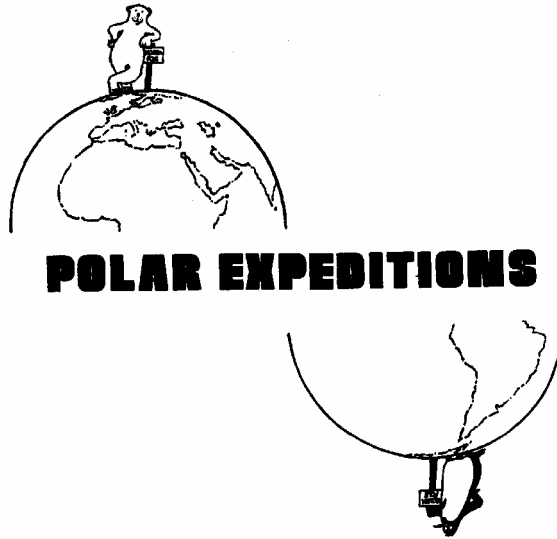


ROYAL GEOGRAPHICAL SOCIETY
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Royal Geographical Society
(with the Institute of British Geographers)
1 Kensington Gore
London SW7 2AR

Tel: 020 7591 3030
Fax: 020 7591 3031
eac@rgs.org
www.rgs.org/eac

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This latest much revised and pruned edition has been so, partly because much of the original material is now readily available elsewhere or was not specifically polar in nature. The list of people who have contributed in one way or another grows ever longer and their names are listed below. Although they may not immediately recognise their contribution, thanks are due to all as without them this Polar Expedition Handbook would have been impossible to produce.

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The evolution of this handbook has been protracted in places and this edition is by no means final. It is intentionally loosely bound so changes can be made easily. Please contact the Editors or the Expedition Advisory Centre if you find obsolete information.

Rachel Duncan

INTRODUCTION TO THIS EDITION

This manual does not try to be comprehensive but aims to be a starting point for those planning a trip to a polar environment. It tries not to duplicate existing publications available although inevitably does in parts. Other key reference sources which complement this manual are listed at the end of each chapter and in the appendices.

To save on printing costs and bulk, the decision has been taken not to include chapters outlining specific science projects. There is a short section in the planning chapter, but as with all scientific expeditions, ideas for research projects will involve reference searches which may include the first edition of the EAC Polar Expeditions Manual. For the same reason this manual does not cover the generic aspects of any expedition such as fund-raising, choosing a research project, young people on expeditions, etc.

INTRODUCTION TO THE FIRST EDITION

by Geoff Renner and David Rootes

“People, perhaps, still exist who believe that it is of no importance to explore the unknown regions...Man wants to know, and when he ceases to do so, he is no longer Man.”

Fridtjof Nansen, Norwegian Polar Explorer

Each of us has that exploratory urge, in some well hidden, in others their life's work. Not everybody is prepared to pass freezing nights in abject discomfort in order to go beyond the frontiers of civilisation; and why should you? Glaciers and snowfields of the polar regions are not the preserve of the professional explorer alone and discomfort is not a prerequisite of adventure. The Polar Expedition Manual has been compiled with this last sentence in mind. It is intended to supply encouragement and assistance to those who wish to visit the polar regions, Arctic and Antarctic. Its aims can be stated quite clearly:

- To provide sources of information for small, relatively short polar expeditions;
- To give an indication of the planning required;
- To highlight the need for training for safe travel in the polar regions;
- To give pointers to scientific guidelines for polar expeditions.

The contributors to the Polar Expedition Manual have wide polar experience, based on many journeys to, or years of scientific endeavour in, the polar regions; their encouragement and advice should not be taken lightly. Distilling such knowledge and experience into the written word is not an easy task and all would advise you to seek further reference and discourse to help plan an active and safe expedition. There is no substitute for speaking to those who have been there and done something similar.

The polar expeditioner is on the threshold of a stunning era. University, school and private expeditions have been heading north for many years, and much good work has resulted. For political reasons more than a third of the Arctic has been inaccessible but expedition planners can now take every opportunity to "open-up" the Soviet north – from Kola to Kamchatka. The second destination, where access, if not the cost, is improving is Antarctica and the surrounding islands.

The choice is almost too much!

Chapter 1: THE POLAR ENVIRONMENT

From space, the ends of the earth look very similar: white, sparkling in sunshine or glowing under the winter moon. These are areas of frozen fresh- or saltwater. This blanket of whiteness obscures mountains and coastlines alike. Like a mirror, the whiteness reflects 95% of sunlight that falls upon it. In winter the areas double in size; in summer they contract but never disappear.

On the ground the polar regions could not be more different. The Arctic is centred on an ocean basin almost ringed by land, by contrast the Antarctic is a high continent entirely ringed by an ocean.

The polar regions are among the last patches of the earth to be explored although we have known of their existence for centuries. The Great Bear and Little Bear constellations revolve around *Polaris*, the North Star. The Arctic takes its name from the Greeks who called the whole of the region *Arktikos*, the country of the great bear. The Antarctic is named as the opposite to the Arctic.

There was a time when polar meant everything remote, cold, uncomfortable and dangerous. Now the polar regions are accessible as never before.

1.1 Definition of the polar regions

Your viewpoint will determine the boundary of the polar regions. There are no definitive boundaries for either the Arctic or the Antarctic. Each starts at its geographic pole and extends an indefinite distance towards the temperate zones. Geographers often use the polar circles, biologists look for ecological limits, oceanographers use boundaries between water masses, climatologists use the 10°C summer isotherm and politicians and lawyers use other parallels of latitude.

A 'polar' environment exists as far south as Southern Greenland and the Canadian Barren Grounds. Conversely, parts of Northern Norway lying well above the Arctic Circle enjoy an almost temperate climate with ice-free harbours and cultivated fields. Ellesmere Island at 83°N is unusually mild for the latitude, in the summer.

In this manual, we are concerned with those environments that have polar-like conditions, be it at high latitudes or nearer the equator where there is glacial activity at high altitude. Clearly the land and oceans adjacent to the Poles are included but so too are for example, Greenland, Iceland, Svalbard and the Patagonian ice cap. These last areas are all very accessible during their summer and annually accommodate several hundred expeditions. Even the Cairngorm plateau, Scotland, in the depths of winter has a tundra-like quality, that makes an excellent training ground before going further afield.

A widely used definition is the maximum mean temperature of 10°C in the warmest month. This isotherm in the northern hemisphere effectively marks the (gradual) transition from northern forests to the treeless tundra. The short period warm enough for photosynthesis limits growth enough for trees. This may be further divided into two zones: the High Arctic (and Antarctic) has a severe polar climate with minimum snowfall. The winters are long and cold and the summers short and very cool with a July (January) mean of less than 5°C. The coasts are usually blocked with ice, which does not scatter until July and August (January and February) and navigation is only possible for about six weeks,

except for powerful icebreakers. The tidal zone is lifeless. Vegetation is much reduced and consists of rock desert, there being no real heaths, shrubs or willow copse.

The Low Arctic has a much greater snowfall and winters are not so cold or long, often showing periods of thaw and refreeze. For this reason, the periglacial geomorphologist will find much to study. Summertime is more extended and milder with a July mean of 5–10°C. The coasts are ice-free for varying but longer periods. Protected bays and fjords are ice covered even into the beginning of summer, but open coasts may be ice-free all year. The tidal zone is inhabited by a considerable number of animals and the vegetation very often forms a continuous mat of dwarf bush heath mixed with copses of willow and shrub.

There are four boundaries commonly held to define the Antarctic: the most widely accepted is the Antarctic convergence: a belt of water, in places only a few kilometres wide, separating Antarctic surface water from slightly warmer and more saline sub-Antarctic surface water. It is detectable at the surface by a sudden sharp gradient in sea temperature; the other boundaries include the 10°C July isotherm, the northern limit of the pack ice and the Antarctic Circle, which is defined in the Antarctic Treaty as 60°S. The Antarctic covers a great deal more than the continent its self, including the sub-Antarctic islands; e.g. the South Orkney, South Shetland and South Sandwich islands.

1.2 Special aspects of the polar regions

1.2.1 Magnetic poles

The magnetic poles lie some distance from the true poles. They do not align with the poles of rotation because the electric currents that cause the magnetism are affected by magnetic rocks in the Earth's crust. The magnetic poles wander and the North Magnetic Pole has drifted more than 750km since its discovery by James Clark Ross in 1831. The notional 'geomagnetic' poles are artificially calculated points based on where the magnetic poles would be if they lay at either end of a straight bar magnet. The positions of these affect the positions of the Aurora.

1.2.2 Aurora Borealis and Aurora Australis

The Aurora Borealis/Australis (Northern and Southern Lights) are caused by electrically charged particles streaming from the sun and hitting the upper atmosphere and diverting towards an oval ring centred on the geomagnetic pole (hence their appearance in polar regions). They are at their best in the vicinity of this ring which tends to be nearer the polar circle. See Pielou (1994) for more coverage.

1.2.3 Day length

Over the year, due to the tilt of the earth's axis, the period of daylight varies far more in polar than in temperate regions and even at 60° latitude there is almost twenty-four hour daylight for the month spanning mid-summer; at higher latitudes continuous daylight lasts even longer. Conversely, at either end of the summer season, short daylight can considerably constrain travel. Twenty-four hour daylight sounds attractive but you must still schedule sensible work and rest periods. Poor travelling surfaces can also result from long summer days and many expeditions prefer "night" travel when the sun is lower, resulting in cooler air temperatures and snow surfaces more likely to be frozen.

Unfortunately, overheating in the tent during the "day" when you are trying to sleep may then become an irritation.

1.3 Common climatic features

1.3.1 Albedo

Due to the high reflective nature of snow and ice you should note the importance of albedo (reflection of the sun's radiation) particularly over ice-covered areas. Over much of the Antarctic mainland so much radiation is reflected that for most months, even in summer, there is a net loss of heat. You should take extra care to protect yourself from the sun including such places as the base of your nose (see section 9.3.5).

1.3.2 Whiteout

'Whiteout' occurs when cloud reduces contrast and definition, thereby merging the visibility of the ground, horizon and sky into one. Any sense of scale, distance and horizon are lost causing complete disorientation such that you cannot tell whether you are going up or down slope. Undulations, crevasse bridges and snow features are invisible and travelling in such conditions can be extremely hazardous. Whiteout is not to be confused with just poor visibility caused by rain, drifting snow, fog, etc. The dangers of moving around in such conditions cannot be understated and it is best to try to avoid travelling in such hazardous conditions.

1.3.3 Wind/Wind chill

Both poles experience fairly similar general air circulation patterns, with strong surface Westerlies in the sub-polar belt associated with the so-called Ferrel jet stream. When making camp, always bear in mind the prevailing wind direction to minimise drifting of snow on the lee side of objects. Always mark tents and other stores with a ski stick or other vertical marker. The lee side of hills and slopes will be deposition areas and thus a poor campsite choice.

Where elevated, steep and ice-covered land borders the sea fierce katabatic (downslope, gravity-fed) winds are common, often induced by the presence of comparatively warm ocean water. The piteraq of East Greenland, and the blizzards of the Antarctic coast of Adelie Land are extreme examples, but downslope winds are common round icecaps elsewhere, perhaps triggered by the passage of low-pressure systems. Wind, rather than temperature, is the main enemy of human activity and in windless conditions extremely low temperatures can be endured with a minimum of clothing. The effects of wind chill cannot be understated. Wind will strip warmed air from tent and clothing and exposed flesh can be affected in seconds (see Wind chill Index, below).

Wind speed mph kph		Ambient temperature (°C)							
		-40	-30	-20	-10	-5	0	+5	+10
		Equivalent temperatures (°C) and danger of hypothermia for a fully clothed person							
		GREAT <i>(exposed flesh may freeze)</i>			INCREASING			SMALL	
46	74	-87	-71	-54	-38	-29	-21	-13	-4
35	56	-84	-68	-52	-36	-28	-20	-12	-3
23	38	-77	-62	-49	-31	-24	-16	-9	-1
12	20	-62	-49	-36	-23	-16	-10	-3	+2
6	10	-48	-37	-26	-15	-9	-3	+1	+7
0	0	-40	-30	-20	-10	-5	0	+5	+10

Figure 1: Wind Chill Index

1.3.4 Precipitation

High latitude areas are often deserts due to the limited capacity of cold air to hold moisture. The northern part of Greenland is one example but the most extreme case is Antarctica where annual precipitation may be 30–40cm around the coasts but only 5–10cm inland. Even on sunny days blowing snow (spin drift) can impede travel. Most of the snow causing loss of visibility is old snow raised from the surface by wind with speeds as low as 10 knots obscuring ground features and crevasses. A speed of 30 knots causes blizzards and complete loss of visibility.

1.3.5 Visibility

Under good weather conditions polar air can produce visibility limited only by the curvature of the Earth and beyond by refraction. The estimation of distance by eye is thus a matter requiring extreme caution by the inexperienced. Objects are likely to be much further away than you may think. A further complication may be caused by mirage, in which distant objects are apparently raised above their natural position by instability in the air above relatively warmer surfaces. Icebergs in open ocean are often seen raised, while early sightings of the Antarctic continent may have been confused by this phenomenon. This is known as *Fata Morgana* and is the opposite type of mirage to that experienced in hot deserts. On the Arctic Ocean, the presence of open water can be deduced from shadows of the dark surface water on the underside of clouds.

1.4 Climatic differences

The principal difference between the two polar regions is that the north polar region is an ocean surrounded by (more or less) elevated land masses, while the south polar region is itself an elevated land mass. In winter, sea ice extends the ice-covered areas and thus heat loss, especially around Antarctica where the ice covered area approximately doubles. In summer the melting of sea ice from the Arctic Ocean allows significant heat exchange which is not nearly so significant in the continental mass of Antarctica. These geographical factors cause the Antarctic region to have mean temperature values below those of the

Arctic where natural life can flourish. For instance, Barrow in Alaska has an approximate annual mean temperature range from -10°C to $+20^{\circ}\text{C}$ while Ellsworth in coastal Antarctica has -30°C to -6°C , and the South Pole -60°C to -28°C . The occasional ice-free oases in Antarctica have much higher summer temperatures than the rest of the continent.

The air circulation pattern in the Arctic, especially the course of the stormy *Ferrel* Westerlies, is irregular and determined by the surrounding land masses. Surface Lows pass over the barriers of elevated land, such as the Greenland plateau, in modified conditions, or are deflected by them but in general the sub-polar regions in both hemispheres are stormy. The spring warming in the Arctic, especially the western part, is earlier than in the Antarctic and is caused by solar conditions over areas possibly as distant as the Himalayas.

Moisture conditions vary with distance from the warmer oceans. Although, as mentioned above, high polar regions tend to be deserts, whilst in summer the lower-latitude Arctic can be moist and, with higher temperatures supports vegetation, animal and human life. Human activity or animal life on land in the whole Antarctic zone is only possible under artificial conditions and only the ocean supports what natural life there is.

Further Reading:

See also the list of useful resources in the Appendices.

- BRUEMMER F. (1985) *The Arctic World*. Sierra Club, San Francisco: 256pp. ISBN 087156842X.
- CENTRAL INTELLIGENCE AGENCY (1978) *Polar Regions Atlas*
- CHATURVEDI, S. (1996) *The Polar Regions: A Political Geography*. John Wiley and Sons, Chichester: 306pp. ISBN 0471948985.
- HYDROGRAPHER OF THE NAVY (1985) *Arctic Pilot* (7th Edition). This publication comes in several volumes covering various parts of the Arctic and provides general weather/sea ice information along with weather data for a number of high latitude localities.
- HYDROGRAPHIC OFFICE (1974) *Antarctic Pilot* (4th Edition). Hydrographic Office, London. 336pp. A single volume publication which as with Arctic Pilot provides general sea ice/weather conditions as well as met data for various locations around Antarctica.
- Iceland, Greenland & the Faroe Islands*. 4th Edition Graeme Cornwallis and Deanna Swaney . Published May 2001. ISBN: 0864426860
- LONELY PLANET GUIDES www.lonelyplanet.com
- Antarctica*. 2nd Edition . Jeff Rubin . Published September 2000
- Arctic* . 1st Edition. Deanna Swaney. Published November 1999
- Hiking in Alaska*. 2nd Edition. Jim DuFresne . Published January 2001
- LOPEZ, B. (1986) *Arctic Dreams: imagination and desire in a northern landscape*. Collier Macmillan, Toronto. ISBN 0684185784. Celebrated meditation on Arctic travels.
- PIELOU, E.C. (1994) *A Naturalist's Guide to the Arctic*. University of Chicago Press, Chicago: 327pp. ISBN 0 226 668142. A beautifully illustrated treat which goes beyond flora and fauna to encompass climate, geomorphology and snow and ice.
- READERS DIGEST (1985) *Antarctica – The Frozen Continent*. ISBN: 0 949819 64 6. A revised edition of this excellent publication came out in 2000
- SALE, Richard (2002) *To the ends of the earth, the history of polar exploration*. Harper Collins, London
- STONEHOUSE, B. (1990) *North Pole, South Pole – a guide to the ecology and resources of the Arctic and Antarctic*. Prion, London: ISBN 007510677.

- UK MET OFFICE Publication 617 (1958) *Tables of temperature, relative humidity and precipitation for the world*. (See also UK Met Office Publication 856 (1980)). These excellent reference sources, sadly now out of print are divided up into various volumes. They may be found in large public libraries in major cities such as Cambridge, Oxford and London. Part 1 includes Alaska, Canada and Greenland. Part 2 includes Antarctica. Part 3 includes Iceland, Svalbard, Scandinavia and western Russia (including the Ural Mountains). Part 4 includes eastern Russia (east of Ural Mountains to the Bering Sea).
- WORLD METEOROLOGICAL ORGANISATION. *Climatological norms for the period 1961–1990 (WMO/OMM No. 847)*. This publication, a poor second for polar weather statistics, now supercedes UK Met Office Publications 856 and 617
- WORLD SURVEY OF CLIMATOLOGY *Volume 14 Climates of the Polar Regions*. ISBN 0444408282.
- YOUNG, S.B. (1994) *To the Arctic: an introduction to the Far Northern World*. John Wiley and Sons, New York: 354pp. ISBN 0471078891.

Weather data Websites

Websites offering access to basic weather data on a daily basis, including some polar localities:

- www.washingtonpost.com/wp-srv/weather/world.htm Daily weather details from around the world;
- www.wunderground.com/ Daily weather details from around the world;
- www.msc-smc.ec.gc.ca/index.html Weather reports for northern Canada.
- <http://science.nasa.gov/> NASA, Ozone details
- <http://theyr.com/cg/cny/NA> World Weather, Surface and upper air forecasts. Used by pilots
- www.ecmwf.int European Centre for Medium-Range Weather Forecasts, Links to national weather centres
- www.metoffice.gov.uk UK Meteorological Office, Useful surface weather charts + links to other bureaux
- www.natice.noaa.gov/home.htm National Ice Center, USA, Sea ice and Iceberg charts and data. Current and historical data

Journals and newsletters

Antarctic, published quarterly by The Journal of the New Zealand Antarctic Society. It is an informative and interesting update on all Antarctic news. Contact: the Antarctic Society, PO Box 404, Christchurch 8015, New Zealand. Tel: +64 03 377 3173; fax: +64 03 365 2252; email: antarctic.soc@cyberexpress.co.nz

Polarboken (ISSN 0-382 7620) – a Norwegian text publication with good coverage of polar expedition news. *Polarboken* is issued once a year in Oslo.

Polar Record published quarterly by the Scott Polar Research Institute.

Chapter 2: EXPEDITION PLANNING

2.1 Initial fact finding

Consultation of previous expedition reports at the London based *Royal Geographical Society (with the Institute of British Geographers)* (RGS-IBG) and its *Expedition Advisory Centre* (EAC) is highly recommended, along with a visit to the RGS-IBG's very extensive map collection. Consider a visit to the library at the *Scott Polar Research Institute* (SPRI) in Cambridge. These organisations are only open on weekdays. It is vital to make an appointment before you visit to ensure staff are best able to assist. See the appendices for contact details.

There is a host of polar related information on the Internet including polar expedition websites, personal accounts of polar travellers as well as travel information. For those not based in the UK see the Scott Polar Research Institute website www.spri.cam.ac.uk for listings of polar institutions around the world. For Antarctic information a good starting place is www.antarctic-circle.org. Other web sites and key source books are listed in the appendix.

There is no substitute for being in touch directly with others who have been to the region. Before asking to talk to people more experienced and knowledgeable than yourself, make sure you have already done some serious ground work and research on the area you plan to visit so you don't waste their time. Find out the problems they encountered. Contact and consult respective organisations/individual in the country/region to be visited. Obtaining local knowledge will make your trip more likely to be a success.

2.2 Access, permits and paperwork

Gone are the days when travel to the Polar regions enjoyed unrestricted access. Various permits and paperwork will almost certainly be required for travel. These include licences/permits for radio or communications equipment, certain other equipment and the export and carriage of firearms. In many cases, obligatory search and rescue (SAR) insurance bonds and risk assessment and/or environmental impact assessment of your activities may also be required. Imported food may well be restricted but this need not be seen as a disadvantage: local supplies can be cheaper and will seriously reduce your freight charges. Don't underestimate the time needed to obtain permissions and book transport and freight. It may have to be done in the previous operational season.

2.3 Equipment

This manual does not intend to cover equipment other than that specific to the polar regions. Equipment taken will be determined by the nature of the expedition (travelling or static), the terrain (flat or mountainous) and time of year (summer, spring or winter).

Standard winter mountaineering equipment, clothing and tents may well suffice in many cases, although not always ideal for polar use. If you already have kit or will want to use it in a different environment, consider the rationale of spending money on something very specific. During summer in much of the Arctic and the northern Antarctic Peninsula,

you will probably enjoy conditions better than Scotland in winter. Avoidance of rain, mosquitoes and sunburn will be your main challenges.

See the relevant chapters on maps and photographs, kites, sledges, tents, stoves and firearms. Food and other consumables can sometimes be cheaper to source at your destination although you must allow time for acquiring/packing/sorting these.

