putting skis, sticks, and clothes together as a lean-to (against the wind). To make a snow mound you start by making a heap and pat the snow down. Put thin sticks, 30–50 cm long, into the heap and let the snow freeze for four to five hours. Dig a small opening hole and then continue to hollow the mound from the inside. You stop when you reach the sticks that you put in earlier. In this way you ensure that the walls will not be thinner than 30–50 cm. Leave a raised sitting/sleeping bench, put your equipment on the floor, dig out a low point at the entrance (acting as a cold trap) and do not forget the ventilation hole over the stove or candle.

Do not give up until you have arranged the camp, changed to dry clothes, heated water, cooked food etc. Do not work up a sweat! If you must stay the night or take a rest, remember: "a lot on top of you, a little on and a lot under you". Decide that you will make it!

Table 9.3

Seek protection from the factor that negatively affects you the most.

Wind Find lee e.g. by seeking a lower elevation, or by building a lean-to, a snow mound or a sleeping hole.

Cold Find warmth e.g. by lighting a stove or fire, by having some food or hot drink or by using your sleeping bag.

Rain Find cover e.g. by putting up a tent or by building a lean-to or other kind of "roof".

Cultural and scientific sites

Whenever you come across what could be a site with ongoing research, historical remnants or a native people's sacred site, you must make certain that you know what rules and regulations apply to visiting such a place. If you are uncertain, then you should not approach it without further instructions from the expedition leader.

10. Glacier safety

You are only allowed to move into glacier areas if you either are truly competent yourself or accompanied by such a person. The expedition leader decides who is competent enough to work on glaciers.

Knots

Four basic knots are used on the Secretariat's expeditions: the autoblock, the prusik knot, the overhand knot and the tape knot.

The autoblock is a braking device very simple to place on a rope, but you need a snap-hook. In winches, where the autoblock also acts as a pulley, you must place the hoisting rope through the snap-hook (as in Figure 10.1). For the prusik knot you use a loose sling coiled in a particular way around the climbing rope. This knot is used when you need to climb up a rope or as a brake when hoisting. The overhand knot is the most basic one and is used when you tie in to a harness, for anchoring etc. It is a very safe knot that also works well on tape slings (one of the few knots that do). The tape knot is tied like the overhand knot, either as in Figure 10.1, with the ends of the tape(-s) entering from the same direction or with the two tape ends coming into the knot from opposite directions. The latter method is used when you need to lengthen, e.g. a cargo strap.

When you make an overhand knot or any other traditional knot, the loose end should be ten times the diameter of the rope.

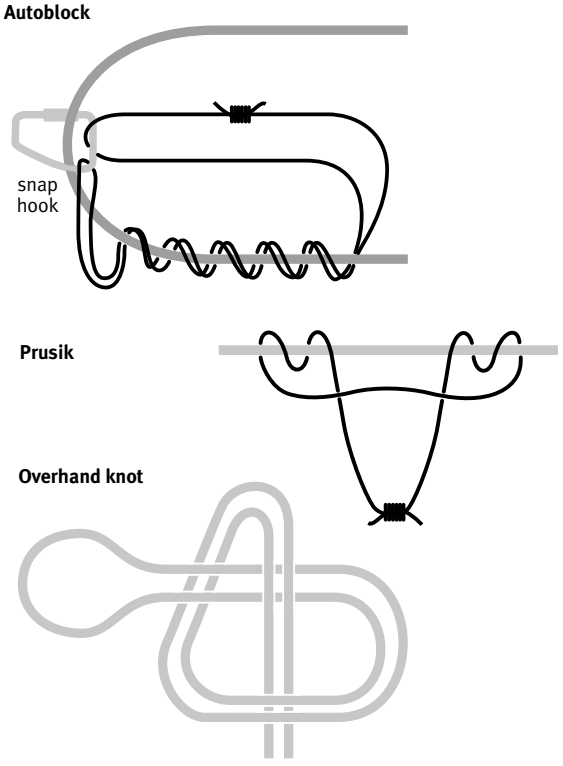


Figure 10.1 The autoblock is a breaking device making use of a snap-hook. The prusik knot is made with a sling of rope on the climbing rope and acts as a break. The overhand knot is used for anchoring and tying in a harness etc.

Rope team

Before you walk onto a glacier you must check that you have the necessary alpine equipment with you. A minimum set of equipment is kept in the emergency boxes of tracked vehicles and snowmobiles used on Swedish expeditions in Antarctica (see Appendix V). Always bring all of this equipment on you: you cannot be certain that you will not need it! When you form the rope team, each person must have a (fitted) harness on and carry the prescribed minimum equipment. Once you move onto the snow or ice, each person must also have crampons on and an ice axe in their hand. Only very experienced people are allowed to form two-person teams (Figure 10.2). All others must form at least three-person teams (three is a minimum, five a maximum here). The reason for this is simply that it is extremely difficult for a single person to arrest the fall of another person in the rope team. Also, only if two (less experienced) persons co-operate "on the surface" do they have a reasonable chance of getting the fallen person up from the crevasse in time. The team members should as much as possible have the same weight, again to increase the ability to arrest a fall. All team members should be warmly dressed: if you fall into a crevasse it is very cold down there.

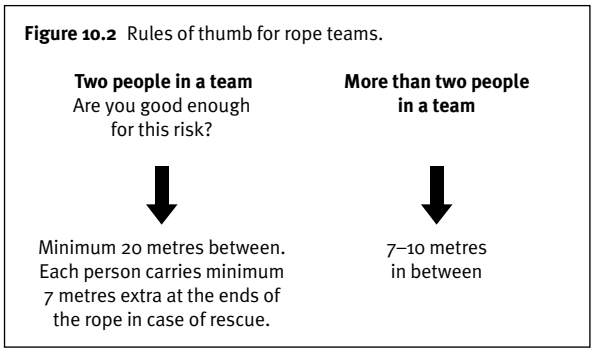


Figure 10.2 Rules of thumb for rope teams.

You tie yourself in on the rope with a regular overhand knot. The two people at the ends of the team must have a minimum of seven metres at the loose end of the rope. This will be used to start making the "Z-pulley" which is used to pull a person out of a crevasse (see below). When you walk, the rope between you should be kept stretched so that it hangs just above the ground. You should not allow more slack to form, as this may result in a powerful pull if someone falls. You should also be careful when using crampons so that you do not step on the rope; this is especially likely for the middle person in a three-person team.

In the beginning, before the rope team achieves a common pace, you should walk slowly so that nobody gets stressed and becomes more prone to making mistakes. Walking with crampons can be quite difficult in the beginning. The technique is to have all downward-pointing spikes in contact with the surface you are walking on, even on slopes. On even ground this may only make your muscles work a bit harder, but in steeper areas you may have to walk side-ways with your toes pointing down. The ice axe should be carried in the hand with the pointed blade forward. On steeper slopes you move only one securing point at a time: axe-foot-foot, axe-foot-foot, etc. When coming to an obstacle that you have to jump across, make sure that you have enough slack in the rope and will not be stopped in mid-air. The person before and/or after you is responsible for keeping the slack optimised (talk to each other!).

Crevasse incidents

When someone falls down into a crevasse or when a vehicle gets stuck, the priorities are (1) your own safety, (2) the safety of personnel and (3) the safety of equipment. If someone falls into a crevasse, once you have arrested the fall, take a minute to make a plan rather than making rash decisions that you may regret a little later. Do this even if you do not have much time to get the person up: in a crevasse, the temperature can be –40°C or lower, and within half an hour the person down there can become severely hypothermic. Keeping your own safety in mind, approach the crevasse carefully and try to contact the person in it. If they are conscious, they may have important information for you and may also be able to help themselves get up. If the person in the crevasse is uninjured, a good way to keep warm is to start prusiking up the rope (i.e. climb the rope using techniques you have practised). If you have a spooky feeling:

Z-pulley

The Z-pulley is a hoisting system used to lift people or equipment out of e.g. crevasses (Figure 10.3). Before constructing the Z-pulley, make a 100% solid anchor (T-anchor, ice screw, snow/ice anchor). When constructing the system always try to minimise the friction, by e.g. digging out where the rope will run, putting rounded and slippery things on the edge of the crevasse, and adding more carbines or pulleys in the system. Before you start improving your Z-pulley from 1:3 to 1:6 you must first reduce the friction.

You are never allowed to use vehicles or mechanical winches to pull people out of a crevasse!

Stuck vehicles

It is difficult to give any specific advice on how to deal with situations where vehicles e.g. get stuck in crevasses. However, the safety of personnel has always the highest priority. Equip one person (preferably two, if there is enough equipment) with harness, rope, and other alpine safety items. This person should be secured with the rope and then given the task of probing the near surroundings for a safe route from the vehicle to a safe area. Once a safe route and area have been established, all personnel should be brought there (secured by harness and rope). After this, contact the expedition leader or logistics manager and discuss how the salvaging operation should be done. Besides the vehicle's own salvaging equipment there are a lot of useful items at Wasa. What you may need are winch tackles, wires, heavy-duty straps, ladders and snow anchors of various kinds. Permission to make a salvage attempt is given by either the expedition leader or the logistics manager. Never try to salvage a vehicle on your own unless you are absolutely certain of how to do it! There is always a risk of pollution when vehicles get stuck in crevasses, but the environmental aspects must be considered secondary to personnel safety.