2.4 Communications, safety and back-up

Most countries will require that your expedition has adequate insurance cover for full Search and Rescue (SAR), or at least rescue from a known point. It is the search component of SAR insurance that is so expensive so check carefully what is required. They will want to approve your expedition. Demonstration of good planning and background knowledge will go a long way to setting you in good stead. The need to communicate is not a necessity but carrying a distress beacon may be advisable although only a life and death situation should warrant its activation. See chapter 7 for more information.

You need to be prepared for your expedition such that only a true mishap/accident, not incompetence or inexperience leads to a SAR. Self-reliance should be your watchword. Plan your equipment with the utmost care, know it and know how to live safely in the terrain. If in a glaciated area, ropework skills should have been practised and re-practised. Learn to watch the weather and always err on the side of caution. Your margin of safety should well exceed that which you may be used to in your home country.

2.5 Scientific projects

This handbook does not attempt to outline possible scientific work. There are numerous examples in expedition reports held at the Royal Geographical Society (with IBG), and in academic journals. Some references are given in the appendices.

2.6 Arctic communities, parks and reserves

Besides your impact on the natural environment, your presence in the Arctic will have an effect, whether economic or social, on the local population. As with visiting any country you should remember that you are a visitor and respect the way of life of the local people. Take time to find out about them in advance (Lonely Planet guides are a good starting point).

The number of tourists and expeditions to the polar regions has increased dramatically over the last decade. Given the increasing pressure of tourism, stringent guidelines have been developed for the management of visitors to the polar regions. In the Antarctic, all British expeditions must receive consent from the Foreign and Commonwealth Office and should operate in accordance with the Guidance for Visitors to the Antarctic drawn up under the Antarctic Treaty www.iaato.org/visitor_guide.html. In the Arctic, the World Wide Fund for Nature (WWF) has published some widely accepted guidelines for visitor behaviour, detailing relations with local communities through to methods of controlling huskies. These are available at the WWF web site: www.ngo.grida.no/wwfap

Special rules apply to National Parks and Reserves and special permission will be needed to enter these areas. Indeed, the reason for their restricted access may be the same

reason you wish to visit. There are a range of categories of protected areas, e.g. Scientific Reserve, National Park, Biosphere Reserve, World Heritage Site, etc., with different regulations for each category and even site.

2.7 Humans and the Arctic

The Arctic has been increasingly populated by humans since the retreat of the last ice-age. The Inuit of Greenland and Canada, marginalised and exploited by European and American traders and hunters have seen a rise in self-determination and some successful land settlement claims. Together with the Alaskan natives, the Norwegian Saami and the tribes of the Russian north, including the Yakuts, Chukchi and Aleut, the indigenous people of the Arctic, until very recently, lived as their ancestors had done during the early days of mainly coastal occupation, in small, nomadic groups with a rich culture but few material possessions.

However, the exploration of the Arctic during the 18th and 19th centuries by whalers, sealers, missionaries and European expeditions under the flag of nationalism, saw the decline of the traditional way of life for many Arctic communities. This rate of change accelerated for much of the 20th century. Today, the ancient traditions are being actively preserved, not just for the tourist but so that the people of the Arctic can retain their identity. Prejudice and persecution is still however rife, with for example, the Saami of Norway still engaged with the government over rights to land. In the 21st century the greatest threat to the Arctic is potential damage to the environment from the search and extraction of fossil fuels, not just from Alaska, but from beneath the icecap of Greenland and the Arctic Ocean itself. The Arctic is also being polluted by contaminants from more industrialised countries, with levels of polychlorinated biphenyls (PCBs) reaching dangerous levels in predators at the top of the food chain such as the polar bear. The Russian Arctic is a particular threat with leaking oil and gas pipelines, nuclear test sites and polluted rivers.

In contrast to the Arctic, the Antarctic has no indigenous people and the Southern Ocean was virtually unknown before the 16th Century. During the 19th and early 20th century sealers and whalers decimated colonies of fur-seals, with factory whaling ships reducing some whale populations to virtual extinction. It is, however, the Antarctic Heroic Age of Exploration which has continued to capture the public's imagination.

Since the signing of the Antarctic Treaty in 1961 the Antarctic has been populated by scientists and support staff and more recently by tourists and travellers. There are a number of bases in Antarctica and on the sub-Antarctic islands, run by countries which have signed the Antarctic Treaty. Like the Arctic, Antarctica receives damaging industrial emissions and is a potential rich source of hydro-carbons. In 2050, when the Antarctic Treaty is due to be reviewed, there could be great international pressure to start extraction of fossil fuels to meet a world-wide shortage, if alternative sources of fuel are not in place.

2.8 Environmentally responsible expeditions

Far reaching international agreements of the 1990s have placed fairly and squarely on every nation, local government and individual, a responsibility to plan our actions so as to limit adverse impacts on the environment. The overriding principle is that of sustainability. This idea is directly applicable to expeditions. You should leave the environment in which you are working, as you found it. Indeed you should aim to have a positive effect, clearing

up and identifying any damage caused by previous expeditions. Other principles which include such terms as: the precautionary principle, pollution prevention, intergenerational equity, polluter pays, public participation, conservation of biological diversity, and ecological integrity have been taken up by governments world-wide with surprising rapidity. What do they mean for expeditions?

What effect can a small, four or five person expedition possibly have on the environment? Well, with a degree of care, very little. Of course not every expedition is that small: many have tens of people, use aircraft or snowmobiles for transport and the potential for environmental impact is far greater. But sheer size alone is not the only consideration. What must also be taken into account is the cumulative effect of your expedition added to those preceding or following you. E.g. perhaps a tourist ship visited the same area, a scientific research team worked there for three months or a second expedition will come later in the season. No expedition can be taken in isolation. Polar regions are fragile environments where fauna and flora battle to survive and human impact can do great damage. Co-ordination and management policies are therefore of paramount importance.

2.9 Environmental impact assessment

The key to planning is to assess the environmental consequences of your proposed activity by writing an Environmental Impact Assessment (EIA). You should predict the environmental impacts, assess their significance, consider alternatives to the activity, evaluate cumulative, long-term and trans-boundary effects and propose mitigating measures. The main points here are that your environmental impact assessment is *predictive* and should be done *before* the activity takes place. During planning, execution and write up of your expedition you should be able to say to yourself that you have acted at all times so as to minimise the impact of your actions.

In addition to an EIA being a responsible part of expedition planning, it can also be a requirement. Rules differ between Arctic Polar nations and you should approach local authorities to see in what form an assessment is required and how it should be presented. If visiting the Antarctic, it is important to check the UK Antarctic Act 1994 and any amendments such as The Antarctic (Amendment) Regulations 2002 (available at www.tso.co.uk) to determine what kind of restrictions apply.

Nothing can be said to have no impact, however, there are impacts that are so small that no lasting consequence can be measured. All expeditions, whether to the Arctic or Antarctic should be planned to have minimal impact. Preliminary assessment is a process that any expedition member can undertake, whatever their environmental knowledge. It can be used to check that you have considered all the potential effects of your planned trip and will help you to identify which ones are significant and how you can minimise the impact.

Stage 1 is assessing what impacts your expedition might have on the:

- Social or cultural state of the area you are visiting;
- Landscape, wilderness and aesthetic values;
- Marine environment;
- Air quality;
- Animals and plant life in the region;

- Gateway port, town or city.

Some of these may be obvious and easy to quantify. For example:

- What will you be doing with your rubbish? Burn, bury (rarely a responsible option) or carry out to a proper disposal site? National laws will probably dictate which. Consider whether you should take your rubbish back to your own country. Many frontier ports or towns ('gateways') have extended rubbish tips which cannot keep up with local waste, let alone yours. The disposal of human waste needs careful consideration. It is classified as hazardous cargo and all sorts of restrictions apply to flying it out, even if this the preferable option indicated by your EIA.;
- Will your science project disturb any bird colonies? If you see predators robbing eggs due to your disturbance you are clearly having an effect.

Some impacts, however, are far less obvious or harder to measure:

- Will your disturbance this summer cause a decrease in the breeding success of a population next year?
- What effect does your mere presence have on the wilderness and aesthetic value of the region?
- A large expedition may outnumber the local village population. What are the social consequences?
- What are the global pollution effects of you travelling to your expedition destination?
- What effects will you have on the gateway port?

It is much harder to calculate an environmental cost of the impact to wilderness and aesthetic values than, say, leaving piles of rubbish to blow around or be scavenged.

The important thing is that you should consider these impacts and decide which of your actions is likely to leave some long-term or permanent effect. These are the effects that you should try to find some way to prevent or minimise, or at the very least be prepared to justify why the impacts are warranted. You may wish to argue overpowering scientific or educational reasons, but in this case you must present a case to show that the activity cannot be reasonably done elsewhere, where the impact would be less.

Mitigation of impacts may be something as simple as adjusting the time of your expedition so as to have the least effect on a breeding population. A very good practise is to prepare a brief environmental code of practice for the expedition. This would contain detail such as the usual way of disposing rubbish, what to do if fuel is spilled, how to avoid leaving tracks across vegetation and the way you interact with indigenous people, etc.

Stage 2 of the preliminary assessment is:

- Are you adding to the effects others may have had – this is cumulative effect.

Cumulative impacts are exceptionally difficult to assess. They usually result from repeat visits to a locality by the same or different expeditions. However, they may result from a variety of different activities such as illustrated above.

Stage 3 is monitoring to check if your predictions were correct. Some examples of monitoring are:

- Litter search completed before leaving the campsite;
- Periodic litter surveys at long-term base camp;
- Record of fuel spills;
- Location of waste water or sewage pits.

A useful side project to any expedition is to measure inputs and outputs. Weights of food, fuel and equipment before and after the expedition give an indication of what has been consumed along the way. Such surveys often show that too much, or the wrong type of packaging was used, resulting in a waste problem.

Ensure that the local authorities are informed about any monitoring results and the location of your campsites. Many authorities hold databases of old expedition campsites and activities in order to take into account any impact on future scientific research and to monitor the use and recovery of areas.

2.10 The polar tundra

The polar tundra is particularly susceptible to damage from expedition campsites and activities. Tracks made by the passage of a single vehicle are still clearly visible on the tundra surface some 30 years after they were made. In order to minimise and avoid damaging the tundra environment, adhere to common sense guidelines as set out in numerous existing publications (see bibliography below).

Do protect and preserve the environment for the benefit of those who follow.

Bibliography:

- BEACH, H. *et al*, (1994) *Polar People: self-determination and development*. Publication 5. Minority Rights Group, London: 147–205.
- BRITISH MOUNTAINEERING COUNCIL has published guidelines on sustainable camping and expeditioning. These are available on-line at www.thebmc.co.uk
- CONSERVATION OF ARCTIC FAUNA & FLORA (CAFF) (1994). The state of protected areas in the circumpolar Arctic: *Habitat conservation report No. 1*. CAFF, Norway and Canada.
- CAFF (1996). Proposed protected areas in the circumpolar Arctic: *Habitat conservation report No. 2*. CAFF, Norway and Canada.
- FOREIGN AND COMMONWEALTH OFFICE, Polar Regions Section (1995) *Guide to environmental impact assessment of activities in Antarctica*. London.
- GLASSON, J., THERIVEL, R. and CHADWICK, A. (1995). Introduction to environmental impact assessment. UCL Press, London.
- MEYER, Kathleen. (1994) *How to Shit in the Woods: An Environmentally Sound Approach to a Lost Art*. Ten Speed Press, ISBN: 0898156270
- PROKOSCH, P. (1996) *CAFF Report on proposed protected areas in the circumpolar Arctic*. WWF Arctic Bulletin no.3: 4–5.
- WEST, M.H., and MAXTED, A.P. (2000) *An assessment of tundra degradation resulting from the presence of a field-camp in Kongsfjorden, Svalbard*. Polar Record 36 (198): 203-210.
- YOUNG EXPLORERS TRUST (2002) *Environmental Responsibility for Expeditions A guide to good practice*. Edited by Mark Smith. British Ecological Society & Young Explorers' Trust.

Addresses for Environmental Impact Assessment requirements:

Conservation of Arctic Fauna and Flora (CAFF)

CAFF International Secretariat, Hafnarstraeti 97 600, Akureyri, Iceland
Tel: +354 462 3350, fax: +354 462 3390
Email: caff@caff.is
Website: www.caff.is

International Centre for Antarctic Information and Research (ICAIR)

Orchard Road, PO Box 14–199, Christchurch, New Zealand. Tel: +64 3 358 4450, fax: +64 3 358 4480. Antarctic Protected Areas list and research information.
Email: ssmith@icair.iac.org.nz
<http://icair.iac.org.nz>

Polar Regions Section, Foreign and Commonwealth Office

King Charles Street, London SW1A 2AH, UK. Tel: +44 (0)20 7270 2614, fax: +44 (0)20 7270 2086. Arctic and Antarctic Advice and Antarctic permits.
Website: www.fco.gov.uk

Scott Polar Research Institute (SPRI)

Lensfield Road, Cambridge CB2 1ER, UK. Tel: +44 (0)1223 336540, fax: +44 (0)1223 336549. Excellent library and expedition resources.
Email: enquiries@spri.cam.ac.uk
Website: www.spri.cam.ac.uk

United Nations Environment Programme (UNEP)

UNEP/GRID-Arendal, Longum Park, Service Box 706, N-4808 Arendal, Norway.
Tel: +47 3703 5650, fax: +47 3703 5050. Arctic Protected Area list.
Email: grid@grida.no
Website: www.grida.no/

World Conservation Monitoring Centre (UNEP–WCMC)

219 Huntingdon Road, Cambridge CB3 0DL, UK. Tel: +44 (0)1223 277314, fax: +44 (0)1223 277136. Information and databases on polar protected areas and species distribution.
Email: info@unep-wcmc.org
Website: www.unep-wcmc.org/

Chapter 3: CAMPCRAFT, EQUIPMENT AND CLOTHING

3.1. Campcraft

Life in the field on a polar expedition is the only true way to experience the wonder of the land in all its moods and to appreciate the tremendous beauty of the landscape. Living comfortably and safely in the field demands considerable attention to detail, practice and rehearsal of techniques and adherence to a workable routine.

There are three main requirements for ensuring comfort and success:

- Keep things simple. If you need to take technical items, then make sure you are totally familiar with their use and can make do if they go wrong;
- Make sure everything is repairable, and take a comprehensive repair kit. But remember that fingers can get very cold very quickly;
- Keep clothing and equipment dry.

The techniques of polar camping have not altered dramatically since the days of Nansen, Scott and Shackleton, but the advances in the technology of fabrics and equipment design over recent years mean that the modern polar traveller can enjoy undreamt of comfort and security compared to the early pioneers. Relative comfort can be found within the security of the tent even in the coldest weather so long as care is taken to observe certain precautions and follow a sensible routine.

Fortunately modern clothing and equipment allow considerably more comfort than the early pioneers were able to enjoy:

The trouble is sweat and breath. I never knew how much of the body's waste comes out through the pores of the skin. On the most bitter days, when we had to camp before we had done a four hour march in order to nurse back our frozen feet, it seemed that we must be sweating. And all this sweat, instead of passing away through the porous wool of our clothing and gradually drying off us, froze and accumulated. It passed just away from our flesh and then became ice, we shook plenty of snow and ice down from inside our trousers every time we changed our foot-gear, and we could have shaken it from our vests and shirts, but of course we could not strip to this extent. But when we got into our sleeping bags, if we were fortunate, we became warm enough during the night to thaw this ice; part remained in our clothes, part passed into the skins of our sleeping bags, and soon both were sheets of armour plate.

Apsley Cherry-Garrard
The Worst Journey in the World

Much of the rest of this chapter pertains to the peculiarities of camping in snow conditions. The basic principle of “Inside” and “Outside” man was established in Captain Scott's day, refined during the 1934-36 British Graham Land Expedition and fine-tuned by the British Antarctic Survey. Experience has shown this system to work well for polar camping excursion though the option exists to adapt and modify to suit your own requirements or situation.

3.1.1 A case study

To illustrate the techniques of polar camping more fully perhaps it is best to describe a likely scenario of a team of four coming to the end of their day travelling in the Arctic. For the sake of brevity 'he' will be used in the generic.

...It is spring and the nights are still longer than the days. The team is travelling by ski, pulling pulk sleds, and has been on the move for fifteen days along the nunatak boundary of the Greenland icecap. On a very good day they are covering 35km and the labour is hard as the pulks are still heavy and the surface covered with sastrugi (a type of old, windblown snow waves). The going will get tougher and they have at least another 20 days to go before the end of their journey.

As they come to rest, the four pulks are grouped together and the team finds the wind is now stronger than they realised. As a precaution, all four take a hand in unpacking and putting up each of the lightweight dome style tents. The gusting of the wind and the rustle of the tent fabric makes conversation impractical but it doesn't matter, each is well practised and their thoughts have already moved on to the next task.

As soon as the tents are up the "outside" two begin to shovel snow onto the valances to hold them down whilst the "inside" two are impatient to get things arranged for the evening in the stillness of the tent.

The inside person will brush all traces of snow off his clothes and boots, arrange the sleeping mats over the groundsheet and call for the sleeping bags, stove and cooking gear (all carefully brushed of snow) to be passed inside. Setting up the stove and placing the first pot of snow to be melted on top, he will then take off windproofs and socks, slide inside his sleeping bag and start the first brew.

The team members outside meanwhile have secured the tents fully with snow on the valance and guys fixed to skis and ski poles and are considering what to do with the pulks. There is a strong possibility of drifting snow so the pulk covers are securely fastened down, the traces propped up in the air to ensure they are visible above any drifts, and the hauling belts harnesses removed and passed inside the tent to prevent them freezing up. Anything that would be easily detached and lost is stacked upright and tied together. Drift will accumulate downwind of any object so all gear is positioned carefully in a line perpendicular to the prevailing wind.

Snow blocks for melting have been cut and placed by the tent entrances. Cooking waste such as food scraps and washing out water and contents of pee bottles will be poured in a pit at the opposite entrance to that used for cooking and snow blocks. Paraffin bottles for the stove are stored at this 'waste end' too.

After a final check round the outside, people will leave a shovel by the tent before brushing off any loose snow and entering the tent. They slide out of windproofs before getting into their sleeping bags.

Damp socks, gloves, hats etc. are placed over the drying line in the roof of the tent and with luck the first mug of tea will be ready. With practice this whole procedure should take less than 20 minutes.

The day's log and science notes are written up whilst the gentle roar of the stove continues as the cooking is completed and the socks and gloves hang in the tent roof to dry. When cooking is complete, further water is melted ready for breakfast and stored in thermos flasks to prevent it freezing overnight and ensuring a quick start in the morning. Other water bottles are also filled and wrapped in a sock to make not only a good hot water bottle but unfrozen water for the morning.

The morning alarm sets the whole process going again but in reverse. The cook lights the stove whilst still half in his sleeping bag and begins breakfast as the hoarfrost line creeps up the inside of the tent as it fills with warmer air. Breakfast consists of brew, porridge, then another brew and then on cue the outside people push their way out of the tent entrance and set about digging the pulks out of the drifted mounds and carefully removing the built up snow from around the tent.

By the time the pulks are free and the tents clear of snow, the inside people emerge with personal kit packed and ready to be put back into the pulks and the next day's travelling begins again.

3.1.2 Review of the case study

This case study contains a useful narrative from which a lot of information can be gained and extrapolated. The following comments explain and comment on the text so that more information can be gained or the points fully understood by the arctic novice.

The daily distance travelled is impressive and for planning purposes it would be sensible to estimate daily distance on a figure between two-thirds and half that stated.

The four person team is using two two-person tents rather than one four person tent. This allows greater flexibility to cope with changes of plan, such as responding to an illness or evacuation. Snow shovels and a snow saw are needed for cutting snow blocks to dig in the tent. The tents operate as separate units for cooking with their own stoves and therefore, the rations will have needed to be planned and packed for pairs rather than for the group. This group is using paraffin stoves. If it is available then 'white gas' or 'blazo' is a cleaner and better fuel for use in MSR type stoves. A stove base is needed to protect the groundsheet and to stop the snow surface melting. Suitable bases are not available commercially and so these tend to be home made articles. Tents burn very quickly and easily and so it is vital to be fully skilled in the use of your stove before attempting to use it on expedition. A good idea is to light the stove outside the tent and then to take it inside. Depending on their design some tents have a useful porch area which can be used. Heavy duty plastic bags such as fertiliser bags are very useful for collecting snow in for cooking. The art of cooking in a tent in low temperatures is to reduce steam to an absolute minimum otherwise all the moisture will make things damp. Sleeping bags are particularly vulnerable to steam and may need a waterproof cover such as a Gore-tex bivi bag. When the stoves are turned off the temperature inside the tent plummets and it is important to take down any items that have been drying for storage inside a sleeping bag, otherwise they will refreeze overnight. In the morning it is more efficient to melt water rather than snow so do leave cooking pans filled with water in the tent porch and reheat them in the morning along with the water in water bottles and flasks.

If there is space in your pulk it is not necessary to pack sleeping bags and mats back into their stuff sacks as one has to do when using a rucksack. Simply roll the whole bundle up and place it on top of other items in the pulk.

3.2 Tents

The criteria for tent selection will depend on the aims of the expedition. There is a relationship between weight, space, strength and durability. The lightest tents are small and not the most durable in strong winds or when buried by snowfall. With a small expedition, consider the pros and cons of one tent for all (risky if destroyed) versus two (colder, less sociable, longer to erect, etc.). Consider the logistics of every stage of the expedition plan. If the majority of the time will be spent with pulks it is easy to underestimate the value of the lightest possible tent for the short period when everything will be carried in rucksacks. The North Face Westwind has been made for many years but is still one of the lightest four-season two-person tents available, and a useful benchmark to compare other models with.

Know how to pitch your tent in high wind. Putting one up in snow blowing 20 knots is not like putting the tent up in the garden at home. Also if the weather is good when setting up camp, assume it will be bad when you take it down. Always anchor both inner and outer tents firmly.