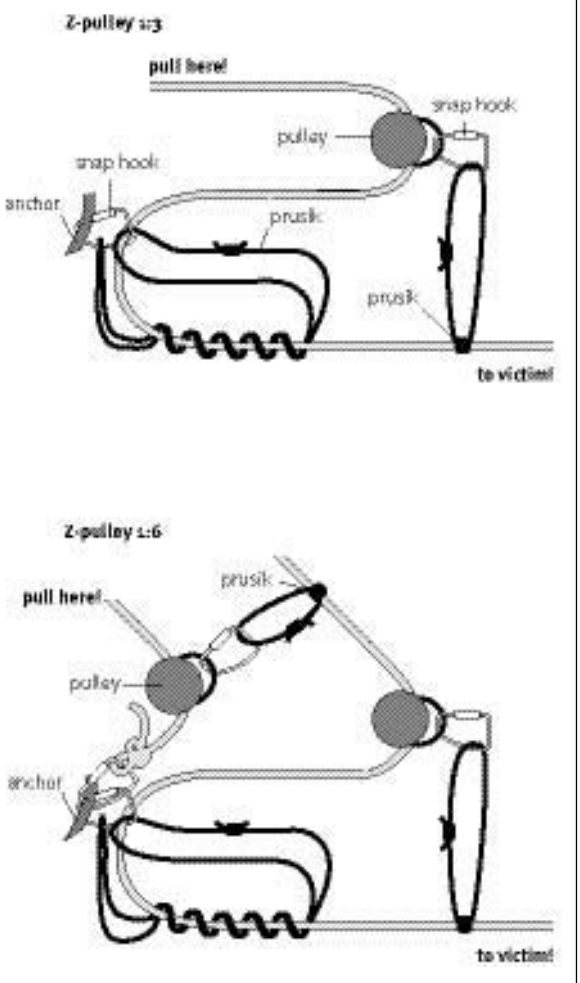


Figure 10.3 Z-pulley. Rope and tackle arrangements used when hoisting a person or equipment e.g. out of a crevasse, with a "power exchange" of 1:3 and 1:6, respectively. The "1:6" version is developed from the "1:3" version.

Figure 11.1 The Wasa station is situated on the nunatakk Basen, here looking towards the neighbouring nunatakk Plogen.
PHOTO: MARGARETA HANSSON

11. Antarctic stations Wasa and Svea

Wasa

Wasa is the main Swedish station in Antarctica. It was built in the Antarctica summer 1988/89, and is situated partway up the nunatakk Nordenskjöldbasen, called "Basen" (Figure 11.1, Appendix VI). The Finnish station Aboa lies some 200 metres from Wasa. The stations lie in an area that is snow free in the summertime. Wasa consists of three buildings: the Radio House, the generator house and the workshop. These buildings surround an area of bare ground that is considered as the station yard (Figure 11.3). Most of the work at the station is done here.

THE RADIO HOUSE

This is a 120 m^2 wooden house standing on a steel framework some two metres high. The house is placed on relatively even ground on the south-western part of Basen. The steel framework and the house's position reduce the accumulation of drifting snow to a minimum. The house contains four bedrooms, showers, sauna, toilet, a combined kitchen and living room and a number of smaller storage rooms (Figure 11.2). The house has many modern facilities such as washing machine, dishwasher machine, microwave oven, gas cooker, kitchen fan, and two refrigerators with separate freezer compartments. The bedrooms are equipped with writing desks and double partly as work areas. The dining place seats 12-16 people and the same number of people comfortably fits in the lounge area. In connection with the kitchen there is a spacious indoor food store.

Energy system The main electricity source for the Radio House is solar panels, which charge a battery bank underneath the building. In the house there are outlets for 12 V DC, 24 V DC and 220 V AC. The availability of 220V, however, is generally quite limited, which is why all electric appliances brought for use inside the Radio house should be adapted to 12 or 24 V. Radiators, water heaters, cooker, refrigerators and the sauna run mainly on propane. The propane is fed from large gas bottles placed nearby the generator house. The amount of propane used in a full summer season is around 400 kg. The water heaters provide hot water to the taps, the washing machine and the dishwasher. The house is equipped with very efficient heat exchange and air humidity recycling systems.

Water system There is running water only in the Radio House. A water tank with a 1200 litre capacity is placed in one of the house's storerooms. Water is generally collected in the blue ice area below Basen. In the generator house there is a snow and ice melting system that can be connected to the Radio House's water supply system. Nowadays the melting system only functions as a backup.

Sewage "Grey water" sewage, i.e. waste washing water, is led through a pipe down to the ice field below the

Figure 11.2 The Radio House at Wasa. The floor area is approximately 120 m².

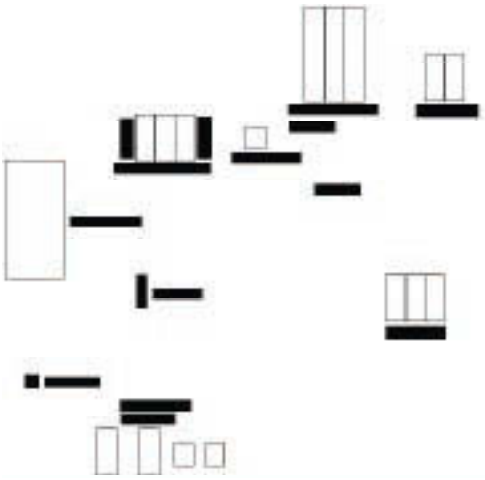


Figure 11.3 Overview of Wasa station.

Radio House. The toilet is a dry closet in the Radio House, with an emptied fuel drum as the recipient. For waste management, see Chapter 8.

THE GENERATOR HOUSE

This building consists of three steel containers welded together and placed on a two metres high steel framework. Outside the doors there is a walkway made of steel grating. In the left-hand container are the generators. The middle container functions as a small workshop and contains the snow/ice melting system. The right-hand container functions as a store mainly for food that should not freeze. On the far side of the generator house, as seen from the Radio House, is Wasa's waste disposal station.

THE WORKSHOP

This building also consists of three containers. However, these are not put together and they do not yet have a proper steel framework to support them. The container nearest the Radio House is a workshop divided into two compartments: the larger one acts as a (mechanical) workshop, and the smaller, inner one as a store for engine oils, lead battery acid etc. The middle container is a food store equipped with shelves ("Wasa Livs"). The third container is a store for field equipment, tools, spare parts etc.

FUEL DEPOT

Slightly below the workshop building is the station's fuel depot. It consists of two "flat racks", i.e. container bottoms with wooden floors, standing on steel props. Fuel drums are secured on the flat racks with cargo straps. Propane bottles are usually stored separately on a tracked vehicle sledge close to the flat racks. Empty drums are placed near the flat racks and secured "in a bunch" with cargo straps, so that they are not blown away.

LABORATORY MODULE

A small glass fibre module normally stands on supportive props close to the generator house (on the far side, seen from the Radio House). It is mainly used as a work place for scientists. It contains a long work bench/writing desk

Figure 11.4 The cooking and dining area in the Radio House, Wasa station. PHOTO: THE SECRETARIAT

Figure 11.5 The Radio House, as seen from the corner of the generator house. The main source of electricity, solar panels, are visible on the wall. PHOTO: KRISTER EKBLADH

and a two-storey bed. The module can be carried on the rear part of a tracked vehicle.

HELICOPTER LANDING PADS

Two "heli pads" are situated between the generator house/laboratory module and the workshop building/ fuel depot. They each consists of an area of about 2.5 × 5 metres, which has been cleared of rocks and stones. Both pads have anchoring points for helicopters (one has four, the other five points). The anchor points are painted bright orange to make the landing easier.

OTHER PLACEMENTS

One or two living modules with spare beds can be parked with their sledges on the even snow field in the direction of Aboa. On the snow field opposite the workshop building, containers brought by tracked vehicles are usually parked.

PROTECTED AREAS

On Basen there are two types of areas sensitive to disturbance, both located on "Fågelberget". One is a permanently protected area with rich growth of lichens and mosses. You must have the expedition leader's permission to visit this area. The other area type is where birds, mainly snow petrels, nest. Since the birds do not nest on exactly the same spots every year, you must be extra careful at the beginning of the expedition before the nesting areas are located. For each expedition the expedition leader will inform you in which areas vehicle driving and in which all visits are prohibited due to nesting birds.

Walking areas The areas on Basen that are not protected may be visited on foot.

N.B.: Although these areas may be visited they are sensitive to wear and normal caution should also be shown here. Outside of the station area, you are not allowed to walk on lichens and mosses; the only exceptions are the marked squares on the slope above Wasa, which act as monitoring areas for extra wear due to human presence. Remember that there are some very steep and high precipices on Basen (>300 metres)!

DRIVING OF VEHICLES

When driving in the area around Wasa and Basen there are some local rules that you must follow:

- In general, all driving on snow- and ice-free ground is forbidden. Driving on bare ground within the station area is only allowed for logistical purposes essential

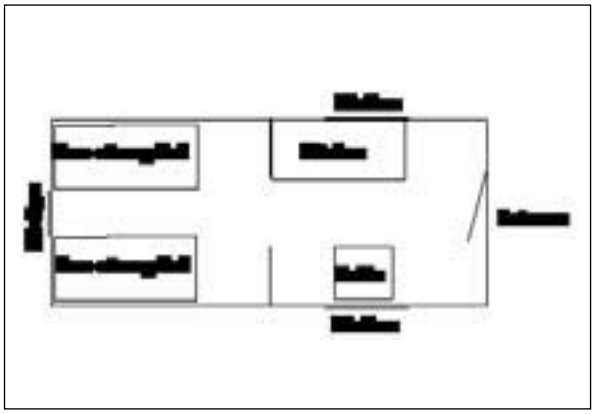


Figure 11.6 Plan of the Svea station. The floor area is approximately 15 m² (each of the two modules are approximately 2.5 by 3 metres). The plan is not drawn to scale.

Figure 11.7 Wasa station yard in stormy weather. The small tracked utility vehicle, the Terry, is mainly used for fetching water and other transportation close to Wasa. PHOTO: PETER DARTH

to the running of the station. If you are uncertain, ask the logistics manager.
- The route straight up to Wasa often gets worn down as the season passes. However, the route cannot be varied much since it is used for heavy transport. It is important that the route is kept in good condition by careful driving. You may only use the Swedish, direct route, or the Finnish route when driving to and from Wasa.
- The only route between Wasa and the "water hole" is marked carefully with stakes, with 50 metres between them, so that it can also be used in poor visibility conditions.
- Refuelling of vehicles is in general only permitted in snow covered areas.

HELICOPTER

The flight route to Wasa follows the regular overland route up the hill to the station. Flights over the station surroundings are otherwise limited to research flights and the placing of the VHF repeater station on "Plogen". Flights close to (steep) cliff sides are not allowed anywhere, due to nesting birds. Landing pads on snow free ground are situated at Wasa and close to Svea.

DRINKING WATER

When starting up the station, the easiest way to get water is to melt snow or ice on the stove. As soon as possible, a "water hole" down into the blue ice area will be opened by the logistics personnel. Before you go down to fetch water, be sure that you know exactly how to do it.

Svea

THE STATION

Svea lies on a nunatakk in Scharffenbergbotnen, in the Heimefrontfjella, around 200 km from Wasa (Figure 11.8, Appendix VI). The station was built during the Antarctic summer 1987–88 and consists of two connected glass fibre modules, each of 2.5 × 3 metres. The outer module contains a kitchen and dining area and the inner one two two-storey beds and a writing desk (Figure 11.6). In between expeditions, the outer room can be used to store a snowmobile, the generator etc. Heating of the station is done through a gas heater (propane). An older, diesel driven heater is still in place but not used anymore. The electrical power mainly comes from solar panels charging car batteries. There is also a generator that runs on petrol that can provide 220 V. The toilet is

Figure 11.8 Svea station, in Scharffenbergbottnen.
PHOTO: ANDERS KARLQVIST

Figure 11.9 The interior of the Svea station.
PHOTO: ANDERS KARLQVIST

placed in a Scott Polar Tent close below the station. The main water source is in the blue ice area close by. For waste management see Chapter 8.

PROTECTED AREAS

Svea lies in an area that is sensitive to disturbance. The nunatakks are among the southernmost in Antarctica, and hundreds of snow petrels and possibly also South polar skuas nest here. In many places you find high abundance of lichens and mosses. It is very important that such areas are not disturbed. You must have the expedition leader's permission to visit protected areas.

Walking areas Those areas that are not protected areas may be visited on foot.

N.B.: Although these areas may be visited they are sensitive to wear and normal caution should also be shown here. Outside of the station area you are not allowed to walk on lichens and mosses. Remember that there are some very steep and high precipices in the area (>300 metres)!

DRIVING OF VEHICLES

The route to Svea from Sveakorset should be reconnoitred at the beginning of the season, since it runs close to crevassed areas. Tracked vehicles should be parked below Svea on the even snow field. There are smaller crevasses in the slope up to Svea. Tracked vehicles should not be driven further into Scharffenbergbotnen than the Svea station. When travelling by snowmobile to the nunatakks close by, you must be very careful not to fall into the wind channels by the mountain sides. They are very steep and deep and may have overhanging snow drifts! In protected areas, all driving is absolutely forbidden.

Appendices

Appendix I Examples of basic personal clothing and equipment.

CLOTHES

ITEM	NO.	COMMENT
Gore-Tex jacket	1	Lent to you by the Secretariat.
Gore-Tex pants	1 pair	Lent to you by the Secretariat.
Fleece sweater	1	Lent to you by the Secretariat.
Pants	1–2 pairs	Work/field work pants (possibly warmer), and "time off"/indoor pants.
Shirt	2	Micro-fleece, wool, and/or flannel. At least one should be micro-fleece or wool.
Warm socks	3–6 pairs	Woollen or synthetic.
Thin socks	1–3 pairs	Preferably synthetic. To use in combination with the warmer socks; and/or indoors.
Water vapour barrier/block	(1 pair)	To prevent foot sweat to wet the socks and shoes from the inside, and in this way chilling the foot.
Underwear (short)	3–6 pairs	In colder climates and/or when drying facilities are lacking, synthetic may be preferred to cotton or cotton mixtures.
Warm underpants, w. long legs	1–2 pairs	Woollen or synthetic.
Warm vest w. long arms	1–2	Woollen or synthetic.
Cap/hat	(1)	To protect from rain and sun, to hold the mosquito net out.
Warm cap	1 (–2)	Woollen or synthetic (and maybe a spare one).
Gaiters	(1 pair)	To keep snow out or when walking in wet vegetation.

ITEM	NO.	COMMENT
Work gloves	1 pair	Synthetic or leather.
Warm mittens	1 pair	Woollen or synthetic.
Scarf, neck gaiter	1	Woollen or synthetic.
Pyjamas	1+1	Something comfortable to sleep in.
T-shirt, or equiv.	2	To use indoors at stations, on ships or in camp.
Walking boots	1 pair	The main pair. They should be well broken in and warm enough for the climate.
Warm boots, rubber boots	1 pair	The spare pair. These could be e.g. extra warm for Antarctica or rubber boots if you are to walk a lot in water or wet areas.
Sandals, or equiv.	(1 pair)	To use indoors at stations, on ships or in camp.

OTHER PERSONAL EQUIPMENT

ITEM	COMMENT
Daypack/small backpack	A useful item on most expeditions.
Thermos	Absolutely necessary on most terrestrial expeditions.
Water bottle	Useful on most terrestrial expeditions.
Toiletry items	Often it is difficult to judge how much, e.g. tooth paste is needed during, say two months. Think it over carefully, there are no shops on expeditions. For longer expeditions you should also think about items that you use rarely.
Towel	If you are not certain that this will be provided for you, bring one.
Sun screen/mosquito repellent	If there is a probable need.
Sunglasses	Good sunglasses are useful on most expeditions, and absolutely necessary if you are to work on snow or ice.
Spare eye-glasses	If you depend on eye-glasses normally.
Small sewing kit	It is often the case that you need it if you have not brought it.
Washing powder	Only when you are certain that it is not provided.
Books and/or CD-player	To make long trips and days with bad weather (which you will experience) pass more quickly.

ITEM	COMMENT
Diary	Both professionally and privately, it may be rewarding to note what is happening.
Camera, lenses, filters, film	The light in the polar regions is different from what you are used to, people bringing cameras usually use more film than they anticipated.
Binoculars	Some deem them absolutely necessary and you will probably not regret bringing a pair.
Pocket knife, multi-tool	Useful on most expeditions. Multi-tools should only be used when "real" tools are unavailable!
Nature guide books	Bird, flower, geology and other nature guides are often worth bringing, if you can find some covering the expedition area.

Appendix II A Message/skrivmeddelande

EXAMPLE OF TRANSMISSION OF A MESSAGE

Researcher Peter Andersson	**Wasa station**
Wasa, Wasa. From Peter. Message follows. Over.	
	From Wasa. Send. Over.
From Peter. Message, from Peter and Johan to Wasa. We want to be picked up by helicopter. Roger so far? Over.	
	Roger. Over.
On Tuesday, after 1400 hours. End of message. Over.	
	From Wasa. Roger. Over.
From Peter. Roger. Out.	

EXEMPEL PÅ SKRIVMEDDELANDE

Forskare Peter Andersson	**Stationen Wasa**
Wasa, Wasa. Från Peter.	
	Wasa, Wasa. Kom.
Skrivmeddelande. Kom.	
	Kom.
Från Peter. Text: Från Per och Johan till Wasa. Vi vill hämtas med helikopter. Kom.	
	Kom.
På tisdag efter klockan 14. Slut på meddelandet. Kom.	
	Wasa, uppfattat. Kom.
Klart slut.	

Appendix II B Radio network traffic

A situation in which many people feel uncomfortable is when their radio station is part of a radio traffic network, and calls are made from the main station to all other stations at the same time. Below you find two examples of common network procedures.

In the first example, in order to save time on the air, Camp 1 chooses to let only Camp 3 acknowledge that the message has been received during its passing. However, when the full message has been sent ("end of message"), all camps acknowledge that they have received and understood it. If any station is uncertain of if they have received the full message, or if anything is unclear, then the (main) station should instead be asked to repeat (part of) the message ("say again, all after...").

EXAMPLE 1. RADIO NETWORK TRAFFIC

Camp 1 – main station	**Camp 2**	**Camp 3**	**Camp 4**
All camps. From Cap 1. Over.			
	Camp 2. Over.		
		Camp 3. Over.	
			Camp 4. Over.
From Camp 1. Message. Camp 3 will acknowledge. Over.			
		Camp 3. Wilco. Over.	
From Camp 1. Re-supply of the camps will take place tomorrrow. Over.			
		Camp 3. Roger. Over.	
From Camp 1. The helicopter will fly in the order Camp 3, Camp 2, Camp 4, and Camp 1. Over.			
		Camp 3. Roger. Over.	
From Camp 1. The ETA at Camp 3 is 1300 hours. Over.			
		Camp 3. Roger. Over.	
From Camp 1. All camps should report to Camp 1 when the helicopter arrives and departs. End of message. Over.			
	Camp 2. Roger. Over.		
		Camp 3. Roger. Over.	
			Camp 4. Roger. Over.
Camp 1. Out.			

When an "all stations/camps" call is sent out, the camps will reply in order. If the station before your own does not reply, you should wait for 5–10 seconds before giving your reply (Example 2, below). When the last station has acknowledged the call, then the (main) station can choose either to try to get in contact with the missing station(s) immediately, or to pass the message on to the stations replying and contact the missing one(s) later.

EXAMPLE 2. RADIO NETWORK TRAFFIC

Camp 1 – main station	**Camp 2**	**Camp 3**	**Camp 4**	**Camp 5**
All camps. From Camp 1. Radio check. Over.				
	Camp 2. Roger. Over.			
		(No reply)		
			Camp 4. Roger. Over.	
				Camp 5. Roger. Over.
Camp 3, Camp 3. From Camp 1. Radio check. Over.				
		Camp 3. Roger. Over.		
All camps. From Camp 1. Roger. Out.				

Appendix II C Procedure words (PROWORDS)

PROWORD	MEANING
ACKNOWLEDGE	Confirm that you have received my message and will comply (WILCO).
AFFIRMATIVE	Yes/Correct.
NEGATIVE	No/Incorrect.
ALL AFTER ...	Everything that you (I) transmitted after ... (keyword).
ALL BEFORE ...	Everything that you (I) transmitted before ... (keyword).
CORRECT (THAT IS CORRECT)	What you have transmitted is correct, you are correct.
CORRECTION	a. An error has been made in this transmission. I will continue with the last word (group) correctly transmitted. b. An error has been made in this transmission. The correct version is ... c. That which follows is a corrected version in answer to your request for verification.
WRONG	Your last transmission was incorrect. The correct version is ...
DISREGARD THIS TRANSMISSION. OUT	This transmission is an error. Disregard it. (This proword shall not be used to cancel any message that has been already completely transmitted and for which receipt or acknowledgement has been received.)
END OF MESSAGE OVER (OUT)	This concludes the message just transmitted (and the message instructions pertaining to a formal message).
END OF TEXT	The textual part of a formal message ends. Stand by for message instructions immediately following.
FETCH ...!	I wish to speak on the radio to that person (appointment title).
... SPEAKING	Requested person is now using the radio himself.
FIGURES	Numerals or numbers will follow. (This proword is not used with the call signs, time definitions, grid references, bearings, distances etc., especially in fixed-form reports.)
FROM	a. This is ... b. The originator of this formal message is indicated by the address designation immediately folowing.