Pegs normally supplied with the tent will not be sufficient for snow. You can buy snow pegs which should be at least 75cm long but where weight is always a priority use snow stakes, skis, ski poles, ice axes, 'dead men' or cut bamboo canes to length. Bear in mind you may wish to use some of these objects while you leave your tent up. If camping on ice then iron pegs or ice screws will be necessary. Always cover up the top of your tent anchors with snow otherwise they will 'ablate out' even in overcast weather.

Never camp near crevasses, cornices, avalanche or rockfall risks. Beware of likely katabatic winds or on the coast, tidal waves. Consider meltwater if the temperature rises. A lee slope will be more prone to snow accumulation and may suffer buffeting from eddies. Sastrugi alignment should indicate the prevailing wind direction. The tent door should ideally face cross-wind as the lee side of the tent (and any other objects) will drift up. If camping in a crevassed area cannot be avoided, probe the area fully and mark out a 'safe' area. A tent pitched on soft snow will not be securely anchored and in the event of a storm, the tent (and pegs) could be completely blown away. Snow walls can protect your tent but also allow drift to accumulate in the lee.

In warm conditions, a tent left in one place for some days ends up on a pedestal and will probably have to be moved.

In contrast, in poor weather a tent can quickly become buried. It is vital to check conditions outside regularly. In such conditions, keep a shovel inside the tent; you may need to dig yourself out! In strong wind or drifts secure yourself to a rope from inside the tent. In 1990, a member of Will Steger's Trans-Antarctic expedition lost his sense of direction only a few metres from his tent and was only found hours later...alive. Others have not been so lucky.

Most four season tents will be suitable for use on Polar trips. At the time of writing both Terra Nova and The North Face produced ranges of high quality 4 season tents that have been used successfully on numerous expeditions. Some of the Scandinavian tents such as Hellsport have become firm polar favourites because they do not have nylon outers. Canadian Arctic Holidays (www.canadianarcticholidays.ca) produce a customised Polar tent that has now become the recognised tent for Arctic Ocean travel. It uses skis and ski poles as the frame, is excellent for groups of five to six persons, but is more vulnerable to strong winds than dome tents. Snowsled also produce special order polar tents. Kyham

Leisure Ltd in Walsall, produce a lightweight 3 person quick erection geodesic tent that was used on a 90-day British North Pole Expedition in 1997. The Vango Force Ten is a summer favourite on youth expeditions, and though heavy is easy to erect and sturdy. A snow valance is useful but not essential. However, having two exits is very useful with at least one having a porch big enough for cooking. In extreme cold, watch out for loss of elasticity in tent pole elastics. Mark your poles in case the elastic has to be cut. Always take a splint for poles. With a small expedition, consider the pros and cons of one tent for all (risky if destroyed) versus two (colder, less sociable, longer to erect, etc.).

In warm conditions, a tent left in one place for some days ends up on a pedestal and will probably have to be moved.

In contrast, in poor weather a tent can quickly become buried. It is vital to check conditions outside regularly. In such conditions, keep a shovel inside the tent; you may need to dig yourself out! In blizzard conditions use a hand line if leaving the vicinity of your tent. In 1990, a member of Will Steger's Trans-Antarctic expedition lost his sense of direction only a few metres from his tent and was only found hours later...alive. Others have not been so lucky.

Bivis, snow holes, etc., are covered comprehensively in mountaineering books and will not be covered here. Suffice to say, you should know how to build one.

3.3 Sleeping bags

The issues for sleeping bag selection are: knowing how cold it is likely to be where you plan to go at that time of year, the duration of the expedition, the opportunities for resupply, the budget available, and weight and volume issues similar to those applicable to tents.

The question of down versus synthetic bags will always elicit different opinions. There are both down and synthetic sleeping bags available for the most extreme polar conditions. However, few retailers stock the warmest models available so it is a good idea to obtain the manufacturer's own brochures. For any given temperature rating synthetic bags are much cheaper than down. All sleeping bags are vulnerable to accumulating moisture from spills and steam in the tent as well as Down, if it gets wet (from overnight sweating. loses its insulation more or accumulates moisture and) will freeze into clumps if it cannot be dried out, . This will be extremely cold and uncomfortable.

The key is to protect the sleeping bag from damp both from inside and from outside the bag. Many bags are available with a more weatherproof outer fabric as an option. Other options are to use the sleeping bag inside a separate Gore-tex type PTFE bivi bag. Vapour barrier liners can be used in continuously low temperatures to prevent the build up of sweat in the sleeping bag. They may only work to a certain extent, and they are pretty unpleasant to sleep in. Though bulkier and heavier, a couple of synthetic bags, one inside the other, is could be the preferred an option. If planning to use a number of layers, match up the zips so that they are all on the same side.

At the time of writing, the Ajungilak Denali and the RAB Expedition bags were top quality synthetic and down bags respectively, that would be good models against which to compare other options.

As important as the warmth of the sleeping bag is the use of some form of mat or mats as insulation from the cold ground. Two mats tend to be warmer than one and have the advantage of in-built spare capacity if one is lost or damaged. Thermarest type mats are particularly prone to puncture damage and it is a good idea to use one in combination with a closed cell foam mat such as a Ridgerest or Karrimat.

3.4 Footwear

Choice of skis and boots is another common difficulty, not made any easier today by the fantastic range available. For such an expensive set of kit, consider future use against their primary function on the expedition. Are you crossing Greenland with a pulk, or doing steep ski-touring, or just using skis occasionally to reach science sites? The combinations leave much to think about: old fashioned 'plank' skis with bindings for ordinary walking boots; touring skis with three pin/cable bindings for leather/ plastic boots or ski-mountaineering skis with raisable heel plate for plastic mountaineering boots.

A good starting point for selection is the lowest anticipated temperature followed by the duration and remoteness of your expedition. The obvious attractions of lightweight can be difficult to weigh up against durability if undertaking a long committing journey.

For extreme low temperature expeditions such as North Pole expeditions the Weber Malakhov mukluk made by Sorel has been a popular choice although at the time of writing these were not available. Acton International also make similar mukluk boots. These are bulky and incompatible with crampons but work well with cable bindings such as the Rottefella NATO bindings. In recent years the weight savings made to alpine back-country ski-mountaineering boots and bindings has been made by making one model of boot specifically for a particular binding. These improvements are now available for Polar expeditions. Both Millet and Meindl now make boots with a sole that is made for the Salomon SNS or Rottefella NNN-BC manual bindings. These have been used successfully on South Pole expeditions. Alfa boots make very warm expedition boots with soles for the standard 75mm 3 pin Telemark binding.

Super gaiters such as Berghaus Y or Wild Country Tundra 'Yeti' gaiters are good for extra warmth and to help prevent snow entering your boots. See section on sledge-hauling in chapter 5 for discussion on sledges versus pulks, etc.

Whether to take waxless or waxable touring skis is another question of preference. Choosing the right wax for the conditions is rather a black art and comes with practice. But getting it right means efficient skiing rather than 'walking' on skis. Telescopic ski or walking poles, though not necessarily as strong are far more flexible in use. Consider a spare. Mountain supplies (Braemar), Scotland, is the UK's biggest and most knowledgeable ski supplier.

If you are going to be pulling a sled then skins will be essential to obtain enough traction. Give consideration before you go to the durability of the skin attachment to the 'ski. Skins may come in very useful but take care to keep snow and moisture from them so they don't lose their stickiness. Make sure the skins hook over the skis and both ends. Take skin glue with you.

A leader is unlikely to receive plaudits if his team has to carry relatively heavy skis only to find dry glaciers. Skis are generally preferred to snow shoes because they are more

versatile and allow faster travel, but their efficient use does require practice. Snow shoes are better than skis in deep-soft snow and in woodlands and need virtually no initial skills.

3.5 Clothing

There are numerous articles on clothing for expeditions and the three-layer principle, not least in the technical brochures of the manufacturers. Here is an overview:

3.5.1 Base layer (or vapour transmission layer)

Moisture should be carried ('wicked') away from the skin through the base layer, instead of remaining and evaporating with consequent heat loss. Garments are generally close fitting and designed to stretch. To be effective, the material should absorb little or no moisture and be quick drying. The layer usually has some insulation value. Synthetic thin fleeces have a high warmth to weight ratio, absorb very little moisture and dry very quickly. Don't be tempted to wear your favourite cotton T-shirt.

3.5.2 Mid layer (or insulation layer)

Warm air is retained within the bulk of the material whilst still allowing moisture to pass through. This layer may also at times be the outer one and garment design should allow for adjustment of ventilation – zip, sleeves able to roll up, etc. Modern fleece garments may have pockets and be of a more generous cut, particularly under the arms. For the upper body, two thinner layers may be more effective than one thick one, thereby allowing one layer to be removed if too much heat is being produced. It should therefore be easy to take off. Mid-layer trousers will only be needed in severe conditions. An outer fleece with a windproof shell can prove very practical. In addition, down clothing cannot be beaten for its insulating properties.

3.5.3 Top layer (or protection layer)

The outer layer should be 'breathable' as far as possible, windproof, and except in dry polar conditions, waterproof. Most fabrics may have to trade 'breathability' for waterproofness and vice-versa. Draw-cords at the waist and lower hem and certainly around the hood, are useful features for helping to retain warm air and reduce its circulation. Saloppes will avoid cold around the midriff but make sure that they have zips so that you can go to the loo without removing the rest of your top layers first. They should also have long leg zips so the legs can then be tied up at the waist when not in use and you do not have to remove boots to take them on and off.

The traditional outer layer used particularly in Antarctica where rain is not a problem, is windproofs of Oxford cotton Ventile. The advantage of Ventile over Gore-tex is that it will release moisture more effectively, is more flexible/softer in the cold and more durable. This has been overtaken by the system described below but Ventile still has its followers.

3.5.4 Alternative layering system

The challenge with polar clothing is how to provide enough insulation to keep warm over a range of efforts from producing a lot of body heat whilst moving to cooling down at rest and how to minimise moisture in the clothing. The traditional shell or outer layer is very wind and waterproof but not particularly breathable.

An alternative clothing system that works really well in polar conditions when it too cold to rain is the combination of fibre pile and Pertex made together into a garment. On their own neither fabric is exceptional but combined together they are excellent insulators and supremely breathable. Such garments combine the mid- layer and outer layer for most conditions. In the UK it is rarely cold enough for tops and bottoms to be worn together so quite how good they are for colder polar environments is not widely appreciated. Brands and models based on this principle available in Britain are: Buffalo, Montane, Patagonia Infurno, Rab Carrington, and Trax. They are worn over a base layer but usually require no outer or shell layer as the outer is windproof. Different manufacturers use slightly different fabrics that have varying degrees of windproofing and water repellency. This clothing is far more breathable than a three-layer system and so eliminates moisture much more effectively. It is now established as the clothing of choice for polar journeys. Dark colours absorb more solar radiation and therefore, are better for low temperatures than light colours.

Special notes

There are few factors worthy of note peculiar to polar conditions. If rain is not going to be a problem, then outer waterproofs would be better replaced by windproofs of Oxford cotton Ventile. The advantage of Ventile over Goretex is that it will release moisture more effectively, is more flexible/softer in the cold and more durable.

All garments should be simple to access with zips and fasteners that can be used with gloves/mitts. Inevitably, nothing is perfect.

In extremely cold weather, keep a down jacket in the top of your rucksack and put it on as soon as you stop for a drink, to pitch camp, etc. However, note that down is useless when wet.

Sweat is your greatest enemy. Moisture will conduct heat away from your body twenty times faster than dry air. Take off your clothes BEFORE you start sweating because as soon as your sweat is 'wicked' away from you body it can freeze, encasing you in a frozen armour. See Apsley Cherry-Garrard's *The Worst Journey in the World* for graphic descriptions of this. If your clothes do become frozen with moisture, shake or beat off the frost before entering the tent, to avoid soggy clothes.

In some situations, where for instance, people are driving snowmobiles for long periods of time, or tending equipment, weight may not be a problem and the priority is to conserve heat rather than to ventilate. All-in-one insulated suits may be the best solution for the top layer. If there is serious risk of falling into polar waters, a lightweight wet suit might be considered.

In very cold weather, the areas most difficult to keep warm are the head, hands, and feet. Always carry spares (even on short excursions from camp). Check your companion for exposed parts of the face or wrists. Frostnip does not take long to take hold.

3.5.5 Head and face

The head and neck area has a large number of blood vessels and little fatty tissue. It is therefore a great centre for heat loss. Up to 20% of body heat can be lost from the head under some circumstances. Ears, nose and cheeks are particularly vulnerable to frostbite.

Traditional protection is the ubiquitous balaclava, available in wool, various pile and fleece materials as well as silk, and is excellent protection for the nose, cheeks and ears. Balaclavas roll up to just protect the top of the head. A hat should be big enough to fit over a balaclava and preferably have ear flaps and be windproof. A variety of headgear to suit all situations is the ideal. A neck gaiter or thin scarf can form the seal between hat and upper body wear. In extreme cold, a neoprene face mask and goggles can effectively cover the face leaving no flesh exposed.

If you wear spectacles make sure your goggles will fit over and if you have prescription sun glasses ensure they give 100% ultra-violet (UV) protection and do not allow light to enter from the side.

With the high UV levels in polar regions, a sun hat may also be necessary. Always carry at least two pieces of eye protection and wear one or the other in most conditions. Snow blindness can occur even on dull days and after only short exposure. It can last for days. In an emergency, the balaclava can be worn over the eyes or goggles fashioned out of rubber/cardboard/material can be worn with only a tiny slit necessary to see.

3.5.6 Hands

Keeping the fingers together in mitts is better protection than separating them in gloves. In particularly severe conditions, the combination of silk gloves, inside fleece or oiled woollen mitts, inside a windproof outer mitt may be necessary. Mitts are available which allow the thumb and fingers to be poked out for use, and, with silk gloves on, fine manipulative work can still be undertaken. Thin inner fleece gloves wick moisture better than silk.

A tape harness system or elastic wrist loops are useful to keep the mitts at hand height when the hands need to be out of them for working. To lose hand-wear is to court disaster; thought must be given on how not to do so. A sock can serve as a mitt.

Again, even with a variety of gloves you will probably find there is no perfect combination/solution. Be careful not to use bare hands and fingers on cold objects (not just metal). They could freeze to the object and you will lose skin if you try to tear it away. Instead use a warm liquid (possibly urine will be most readily accessible) to help free the frozen area.

3.5.7 Feet

Skiing, climbing with crampons, dog sledding, standing whilst tending instruments, sledge-hauling and driving snowmobiles may all call upon different types of footwear, though expediency may demand that one type serves several uses.

The feet should not be constricted inside tight footwear. Some activities may require them to be firm. One pair of thick socks should be sufficient, and if this is not warm enough the situation may demand some kind of double boot or boots with liners and insoles. Which footwear to take is one of the most common topics of discussion and everyone will have a different opinion. A skiing or mountaineering expedition will most easily opt for modern plastic double boots but if most of the skiing is to be flattish then perhaps a softer (and warmer) mukluk boot with mukluk ski binding may be more appropriate. Muklucs are undoubtedly the warmest boot with their felt insulation and felt liners. Leather boots, if they get wet and then freeze can be almost impossible to manipulate. If operating in soggy summer tundra, rubber boots with plenty of pairs of socks may be the answer.

Again moisture is your enemy. Socks and liners should all be dried out overnight (in your sleeping bag if necessary). In temperatures below -20°C , vapour barrier socks (or plastic carriers bags – cheap and minimum space) have been used to great effect to prevent damp getting into the boot's insulating layers.

3.6 An expedition's kit selection

For a 4-person, 3 week very lightweight Easter ski-touring trip to Greenland with simple mountaineering objectives (food list cited in section 4.9), the following expedition kit was used:

*= shared between two

**=shared between group

() = optional

Camping Kit

*tent (North Face Mtn 24 and Quasar)

thermarest

sleeping bag of sufficient rating

compression sack

Gore-tex bivvi bag

vapour barrier liner

short karrimat (use rucksack as foot insulation)

Skiing

rucksack

skis for touring with 'telemark' bindings

poles (telescopic)

'Nordic' boots

skins

**waxes (polar, blue, green and red)

*scraper

*cork

*snow shovel

**snow saw

2 snow stakes for tent pegs

plastic kiddy sledge with traces of plumbers' piping, 3x2m 4/5mm cord, 2 karabiners, made up inner bag secured with bungee cord

**Repair kit

Leatherman (multi-purpose tool)

crampon spanner

ski repair: screws, wire wool, special screwdriver

Araldite

Superglue

wire

paracord

duct tape

thermarest repair kit

tent splint

spare trace pieces

stove spares kit

ski pole

Climbing and Crevasse Rescue

harness

ice axe/hammer

crampons

2 prusik loops

2 locking karabiners

sling

*30m 7mm rope

*30m 9mm rope

*pulley

*ice screw

*belay device

****Misc**

distress beacon
altimeter watch
binoculars (for scouting way ahead)
-40°C thermometer
map set
spare map set
map pen
plastic bags
(GPS)
spare lace
sewing kit
funnel for fuel (top of plastic bottle)

Personal

compass
whistle
camera
film
spare batteries
penknife
diary
pencil
book (one not read by other so can
swap)
toothbrush
*dry skin cream
loo paper (1/2 roll per person per week)
blister prevention
sun block
lipsalve
pee bottle (bottom of plastic bottle)
glacier glasses
double skinned goggles
silk handkerchief

****Medical**

aspirin/nurofen
painkillers
stronger painkillers
antibiotics
eye ointment
anti-inflammatory cream
ibuprofen (non-steroidal anti-
inflammatories)
elasticated bandage
swabs, steristrips, gauze
anusol for piles
lomotil (stopper)
senekot (goer)
dental repair kit

Clothes

waterproof jacket
waterproof trousers
'yeti' gaiters
peaked waterproof/fleece hat
waterproof outer mittens
duvet jacket
fleece salopettes
fleece top (ideally windproof)
scarf
mid gloves/dachsteins
balaclava
face mask
pair pants per week
vapour barrier socks
thick socks
thin socks
thermal top
thermal bottom
fleece top
fleece bottom
two pairs inner fleece gloves
silk gloves
bed/spare thick socks

Eating

*MSR stove
*formica square to rest stove on
*MSR fuel bottle
*2 saucepans
*1 handle
jug/mug
spoon
fuel (1/2 litre/tent/day)
5 litre fuel can
lighter
1 litre water bottle + insulation
food bags

To be left at base

ski bag
passport
insurance
air ticket
credit card
cash
address list
copy of passport
marker pen
set clean clothes
sheet sleeping bag
towel
soap
toothpaste

Bibliography

- BRITISH ANTARCTIC SURVEY (In Press) *British Antarctic Survey Field Manual*. British Antarctic Survey, Cambridge. An inhouse manual specific to the Survey's operations in the Antarctic. Much of it is relevant to all polar regions.
- FYFFE, A. and PETER, I. (1999) *The Handbook of Climbing*. Pelham Books.
- FURSE, C (1997) *Arctic Expedition Handbook*. BSES, Royal Geographical Society, 1 Kensington Gore, London SW7 2AR.
- LANGMUIR, Eric. (1995) *Mountaincraft and leadership: a handbook for mountaineers and hillwalking leaders in the British Isles*. Mountainwalking Leader Training Board..
- McNEISH, C. (1980) *Snow Camping*, Spurbooks Ltd. 96pp

Suppliers: Polar Equipment and Clothing

- Acton International Inc.**, 881 Landry Street, Acton Vale, Quebec Canada J0H 1A0.
Tel: +1 450 546 3735. *Supply cold weather boots & Mukluks*
- Alaska Tent & Tarp**, Main Office, 529 Front St, Fairbanks, Alaska 99701. Tel: (907) 456-5501, fax: (907) 452 5260. Also have a branch in Fairbanks Alaska.
Manufacturers of the Arctic Oven, a cold weather base camp tent designed for use with wood burning stoves. www.alaskatent.com/
- Ajungilak UK Limited**: Unit R, Mount Pleasant Street, Ashton Under Lyme, Lancashire, OL6 6HT. Tel. 0161 344 1449; www.ajungilak.no
- Army/Navy Store** 320 W.4th Ave. Anchorage, Alaska www.army-navy-store.com
- Baffin Inc** 346 Arvin Avenue, Stoney Creek, Ontario, Canada L8E 2MW Tel 1-905 664 3930 www.baffin.com sales@baffin.com *Cold Weather Boots*
- Blizzard Pack** www.blizzard.co.uk manufactures of silver foil emergency blankets
- Cotswold Outdoor** Various branches in UK, including London www.cotswoldoutdoor.com . *Contract outdoor clothing supplier*
- Expedition Kit** Unit 15a, Farm Lane Trading Centre, 101 Farm Lane, Fulham, London SW6 103 Tel 020 7610 0700 www.expeditionkit.co.uk sales@expedition.co.uk
- Kyham Leisure Ltd**: Willenham Lane, Bloxwich, Walsall, West Midlands, WS3 2XN.
Tel: 01922 711286 Manufacturers of quick erection tents
- Montane**, Unit 7 Jubilee Industrial Estate, Ashington, Northumberland NE63 8UA
www.montane.co.uk
- Mountain Supplies (Braemar)**, Invercauld Road, Braemar, AB35 5YP, UK.
Tel: +44 (0)133 974 1242. Chief UK supplier of all equipment suitable for polar/ski-touring/mountaineering expeditions. www.mountainsupplies.com
- Multifabs Survival Ltd**, Kirkhill Place, Kirkhill Industrial Estate, Dyce, Aberdeen, AB21 OGU. Survival suits for hire or purchase
- Open Air**, 11 Green Street, Cambridge CB2 3JU England Tel: +44 (01223) 324 666,
Knowledgeable polar equipment suppliers
- Patagonia** www.patagonia.com
- Rab Carrington Ltd**: info@rab.co.uk, www.rab.uk.com

Sportsnett Norge AS PO box 5914 Majorstua N0308 Oslo Norway. Sportsnett has a shop at 19 Parkveien, 0350 Oslo Norway (closed on Mon and Sunday)
www.sportsnett.no

Steger Mukluks, 100 Miners Drive, Ely, MN 55731 USA . www.mukluks.com

Terra Nova www.terra-nova.co.uk

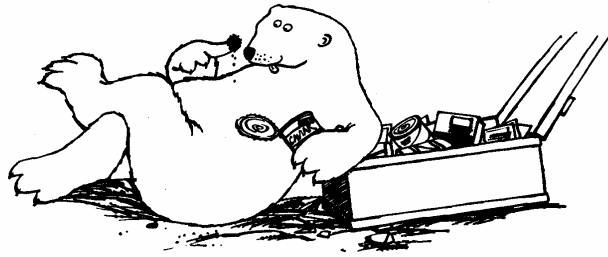
The North Face www.thenorthface.com

Weatherhaven Global Ltd. Bridge Farm House, Elderton Lane, Antingham, north Walsham, Norfolk NR28 ONR UK. UK Suppliers of weatherhaven modular camp units for polar accommodation and field camps.

www.weatherhaven.globalshelter@btinternet.com

Weatherhaven Internatioanl Vancouver Canada www.weatherhaven.com

Chapter 4: FOOD AND COOKING



It is vital that sensible preparation of equipment and rations is carried out before embarking on a polar journey. Undoubtedly this will require training and practice to ensure the chosen systems work faultlessly under even the harshest conditions. This is particularly important when considering the composition of the expedition ration, its method of packing, preparation and cooking, and all other items of essential camp equipment.