PROWORD	MEANING
TO	The addressees whose designations will immediately follow are to take action on this formal message. This transmission is from the station whose designation immediately follows.
MESSAGE	I have a message for you.
MESSAGE FOLLOWS	A formal message which requires recording is about to follow.
OVER	This is the end of my turn of transmitting. A response is expected. Go ahead, transmit.
OUT	This is the end of my transmission to you. No answer or acknowledgement is expected.
OUT TO YOU	Do not answer, I have nothing more for you, I shall now call another station.
READ BACK!	Repeat the entire following transmission back to me exactly as received.
I READ BACK	The following is my reply to your request to read back.
SAY AGAIN!	a. Repeat all of your last transmission.
	b. Followed by identification data ALL AFTER, ALL BEFORE, WORD AFTER, WORD BEFORE etc. It means: Repeat ... (portion indicated).
I SAY AGAIN	I am repeating my transmission or portion indicated.
SEND!	Go ahead with your transmission.
SEND YOUR MESSAGE!	Go ahead, transmit: I am ready to copy.
SILENCE–SILENCE–SILENCE!	Cease all transmission in this net immediately. Will be maintained until lifted.
SILENCE LIFTED	Silence is lifted. The net is free for traffic.
... SPEAK SLOWER!	Reduce the speed of your transmission. (Normally used in connection with request for repetition.)
I SPELL	I shall spell the next word, group or equivalent phonetically.
RELAY TO ...	Transmit the following message to all addressees or to the address designation immediately following.
RELAY THROUGH ...	Send this message through call sign ...
THROUGH ME	I am in contact with the station you are calling. I can act as a relay station.

PROWORD	MEANING
MESSAGED PASSED TO ...	Your message has been passed to ...
ROGER	I have received your last transmission satisfactorily.
ROGER SO FAR?	Have you received this part of my transmission satisfactorily?
WILCO	I have received your message, understood it and will comply. (To be used only by the addressee.) ROGER and WILCO are never used together.
UNKNOWN STATION	The identity of the station calling or with whom I am attempting to establish contact is unknown.
VERIFY	Verify the entire message (or portion indicated) with the originator and send verified version. To be used only at discretion of or by the addressee to which the questioned message was directed.
I VERIFY	That which follows has been verified at your request and is repeated. To be used only as a reply to VERIFY.
WAIT–WAIT–WAIT	I must pause a few seconds, and will call you again when ready.
WAIT-OUT	I must pause longer than some seconds, and will call you again when ready.
WORD BEFORE ...	The word of the message to which I have reference is that follows ...
WORD AFTER ...	The word of the message to which I have reference is that precedes ...
WORDS TWICE	Communication is difficult. Transmit(ting) each phrase (group) twice. This proword can be used as an order, request or as information.

Appendix II D Radio check

PROCEDURE WORDS FOR RADIO CHECK

WORD	MEANING
RADIO CHECK	What is my signal strength and readability, how do you read me?
YOU ARE (I READ YOU)	Your signal strength and readability is as follows ...
SIGNAL STRENGTH	
LOUD (5)	Your signal is excellent.
GOOD (4)	Your signal is good.
WEAK (3)	I can hear you with difficulty.
VERY WEAK (2)	I can hear you with great difficulty.
NOTHING HEARD (1)	I cannot hear you at all.
READABILITY	
CLEAR (5)	Excellent quality.
READABLE (4)	Good quality. No difficulties in reading you.
DISTORTED (3)	I have troubles in reading you because of distortion.
WITH INTERFERENCE (2)	I have troubles in reading you due to interference.
UNREADABLE (1)	I can hear that you transmit but I cannot read you at all.

EXAMPLE OF RADIO CHECK

Ice-breaker Oden	**Camp 1**
Camp 1, Camp 1, from Oden, radio check. Over.	
	From Camp 1, you are loud and clear. Over.
From Oden. Roger. Out.	

Appendix II E Spelling/bokstavering

When something needs to be spelled, the international phonetic alphabet is used.
Numerals are transmitted digit by digit with the exception of round figures as hundreds and thousands.

LETTERS

A	Alfa	**H**	Hotel	**O**	Oscar	**V**	Victor
B	Bravo	**I**	India	**P**	Papa	**W**	Whisky
C	Charlie	**J**	Juliet	**Q**	Quebec	**X**	X-ray
D	Delta	**K**	Kilo	**R**	Romeo	**Y**	Yankee
E	Echo	**L**	Lima	**S**	Sierra	**Z**	Zulu
F	Foxtrot	**M**	Mike	**T**	Tango		
G	Golf	**N**	November	**U**	Uniform		

NUMERALS

0	Zero	**5**	Fi-yiv
1	Wun	**6**	Six
2	Too	**7**	Seven
3	Three	**8**	Ate
4	Fo-wer	**9**	Niner

BOKSTAVERING PÅ SVENSKA

A	Adam	**H**	Helge	**O**	Oskar	**V**	Viktor
B	Bertil	**I**	Ivar	**P**	Petter	**W**	Wilhelm
C	Cesar	**J**	Johan	**Q**	Qvintus	**X**	Xerxes
D	David	**K**	Kalle	**R**	Rudolf	**Y**	Yngve
E	Erik	**L**	Ludvig	**S**	Sigurd	**Z**	Zäta
F	Filip	**M**	Martin	**T**	Tore	**Å**	Åke
G	Gustav	**N**	Niklas	**U**	Urban	**Ä**	Ärlig
						Ö	Östen

Appendix III Waste management

POTENTIALLY HARMFUL PRODUCTS

Examples of products, or equivalent, that might have harmful effects.

The following products shall not be brought to Antarctica:

- polychlorinated biphenyls (PCB),
- non-sterile soil,
- polystyrene chips/beads and similar forms of packaging material, and
- pesticides (except that which is necessary for research or medical/hygienic reasons).

The use of the following products in Antarctica is highly discouraged:

- polyvinylchloride (PVC) products.

For Antarctica, a special permit is required for

- introduction of non-native (non-indigenous) species of animals and plants (including seeds), and
- introduction of any non-native micro-organisms (including viruses, bacteria, parasites, fungi and yeast).

WASTE REDUCTION

General measures to reduce waste production in Antarctica.

- Minimise purchase of products with plastic, glass or other bulky packaging material.
- Buy durable products instead of disposable products.
- Get rid of unnecessary packaging material (especially plastic) before leaving for Antarctica.
- Substitute shredded paper, polystyrene chips, beads and other similar loose packaging material with bubble wrap, cardboard or paper.
- Buy products that easily can be reused for other purposes.
- Use packaging material that can be reused.
- Reuse products and material whenever this is practicable.

HAZARDOUS WASTE

Examples of hazardous waste.

Liquid hazardous waste

- oil products,
- anti-freeze,
- paint products,
- detergents and disinfectants,
- glue, photochemicals,
- chemicals,
- mercury, and
- oil polluted soil and water.

Solid hazardous waste

- treated wood (treated or painted wood, particle board, and plywood),
- medical waste (syringes, knifeblades etc.),
- electrical batteries,
- asbestos,
- explosives,
- solid chemicals, and
- fluorescent tubes.

RADIOACTIVE WASTE

Examples of hazardous waste.

Liquid radioactive waste

- organic solvents,
- all non water-soluble scintillants, and
- all water-soluble waste.

Solid radioactive waste

- isotope containers,
- damaged calibration sources, and contaminated laboratory clothing, gloves, paper towels, soiled, pipettes, and vials.

Appendix IV Actions relating to oil spill incidents

INITIAL OIL SPILL ASSESSMENT

- Probable quantity of fuel spilled.
- Type of fuel.
- Location of the spill.
- Probable source and cause.
- Any risk of fire.
- Any risk of harm to human health.
- Any risk to the environment.

On Swedish expeditions, oil spill incidents are classified into two types, each with its own set of actions to be taken.

TYPE 1	ACTIONS
Small local spills that can be dealt with immediately by one person (<200 litres).	1. Ensure the safety of all personnel. Check for fire and explosion risk, and ensure that any necessary safety equipment is worn. 2. Make an initial assessment: ▪ Probable quantity of fuel spilled. ▪ Type of fuel. ▪ Location of the spill. ▪ Probable source and cause. ▪ Any risk of fire. ▪ Any risk of harm to human health. ▪ Any risk to the environment. 3. Priority should be given to protecting any drinking water supply area. Also, if the spill occurs on ice, attemps should be made to stop it reaching ice-free ground. 4. Recover as much oil as possible (see below). 5. Report to the expedition leader, as soon as convenient.

TYPE 2	ACTIONS
Medium spills that require a dedicated clean-up team (>200 litres)	1. Ensure the safety of all personnel. Check for fire and explosion risk, and ensure that any necessary safety equipment is worn. 2. Make an initial assessment. 3. Report the assessment information to the expedition leader as soon as possible.

GENERAL PROCEDURE FOR RECOVERY OF SPILLED OIL

- If a spill occurs, try to stop or minimise any further spillage.
- For all spills, deploy absorbents to contain the oil. It may be possible to hold the oil in depressions by using absorbent materials, or by building small dams.
- If possible, use pumps to remove the fuel from the ground straight into 200 litre drums. Ensure that empty drums of sufficiently good quality are available near the spill site.
- Absorbent pads should be spread on any remaining oil that cannot be pumped or manually removed.
- Oil soaked absorbents must be picked up and placed in plastic bags or empty 200 litre drums.
- Contaminated snow can be stored in 200 litre drums which have had their tops removed. Allow the snow to melt and decant off the oil.
- Any waste drums containing a mixture of oil and snow or water are likely to freeze. To prevent drums from splitting, use only such in good condition. Do not fill them up completely.
- Drums containing recovered oil or water should be stored on oil containment mats.
- Drums containing recovered oil or water, oil soaked absorbents and contaminated clothing must be sent for disposal outside of Antarctica.

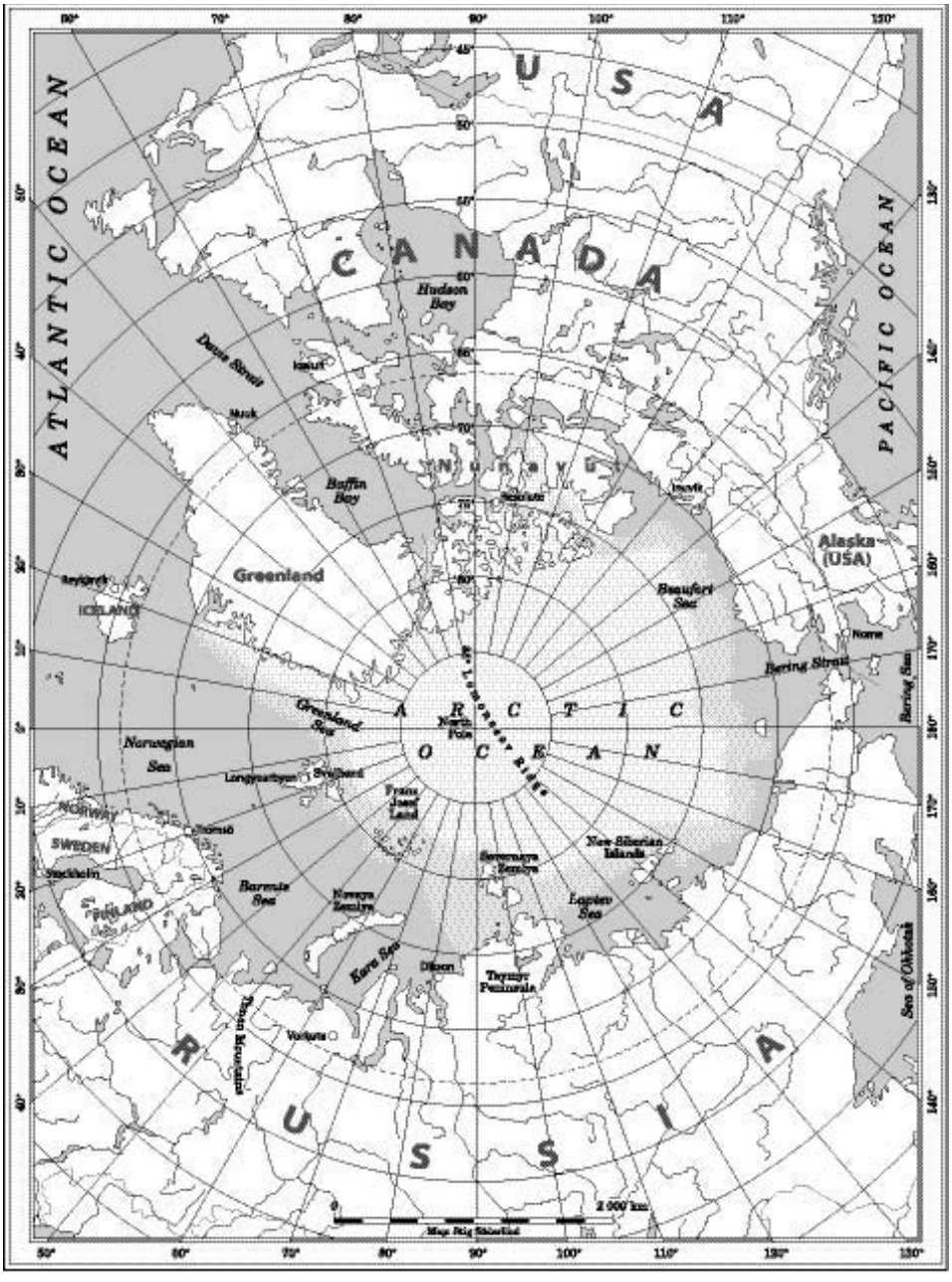
Appendix V Contents of SWEDARP emergency boxes

ITEM	NUMBER OF	ITEM	NUMBER OF
Tent	1	Signalling mirror	1
Sleeping pad	2 (Snowmobile)	R6 batteries	10
	4 (Tracked vehicle)	Battery holder for VHF	1
Sleeping bag	2 (Snowmobile)	Snow shovel	1
	4 (Tracked vehicle)	Rope, 40 m (9 mm)	1
Burner	1	Ice axe	1
Pot	1	Crampons	1 pair
Fuel bottle	1	Harness	1
Fuel pump	1	Snap-hook (screw lock)	6
Suction tube	1	Matchbox	1
Compass	1	Prusik	4
Cutlery set	1	Tape sling, 120 cm	2
Knife	1	Rescue sling (tape)	1
Emergency rations	(See below)	Ice screw	1
First aid kit	1	Abseiling device (rope brake)	1
Smoke flare	3	Pulley	2
		Tent pegs (snow)	10

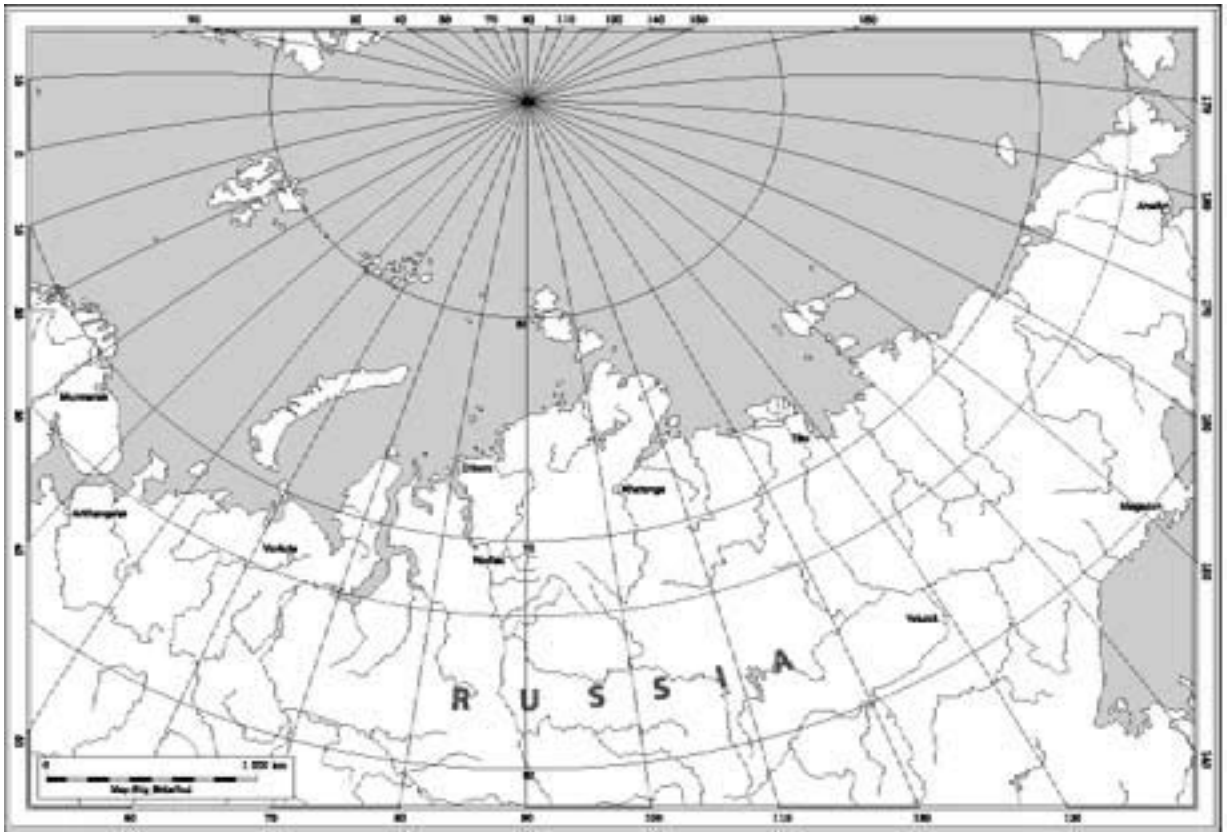
EMERGENCY DIET, SWEDARP

NO. OF DAYS	TYPE OF FOOD	AMOUNT
2	Freeze-dried food	Snowmobile 1 × (4 bags) Tracked vehicle 2 × (4 bags)
2	Emergency food (Seven Oceans)	Snowmobile 4 × packet
2	Soup and energy drink	Snowmobile 2 × (4 soup, 2 drink) Tracked vehicle 4 × (4 soup, 2 drink)
Extra	Coffee, tea etc.	Snowmobile 4 × bag Tracked vehicle 2 × (4 bags)