The overriding considerations for planning an expedition menu, whatever the climate, is ensuring the expedition team will actually eat what you give them and that the chosen menus can be prepared and cooked efficiently.

Food on any expedition has a tremendous effect on morale and it is quite amazing how, after only a short period of time, the team will focus on food and how it can be the root of many gripes or disharmony.

4.1 Menu

Lack of variety in the expedition diet can be very boring and frustrating especially over extended journeys. Try to plan menus to avoid monotony. However, it is important to ensure methods of preparation and cooking times are similar so that meals can be prepared each day in a similar manner, with the same resources of fuel, water, cooking time, etc.

A variety of spices, curry powders, etc., can be added when required and will make that little bit of difference every day. The same variety can be achieved with the addition of cinnamon to morning porridge and the rotation of hot drinks with tea (instant is palatable and there is no tea bag to deal with), coffee, hot chocolate and fruit or herbal teas. If there are depots of food, you may be able to include treats or luxuries: morale boosters second to none.

Some foods do not do well in extreme cold. Chocolate and cheese should be kept close to the body if possible. Spaghetti is difficult to eat with limited cutlery!

Do not assume that you should (or can) take all your food from home. Food may well be readily available in your destination country, and cheaper (especially when you consider the cost of freight). The inclusion of some local fresh produce can also be beneficial. This is particularly useful in the Arctic where fresh fish, seal or reindeer may be procured from local Inuit communities. This not only brings the nutritional benefits of fresh food but can often provide an insight into the local traditions and culture.

4.2 Nutrition

The correct nutritional balance is particularly important to ensure that the team will function properly over extended periods of physical work, e.g. sledging journeys. The type of activity being undertaken will influence the type of rations used. A prolonged sledge-hauling journey on the icecap will have different requirements from a summer expedition at a fixed site on the coast, which in turn will probably be different from a mountaineering team attempting alpine style routes.

Food is required by the body for three main functions: warmth and energy, material for growth, repair and reproduction and regulation of body functions. Food can be divided into three principal categories:

- *Proteins* for the provision of materials for growth, repair and maintenance of body tissue, and to a lesser extent for the provision of heat and energy. Proteins are found mainly in meats, fish, cheese, eggs, nuts and cereals.
- *Carbohydrates* for the provision of heat and energy to the body. Foods high in carbohydrates should always form the principal constituent of rations. Carbohydrates can be broken down by the body to provide energy much faster than proteins or fats. The simple sugars, jam, honey, etc., can be absorbed 4 times faster than protein and about 9 times faster than fats. Foods high in carbohydrates are biscuits, cake, chocolate, cereals, dried fruit, sugars, jam, honey, etc.
- *Fats* for the provision of heat and energy, and also body fat. Fats are found mainly in butter, margarine, dairy products, meats and nuts. They have the advantage of providing the most number of calories for weight (butter being the highest). But living on butter alone would be impossible!

The body also recruits various *vitamins, minerals and roughage* for regulatory functions and most importantly *water*. On longer journeys it may be advisable to take vitamin supplement tablets to ensure adequate vitamin intake.

The calorific value of the expedition ration is probably the most important factor to design the menu plan around, followed next by a breakdown of the ration into the most suitable proportions of proteins, carbohydrates and fats. This should be roughly 10-15% protein, 60-65% carbohydrate, and 25-30% fat. In terms of proportion through the day, breakfast should be around 20%, lunch 50%, and supper 30%.

The basal metabolic rate (the amount of energy used only for the process of being alive whilst at rest) has a value of around 1600 Kcalories for a man weighing 9 stone and a value of around 1300 Kcalories for a woman weighing 8 stone in a European type climate. The average energy intake for most expedition members whilst in the UK will be around 2500 Kcalories per day. On a cold polar expedition you will want a well balanced diet providing around 4000+ Kcalories per day. In addition, you will need a liquid requirement of at least ½ litre per 1000Kcal.

In some cases, considerably higher energy intakes may be required. On the 1993 crossing of Antarctica, Ranulph Fiennes and Mike Stroud used a diet giving 6000 Kcalories, but experienced energy expenditures of up to 10,000 Kcalories when climbing onto the Antarctic plateau. 7,000 Kcalories per day seems to be the amount needed on North Pole expeditions to avoid weight loss. There has recently been some interesting research undertaken into developing individual ration plans to maximise the use of stored body fats and to reduce daily calorific intake and therefore weight of rations.

The type of activity an expedition undertakes and the supply of water and fuel for melting or cooking will determine the composition of the expedition ration. If weight is not a problem, then plenty of tinned foods can be taken which simply require heating. However, if weight is of paramount importance then it is likely that freeze dried or less good, dehydrated foods will provide the most convenient solution – though these will obviously require more cooking and hence fuel. If fresh water is in limited supply and this has to be melted from snow or ice then the fuel requirement is increased further. On an unsupported sledging journey, the balance between weight of food and fuel will be an important consideration. Some lightweight mountaineering expeditions intentionally carry far less food than they need or would like per day, expecting to lose weight over the trip. If weight is crucial then this may be your preferred option.

4.3 Packaging

It is vital that the expedition rations are packed suitably to avoid contamination and deterioration. For sledging journeys, personal experience has shown that packing the rations into multiple “man-day” units is the most suitable. This method is probably the most appropriate for any expedition that is continually on the move.

For this method, the rations are packed into appropriate “man-day” units per tent group or cooking group. In this way only a limited amount of food has to be opened at any one time and the rations can easily be divided up between personnel or sledges. If food is left along the route in depots or if the team splits up into smaller groups to carry out specific tasks, it is easy just to hand out an appropriate number of ration packs. But watch out for hungry animals. A polar bear will stop at nothing to ravage your depot for food.

Man-day packs are made up by devising the daily menu or ration for the team and packing everything required for say, two or four days per team into a single finished pack. Excessive food packaging can be discarded (careful not to throw away cooking instructions) and where containers are not filled completely, e.g. plastic bottles of powdered milk, these can be topped up to the appropriate weight and re-sealed. For items such as pasta, rice and dehydrated foods, these are often purchased in bulk from cash and carry outlets and weighed out into a single day’s worth of product and then packed into plastic bags. The whole process is time consuming and a weekend or two should be devoted to ration packing in the UK before departure to ensure it is done carefully.

Items likely to leak if damaged such as tubes of honey, tubs of margarine, etc., should also be sealed into plastic bags to prevent contamination of the rest of the ration pack if damaged. It is possible to carefully work out a regulated menu that delivers the required number of calories, at a set weight per person per day so that loads can be calculated easily. This prevents the need to have lots of packs of food open at any time and hence at risk of leakage, loss or contamination.

When all the individual food items are double wrapped in plastic bags then other necessary items are added, e.g. lighters for stoves, pan scrubber, toilet paper, etc., and the whole “man-day” unit is double wrapped in heavy gauge polythene bags and securely taped up with industrial packing tape.

On most longer expeditions it is probable that food is the largest and heaviest items being transported. Consequently it may be desirable for the expedition to be re-supplied by air whilst in the field. If this is by helicopter or ski-plane that can land easily, then no further repackaging should be needed than that described above. If, however, an air drop is

proposed, then this adds further requirements to the packing of items to be dropped to ensure minimal damage (see section 5.1).

Generally, packaging should be kept to a minimum. Not only does it add extra weight but will also become the rubbish that you have to take out.

Depending on the size of your expedition, today's supermarket should have everything you require, and probably at competitive prices. Dehydrated meat is harder to come by and you may want to investigate the cash and carry or 'Batchelor's' type dried food. It is worth getting quick cook rice (NISA; 3 minutes) and pasta (Buitoni; 3 minute macaroni). Chewy muesli bars hold together better than crunchy ones. Suppliers are listed at the end of this chapter.

4.4 Emergency rations

These are a vital part of expedition planning and should never be overlooked. It is not sufficient to merely allocate additional standard rations. The emergency rations should be of high carbohydrate content and of a type easily absorbed by the body. Suggested emergency food types are: chocolate, glucose tablets, dried fruit, muesli bars and hot drinks. They must be clearly marked and carefully packed to allow repeated handling without actually being opened. It may be advisable to include the emergency ration packs with other emergency gear such as flares, survival bag, etc.

4.5 Water intake

It cannot be over stressed that water intake is of vital importance and provision should always be made to secure sufficient quantities of fluid. Fluid loss on expeditions where strenuous activity is undertaken, particularly at altitude, can result in fluid loss through perspiration and respiration of up to six litres per day. These lost fluids also contain important minerals, and if the balance is not maintained the body's chemical equilibrium is upset.

If liquid water is available, don't waste fuel by melting snow. But on no account should water emanating directly from a glacier be drunk, the milkiness is due to very fine rock particles too small to see and in suspension in the water. Supraglacial (surface) water is usually OK. Watch out for potential contamination from wildlife.

As a general guide the fluid intake should be:

- For a day of moderate activity: at least 2 ½ litres (4 pints);
- For more severe activities or a long day of climbing: 3–6 litres (dependant upon the altitude, the climb severity, previous day's activities and the individual's requirements);
- If severe dehydration occurs; 6 or more litres should be given at the rate of about ½ a litre per hour.

Both coffee and tea are diuretics so should make up only a minor proportion of the total drink. Ensure that food is properly re-hydrated before eating it. Avoid eating snow direct. It cools the mouth and teeth and uses valuable energy to convert it to liquid. Better to stop and make a brew or to carry liquid in a flask.

Do not cut down on fluid intake to avoid going outside to the loo. A pee bottle or tin makes life much more comfortable in bad weather. Emptying the bowels in poor

weather is one of the unavoidable discomforts of polar expeditioning and could be reason for piles being endemic among polar explorers.

4.6 Stoves and fuel

Stoves are an absolutely critical item of equipment and therefore a spare is essential on even the smallest expeditions. People have firm views on which stove they prefer. Whichever stove you choose, make sure that all the stoves within your party are the same type so that spares and repairs can be maximised.

Fuel type is probably the critical factor. You should always check on how or whether your fuel can be transported and ensure it is properly contained. Fuel contamination into your kit and food is not to be recommended! Petrol will be readily available and cheap anywhere there are vehicles or snowmobiles. It has a low flashpoint and does not burn that cleanly so extra care should be taken in the tent. Coleman fuel or similar fuels white gas or Blazo equivalent is as efficient and burns the most cleanly but is expensive. You should check whether you can source it at your destination – possibly not. Kerosene (paraffin or ‘lamp oil’) is safer but you should check whether you can get it at your destination and requires a priming fuel as well. Methylated spirit (meths) and gas do not perform well in the cold. Meths is inefficient and gas freezes.

- Stoves should be multifuel to allow for all possibilities and wholly maintainable in the field;
- The mountaineer’s favourite, The Mountain Safety Research (MSR) range of stoves (e.g. Dragonfly, Whisperlite and XG-K II) are lightweight, and efficient and have tremendous heat output for snow melting though expensive. You can burn a multitude of fuels on them and water boils fast, so much so that simmering is difficult. There are number of similar stoves to the MSR now on the market, including one by Optimus;
- The British Antarctic Survey uses the primus stove as developed by Nansen for his crossing of Greenland in 1888. Although very effective, it is bulky and requires both kerosene (paraffin) and meths;
- The smaller but equally robust Optimus used by the British Schools Exploring Society is also heavy and relies on meths and kerosene or petrol. Many polar explorers swear by them;
- The favourite of scouts Scouts and other youth expeditions is the meths-burning Trangia which is compact, simple and safe but not really suitable for extreme cold as meths is hard to light and cooking is very slow;
- Butane gas stoves do not perform well in the cold. Butane and Propane mixed gas cylinders work well in low temperatures but transporting the cylinders may be tricky as they are hazardous cargo and can not be transported as normal freight.

4.7 Preparation and cooking

Once the expedition ration or menu has been devised, it is essential to practise cooking the precise quantities under comfortable conditions to ensure that you become familiar with the cooking procedures, cooking times and to make sure that the quantities are suitable and there is sufficient variety in the menu to avoid monotony.

When melting snow/ice, always start off with a small quantity of water (saved from your flask/bottle) and add the snow/ice a bit at a time. A pan jammed full of snow will just burn and the snow turn to steam before it melts.

Fuel quantities: A general rule of thumb is $\frac{1}{2}$ a litre per person per day. It is better to err on the side of caution and winter conditions may well require more.

With dehydrated foods, it is most important to use the correct quantities of water to ensure the food is properly rehydrated. When in the field, if possible prepare the food well in advance by adding the precise amount of boiling water to the contents in either a strong plastic bag or a pan and leave the contents to rehydrate during the day.

When cooking in the field, heat conservation is the most important principle to observe. Boil water by measured cupfuls so as not to waste valuable fuel. A pint ($\frac{1}{2}$ litre) plastic measuring jug makes this easy and doubles as a mug. Always cook with the lids on and use a reflective metal surround to ensure the maximum heat is reflected back onto the pots. Cook in a sheltered environment, e.g. tent bell end, snow hole, or behind an improvised windbreak. On a sunny summer day, a black snow block bag left outside on a box by the tent will produce a few litres of water with no effort or fuel. In a real emergency body heat can be used to melt snow for water, but it could well produce a descending spiral of energy expenditure.

Collect snow for water from a designated marked spot upwind of the tent. Use an area downwind of the tent or hut for toilet and washing. Take care if camping in an area that has been used before. If the area is likely to be used again then mark **[how?]** toilet and water spots for future years.

Make sure you are fully familiar with your stove. It should be maintained and checked regularly to ensure it runs efficiently. Carry adequate spare parts. Never change a gas cylinder inside the tent, nor refill a petrol stove, while it is still hot.

If you are cooking inside the tent, be *extremely* cautious of fire and of carbon monoxide poisoning. Carbon monoxide poisoning is insidious. You cannot smell it. It stems from incomplete fuel combustion which on a pressure stove may be indicated by yellow or red flame. Additional factors include the pan being too close to the flame, condensation dripping from the outside of the pan. Always ensure full ventilation and never go to sleep with the stove on.

4.8 Hygiene

Dirty pans can harbour germs even in a cold climate. It may be tempting not to do a thorough job with limited fuel and water. But with a little forethought it is possible to be fastidious with minimal water. For instance, use your pasta/rice water for initially washing and do a final rinse with clean water. Detergent is unnecessary and a green scourer should be sufficient.

Personal washing is important to avoid chafing, discomfort etc. As with the pee tin, shyness should be overcome in the interests of health, and your partner's olfactory!

4.9 Case study

A typical daily ration for one person on a lightweight ski-touring expedition might be as follows:

	Kcal per 100 gms	Weight (gms)	Kcals
Muesli/oats	300	75	225
Dried Milk	490	50	245
Sugar	400	50	200
Tea	0	8	0
Biscuits	490	100	490
Butter/margarine	750	50	375
Pepperoni	550	75	413
Primula/pate	400	50	200
Chocolate	500	150	750
Muesli bar	400	33	132
Peanuts	680	50	340
Raisins	165	50	83
Fig rolls	330	30	99
Cup-a-soup	330	15	50
Dehydrated Meat	400	80	320
Rice/Pasta	150	80	120
Custard/Angel Delight	425	20	85
Hot Chocolate	420	15*	63
TOTALS		981	4190

* Normal recommended serving portion is 28g hot choc for a drink, so this fig of 15g seems rather low!

Bibliography:

BRITISH ANTARCTIC SURVEY *BAS Field Manual* (Sections 5 and 6). British Antarctic Survey, Cambridge.

BRITISH ANTARCTIC SURVEY (1991) *Food and clothing in the Antarctic*. BAS, Cambridge: 12pp. (Part of series of Information Booklets).

ELLEN COLEMAN, *Eating for Endurance*. 1997, Bull Publishing Company ISBN 0-923521-38-0

GIFFORD, Nigel (1990) *Expedition Catering*. Expedition Advisory Centre, London.

THE SCOUT ASSOCIATION website:

www.scoutbase.org.uk/activity/outdoor/exped/food.htm

Polar Food Suppliers:

Andrew Lusk & Company (ration components for polar food boxes/rations), Lower Addicroft, Upton Cross, Liskeard, Cornwall PL14 5AH. Tel: +44 (0)1579 363104, fax: +44 (0)1579 363162. No website

BCB International Ltd (survival foods). 7–8 Clydsmuir Industrial Estate, Tremorfa, Cardiff CF24 2QS, UK. Tel: +44 (0)29 20433 700; fax: +44 (0)209 20433 701. www.bcb.in.com Email bcb@celtic.co.uk

Be Well Foods. Brian Welsby, 20 Kings Street, Langtost, Peterborough PE6 9NS, UK. Tel: +44 (0)1778 560868; fax: +44 (0)1778 560872.

First Choice Expedition Foods, Ian Wilson, High Raindale, Spape, Pickering, North Yorks YO18 8HX, UK. Tel: +44 (0)1751 473330; email: ianfcef@btinternet.com www.webart.co.uk/clients

Jordans (Cereals) Ltd. (Fruesli bars, muesli, etc.). Holme Mills, Biggleswade, Beds SG18 9JY, UK. Tel: +44 (0)1767 318222.

Mitchell Biscuits Factory (high calorie brown biscuits). 90 Peffermill Road, Edinburgh EH16 5UU, UK.

Mornflake Oats Ltd (Instant oats). Crewe. Tel: +44 (0)1270 213261

Suma Wholefoods, (all sorts of dried food). Lacy Way, Lowfields Industrial Park, Elland, West Yorkshire HX5 9DB. Tel: +44 (0)845 458 2291; fax: +44 (0)845 458 2294; email: sales@suma.co.uk; website: www.suma.co.uk

Chapter 5: TRANSPORT AND TRAVEL

5.1 Air transport

Although air travel into and within the polar regions has been evolving for the best part of a century, regular air operations have only developed in the past four decades. Aircraft can provide a tool for working speedily and efficiently in polar environs.

One of the few similarities shared by the Arctic and the Antarctic are the long periods of unsuitable flying conditions; therefore pilots must be ready to fly as soon as the favourable weather permits. Though 24 hours of daylight is available, the polar summers are short and the climate unpredictable so travelling time on any expedition is of the essence.

With the above in mind, here are some of the factors to consider:

5.1.1 Type of aircraft

Most polar expedition destinations have limited air charter operators with known aircraft types. Contact them at an early stage of your planning to find out what is operationally possible and what limitations exist.

There are a limited number of aircraft suited to flying in the polar regions. These include Cessna 185DHC-6, Antonov AN2, Twin Otter, Dornier 228, Dakota (DC-3), and Lockheed Hercules C-130 which can all be ski-equipped to land on snow. In addition, HS-748, DC-4, DC-6, Galaxy and various other Russian Aircraft such as the Antonov AN-74 can be landed on sea ice or inland on wind scoured ice (blue ice) landing sites. The Arctic and Antarctic have different operating conditions and should be looked at from different perspectives.

5.1.2 Helicopters

Helicopters have the obvious advantage of access to tight spots but cost considerably more. They often operate from ships and Mil Mi-8s are the common charter aircraft in the Russian Arctic. The same operating procedures as for fixed wing aircraft apply. But additional considerations include guarding kit against rotor wash, preparation and use of slung loads (which requires specialist training) and limited space (as opposed to weight). Many tour ships have helicopters. Using ferries to access the land would be by private negotiation with the operator.

5.1.3 Antarctic air transport

Due to vast distances, unpredictable weather and lack of refuelling stops along the route, preparations and pre-planning for a flight to Antarctica are completely unlike anything you have encountered before.

In order to enter the continent it is necessary to fly from one of the nearest countries to a point which is closest to your destination. Air routes are already established from South America (Punta Arenas) to the Antarctic Peninsula (approximately 650 nautical miles (nm)); and to the Antarctic interior at Patriot Hills, Ellsworth Mountains (distance approx. 1700nm); from South Africa to Dronning Maud Land (approximately 2100nm)

and from New Zealand to McMurdo Base, Ross Island (approx. 2000nm). All of these journeys require a large passenger/cargo aircraft with long-range fuel capabilities.

Perhaps the most appropriate aircraft for this initial input to the continent is the Lockheed Hercules C-130 which is operated by several of the national programs in Antarctica. First produced in 1945 and still manufactured today, it has long-range capabilities, additional fuel tanks and a large cargo section. The cargo compartment is accessible from the rear of the aircraft at ground level by a tail ramp, enabling large or bulky equipment to be loaded on to the aircraft more easily. This particular aspect would be relevant to loading/offloading in Antarctica where heavy lift vehicles may not be available and manual labour would be required.

The Hercules is known throughout the world for landings on unprepared surfaces and for the vast payload it can transport over prolonged distances. Hercules are produced on wheels but only the US government is licensed to operate a ski version, extending the capabilities of an already versatile aircraft. The aircraft would normally transport about 40 passengers and expedition baggage to the interior of the continent. The number of passengers can be increased if the baggage is reduced or vice versa.