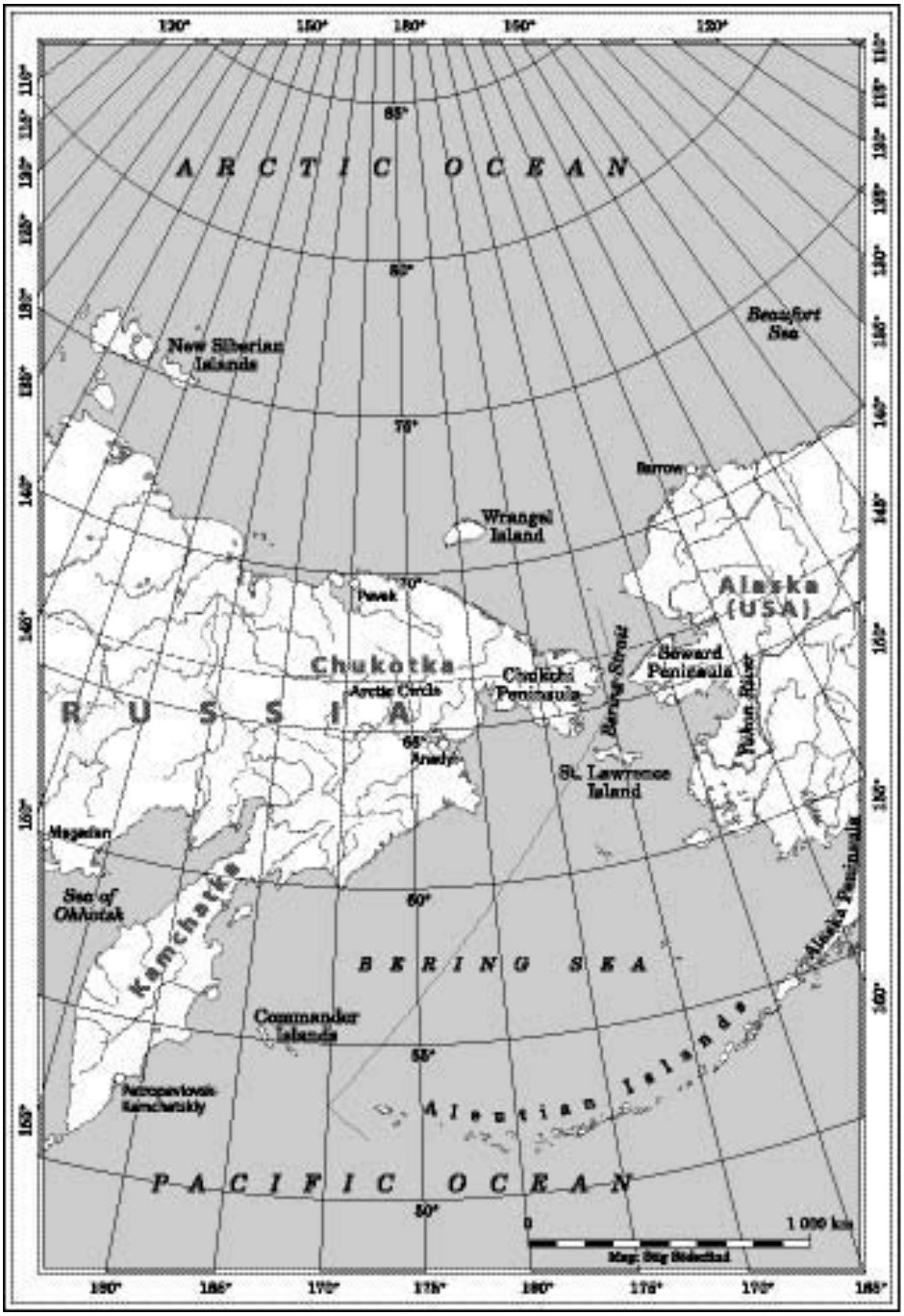
Appendix VI Maps



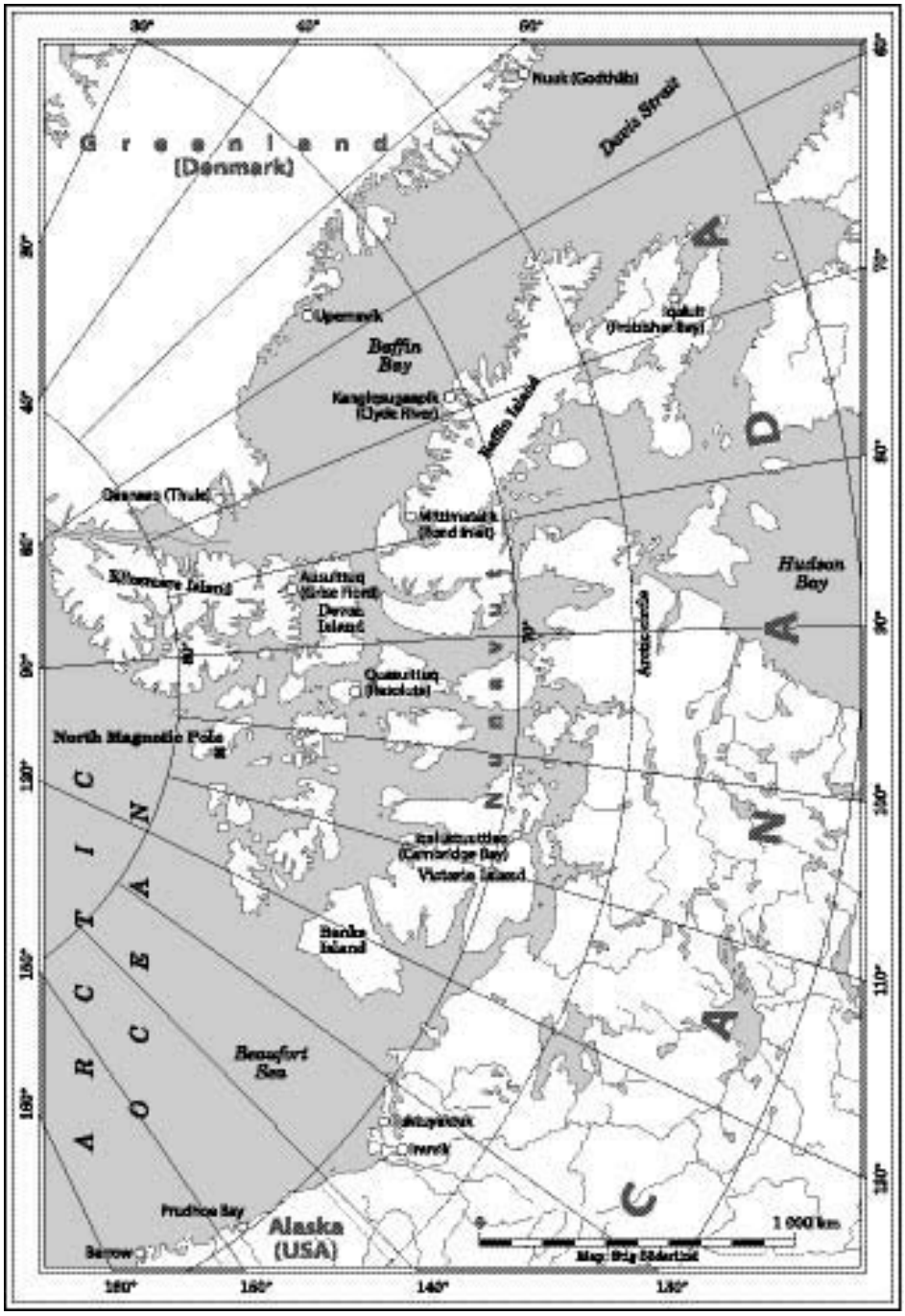
The Arctic



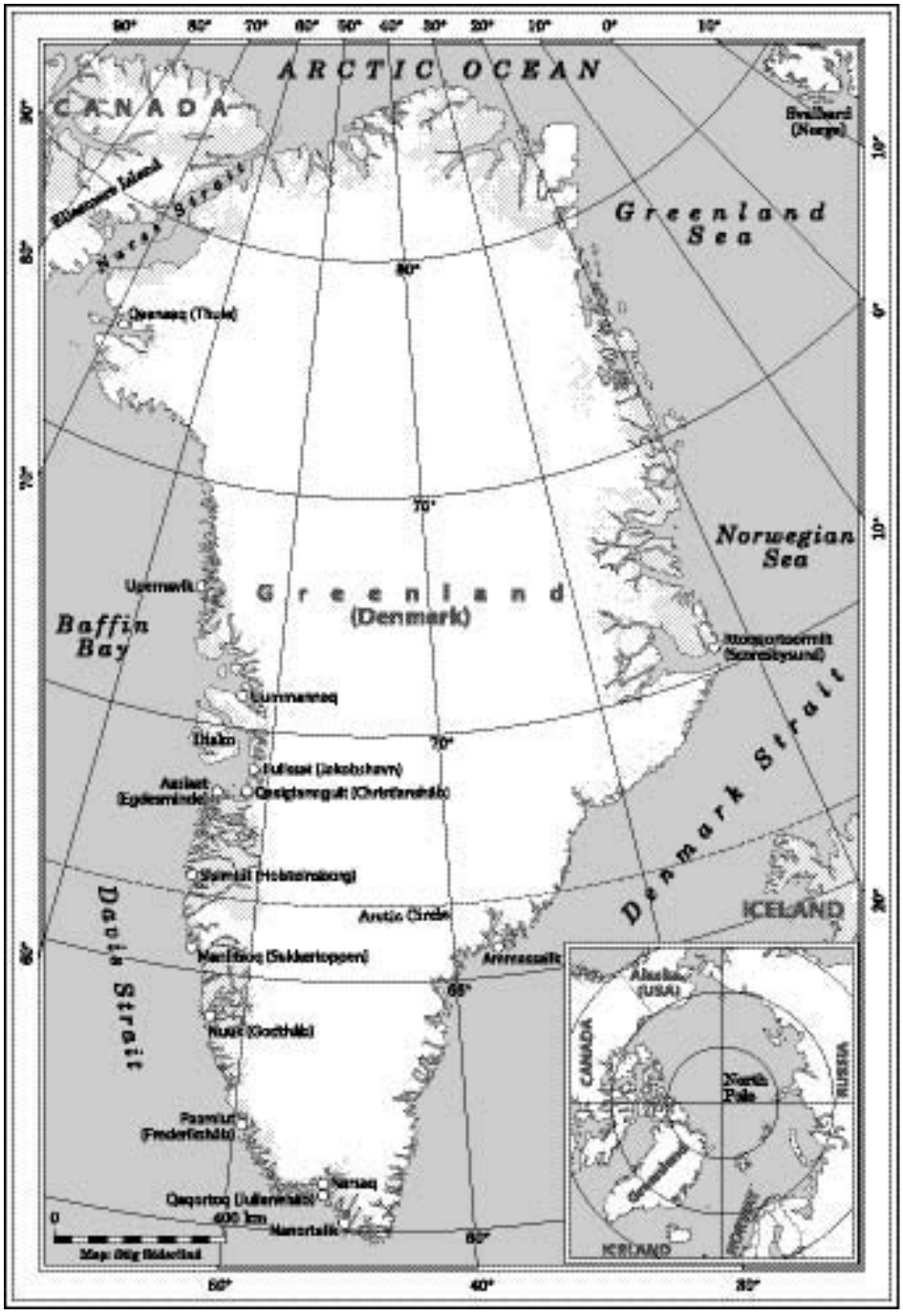
Siberia


ARCTIC OCEAN
Beaufort Sea
New Siberian Islands
Barrow
Wrangel Island
Alaska (USA)
Chukotka
Chukchi Peninsula
Seward Peninsula
Bering Strait
Yukon River
RUSSIA
Arctic Circle
Anadyr
St. Lawrence Island
Magadan
Sea of Okhotsk
Kamchatka
Alaska Peninsula
BERING SEA
Commander Islands
Aleutian Islands
Petropavlovsk-Kamchatskiy
PACIFIC OCEAN
1 000 km