Once in Antarctica, onward journeys may be achieved by air or overland. Aircraft working within the continent will have similar specifications as those mentioned above. There is little in the way of Air Traffic Control and the Antarctic pilot becomes his own arbiter while flying over the continent. The Antarctic Flight Information Manual (AFIM) provides guidelines and procedures for operation within the Antarctic Treaty area.

With the above items taken into consideration, the De Havilland DHC-6 Twin Otter became the favourite of air operators on the continent. This twin engine turbine aircraft is much smaller than the Hercules with a passenger capacity in the region of approximately 8-10 people depending on total equipment and baggage weight. The volume of your equipment as well as the total weight is an important factor. It may be that the aircraft can carry the weight you have specified and then find it does not physically fit through the door or the bulk exceeds space available. Always check the dimensions of your sledge or equipment boxes to ensure it will fit inside the aircraft along with the other baggage and passengers. The range of the Twin Otter is less than the larger aircraft due to the smaller fuel tanks, so for any extended journey's, fuel must be placed in the field in advance. Most operators would depot fuel at least a year in advance. As this fuel has to be flown in, it makes operations within the continent incredibly expensive.

5.1.4 Arctic air transport

Physical access to the Arctic is not as restricted due to the shorter distances involved, The choice of aircraft is therefore optional within limits.

Twin Otters and Hercules remain the favoured models. However, Boeing 727's DC6's and DC4's along with a selection of Russian aircraft operate in the north. Air routes into the Arctic are as follows:

- Nunavut, Northern Canada: Commercial flight to Cambridge Bay, Resolute Bay or Pangnirtung, or Iqaluit. Onwards by chartered Twin Otter;
- Greenland: Commercial flight to Angmassalik (Tasilaq), Constable Pynt, Nassarssuaq, Sondre Stromfjord (Kangerlussuaq), and then onward by. Charter helicopter or Twin Otter to destination; or charter the ski-equipped Twin Otters from Akureyri in Iceland. Depending on numbers and payloads, one established

routine to economise as much as practicable is to fly the maximum number of passengers in to East coast destinations in a ski-equipped Twin Otter with a Piper Chieftain being used to carry supplies that are air-dropped once the party has been put down by the Twin Otter.

- Svalbard: Commercial flight to Longyearbyen from Oslo or Tromsø, Norway
- Arctic Russia: Commercial flight to Khatanga in Siberia. Charter Antonov AN-74 STOL jet or Mil Mi-8 helicopter onwards. Costs negotiable.
- Arctic Ocean ice stations. Various commercial operators open ice-runways on the Arctic pack ice each Spring. These can be launching pads for expeditions and provide air support. The best known in recent years has been Cerpolex's base called Borneo that is located at about 89°N in the Russian Arctic and is accessed by charter AN-74 from either Khatanga in Siberia or from Spitsbergen.

5.2 Logistical considerations for air transport

5.2.1 Fuel

This is normally organised in advance by the aircraft operator and a charge is apportioned to your expedition. Do confirm this with them well in advance. Once you have ascertained which aircraft will meet your needs, then the preparation of logistics begins.

If the operator does not have fuel at your required locations, this should be placed at least six months in advance. When preparing a list of fuel required, remember to include aircraft fuel as well as fuel for any vehicles, generators and cooking. This has to be included in your total weight. Consider using one type of fuel for everything to avoid confusion.

5.2.2 Air operations plan

Prior to approaching an air operator, you should have a list with answers to the following questions. This allows the air operator to assess your needs and give you an estimate of costs based on your answers.

- Layout in as much detail as possible what you hope to achieve to include route and re-supplies;
- What time of year are you planning to travel?
- How many days do you anticipate the journey taking?
- How many members will be in your group?
- What will be the total weight of your group's equipment?
- What are the dimensions of the largest/bulkiest item?
- Where will you finish your journey?
- What is the estimated weight that will return with the group?
- Will all members be picked up from one location?
- What experience do the expedition members have in polar travel?
- Do you have an adequate insurance policy in place to cover any potential emergency evacuation?

5.2.3 Landing sites

Most polar outfitters have prepared landing sites that they use and maintain during the operating season. However, should you require an unplanned evacuation, the incoming pilot will require detailed information about the area in which he will land and where practical ask that you prepare a basic runway on which he can land safely. His questions will include some of the following:

- Co-ordinates of your present position;
- Weather conditions:
 - wind direction and speed
 - cloud height and type
 - ground contrast (flat light) and horizon definition
 - temperature
 - any recent changes in local weather
- Length and orientation of runway and thickness of the ice if on sea ice;
- How many members are in your party?
- How many will be airlifted to safety and how many will continue the expedition?
- Approx. weight and volume of your equipment?
- What is the condition of the snow surface in the immediate area? Can you create a smooth area (pilot will give dimensions) into wind with markers either side, No obstructions, not close to mountains, into wind landing?
- Should the pilot expect ground signals from your group, i.e. signal mirrors, fires, flares, etc?
- It is very useful to be able to speak to your air support whilst they are in the air, and a VHF hand held radio can be a lightweight and practical solution. Find out in advance what frequencies the air charter company uses and whether they can lend or hire you a hand held radio for this purpose. If possible exchange the Ni-cad battery pack for one that takes AA batteries then you can have power when it is needed. This can be especially useful if the weather in your location is poor and the re-supply aircraft is in your area but cannot land. In this situation you could ask for items to be air dropped or for the pilot to stay in the area for an agreed amount of time in the hope that a clearing in the weather appears.

Re-supply by air

If planning for re-supply by charter aircraft, particularly in Antarctica, it is cheaper if the air charter company can land and place your cache at a prearranged location at a date and time convenient to the air charter operator, i.e. in advance of your team's arrival. It is much more expensive if you want the re-supply aircraft to rendezvous with your party at an exact location at a specific time.

On the Arctic Ocean, expeditions being supported by one of the Twin Otter operators in Canada can choose to either set up camp and wait for the re-supply aircraft if they find a suitable landing site for a Twin Otter, or to press on, on the assumption that the re-supply aircraft will find somewhere suitable to land, within a range of one to three miles from their position.

Inevitably your plans may change as the expedition progresses and you may wish to modify a pre-arranged resupply schedule. Having a method of voice communications with the air charter company or with a local contact is very useful. Either an HF radio or a satellite phone such as Iridium is very useful and allows for far more complex exchanges of information than beacons such as Argos transmitters.

5.2.4 Airdrops

It may be advantageous to use airdrops to position supplies and thus avoid the need to haul or backpack large loads. In some polar regions, e.g. Greenland National Park, advance airdropping of supplies is not permitted, so do check this with the relevant permitting body for the region you plan to visit. Some general guidelines for the management of airdrops are:

- pick the “drop zone” carefully to ensure it is a suitable area for both the aircraft and you to find;
- ensure that visual contact is maintained throughout the drop either by having a team member on board the plane as the airdrop is made or by having the team on the ground to directly receive the drop;
- package supplies suitably so that everything survives the impact.

There will be several factors which determine the height from which the drop is made (and the speed of the aircraft at the time). These include the layout of the terrain, prevailing weather conditions, skill and experience of the pilot etc.

The higher the drop and the faster the aircraft speed, then the greater the force of impact and the further the items are likely to bounce and travel across the ground on impact. The ideal situation is to have the expedition team on the ground to receive the drop and to be in radio contact with the pilot at the same time.

If you are to receive an airdrop, simply trample or mark a cross on the ground at the drop zone. This should be well clear (minimum 100m) of campsites, buildings and vertical obstructions. Aircraft will normally approach into wind. Station yourself at least 100m at right angles to the aircraft's approach path.

Ground-to-air Signals:

<i>Message</i>	<i>Symbol</i>
Require assistance	V
Require medical assistance	X
No or negative	N
Yes or affirmative	Y
Proceeding in this direction	→

Symbols should be at least 3m long. Use anything that provides good contrast against snow. Digging or trampling the snow is acceptable because depressions will appear darker from the air. In addition to static signals, you should attract attention by radio, flares, smoke, etc. The pilot should acknowledge the message by dipping the plane's wings from side to side.

If it is not possible to have a team on the ground to receive the drop, then make sure that one of the team is on the plane when the drop is made. The team member can then note the area of spread over which the boxes have fallen and can relate the drop zone to the relative position of key ground features such as moraines, ridges, crevasse fields etc.

In addition, take GPS readings as the plane makes repeated runs over the drop zone to get a position fix. Where possible, cross check maps with aerial photos and corroborate data with reports and personal accounts from previous parties who may have visited the region. Items can be quickly buried by snow if left on the ground.

How you package up your supplies may be the key to either a successful or disastrous airdrop. The outer packaging of the final container will take the heaviest impact on landing and is the key to avoiding everything bursting on impact. If making a drop from a relatively small aircraft then there will be a maximum dimension of outer case that will fit through the door – check the dimensions with the pilot!

There are likely to be a number of suitable methods of packing items for airdrops. From personal experience, a successful method is using strengthened corrugated card cases and steel or nylon banding. This involves typically triple walled corrugated boxes with an additional “liner” of similar material to increase the wall thickness. A number of “spacers” of corrugated card are then used at the top, bottom and in the centre of the box to provide some rigidity to help prevent the box from twisting. Once the box is packed, it should be sealed up with industrial packing tape. To ensure maximum strength on impact, however, the boxes must then be secured with 4 to 5 tensioned steel or nylon bands. It is these bands that provide extra strength to the finished container. This type of steel or nylon banding is very commonly used throughout the packaging industry.

5.2.5 Aircraft emergencies

Possible emergency and evacuation procedures are pertinent to each individual aircraft. The air crew should give demonstrations and relevant information before every flight. If you need to know more prior to the start of your journey, contact the air operator.

5.2.6 Safety considerations

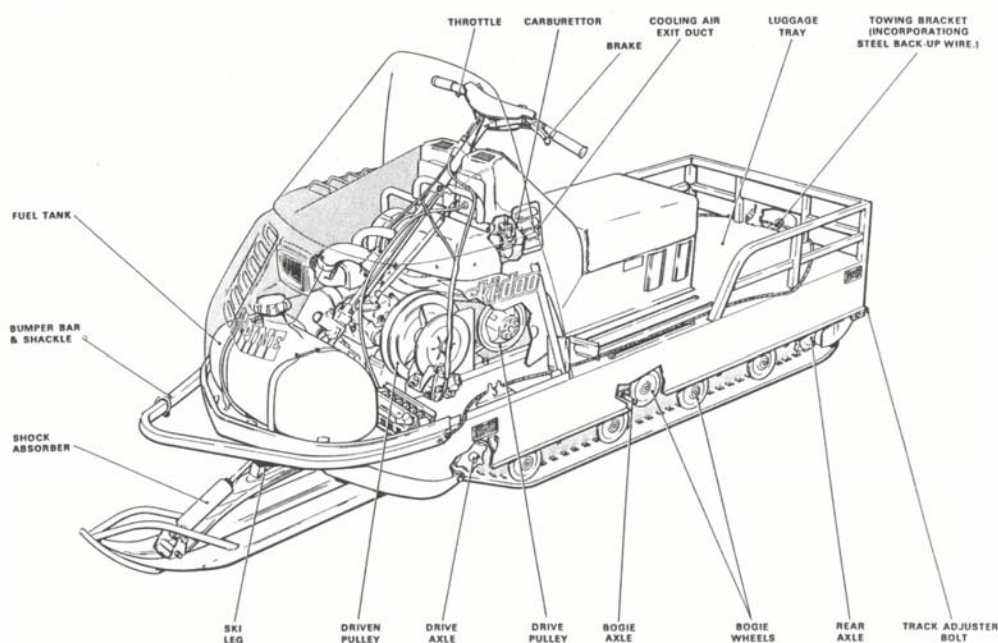
The polar environment can be distant, hostile and unforgiving. Therefore you cannot rely on others for your safe passage or return. All expeditions must be self-sufficient and as far as possible the individuals within the group should also be. The secret of success on most journeys is pre-trip planning, preparation of equipment and planning for all eventualities, especially for the weather.

- Ensure you have established an expedition liaison person if you are not able to be in direct contact with your air operator and that they know your intended route/s and anticipated speeds; how much food and equipment you will carry; and what form of communications and navigational equipment you will have available;
- Preferably have a method of voice communication such as HF radio or satellite telephone to regularly update authorities/expedition headquarters of your position, current weather and well being;
- Plan to have more than one independent method of summoning help in the event of an emergency. For example, a combination of Iridium satellite phone, an Argos transmitter and a 406 MHz Emergency Position Indicating Radio Beacon (EPIRB). (see section 7.4)

- Take enough food for the number of days you expect to travel plus at least 10 days more in case of equipment failure or weather delays;
- Carry a first aid kit, the contents of which all members of the group can administer;
- Try and cover as many eventualities as possible with a back-up option;
- Make certain you have adequate insurance cover.

5.3 Snowmobile travel

Snowmobile (often called snow-scooter or 'skidoo') travel has become one of the cheapest means of reaching an onward destination. Today's snowmobile, while lacking pulling capabilities of earlier models, is fast and reliable. They are used widely in the Antarctic and in most parts of the Arctic. They are banned from certain areas such as national parks and permission should always be obtained for their operation in your chosen area.



Schematic diagram of a snowmobile

The British Antarctic Survey has developed a sophisticated system for long distance 'skidoo' travel specially adapted to Antarctic conditions. It involves connecting two snowmobiles and sledges by long ropes and connecting the driver to the skidoo, all to ensure safer driving over glaciated terrain. For their methods, refer to the BAS Field Manual.

In many places, hiring a snowmobile is an easy option. However, it may be cheaper to be taken to or picked up from your destination. Modern snowmobiles can go at incredible speeds and with unpredictable surfaces, you should be cautious in your driving technique. Practise first with the instruction of the hirer. You can be suddenly confronted by potentially dangerous terrain, therefore be alert, concentrate and think well ahead. Discuss and practice crevasse rescue, and be prepared to adapt and improve. Snowmobiles

are a relatively new expedition tool and lessons learned will benefit others. Always wear a helmet.

Be extremely cautious if travelling over glacial terrain and take local knowledge or probe an area on foot/ski first. The ground pressure of a snowmobile is less than that of a person on skis.

Never travel in white-out or in poor visibility. Crevasses, sudden drops etc. can appear all too quickly on a snowmobile. Never travel away from camp without safety gear enabling you to survive should the snowmobile break down. A snowmobile travelling over sea-ice can really move. Beware of leads, pressure, melt pools etc. Again, exercise extreme caution and do not be seduced by how fast you can go.

If travelling with a snowmobile, look after it as you would yourself. Preventative care is paramount. Ensure you are familiar with its workings and have spares: plugs, drive belts, left and right rear springs, starter rope, spare carburettor, spare bogie wheel set, a selection of nuts and bolts and appropriate tools. Cover the snowmobile when you stop for the night to make sure no blowing snow gets into the engine and fuel tank. Keep the fuel tank topped up, especially overnight, to ensure there is no space for condensation build-up.

Be particularly careful handling fuel in the cold. Fuel on your hands or clothing will freeze at a lower temperature thus exacerbating any cold injury. When hiring the snowmobile, you should be able to hire a sledge, which may be light aluminium and connect directly into the back of the machine.

For the armchair traveller, it is hard to imagine driving an open vehicle at temperatures below -30°C , temperatures at which, with wind-chill, exposed flesh will freeze in a matter of seconds. For some people in the polar regions such environmental demands are a daily event. Extra warm clothing, footwear, headgear, and mitts become essential. Observe what the locals do.

5.4 Small boat travel

Boating is an efficient means for covering long distances up-river or along the coast and for reaching start-points for subsequent travel inland. Most polar travel is undertaken during the summer when seasonal winter sea ice will be dispersing. Apart from the basic equipment there is some similarity between polar boating and its temperate counterpart; although one concern is the lack of Coast Guard cover in polar waters.

As with aircraft and snowmobiles, boats can be chartered for drop-off/pick-up to/from your field location. As a result of various incidents in the 1980s, Svalbard no longer allows locals to drop off or pick up expedition groups in small boats. Instead an expedition group must hire or provide its own small boat or get a larger charter vessel to drop them off. In addition to the skills required in temperate waters there are additional hazards to deal with:

5.4.1 Cold

Sea temperature will be similar or lower to North Sea winter conditions. At 0°C (sea water freezes at -1.7°C) an unclothed swimmer would have about 5 minutes before serious and possibly fatal muscle cramp sets in. The usual requirement for wet and cold weather

clothing is even more relevant in polar seas. Boating suits should be worn as minimum protection, while a dry suit with a buoyancy aid is preferable.

5.4.2 Ice

The dangers of ice to small boats include:

- **Strike** by small lumps or glacier ice, may easily hole a boat cruising at speed;
- **‘Growlers’**: transparent hard, surface-lying pieces of ice can be impossible to see;
- **Encroachment**: pack-ice drifts at the whim of the wind and tide. It is easy to be trapped, encircled and immobilised. Once trapped in pack-ice, you will drift with it possibly towards rocks, reefs or ice cliffs;
- **Crushed**: pack-ice is predominantly wind affected, whereas icebergs are current controlled – don’t become caught between the two;
- **Stuck**: the first warning that it is time to retreat is the formation of grease ice through which it is still possible to navigate. However, once porridge ice forms, your progress will cease. It may be some considerable time (days) before the ice has thickened sufficiently to allow you to walk to safety (if at all);
- **Field ice**: an impenetrable barrier to small craft;
- **Calving glaciers**: never go near ice cliffs which could calve without warning;
- **Icebergs**: never go near icebergs which could turn over or release bits from underwater without warning. Nine-tenths of an iceberg is underwater and may well project out below the visible water line.

In some instances, it may be possible to haul the boat out onto the ice and use the boat as a sledge. This technique was used by early polar explorers and is still practised by the Inuit to navigate broken pack-ice. Because of the poorly charted waters in polar regions, be especially vigilant of reefs, etc.

As with all equipment, carry requisite spares and know your engine. In addition to normal safety gear carry a hand brush to clear snow.

5.5 Sea Kayaks

To experience the true Antarctic or Arctic, sea kayaking is an experience that must be sampled. Sea kayaking will extend the areas that you can visit and the wildlife and marine life you can see. The versatility and flexibility of sea kayaking as a means of transport in Polar Climes, can be very effective with careful planning and preparation. The following subsections will cast some light on a variety of topic relating to equipment, ideas and experience:

5.5.1 Preparation

In many polar areas, you must obtain permission from the local government or ranger. It is also advisable to research as much as possible the local weather and tides and if possible look at data from previous years. Studying maps, charts and books such as Arctic pilots and old expedition books is often invaluable – especially for ideas and planning. Obtaining

the correct scale maps and charts and then sealing them with a waterproof coat is always time well spent.

Prior to departure it is well worth packing the kayak and what other equipment you may be sending in a container, the most rigid and expensive crate you can afford. Damaged kit may mean your trip is over before you begin. Food is worth packing in a controlled environment, making sure to get the balance of quantity and content correct. Dispose of unwanted packaging whilst packing and waterproof everything, as space is always important and kayaking is wet !

Apart from the bulkier items being packed in your crate, it is worth sending up all the items you may have difficulty in taking on a flight eg: air horns, flares, life jacket, gas canisters etc.

5.5.2 Kayaking Equipment

It is personal choice how you customise and personalise a sea kayak and also relevant to the objectives of the trip and the area you are visiting. In areas you are going to experience sea ice, the choice of kayak and accessories is important: there are the physical considerations with either fold up, fabric, plastic or fibreglass and each has there own merits, with regards to performance and handling. Having a strengthened keel or hull is worth considering, if you intend to paddle through areas of sea ice, as are stronger paddle blades. Consider a spare set of paddles each, repair kits, throw line/tethering rope, either fixed or mobile pumps, sponges and loads of deck elastics and lines.

When choosing a suitable kayak and specialising it to a Polar environment, then pay attention to metal fittings, plastic attachments and rubber accessories and how they will react to low temperatures and brittle ice.

5.5.3 General Equipment

A great deal of the following equipment ideas are open to personal preference and experiences, cost and availability: The following list may be of some use

- Consider using a Gore tex dry suit and/or be aware of the implications of wearing pile and shell clothing if you capsize. A compromise between warmth and being dry must be thought about.
- Use a Cagoule with sealed cuffs and large, deep chest pockets – great for storing knives, chocolate etc.
- Tie everything down on the kayak and everything inside the kayak.
- Use strong and waterproof bags (also take loads of bin liners)
- In Polar areas where bears are a danger, take a rifle, ammunition, trip flares (and poles) and even an air horn. Keep them in a strong container (BDH). Keep the rifle accessible and in a waterproof bag, preferably on the deck of the kayak.
- VHF Radios and Epirb emergency distress beacons are mandatory in certain areas.
- Evaluate the benefits between wearing a buoyancy aid and a slim line life jacket and if these are chosen, consider taking spare gas canisters.
- Use double spray decks to prevent imploding and leakage in heavy Polar seas.
- Evaluate your choice of footwear – either Teva type sandals, wellingtons or wet suit boots and consider how they may be to swim in.
- Consider taking collapsible water containers and a flask.
- Plastic coat all maps.

- Choose what navigation equipment you prefer ie: hand held Silva type compass, a deck compass as well as a GPS.
- Take two stoves and spares – no heat = no water no food.
- Use either plastic 5 litre type fuel cans or Sigg type 1 litre fuel bottle – bare in mind spillage and leakage, both have their benefits. Remember a funnel.
- Take distress and signalling flares – both hand and smoke flares are necessary, for either attracting attention or indicating wind direction.
- Consider using over mitts to keep the wind off and fingerless suede gloves to prevent blisters.

5.5.4 Other Considerations

Kayaking in frozen regions can be very dangerous and you should bear certain things in mind. Sea temperatures in polar climes will allow a clothed kayaker to survive for minutes, therefore to wear the proper gear is vital. Devising a method of either rolling the kayak or a method of getting back into the kayak offshore is vital.

The dangers of kayaking near glaciers and icebergs is all too apparent and great care must be taken to avoid being caught near turtling icebergs and falling ice debris near the glacier snouts. The legendary Gino Watkins, despite his experience, almost certainly died as result of a calving glacier.

Any kayaker should be aware of changing weather and wind and realise the physical and safety limitations, they impose. As with any other operation in a polar area, your margin of safety should well exceed that you have set at home.

Wildlife and marine life can pose dangers and you should research the behaviour of Walruses, Polar Bears, Seals, Whales and Birds etc.

Finally, with careful planning and research, kayaking in Polar Latitudes is the most wonderful experience and there is no better way to see and taste these real wilderness areas – than by kayak.

For more information on specialist polar small boat operations, see the BAS Field Manual and BAS Small Boating Manual. For information on particular areas, see one of the Arctic Pilots and the Antarctic Pilot manuals published by the Hydrographic Office. For small boat operations generally, refer to the relevant Royal Yacht Association (RYA) manuals.

5.6 Sledge-hauling

5.6.1 Introduction

Of the transport options available to expeditions travelling through snow country, sledge-hauling can represent a low cost, self-contained and efficient way of travel. It will certainly not be the fastest, can often be the most energetic but can also at the same time be the most peaceful way with least impact on the environment.

Modern materials and refined techniques have contributed to the benefits gained by expeditions using sledge-hauling, where personal loads of up to three times the weight of

those 'backpackable' can be hauled in relative comfort. With a larger sledge, unsupported journeys of up to 100 days with sledge loads of up to 400lbs may be considered.

Although not always essential, it is often a decided advantage for the hauler to ski and this can lead to faster, more efficient and safer journeys. Even complete beginners can soon learn to haul on skis. Keeping weight down will be an important factor in planning and should receive every consideration. For example: is that all singing, all dancing Swiss army penknife really necessary or will only a few features get used?

5.6.2 Types of sledges

The three common types of sledge are Scandinavian *pulkas* (*pulks* in the UK), the traditional wooden 'Nansen' style sledges, and for smaller trips, the plastic 'kiddie' sledge. There are clear advantages and disadvantages for each type, which are described below.

- i) **Pulks.** These may be between 1m and over 2m long and more usually made of fibreglass/resin laminate, although wooden ones are still available. For lightweight and, more particularly, for improved impact resistance and strength properties, Kevlar and carbon fibre composite pulks can be made. The cost of these, however, could be up to three times that for fibreglass or wood.

A pulk is basically an elongated tray with shaped sides. A cover may be integral with the shell, and more useful if waterproof. Straps from within the pulk shell or over the cover serve to tie down and contain the load.

The bottom of the tray is shaped, with two or more keels. These are the runners, usually shod with high-density polyethylene or sometimes PTFE which are important for helping to keep the pulk travelling in a straight line.

The hauler wears a harness, which clips into a rigid or semi-rigid double pole hauling shaft and which must be sufficiently long (about 2m) to prevent interference between the rear of the hauler's skis and the pulk. The shaft is attached at the front of the pulk and allows the hauler to control the pulk's movement. This is particularly important when traversing or descending slopes.

If the situation does not demand this measure of control, the pulk can of course be hauled with just a rope, although when descending slopes, the pulk will want to overtake the hauler or even run them down! To alleviate this you could run a rope from the back of the sledge to the person behind with a prusik attached to this rope to prevent the sledge from running too far forward. Alternatively, fit a rope brake under the front of the pulk for descents of any long or steep slopes.

On the Arctic Ocean it is standard practice to use a long length 6mm cord as trace with small knotted loops every 60 cm so. These loops act as useful handles that are easier to grip than the cord and they can also be very quickly clipped together with a karabiner to shorten the overall length of trace when negotiating obstacles or lengthened to maximum length when on thin ice. A short length of bungee cord between two karabiners works well as a shock absorber at the harness end of the trace.

- ii) **'Nansen' type sledges.** These are usually made of wood, the superstructure and loading platform of the frame being mounted on runners which are now usually shod in high density polyethylene. The whole is usually lashed together with cord and hide, or,

unusually, screwed and bolted. The sledge must be flexible. They can vary between 2 to 3½m in length.

The Nansen is longer than the longest pulk available and, having a larger loading platform, will be capable of carrying a heavier load than a pulk (see section on ground pressure). This means that more than one person will probably be needed to haul a Nansen, and they will conveniently, and for greater safety, be attached to the sledge by ropes of differing lengths. Hauling in unison produces the most efficient results. With higher ground pressure, a Nansen will be harder to haul in soft condition but will always give a smoother ride.

The load is often secured on a Nansen by a continuous lash-line. Bungies (elasticated cord with hooks) might be useful for top stowage of items for ready accessibility, which saves unlashing the whole sledge. However, bungies can freeze. The sledge can flex considerably when moving over uneven terrain. The lash-line may well become loose and require tightening a short time after starting.

- (iii) **Plastic sledges.** A £5 children's play sledge is capable of carrying up to about 40kg. It can be attached to the waist belt of a fully laden rucksack. Plumbers' plastic conduit can be slipped over cord to provide some rigidity. One of the most important things is to get the widest sledge possible but with some form of 'runner' to keep weight low and avoid the sledge turning over. A nylon (preferably waterproof) bag can either be integrated into the sledge or placed in to and secured by bungies. Professionally modified plastic sledges with increased rigidity and a good towing system are available in the UK from Snowsled.

Two sledges can be towed one behind the other if bulk is a problem. One of the advantages of such a light, small sledge is that as loads decrease, the sledges can be nested (for more protection) or strapped on to the back of the rucksack. They are regularly used by mountaineers on big mountains and have been used in various forms on recent North Pole trips, e.g. Polar Bridge, Icewalk and Weber/Malakov Expeditions.

For help whilst traversing, a metal keel plate can be fitted to the rear of pulks, for example those made by Mountain Smith of Golden, Colorado, and to Nansen runners.

5.6.3 Comparison between plastic sledges, pulks and Nansens

	Plastic sledges	Pulk	Nansen
<i>Capacity</i>	Up to 40kg (1m length)	Up to 120kg (1.5–2m length)	Up to 500kg (3.5m length)
<i>Hauling</i>	One person per sledge	Usually one person per pulk	Probably requires several haulers and concerted effort
<i>Safety</i> <i>(a) Personnel</i>	Can rope up as an 'alpine' pair	Rope safety systems – difficult to devise and manage. Group can get split up	Haulers on different lengths of rope to one sledge can be more secure
<i>(b) Loads</i>	Loads easily shared	Loads are easily shared, if one pulk lost, not all is lost	Unless more than one sledge, all equipment could be lost at once
<i>c) Ground pressure</i>	Very low	Low (in soft snow)	High

	Plastic sledges	Pulk	Nansen
<i>Morale</i>	If not roped, group can separate	Group can separate. Group encouragement difficult	Group keeps together but can get resentment over who pulls hardest
<i>Manoeuvrability</i>	Much better, although may slip more on traverse	Better sledge	Worse
<i>Unladen weight</i>	Less than a 1kg	From approx. 3kgs to 15kgs	From approx. 12kgs to 20kgs
<i>Cost</i>	Very low £15	Medium £200 – 1000	High £500+

5.6.4 Repair kit

You will need adequate tools and sledge parts for repairs or replacements during the expedition. Seek spares from the sledge supplier.

5.6.5 Sails

A ‘DIY’ sail arrangement can often be a great help, usually on a Nansen sledge, but has also been used with some success on a pulk. Traction kites are the best method of utilising wind power with pulks.

5.6.6 Safety and rescue

i) Crevassed areas

If there is a likelihood of crevassed areas, a roping system should be used. Manhaul harnesses are available which combine the necessary hauling and safety features. Otherwise, a separate safety harness will be needed. Planning and practice for emergencies is strongly recommended.

Whatever the system, the hauler must ensure that in the event of a fall, it is possible to be detached from the pulk whilst still being attached to the safety rope. The system must ensure that the pulk, in the event of a fall, is capable of being belayed from above. The safety rope should not be part of a pulk hauling system.

Approach crevasses at right angles. Probe ahead on skis detached from the sledge and protected by a rope if at all unsure of the ground ahead.

If several people are hauling a Nansen, they should be attached to the sledge on different lengths of hauling rope. In the event of a fall, overturning the sledge can be an effective first belay technique. The hauling rope will probably also act as the safety rope when a fall occurs. An additional rope for rescue might then be more effectively employed.

ii) Split parties

A party of people hauling individual pulks could become widely separated over a period of time. Whilst it may be a personal preference to be on your own from time to time, the party must keep in touch for safety reasons (and must be together in bad weather). It can, however, be very frustrating and tiring not to be able to travel at your most comfortable

pace. Common sense must prevail, but talk through the matter before moving off and keep to the agreed plan.

5.6.7 Ground pressure

The following figures illustrate the relative approximate ground pressures for walking and skiing with and without pulks. Calculations are based on a fully clothed person weighing 70kg with a 27kg rucksack and wearing size 10 boots.

Walking with rucksack on back	5.5lbs/sq. ins.
Skiing with rucksack on back	1.3lbs/sq. ins.
Walking and hauling pulk containing rucksack	4lbs/sq. ins.
Skiing and hauling pulk containing rucksack	0.95lbs/sq. ins.

All the figures are minima, and are for the ground pressure whilst standing on one foot or ski. The action of walking/skiing, and transferring the load from one foot to the other, and of leaning forward to haul, will raise all these figures. They illustrate that it is much safer in crevassed areas to use skis and a pulk rather than carry backpacks.

5.6.8 Sledge travel tips and techniques

- Ensure that the runners are kept free of ice. Check before the day's journey starts.
- Night-time travel may be necessary if daytime temperatures are high enough to give poor surface conditions.
- Skis with a fish-scale or other pattern on the soles, or better still, skins, will be necessary for hauling uphill. As the slope steepens, you will reach a point when you need to take off your skis.
- Ski sticks are essential when using skis and still very useful even when just walking.
- Rope brakes can be used for pulks and sledges for downhill stretches. Their effectiveness decreases with denser surfaces and lighter loads.
- Descents. Steep drops further down a snow slope may not be seen from the top. It will be almost impossible to stop or turn quickly when controlling a sledge behind.
 - Pulks: Descend slopes straight when safe to do so and you can maintain control; otherwise, zig-zag in wide turns when necessary.
 - Nansens: As above when rope brakes available and workable. Otherwise one hauler steering at the front and the rest braking at the rear.
- Sideslipping of a pulk or sledge on a traverse can be a problem with increase in steepness and surface density. If you cannot avoid traversing, attach a second person to the rear of the pulk or sledge, or load the uphill sledge ski (with a person or load).
- When the going gets heavy, try to keep the load moving all the time, however slowly. Restarting can be tiring and disrupt rhythm.
- It is quite reasonable for two people to haul one pulk if necessary; when this is done, one behind the other rather than side by side is probably more efficient. Consider the safety implications of this arrangement when in potentially dangerous terrain.

- **Packing and loading.** At times, you may need to unpack and relay manhaul sledges by backpacking across snow-free areas and melt streams or up and down steep slopes. If this is likely, pack sledge loads in manageable sizes and weights with this in mind. You will attain maximum hauling efficiency by loading sledges and pulks with the centre of gravity slightly to the rear of centre and as low as possible. Unless delicate equipment requires sturdy and perhaps heavy protective packaging, use lightweight packaging where possible.

5.7 Kites and sails

These range from ex-military parachutes to purpose made highly sophisticated adjustable kites. Designed for hauling loads, they can be most efficient if the wind direction coincides with one's intended direction of travel. In reality, some designs will work up to 30° off the wind direction. They are usually attached to the hauler's harness. Under the right conditions, they can give very fast travelling times (and legs like jelly). A trans-Greenland party travelled 130kms in a 9 hour day on one occasion, whilst Borge Ousland travelled 210km in one day.

The use of kites to assist with traction of sledges in polar travel has become increasingly popular. Don't be lured into thinking that use of such items eradicates the need for extensive training and preparation. In many respects it requires more knowledge and training as the risk of injury and accident are higher than with standard sledge hauling. *Spider* in Carmarthenshire are expedition-proven providers of kite/parafoil traction systems. Other providers include *Parawing* from Wolf Beringer of Germany and *Skiseil* of Norway. Easy to raise even in very light wind.

Suppliers:

Acapulka AS of Norway is currently the leading manufacturer of pulks for expedition use. Their pulks have been used on most of the groundbreaking expeditions of recent years.

Acapulka a/s N 3810 Gvarv, Norway. Tel: +47 359 581 86; email:
info@acapulka.com

Acapulka GBR Kappellenstr. 101 D-46119 Oberhausen, Germany. Website:
www.acapulka.com

Bombardier Snow mobiles

Alpine III skidoo is the current field snowmobile in use by both British Antarctic Survey and has been modified for carriage in Twin Otter Aircraft The Lynx 6900 FCE is the equivalent of this machine and available through Supacat UK.

See www.bombardier.fi/en

Canadian Tire hardware stores in Canada, Walmart Stores in the USA and **Canadian Arctic Holidays** in Quebec have various models/designs of lightweight plastic sledges. Canadian Arctic Holidays, Box 570, 513 Rte 105, Chelsea, Quebec, J0X 1N0, Canada. Tel: +1 819 827 4732.

Email: Icweber@CanadianArcticHolidays.ca
Website: www.canadianarcticholidays.ca

Fjellpulken AS of Norway supply fibreglass sledges (both off-the-peg and bespoke) and their price may well be competitive depending on the exchange rate.

Fjellpulken AS, Hagevn. 3, 2613 Lillehammer, Norway. Tel: +47 61 05 40 00;
fax: +47 61 05 40 01; email: post@fjellpulken.no
Website: www.fjellpulken.no/indexe.htm

Hvitserk in Norway can provide information on sourcing larger plastic toboggans.

Hvitserk AS, Ullern Allé 41, N-0381 Oslo, Norway. Tel: +47 24 12 62 30;
fax: +47 24 12 62 31; email: post@hvitserk.no
Website: www.hvitserk.no

Mailbox International Ltd include in their product line cheap and lightweight small plastic sledges .Mailbox International Ltd, Bayley Street, Stalybridge, Cheshire SK15 1QQ, UK. Tel: +44 (0)161 330 5575; fax: +44 (0)161330 5576. Note these mailbox sledges are somewhat narrow and tend to roll. The Paris Expedition sledge below is a better option to go for.

Paris Company Inc. PO box 250, South Paris Maine 04281-0250 USA. Tel (207) 539 8221 Fax (207) www.theparisco.com email info@theparisco.com. The Paris Company manufacture the Expedition Sledge (plastic sledge 6” deep by 20” wide and 60” long)

Snowsled Polar supply sledges for snowmobile and dog sledge travel as well as smaller fibreglass or kevlar pulks and sledge hauling harnesses for human-powered sledge pulling.

Snowsled, Marketplace Mews, Tetbury, Glos GL8 8DN, UK. Tel & fax: +44 (0)1666 502731; email: polar@snowsled.com
Website: www.snowsled.com

Spider supplies parafoil/kite traction systems for ski-kiting.

Spider, Unit 11a Pembrey Properties Ltd, Pembrey Industrial Estate, Pembrey, Carmarthenshire, SA16 0HZ, UK. Tel & fax: +44 (0)1554 834576; email: spidertraction@ic24.net
Website: www.spidertraction.ic24.net/

Sportsnett Norge AS of Norway – Sportsnett have mail order service and a shop in Oslo and stock what is undoubtedly the best plastic expedition sledge available. www.sportsnett.no Sadly this webpage is in Norwegian !!!

Supacat Ltd www.supacat.com who are based at Dunkeswell in Devon are UK agents for the lynx range of snowmobiles and other snow vehicles

Further Reading

- **Antarctic Flight Information Manual**
- **BAS** Small Boating manual
- **Hydrographic Office** – Arctic pilot, Antarctic Pilot
- **Royal Yachting Association**

Chapter 6: NAVIGATION

Navigation is the science and technology of finding your position and direction of travel. In ancient times, navigation was based fundamentally on observing landmarks and the positions of the sun and the stars. A tremendous advance took place with the introduction, in the 12th century, of the compass into Europe. Instruments used to find latitude in medieval times included the astrolabe, the cross staff, and the quadrant. The problem of finding longitude, however, was not satisfactorily solved until the 18th century inventions of the chronometer, sextant and the appearance in 1765 of the British Nautical Almanac.

The next great revolution occurred in the 20th century when radio signals came into wide use. The development of RADAR and radio direction finding during World War II, plus the subsequent use of navigation satellites caused fundamental changes in navigational practice. With satellites came sophisticated and highly expensive receivers and processors, used by ships and aircraft. These units are now available at comparatively minimal cost to the general public. The GPS (Global Positioning System), works on transects from a number of satellites and gives remarkable accuracy; some within a few metres. They are getting cheaper every day.

Although navigation in any part of the world requires careful observation, recording and interpretation of physical features, the polar regions have specific problems.

6.1 Maps

Maps of polar areas vary from the extremely accurate and detailed to those of questionable or almost unrecognisable representation. Their scales may be great or small. Some areas have been little updated since they were originally surveyed but can still be reliable. Other areas, such as the majority of the Antarctic and Greenland plateaux have **no** features that would warrant the production of a topographical chart. Here JNC, ONC or GNC (aeronautical charts) are adequate for travel and are available from Stanfords maps in UK.

There are numerous different types and projections of charts (generally referring to sea and air navigation) and maps (generally referring to the land): charts with isogonal lines (lines joining points of equal magnetic variation) and charts that report on sea ice drift and geological features, wildlife densities and migrations. There are maps from the rough preliminary survey sketches to those that are intricately produced by the most modern technology.

In addition to maps there is satellite imagery or aerial photographs that can be viewed or purchased. The latter are of high image intensity and, when viewed through a magnifying lens, will reveal even such things as crevasses and detailed ground features.

Although a navigator in the field may always wish that he had brought along yet another map, more detailed, of another area, different scale – do not go overboard with purchasing excessive maps. They are expensive and on the move add to the weight and volume of equipment. Photocopies or tracings may be made of relevant sections to save weight and money.

Maps are easily damaged and hard to replace once you have set off so it is a good idea to laminate them before you go.

6.2 Compasses

There are numerous compasses available. What you are looking for is a magnetic needle on a pivot housed so that it is easy to read and interpret. With even the cheapest compass, the needle will point magnetic north/south. Your accuracy of travel will rarely be better than a few degrees. Look for a simple system, such as you would use in your home country. A Silva Type 7NL, Suunto A1000, or Recta Type 110 are all inexpensive. Most contain a liquid to dampen the needle to prevent it oscillating.

It is important to contact the manufacturers (or a reliable supplier) and state where you are wishing to travel: the Arctic or Antarctic. Compasses are affected by 'dip' with the needle being pulled down at the tip, and compensation must be made for specific areas of the world. Silva provides compasses for five areas of the world.

If you wish to carry out sighting or accurate back-bearings of features, you may have to purchase more expensive compasses with mirrors, cross wires or similar additions for fine readings.

When near the magnetic poles—the North Magnetic Pole is north west of the islands West of Ellesmere Island and the South Magnetic Pole is in the sea just off the coast of Antarctica opposite Tasmania—compasses become unreliable and sluggish. In the past some form of sun compass would be used.

A sun compass can be anything from a calibrated watch dial to a sophisticatedly manufactured sun compasses such as those used in aircraft, or the traveller's own shadow. A chart can easily be constructed to determine the direction of your shadow relative to your position for any time of the day. E.g. In the Arctic, at midday local time your shadow will be pointing due geographic north. At 6pm local time, it will point due west.

The key to solar navigation is to obtain your longitude from a GPS then to adjust a watch from GMT to the exact local time specific to your longitude, i.e. navigation time. The Earth's 360° rotation in 24 hours equates to one degree every 4 minutes. For example, if your Longitude is 90°West, $90^\circ \times 4 = 360$ minutes = 6 hours so move the time back six hours from GMT to give navigation time. If your longitude is 170° West, navigation time is GMT minus 11 hours and twenty minutes. On navigation time 0600, 1200 and 1800 hrs cast shadows from due East, South and West respectively. A second watch is useful for using this method.

Navigation near the magnetic poles in fog may be hampered or stopped until landmarks or the sun reappears. Further from these poles, even if the compass is sluggish, mist and whiteout should not be a worry unless you are near to objective dangers such as open water, crevasses or ice cliffs.

Magnetic variation (the difference between where the compass needle points and the true geographical north) in the polar regions can be as much as 180°. Beware of this and check your charts. If you do not know the variation, you can make an approximation, if you know your local time (sun time but not watch time). At midday local your shadow should be (Arctic) due north. Measure the magnetic bearing and compare it to true north.

6.3 Altimeters

A reliable altimeter is essential for glacier and ice-cap travel where landmarks are minimal. Only consider purchasing a model that can read accurately to 10 or 20m. The combination

of compass and altimeter is a very powerful navigational aid but one that needs practice. Reset it at every known height and be aware that indicated altitude is directly affected by the changing atmospheric pressure. Using the altimeter as a barometer at a static camp can assist in weather prediction.

6.4 Global Positioning Systems (GPS)

The variety and sophistication (and price) varies by the day! Most, as with other computerised machines, have a selection of options far exceeding anything that is likely to be required.

Features worth considering:

- Robustness;
- Reasonable water resistance (snow is wet!);
- Lightness;
- Ability to work at low temperature;
- Battery power and life required to run;
- Accuracy.

Batteries need to be long life (preferably lithium). The instruments (batteries) work best when warm - therefore seek a model that easily fits your pocket or can be hung around your neck and inside your clothing. LCD display can fail in extreme cold and you should be aware of this and guard against it if possible.

The GPS is now almost considered standard navigation equipment, however, it is not essential. Good map and compass work can be as efficient (and less likely to break down) and certainly much cheaper. It will also make you much more observant of your surroundings and save you quite a bit of money. In any case **all** GPS navigation should still be backed up with normal map and compass use.

Many people also use GPS as a useful means of storing waypoints, as GPS: can follow and even record points on the outward journey to enable you to race same route on return journey, avoiding known crevasses, etc.