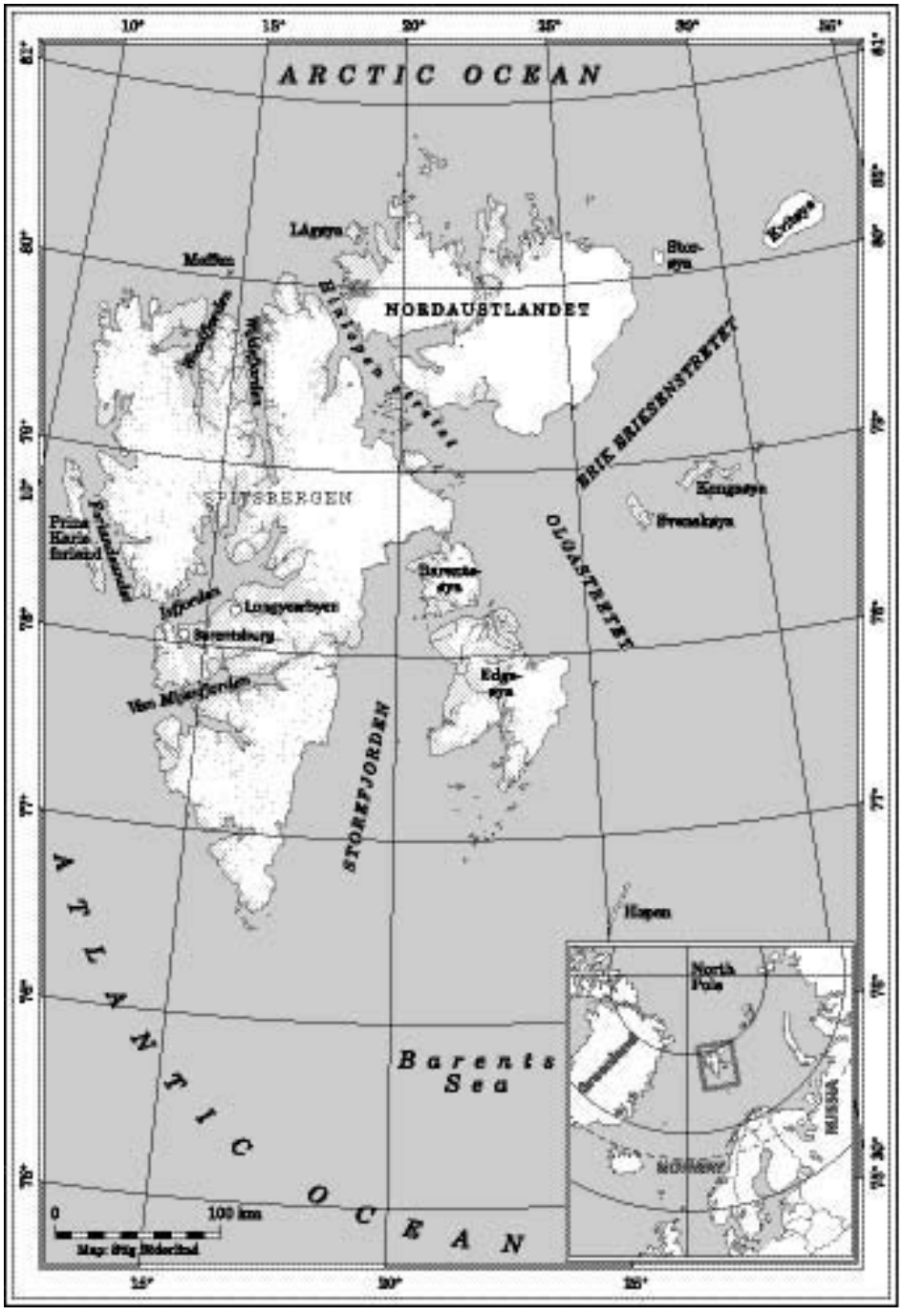
Beringia


Greenland
(Denmark)
Davis Strait
Baffin Bay
Hudson Bay
Nunavut
Victoria Island
Banks Island
Beaufort Sea
North Magnetic Pole
Alaska
(USA)
Prudhoe Bay
Barrow
Devon Island
Ellesmere Island
Boothia Peninsula
Amundsen Gulf
0
1 000 km

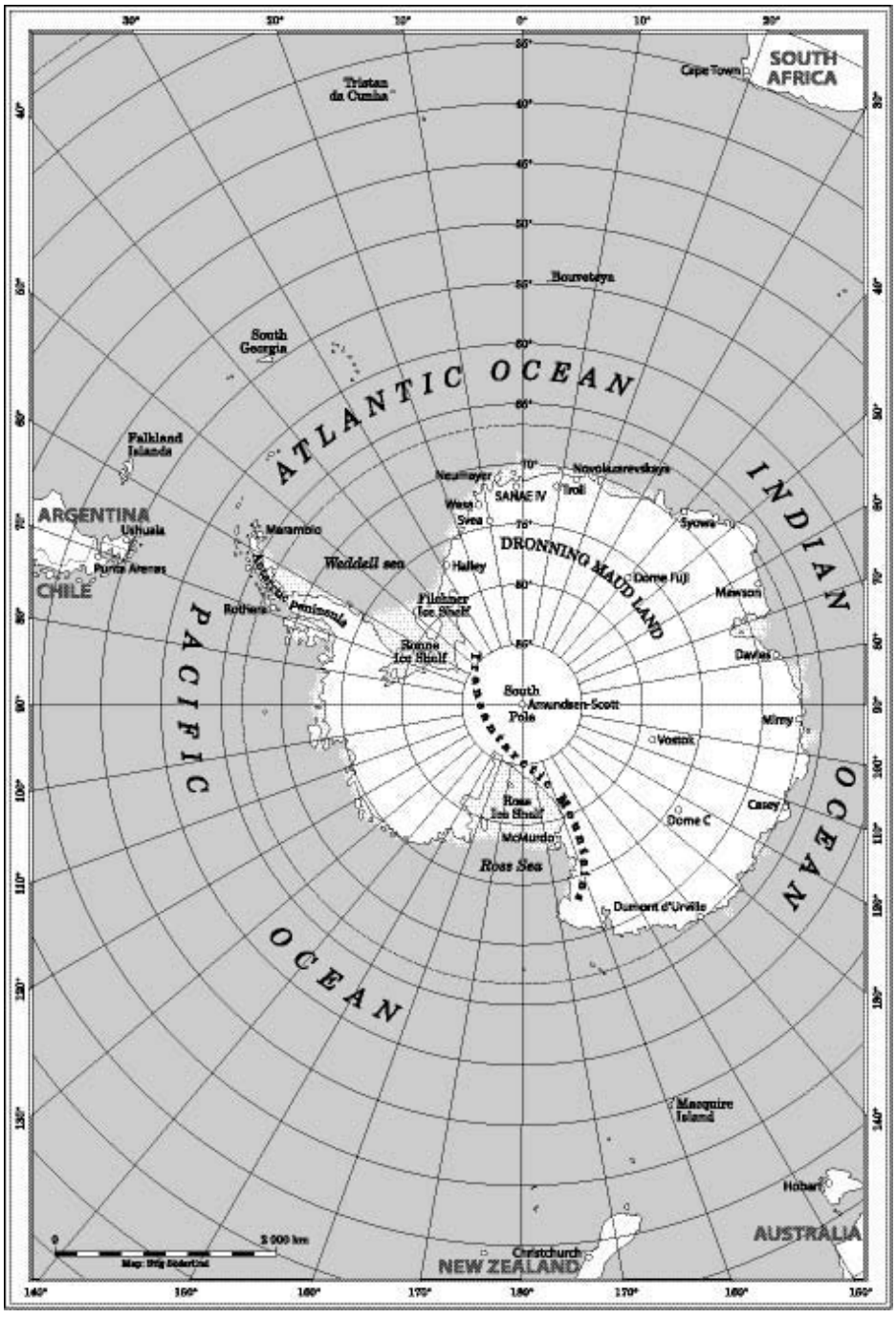
Canada


ARCTIC OCEAN
CANADA
Greenland Sea
Norwegian Sea
Baffin Bay
Greenland (Denmark)
Denmark Strait
ICELAND
Davis Strait
Nares Strait
Ellesmere Island
Qaanaaq (Thule)
Upernavik
Uummannaq
Ilulissat (Jakobshavn)
Aasiaat (Egedesminde)
Qeqertarsuaq (Christianshåb)
Sisimiut (Holsteinsborg)
Arctic Circle
Maniitsoq (Sukkertoppen)
Nuuk (Godthåb)
Paamiut (Frederikshåb)
Narsaq
Qaqortoq (Julianehåb)
Narsarsuaq
Kangerlussuaq
Ittoqqortoormiit (Scoresbysund)
Tasiilaq
Alaska (USA)
CANADA
Greenland
North Pole
RUSSIA
ICELAND
NORWAY
0
600 km