6.5 Sextants

Sextants have been so completely overtaken by new technology, particularly GPS, that even mentioning them as anything other than as a historical footnote may seem odd. However, historical re-enactment expeditions and retracing routes of polar pioneers is a popular theme of current expeditions and therefore, this largely obsolete method is worth mentioning briefly. Unless you are motivated by a particular desire not to use satellite navigation systems ignore what follows and practise using a GPS.

Contrary to popular myth, the sextant is quite simple to use, particularly in the polar summer where there are plenty of daylight hours. Two sun sights six hours apart could position you to an accuracy of a mile or two. If you were to use a theodolite you could bring the fix to within a few hundred yards. There are lightweight sextants available such as the Zeiss Yachtmaster or even a plastic Ebco or Davies, although the plastics can be affected by extremes of temperature. For serious polar journeys, metal sextants should be used and these may have options of a built-in bubble in place of a mirror. A theodolite is very expensive, heavy, requires a solid tripod and observations are time consuming.

Along with your sextant you need a current Nautical Almanac and Sight Reduction Tables for your latitude. For land, use an artificial horizon (mirror or oil/mercury bath system) and a reliable watch. It will also require some homework and practice. However, great satisfaction and a feeling of pioneering can be obtained by crossing a wilderness and reaching your desired destination by simple astronomical observations and arithmetic.

For ease of calculation and elimination of the Reduction Tables, there are pocket calculators programmed to do the work for you, e.g. the Merlin II or the 'IS' tables, which although very simple, require extreme care in transposing figures and eliminates the Reduction Tables. Here you carry out mathematically what the calculator would do and it requires just a few sheets of tables.

6.6 Local knowledge

The Arctic writer Barry Lopez noted in his book *Arctic Dreams* that the Eskimos/Inuit, without ever seeing a map, could draw remarkably accurate sketches of coast lines and would detail features probably irrelevant to the mapmakers. Even in the Antarctic, there are now few areas which that have not been travelled. Ask around for information. However, use advice given in conjunction with your other navigational aids.

Amongst the islands of the Arctic there are still numerous communities. Some will be hunters and traders and may be able to pass on information on local topography, ice conditions, and weather that could be invaluable to your journey.

6.7 Finding your way

As with all navigation, practice, with meticulous records, keen observation and careful interpretation are imperative.

- Before leaving, mark on the map your departure point and where you are going. Make a written route plan. Work out bearings and study the map for topographical features that may be relevant to pinpointing your position;
- An idea of your rate of travel will be invaluable to confident evaluation of distance travelled. Record your travel times between known points and find variations for different terrain. Walking for a given time on a specific course will put you within a surprisingly accurate location at a given time;
- You may consider it worth fixing a wheel with a mile counter to your sledge. Having steered an accurate compass course, knowing from the wheel odometer to within one or two percent your distance, your position can be assured!
- By keeping a detailed account with known or assumed positions, directions travelled, times, etc., there is always a reference to help when confusion arises. Return to basics and study the records. Somewhere there will be a clue that will clarify doubts;
- Perhaps a feature appears where there is none on the map. First check your line of travel on the map. Is it correct? Then what about the distance from your last known point? Is your compass bearing correctly transferred onto your compass and, are you reading it correctly? Is the sun in the correct position relative to your direction of travel? Are there any other known landmarks that can confirm your position?
- Each aid in navigation – distance, bearing, time, sun, topography, map, when used individually gives only part of the story. By interrelating all of these you could well

find that your feature is **not** on your map. Pencil it in and note its bearing. Do this again after a few miles and by triangulation you can determine its location. Maybe you could have it named after yourself.

6.8 The environment

Reports of temperatures in polar regions tend to emphasise intense cold. As a rule, most polar journeys are undertaken during the late spring and early summer when the weather can be quite balmy. However, it is prudent to study expedition reports to obtain a true indication of the conditions that you will encounter. Be prepared for the worst and be pleasantly surprised with the favourable.

Every task undertaken in the extreme cold will be far more difficult to complete than in temperate or hot climates. To take out the map or set compass bearings while wearing heavy gloves or mitts may be uncomfortable and awkward but, perhaps more important than when in the warm, so never skimp on the number of readings you take.

In extreme cold, instruments will be difficult to manipulate. GPS or calculator batteries may not work. Electronic and computer programs could be lost unless kept above a certain temperature.

Most polar journeys involve prolonged periods of self-sufficiency and commitment. There are few stores on the polar ice caps and not much chance of replacing missing or lost equipment. Ensure that everything is robust and capable of withstanding the conditions to which you will expose it.

6.9 Fog and whiteout

Fog is essentially cloud on the ground. Visibility will be restricted to your immediate surroundings, 50m or less and features that had been relying on for direction will have been obscured. If you are also on snow, the sensation will be that of walking in a "ping pong" ball. Above, below and to your side will all look white. Ground features such as tracks, crevasses, dips and mounds will all merge into one.

If travelling in whiteout or fog you may have to regularly stop and take compass bearings perhaps every few minutes. Once you are well practised, you may be confident to walk all day with just glances at your compass. Knowing your rate of travel will help you assess your distance travelled. The strength and direction of the wind, temperature and conditions underfoot could well influence your direction and speed. A crosswind may make you crab sideways, a headwind will slow you down.

With diligent use of the compass, it should not be necessary to have a partner behind you to give corrections to your track.

If you are off bearing by a few degrees there will still not be a great percentage error by the end of the day. An estimated position can still be plotted and with improvement in visibility, corrections can be made. Navigators at sea may travel hundreds of miles in fog and, on a clearing or sight of the sun or stars, very soon assess their true position *provided an accurate log has been kept during the fog period*. You may need to stop and await better visibility if you are requiring pinpoint accuracy or you are in the vicinity of hazards, a cache or a specific landfall. Obviously, with a GPS you can monitor distance travelled and check your location regardless of the weather.

6.10 Marking of routes

You may have cause to mark your route for the return journey, perhaps for following parties or to identify depots or locate crevasses. One obvious method is with rock or snow cairns although detecting a snow cairn in a whiteout or after heavy drifting can be frustrating. Alternatively and provided weight is no problem, you can take avalanche poles or bamboo canes fitted with large black flags. These are very visible against snow and should last for several months. If weight is restricted then the visibility of the cairn can be improved by attaching some dark object, e.g. a black flag wrapped around a snowblock. Should the site be very important, then lay several locating cairns at known distances apart, perpendicular to the line of travel to safeguard against cloud or poor visibility.

Bibliography:

FERGUSON, M. H. (1997) *GPS Land Navigation*. Glassford Publishing, USA. ISBN: 0-9652202-5-7

LETHAM, L. (1995) *GPS made easy*. Rocky Mountain Books, U.S.A. ISBN 0921102410.

Good overview of use of GPS for land rather than marine applications.

MOTT, P. (1978) *The use of Landsat imagery by small expeditions*. *Geographical Journal* 144 (2): 271–276.

Sources of maps, air & satellite photographs:

British Antarctic Survey

High Cross, Madingley Road, Cambridge CB3 0ET, UK.

Tel: +44 (0)1223 221400; fax: +44 (0)1223 362616; email: information@bas.ac.uk

Website: www.antarctica.ac.uk/

Royal Geographical Society (with IBG)

1 Kensington Gore, London SW7 2AR, UK.

Tel: +44 (0)20 7591 3000; fax: +44 (0)20 7591 3001; email: maps@rgs.org

Website: www.rgs.org

Scott Polar Research Institute (SPRI)

Lensfield Road, Cambridge CB2 1ER, UK. Tel: +44 (0)1223 336540, fax: +44 (0)1223

336549; email: enquiries@spri.cam.ac.uk

Website: www.spri.cam.ac.uk

Stanfords

12–14 Long Acre, Covent Garden, London WC2E 9LP, UK. Tel: +44 (0)207 836

1321; fax: +44 (0)20 7836 0189; email: customer.services@stanfords.co.uk

Website: www.stanfords.co.uk

United States Geological Survey (USGS)

The USGS Earth Science Information Centres can answer questions relating to such things as map availability, map catalogues and indexes, geospatial data, publications, map dealers and product ordering.

USGS Earth Science Information Center U.S. Geological Survey, 507 National Center, Reston, Virginia 20192, U.S.A. Tel: +1 888 275 8747; email: ask@usgs.gov

Website: <http://mapping.usgs.gov/>

Satellite Imagery

See also www.rgs.org/mapping:

Infoterra Ltd (Was formed by a combining of the **National Remote Sensing Centre** and the **Earth Observation Services of Astrium GmbH** Germany in 2001)

Infoterra Ltd, Delta House, Southwood Crescent, Southwood, Farnborough, Hampshire GU14 0NL, UK. Tel: +44 (0)1252 362000; fax: +44 (0)1252 375016;
email: info@infoterra-global.com
Website: www.infoterra-global.com/

National Imagery and Mapping Agency (NIMA) has of Nov 2003 been superceded by the **National Geospatiale-Intelligence Agency (NGA)**but maintains the same address of . 4600 Sangamore Road, Bethesda, MD 20816-5003.

US NOAA Defense Mapping Agency

Has stocked ONCs (Operational Navigation Charts) 1: 1 mill and TPCs (Tactical Pilotage Charts) 1: 500,000 and GNC charts at prices below anything in the UK and available by mail order paid for by credit card. While not necessarily that accurate for roads/settlements, they give an excellent overview of the terrain and may be the best map available for your area. NOAA Distribution Branch, N/CG33, National Ocean Service, Riverdale, MD 20737-1199, tel 310-436 6990, fax 301-436 6829, Website: www.noaa.gov/

Both establishments maintain reference maps and catalogues and will supply Landsat imagery on pre-payment. EROS Data Centre alone maintains world-wide coverage. NRSC is cheaper but they may not have the scene you want. Index maps are also available for reference at the Royal Geographical Society (with IBG).

Navigational Aids

A very useful navigation tool to have is the Plotfix®. This device is a perspex triangle with 6 scales marked in minutes of lat/long allowing one to match the intervals of the latitude and longitude of the map one is using to plot GPS waypoints.

Proprietary and freeware/software is readily available which allows easy, quick and error free transfer of waypoints and GPS data between GPS and PC's along with waypoint and route management and creation.

Suppliers

- Compasses:
 - Silva (www.silva.se/)
 - Suunto (www.suunto.com/)
- GPS systems:
 - Garmin (www.garmin.com/)
 - Silva (www.silva.se/)
 - Magellan (www.magellangps.com/en/)
 - Trimble (www.trimble.com/)
- Sextants:

- Zeiss Yachtmaster

Websites:

www.gpsu.co.uk GPS software enabling GPS waypoint transfer to, and management on, PC for many different models and makes of GPS.

www.marineplanner.com/bowditch/bowditch/cfm PDF online version of world famous Bowditch manual of navigation. Has section on GPS and navigation in sea ice.

www.landfallnavigation.com/-ngpsp.html for plotfix latitude and longitude plotting device.

www.celestaire.com/catalog/products/6150.html for plotfix latitude and longitude plotting device.

www.waypoint-ent.com Waypoint Enterprises produce the following latitude and longitude plotting devices for most of the map scales used on US top maps.

Chapter 7: COMMUNICATIONS



When planning an expedition the communication system to be employed is one of the most important factors. Many countries require an adequate Safety/Communications plan to be in place prior to granting permission for travel in their area of jurisdiction.

This requirement serves to ensure the safety and well being of the expedition members and safeguards the authorities from launching expensive rescue missions that may or may not be necessary. Knowledge of SAR procedures both generally and within the chosen area of travel must be a top priority.

In the event of a SAR being instigated by either the expedition or the authorities it is imperative that accurate information i.e. last known position is available for the rescue services and that updated information, if available, can be passed on accurately and without delay. The rescue services will also need to be aware of any signalling devices carried by the expedition.

For high profile large scale expeditions, who may well have a commitment to a commercial sponsor and/or a charitable body, high quality communications on a daily basis may be a necessity.

The sourcing of equipment can begin once you have obtained the guidelines from your selected organisation. The choice of equipment will be dependent on location operability and physical functionality in sub-zero temperatures.

Most communications equipment is not designed to cope with Arctic/Antarctic temperatures, humidity and general violent vibration. If equipment is specified for rugged military field use, it is normally acceptable. Polar conditions sometimes exceed these stringent stipulations. The drawback is often weight, therefore the selection generally needs to be a working compromise.

For the most part all communications equipment will be carried either in a backpack or on a sledge and is therefore susceptible to breakage and possible submergence. It is advisable to look for equipment with vibration criteria and water/water vapour exclusion specifications. Most high specification equipment has replaceable desiccant inserts. Pelican cases are excellent protective cases available in a huge number of

sizes that are highly suitable for protecting expedition electronics from getting wet, damaged or covered in dust.

Options for communications are as follows:

7.1 Written messages

A note of your planned route date and time of departure plus your estimated time of return left with a responsible person, is one of the most useful and inexpensive methods of communication for relatively short duration journeys.

7.2 Visual and audible signalling devices for use when rescue services are in close proximity

These devices are cheap and functional and could make the difference between life and death if carried as a matter of course on any venture.

Mirror	Excellent for silent signalling and attracting attention;
Torch	A robust waterproof type, with spare batteries. Use to attract attention or as signalling device where there may be danger of avalanche (Visual Morse Code);
Flags/Wands	Tied to ski poles to mark snow hole position or to mark a safe route;
Whistles	To attract attention;
Flares	Smoke, pin-point and rocket flares, each with a specific use are useful in emergency situations and for indicating wind direction to aircraft. White flares are of little use in snow-covered regions!

7.3 Radio

Radio licensing rules vary from country to country and you should be sure that you have the authority to use any radio in your possession. You may have to use a third party in your destination country as the applicant for the licence. It is illegal to use Radio amateur frequencies. Approval can be a long process and you should begin at least a year in advance. Some countries will not allow the use of portable satellite equipment or may restrict its operation in ports.

7.3.1 High frequency (HF) short wave radio and very high frequency (VHF)

HF (short wave) radio has virtually unlimited range, subject to ionospheric conditions, power, aerial efficiency and operator experience.

The 10W crystal set Spillsbury SBX11 now being superseded by the Paracomm PCX250 is probably the most widely used HF radio for polar travellers. We have used Racal PRM 40XX series radios and Yeesu FT70G Portable commercial HF radios. These alternatives work very well and have specifications suitable for polar use. The polar communications expert Laurence 'Flo' Howell has made very lightweight HF radios for polar expeditions under the brand name CAVU communications.

VHF portable radios have a limited range of only a few miles over the ground, subject to topography, but they can be used to speak to aircraft at greater distances. The lack of scheduled airline traffic over the polar regions for the most part, means that this system can only be used with accurate planning and agreements prior to departure.

The above systems are only as efficient as the person using them. It is recommended that personnel be trained in all aspects of the above systems, to a level where actions are automatic.

7.3.2 The ionosphere

The layers of ionised gases ranging from 90–600km above the earth are used as a reflective medium for short wave radio signals.

Communications in the polar regions are extremely difficult due to the effects from solar storms and the particles the sun emits being focused in the polar regions. This can cause radio black outs or severe attenuation of radio signals for hours or days on end.

7.3.3 Radio procedures

- Check all equipment is connected properly; look for snow and ice in plugs and sockets. Check security of wires and battery terminals;
- Set up your aerial with care as this has a great effect on reception. A dipole aerial should be as far off the ground as possible (and connected by paracord to the ski stick (or other stick) so it is not earthed. Make sure it is perpendicular to the direction of transmission. Also make sure you have the dipole length suited to the frequency in use;
- Double check frequency and mode, i.e. (LSB, USB, AM, FM);
- Always keep to your planned schedule time and frequency;
- Keep your transmissions short and to the point, don't waffle;
- Discuss fully with your air charter company about pilot radio procedures for a pick-up situation.

7.4 Satellite communications

Long range communications in polar regions have generally relied on HF (short wave) transmissions but these may suffer from temporary blackouts of up to a few days caused by sunspot activity. Developing technology has brought down the size and cost of satellite communications systems and made them a viable option for groups operating in polar areas.

7.4.1 Iridium satellite communication system

Introduced in the late 1990s, the iridium satellite communication system offers very reliable 24 hour coverage all the way to both the North and South Poles. A large number of government operators, science and expedition teams use the iridium system in preference to HF (shortwave) radio links. Iridium phone handsets are small, light and easily powered from lithium cells or recharged with a solar panel.

7.4.2 Distress systems

i) Emergency Position Indicating Radio Beacons (EPIRB's)

EPIRBs do as their full title indicates: they transmit to a network of satellites known as COSPAS/SARSAT, The International Satellite System for Search and Rescue. EPIRB is the acronym used to describe units which would mainly be deployed on ships to comply with GMDSS (Global Maritime Distress and Safety Systems) regulations, but to understand the next section on PLBs it would be beneficial to look at their function.

When an EPIRB is activated it transmits simultaneously on 121.5MHz (Aeronautical Distress Frequency) and 406.025 MHz. Each unit has its own set of identifiers. The COSPAS/SARSAT network of satellites receives and stores the location co-ordinates and the identity code of the unit which is then downloaded to LUTs (Local User Terminals) which continuously track and monitor the various satellites in the network and receive information from them.

Once an emergency signal has been received and the beacon is identified the position is logged and the information is forwarded to the MCC (Mission Control Centre) who in turn advise the RCC (Rescue Co-ordination Centre) who activate and co-ordinate the SAR (Search and Rescue).

Once the SAR is activated and aircraft have been mobilised, updated positional information is relayed from the network to the aircraft. When the aircraft is in close proximity to the distress location they can home in on the 121.5MHz transmission (typically 50nm at 10,000ft with no obstructions).

EPIRB shape and size varies greatly from the very small 650 gram, pocket-sized version to the ca.8kg variety fitted with hydrostatic release mechanisms.

ii) Personal Locator Beacons (PLBs)

A PLB is a small device designed to be carried on your person for use as a survival aid. Upon removal of a pin the unit transmits internationally recognised swept-tone radio distress signals on VHF distress frequencies. (121.5MHz Civilian Aeronautical Distress Frequency and 243MHz Military Aeronautical Distress Frequency. Some also have two-way voice communication facilities.

When the beacon is operated, the position information is transmitted to the COSPAS/SARSAT network of satellites and then relayed in real time to the nearest LUT (Local User Terminal).

Once the information has been received at the LUT the MCC (Mission Control Centre) will alert the RCC (Rescue Co-ordination Centre) who in turn will mobilise Search and Rescue.

The units are designed to transmit continuously for 48 hours at -20°C and slightly longer at 0°C . Thus maintaining continuous updated positional information and homing signals for the approaching SAR aircraft (typically 50nm at 10,000ft with no obstructions).

PLBs are designed for personal emergency situations whether at sea or on land, in remote or harsh environments. Misuse of these or any distress beacon can carry heavy

penalties and should only be used in the case of real emergencies. Many countries now require expeditions travelling in their remote areas to carry PLBs.

The satellite coverage of 121.5 MHz units will be stopped in 2009. Therefore, you are recommended to only purchase a 406 MHz transmitter. The key advantages of the 406 MHz beacons is that they are more accurate and also transmit the unit's unique reference ID number. As they need to be registered to a government body after purchase (in the UK the HM Coastguard's EPIRB Registry), in the event of the beacon being used, a nominated contact person is called to alert the contact that the beacon has been used. The most up to date models now incorporate a GPS and can transmit the precise location.

For more information on how the system works, take a look at the COSPAS-SARSAT website www.cospas-sarsat.org

7.4.3 Tracking and messaging systems – ARGOS

Argos is a system of Low, Earth Orbiting (LEO) satellites and the result of a joint venture between the French and American governments. Argos provides geo-positioning services worldwide. As well as supporting environmental related programs it also supports industrial and private use of the system. For expedition purposes the system provides the outside world with the 'expeditions' location and status.

Lightweight portable beacons with the ability to transmit the expedition's position, current temperature, current time, current status (16 code facility) and signal quality are available. The signals are relayed by the satellite to earth stations where the data is made available to the expedition headquarters, etc. Check the cost of using such units as the Argos system is operated on a cost recovery basis. Argos units are hired for the expedition and the French or US system operators can e-mail the latest information to nominated contacts every time the unit is used.

It should also be noted that it clearly states in Argos literature that clearance to operate on the up-link frequency of the unit must be approved by the authorities in whose country the unit will be deployed.

7.5 Power supplies

Most electronic systems require some form of electrical power to make them work – dry, alkaline and other cell types will give minimal power output when put in a -40°C environment. Check your equipment for battery type. Some forms of Lithium battery will give near 100% output at these temperatures but there may be restrictions on transportation on aircraft without special packing or conditions of carriage. Solar cells are fine with static expeditions but tend to break when given a day's hard sledging as they are vulnerable to damage. Remember some systems have internal backup batteries as well as the main battery.

7.5.1 Batteries – field radios and portable equipment

Low temperatures can prove problematical and specifications are such that a battery which has the same capacity as a nuclear reactor and the physical strength of a tank weighs an inordinate amount.

The selection of the battery will be dependent on the continuous or peak current required, period of use, temperature, weight allowances and sometimes cost limitations.

Modern technical breakthroughs in battery design are changing the battery capacity to weight ratio, whereas a lead acid battery was one solution to medium and heavy current needs in the past, today nickel-cadmium, lithium-based, air-polarised and aluminium-based batteries are now practicable alternatives.

The choice of battery will also be dependent on whether the battery is of primary type, i.e. throw away after use – not being able to be recharged, or secondary, where there is a need to recharge the battery using solar panels, a wind turbine, generators or a combination of all three.

Dry cells (or the higher capacity at lower temperatures Alkaline types) as used in flashlights, radio receivers or similar devices can be used down to 0°C. Below this temperature the chemical reaction reduces, lowering the current that can be supplied.

Nickel-cadmium batteries can produce large currents with a stable voltage until the end of battery life, and are an excellent solution down to temperatures of –20°C, but need to be charged at a higher temperature, preferably above 0°C otherwise the capacity will be reduced. Partial discharge and recharging can cause a lowering of capacity (the ‘memory effect’).

At lower temperatures all batteries suffer lower storage capacity, however self-discharge is reduced. It is better to raise batteries off the ground and mount as high as possible, as an uncharged or partially charged battery may suffer damage due to the internal electrolyte in gel or liquid form freezing, expanding or cracking the surrounding case material.