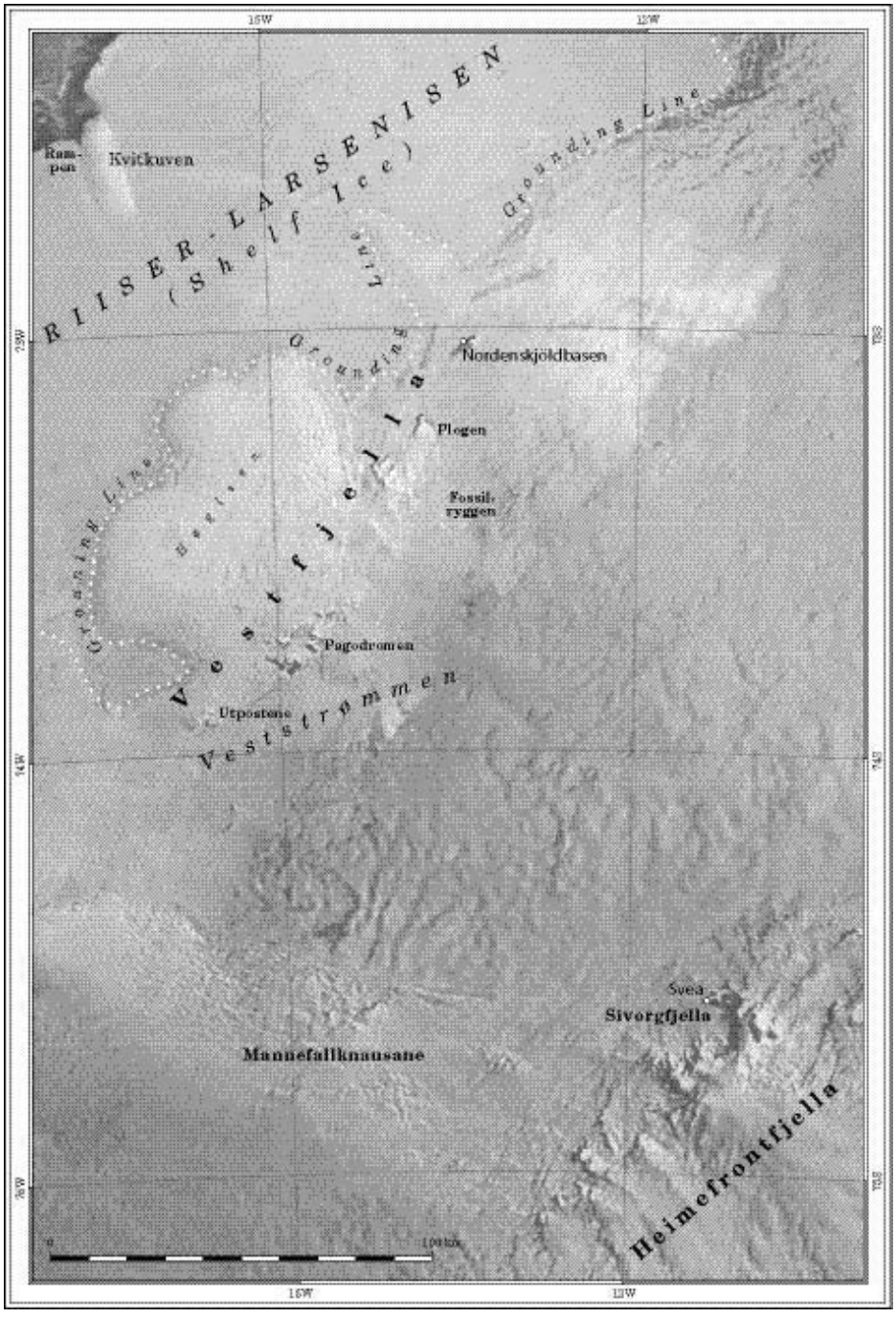
Greenland


ARCTIC OCEAN
NORDAUSTLANDET
ERIK EIRIKSSENSTRETET
SPITSBERGEN
OLGASTRETET
STORFJORDEN
Barents Sea
GREENLAND SEA
RUSSIA
NORWAY
North Pole
0
100 km

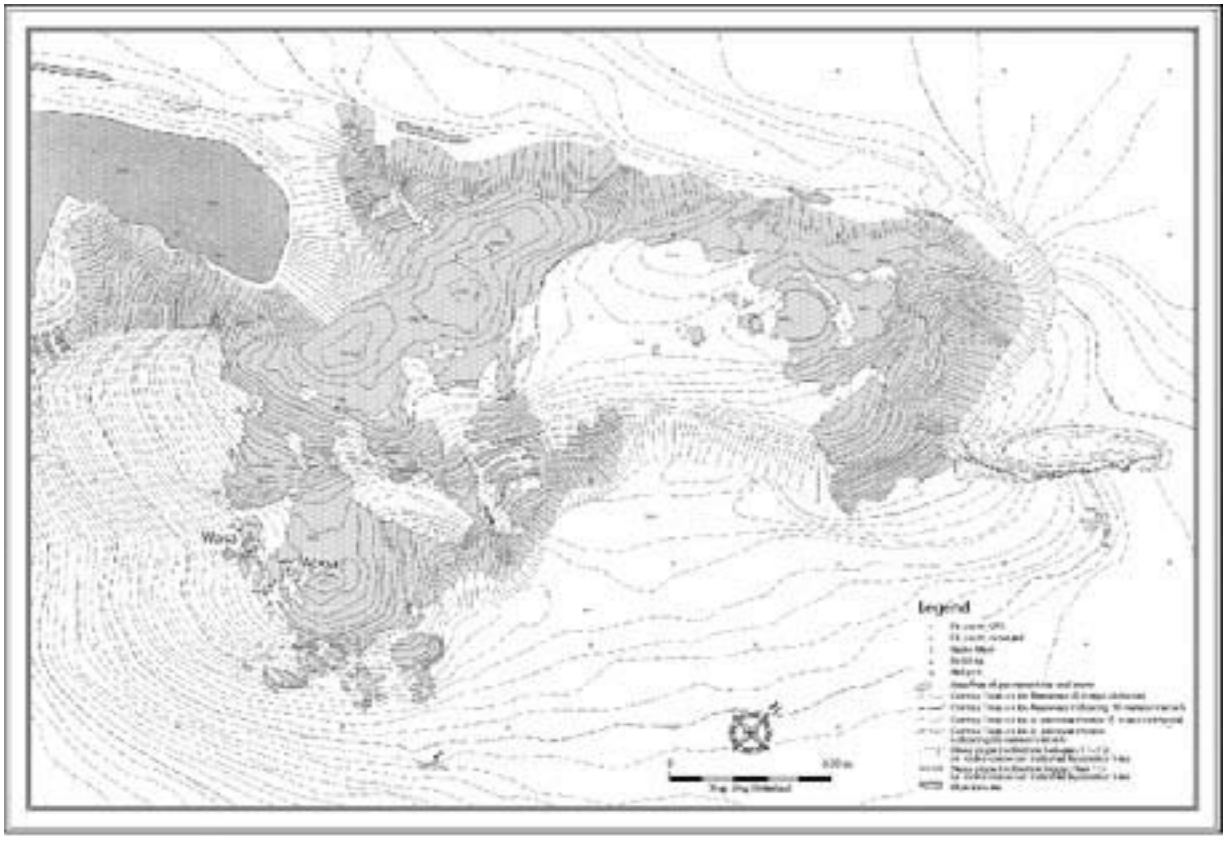
Svalbard


SOUTH AFRICA
Cape Town
Tristan da Cunha
Bouvetøya
South Georgia
ATLANTIC OCEAN
INDIAN OCEAN
PACIFIC OCEAN
Falkland Islands
ARGENTINA
Ushuaia
Punta Arenas
CHILE
Marambio
Weddell sea
Halley
Neumayer
Novolazarevskaya
SANAE IV
Wasa
Svea
Aboa
Syowa
DRONNING MAUD LAND
Dome Fuji
Mawson
Davis
Filchner Ice Shelf
Ronne Ice Shelf
Transantarctic Mountains
South Amundsen-Scott Pole
Vostok
Mirny
Ross Ice Shelf
McMurdo
Ross Sea
Casey
Dome C
Dumont d'Urville
Macquire Island
Hobart
AUSTRALIA
NEW ZEALAND
Christchurch
0
1 000 km

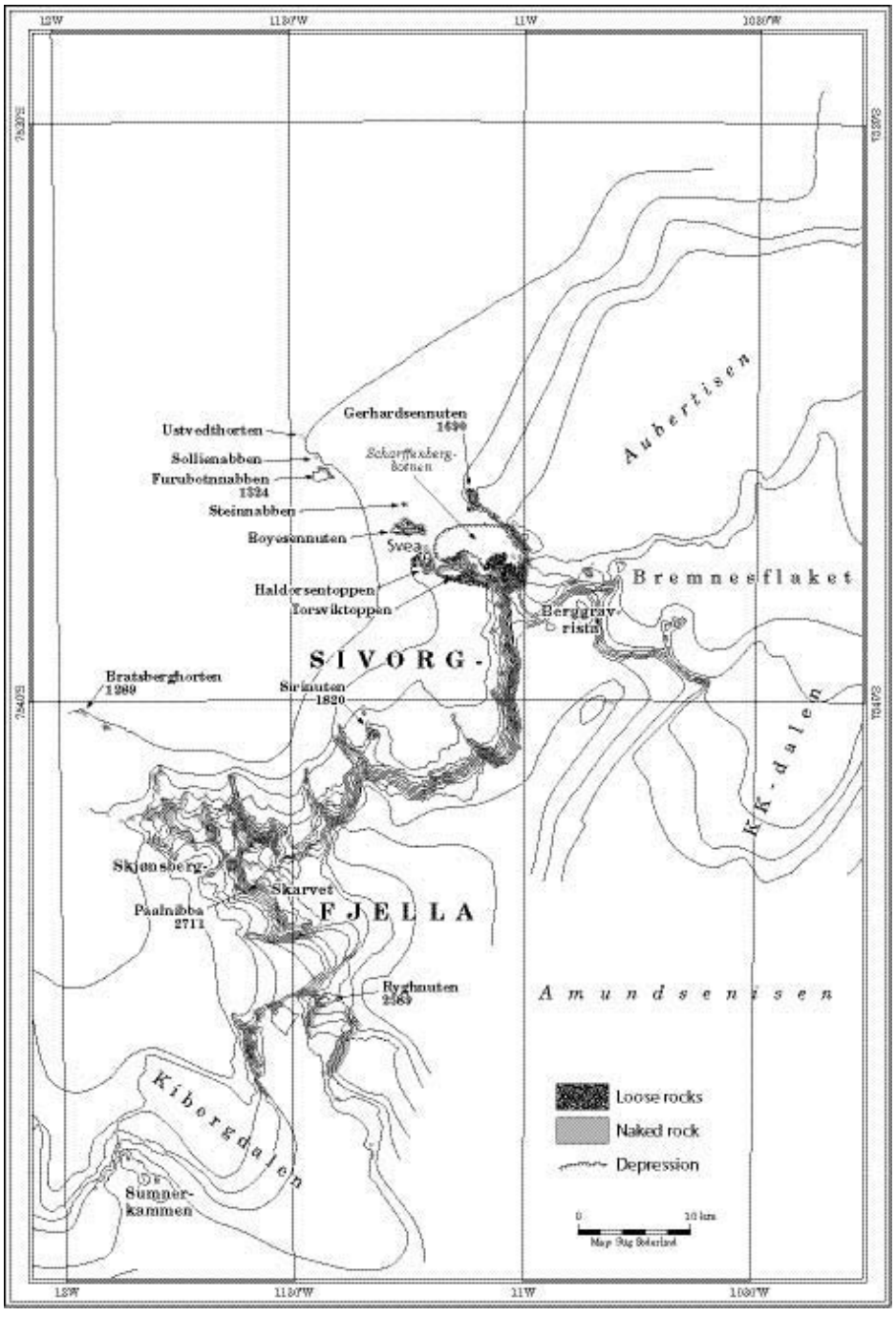
Antarctica



Overview Rampen–Wasa–Svea



Nordenskjöldbasen



Sivorgfjella (Svea)