7.5.2 Battery selection

Lithium-based primary cells each producing a stable 3.3 volts can be put in parallel or series to produce solutions to very long low current and high pulse current needs, but generally are not so good at long term continuous high current demands.

Lithium cells are expensive but can give outputs down to below –40°C. 14-volt banks of cells each with a diode have been assembled providing a safety route if a cell fails. This weighs only 1kg but provides a capacity of over 35amp/hr. The battery cell should not be exposed to mechanical and thermal stress and can self-ignite if abused or if internal safety fuses are bypassed or pressure vents are blocked. Make sure the maximum current you draw does not go below the maximum allowable depression voltage of the battery, otherwise damage can occur.

There are still transportation difficulties with some types of batteries and strict adherence to International regulations with reference to the Transport of Dangerous goods should be observed. Special packing is often required, and some batteries are banned from passenger flights.

Plugs, sockets and cabling should be suitable for low temperatures and have adequate dimensions and cross sectional area for the current requirements or length of cables. Beware of tapping off large cells at different voltage points, especially if the metals cases of equipment are at different potentials. Unequal discharge in this configuration can be problematic and can cause early battery failure and low capacity.

For your fixed radio or communications equipment you should consider using a leisure battery as used in caravans. Alternatives such as car batteries are designed for high current discharge and rapid recharging and may not provide the output or recharge properly with solar cells or wind turbines.

Leisure batteries are designed for the sometimes intermittent nature and different rates of field charging. Low maintenance or sealed (but vented) types are preferred. They have often the electrolyte in a safer gelled form, eliminating the risk from acid spills even if the battery is inverted.

Beware in all cases of potentially explosive battery gas build-up in confined spaces whilst charging. Beware also of disconnecting power leads from batteries under load or charge, as the gas given off in the charging process can be ignited by such sparks, causing a nasty explosion. One accident of this type in Antarctica sadly resulted in the loss of sight for an expeditioner.

7.5.3 Generators

If higher voltage or current requirements are needed, portable generators may be selected, though the transportation weight of the generator and restrictions on fuel may preclude their use.

Power outputs are available from a few hundred Watts up to tens of Kilowatts. Voltages tend to towards either 220/240 volts or 110 Volts 50/60 Hertz AC. The lower voltage is preferred for safety purposes and plugs/sockets are colour coded, Blue for 220/240 and Yellow for 100 Volts. DC charging voltages are often available simultaneously – either 12 or 24 Volts are common with currents sometimes exceeding 15 amps.

7.5.4 Fuel

Gas powered – generators at low temperatures are not favoured due to low vapour pressure.

Diesel – commercially available low temperature additives help prevent diesel or fuel oil from ‘waxing up’. Starting at low temperatures without a heating element—such as a glow plug—can be difficult, though once they are running diesels are easy to maintain and operate.

Petrol – low temperature additives are available too; most help to absorb water in the fuel, without which freezing of the carburettor can be problematic. Starting using a hand pulley without the use of low temperature grease can lead to strained muscles. The engine oil should be suitable for low temperatures.

Where possible—when not in use—a cooling shutdown generator should be moved into a warm and dry environment, though rime and ice build up is likely when first moved into such locations. When the generator has dried off and warmed up it can be, when required, moved outside and started with some confidence.

Fuelling should be carried out externally, using a device to stop snow and ice particles entering the fuel tank.

Avoid getting fuel onto unprotected hands especially at low temperatures. Always use gloved hands when handling generators; hot and cold burns can be a serious problem.

Make sure the exhaust gases cannot be blown back into your accommodation and that the generator has adequate ventilation and a source of clean air for combustion. Snow blocks placed strategically can reduce noise and pollution. Power cables should be kept off the snow/ice surface. Make sure your generator is operated on a flat stable surface.

7.5.5 Solar panels

Portable fold up lightweight panels are available for the traveller, but make sure the interconnecting wiring, plugs and sockets are suitable for cold climates.

Most solar panels are manufactured on strong robust backing materials and can suffer limited mechanical stresses and knocks. Efforts should be made to protect the panels from sharp edges and too much flexing.

7.6 Suppliers:

ACR Electronics in California distribute a new lightweight PLB called the Terrafix 406 GPS PLB which incorporates a GPS output option. www.acrelectronics.com

CLS Argos co-ordinate a well proven system that allows one to send position data and messages from expedition teams via Low Earth Orbit (LEO) satellites back to an earth station and onto designated addressees. Latest versions of Argos now allow two way message transmission

CLS Argos, 8-10, rue Hermès, Parc Technologique du Canal, 31526 Ramonville Saint-Agne cedex, France. Tel. +33 (0)5 61 39 47 20; fax. +33 (0)5 61 39 47 97; email: monsaingeon@cls.fr

Website: www.cls.fr/html/argos/welcome_fr.html (in French with in-depth FAQ section in English. List of worldwide distributors.)

Inmarsat Inmarsat, 99 City Road, London EC1Y 1AX, UK. Tel: +44 (0)20 7728 1000; fax: +44 (0)20 728 1044; website: www.inmarsat.org/

Iridium www.iridium.com provide contact addresses for iridium/motorola handheld sat phones dealers/distributorships around the world

Lowe Electronics stock Yaesu and ICOM HF radios suitable for expedition communication links,.Lowe Electronics Ltd, Chesterfield Road, Matlock, Derbyshire DE4 5LE, UK. Tel: +44 (0)1629 580800; fax +44 (0)1629 580020; email: info@lowe.co.uk; website: www.lowe.co.uk/

Pains Wessex/McMurdo Ltd, Silver Point, Airport Service Road, Portsmouth PO3 5PB. Tel: 023 9262 3900, fax: 023 9262 3998. www.mcmurdo.co.uk
Manufacturers/distributors of guardian wristwatch with in-built 121.5 MHz emergency transmitter fastfind Personal Locator beacons with 121.5 & 406 transmitter, plus option of inbuilt GPS.

Paracomm Technologies Inc Suite#204 -1321 Hill Rd, Lake Country, BC, Canada V4V 1G1 Tel +(250) 766 9304 www.hfradio.ca sales@hfradio.ca offer a non synthesised lightweight HF radio (PCX250) which essentially replaces the well known SBX11 previously manufactured by Spillsbury of Vancouver Canada and used by many North Pole Expeditions

Sartech Engineering Ltd suppliers of EPIRB's 80 Brighton Rd, lower Kingswood, Tadworth, Surrey KT 20 6SY Tel 01737 832237 www.sartech.co.uk

www.thepoles.com offers hire and purchase options for iridium/Motorola handheld satellite phones with global coverage

Chapter 8: SAFETY

This chapter may seem surprisingly short. That is because most of the aspects of safety have been excellently covered in the following publications: Fyffe and Peter's definitive *Handbook of Climbing*, Langmuir's *Mountaineering and Leadership*, British Antarctic Survey's *Field Manual* (and other national operator manuals) and Chris Furse's *Arctic Expedition Handbook*.

Expedition safety planning and safety management starts at the planning stage. Writing a Risk Assessment for the expedition and preparing an emergency plan to cover as many contingencies as you can think of are important and now standard components of expedition planning. As they are not intrinsically polar they are covered in detail in other publications and training organised by The Expedition Advisory Centre.

8.1 Snowfields, glaciers and ice-caps

Snowcraft may be your weakest skill and although snow and ice techniques, methods for roping up, crevasse rescue and other safety procedures are well covered in a number of publications there is no substitute to pre-expedition training; winter visits to Wales or Scotland will be worthwhile. Also learn about avalanche dangers and their causative conditions.

Plan to spend the first day of your expedition on snow re-practising techniques and re-familiarising yourself with all the equipment. For example, try out crampons; fitting them in the cold on a slope is very different to that in the warmth of the UK; practise ice-axe arrests; dig a simple snow hole; set up a crevasse rescue. In other words, hone the experience gained during pre-expedition training

The safest way to travel over snowfields and glaciers is to rope-up, preferably wearing a full body harness. However, roping needs to be tempered with experience and common sense, and a key consideration is the ability to travel safely yet quickly over ice and snow. Being roped will slow down most parties and whether you are descending mountains or crossing glaciers, the ability to effect a rapid retreat should weather conditions deteriorate is most important. Aim to develop your skills so you can correctly decide when and where not to rope-up. Dry glaciers (i.e. glaciers free of snow) present few problems even to inexperienced travellers because crevasses and holes are easily visible and provided you have good crampon and ice-axe technique, ropes are not required. Beware of a fresh fall of snow which can quickly mask crevasses and make roping-up necessary.

There are several different ways of roping-up on a glacier and personal preferences and glacier type often determine which system to employ. Safety relies on keeping a taut rope between team members. Review and try various methods, but do bear in mind:

- Three is the ideal number on a rope. It is difficult for one person to arrest another's crevasse fall and extremely difficult for one person unaided to recover another from a crevasse.
- You must be able to quickly and effectively arrest the fall of the person *behind* you as well as the one in front.

- Having controlled the fall you must secure the rope with an ice-screw, deadman, or snow stake, etc.
- Can you now extricate yourself from the rope system? When you have, immediately clip a runner onto the rope because where there is one crevasse there is likely to be another, and do resist the temptation to wander unbelayed for a closer look. The last person who did that to me was soon sharing the crevasse; fortunately a shallow one.
- The victim, you and fellow rescuers will soon become cold; be prepared to camp and warm up.
- Falling down a hole is not as bad as first imagined. Rope-up and practise on a simple shallow crevasse and you will see that most systems will help arrest themselves as the rope bites into the crevasse lip.

8.2 River crossings

Crossing rivers and melt streams is a potentially dangerous hazard encountered by many polar expeditions. *Only cross if:* (1) the alternative is more dangerous; (2) the crossing can be adequately safeguarded; and (3) the river is fordable (not swim-able!)

Do not underestimate the strength flow which will be related to speed and depth. Unless the river is very shallow and slow running you are well advised to use a rope using the continuous loop method described in Langmuir (1984).

Beware of the rope snagging on submerged rocks and pulling the person crossing underwater. In such an event rescue will be difficult or even impossible. As a precaution release your rucksack waistband before crossing so that it can be quickly discarded in an emergency, e.g. a slip.

See Furse (1997) and Langmuir (1984) for further information.

8.3 Emergency Shelters

8.3.1 Snow camping bivis

Whether or not you have planned to camp on snow, if you venture onto snowfields or glaciers, you should be prepared to make an emergency ouac (bivi).

Given a reasonable depth of snow you can make a snow shelter. At the very least a shallow trench overlain with snow blocks, bivi bag, tent or branches, perhaps supported by skis or an ice axe, will help survival. With more energy you can dig a simple snow cave although this may take an hour or two. For the committed snow-holer more sophisticated quarters can be constructed. A crevasse bivi may be the best solution if available.

Read about the structure of snow and the changes that can occur within the snow layers. Whatever the reason for snow-holing and whatever the final design, always remember *ventilation*. Deaths have occurred in snow holes because of carbon monoxide poisoning. You must prepare an air hole and keep it clear with an ice axe or ski stick. Igloos are time consuming and for the uninitiated would not count as an emergency shelter. Nevertheless, they are fun to build, given the right type of snow.

For further information see: *Arctic Expedition Handbook*, by Chris Furse (p.130), *Handbook of Climbing* by Fyffe and Peter, *Mountaineering and Leadership* by Eric Langmuir, *Snow Camping* by McNeish, and the *British Antarctic Survey Field Manual*.

8.4 Tundra

Tundra surfaces can range from a pleasant dry, springy turf, as agreeable to traverse as a heather field, to a wet, insect-ridden quagmire.

- Do not assume from your map that where the symbol for water ends, dry land begins because underlying permafrost may prevent drainage leaving several miles of sandflats or boggy terrain. Try to bypass these areas or use an all-terrain vehicle!
- Drinking water can be in short supply on foul and boggy tundra. (Signs of dehydration in your party may be indicated by premature exhaustion and irritability). Avoid drinking directly from glacial streams as suspended rock flour may lead to stomach upsets. Try to find meltwater from a clean snowbank or carry sterilising tablets to purify suspect water;
- Many animals inhabit the tundra, from moose to mosquito. Be prepared.

8.5 Ten rules for survival

1. You must help yourself. You cannot depend on someone else to think for you. In a survival situation confidence in your own ability and a will to live can make the difference between life and death;
2. Prepare yourself for a possible emergency whenever leaving camp and travelling beyond the normal lines of communication or civilisation;
3. Tell someone or leave a note as to when and where you are going and when you expect to return. Make a plan and stick to the plan;
4. Never leave camp or travel alone. The buddy system helps in the prevention and early treatment of frost bite/hypothermia. If one person is injured, the other can go for help;
5. Don't fight the environment. It will invariably win. Wait out bad weather. Go round obstacles;
6. Know basic first aid;
7. Know how to make an emergency shelter;
8. Obtain water. But don't eat snow. It takes too much energy for the body to melt snow and cools the body's inner core;
9. Conserve heat. Eating adds fuel and increases energy levels.
10. Use your head. Analyse your options and then plan the best course of action.

8.6 Objective dangers

The following objective dangers are well covered in the safety manuals listed previously but you should be ready for them:

- Water hazards – melt pools, melt streams, tides, tide cracks;
- Differing snow conditions;
- Crevasses;
- Cornices;

- Avalanche;
- Rockfall.

8.6.1 Sea ice

The Inuit have countless names to describe the different types of sea ice. In calm conditions, it forms in five stages:

1. *Grease ice* – an oily appearance to the water surface;
2. *Porridge ice* – slushy layer through which it is surprisingly difficult to boat;
3. *Pancake ice* – circular pieces of newly-formed ice with characteristically raised edges caused by movement between adjacent floes;
4. *Young ice* – the pancakes consolidate into a continuous sheet a few centimetres thick;
5. *Field ice* – the ice matures and falling snow blankets to an even surface.

These five steps can, however, be short-circuited. Broken pack-ice may be driven by wind or current into an irregular surface with blocks of ice thrown up into a network of pressure ridges. Travel over such a surface is very strenuous and time consuming.

It cannot be overstated how dangerous sea ice can be, especially to the inexperienced. The majority of deaths in polar regions are in sea ice accidents. Walking or sledging over polar pack-ice requires the utmost care borne out of experience, local knowledge and respect. The consequences of getting it wrong can be very serious. So many critical factors are at play including maturity of sea-ice, winds, undercurrents, seasonal variations, pressure ridges, shore leads, open leads and of course, ice thickness.

One experienced Arctic explorer quoted that for safe travel, a minimum ice thickness of 11cm was required but preferably it should be thicker than 16cm. At temperatures of -40°C to -45°C a sufficient thickness of ice could form overnight but at temperatures of -20°C to -25°C , it may take several days. Seasonal variations can also affect the strength of the ice because after a long summer the upper layers of water can be fresher resulting in a stronger ice.

Conversely if the water has been turbulent it is more saline, thereby forming a less rigid sea ice. The effect of sea currents flowing over underwater obstructions or round a headland can markedly weaken the ice over a wide area and it may be safer and wiser to travel 200-300m offshore. Seek local knowledge about such areas.

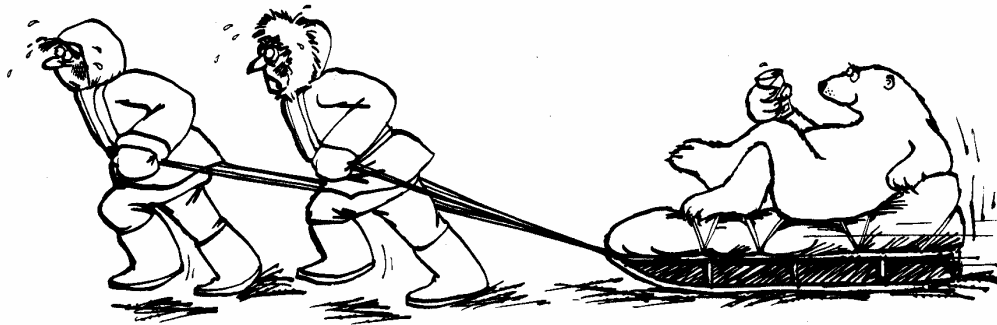
How do you test the suitability of sea ice? Difficult – but an indication is given if the ice is not punctured by a couple of sharp blows with an ice axe or crevasse probe. Alternatively, cut a small hole and measure the ice thickness.

8.7 Animals

Threats from animals in the Antarctic tend to be restricted to underwater work and mainly stem from Leopard seals. If you intend diving in such areas, seek advice from the biologists with the British Antarctic Survey.

There are a number of animals in the Arctic which present a threat. Whilst most animals will cautiously retreat when approached, it is better if the casual explorer observes the larger species from a discreet and safe distance.

8.7.1 Bear (Polar and Grizzlies)



Polar bears are one of the world's most dangerous animals to man. They are hunters and will not distinguish between you and a seal. Their sense of smell is outstanding and you will be smelt from a great distance. In certain areas, e.g. Svalbard, you must carry a rifle and know how to use it. Nevertheless it is illegal to kill a polar bear unless in self-defence. In other areas (such as northern Canada), they are a protected species. In such areas they may have less fear of man and will approach more closely. A polar bear's main diet is seal (usually the Ringed Seal) but they are opportunists, and may become a nuisance when the break-up of sea ice restricts their seal catch.

Use trip wires placed at least 25m from camp. These activate a blank charge, which may frighten off the bear but will certainly alert you to the presence of an intruder.

The procedures therefore are different. If you have a rifle (which should be approved, permitted and practised with) and if a bear reaches 15–20m distance you should shoot to scare it away – most should run off at this stage. If within 6m and advancing, shoot at the heart to kill.

There are signs as to a bear's intent. A curious bear will often approach slowly, stopping now and then, craning its neck, sniffing. It will move its head from side to side, up and down. An aggressive bear will show more determination, and may often attack without warning. Sometimes, however, it may give you an aggressive signal in advance, for example by blowing violently through its nose like an angry bull, or by gnashing its teeth with a smacking sound. A polar bear will usually attack very quickly. At a rapid trot or in great, supple leaps it will aim directly at its prey. If possible, fire warning shots or throw flares onto the ground around the bear.

Always carry a weapon when travelling in polar bear areas. Keep calm if you see a bear approaching. Keep your weapon ready and withdraw slowly if the bear comes closer. You cannot outrun a polar bear. If you find yourself in a dangerous situation, throw down your hat, mitten, scarf, etc. The bear will usually stop to sniff the garment, which may give you time to reach safety.

The polar bear is protected and should only be killed in self-defence. If there is time, fire one or more shots in the air or into the ground well to the side of the bear. In case you must shoot to kill, aim at the chest or shoulder, not the head which is easy to miss. Even if the first shot is not fatal, the bear will stop for a moment, giving you enough time to fire again.

The *Pennine Shooting Sports Association* runs firearm training days specifically for visitors to the Arctic. Contact: The Range House, Diggle Ranges, Nr. Oldham, Lancashire OL3 6LB. Tel: 01457 872074.

Grizzly bears roam in the arctic tundra and most of the above rules apply. BEWARE. Seek local advice on procedures before venturing into the field.

In Svalbard, SNUBLEBLUSS polar bear alarm fences are available for hire/purchase from Geir Paulsen.

8.7.2 Wolf

Wolves will do their best to keep well out of your way. Take local advice.

8.7.3 Musk Ox

Often seen in herds of 20–30 although smaller groups are sometimes observed. They will usually retreat but if approached (<100m) or threatened they will form a circular defensive formation with the bull as spearhead. They may look and sound aggressive.

8.7.4 Caribou

Very timorous.

8.7.5 Fox

Foxes are omnivorous scavengers and will be tempted to any unguarded and unsecured supplies. You should not leave rubbish around and all waste bags will need to be hidden if foxes are not to scatter the contents. They can carry rabies and it may be prudent to be vaccinated against this.

8.7.6 Seals

To all seal species your upright posture represents a threat and hence at close quarters they may respond aggressively. Seals have acute hearing and it is unwise to creep up to them; make your presence known at some distance by a clap or shout. All will defend the family group with vigour and must be treated with caution. True seals (e.g. Ringed, Bearded, Southern Elephant) and walrus will tend to disperse when you approach. If you do wander too close you may be unpleasantly surprised how far they can lunge.

All seals have to leave the water to breed and pups may be born on the sea-ice. Some species form harems, some are monogamous. Eared seals (e.g. Fur Seal, sealions) usually breed in large groups on the foreshore. During moult you may inadvertently stumble across one dozing behind a boulder. On land, over short distances, they are very agile. Take care not to be bitten because it will suppurate and take a long time to heal. When boating you should respect any seals swimming nearby. A startled seal can puncture an inflatable boat. Seals will also occasionally attack moored or beached boats.

8.7.7 Midges and mosquitoes

A curse of the tundra which thankfully disappear at higher latitudes; midges and mosquitoes cannot tolerate freezing conditions. The Canadian tundra can probably claim to have the nastiest biting polar insect. For most arctic travels a suitable anti-inflammatory cream should be carried, as well as an insect repellent. Take a tent with a good mosquito net, preferably one at each end thus improving ventilation. A calm dawn and dusk are the worst periods for insect activity so you might well consider this in any planning.

8.7.8 Birds

All bird colonies and nests should be treated with respect and not disturbed, especially during the breeding season. The arctic tern and skua can be particularly aggressive during nesting and will dive and attack you with unnerving persistence and courage if you threaten their territory.

Bibliography:

- ARMSTRONG, T., ROBERTS, B. and SWITHINBANK, C. (1966) *Illustrated glossary of Snow and Ice*. Scott Polar Research Institute, Cambridge. Special publication No. 4:
- AUSTRALIAN ANTARCTIC DIVISION *ANARE Antarctic Field Manual* (ISBN 0-642-11783-7) and *ANARE First Aid Manual* (ISBN 0-642-11807-8). Produced by the Australian Antarctic Division, Hobart, Tasmania, for their Antarctic Personnel.
- BRITISH ANTARCTIC SURVEY *British Antarctic Survey Field Manual* British Antarctic Survey, Cambridge.]
- BRITISH MOUNTAINEERING COUNCIL *Safety on Mountains* and other publications.
- CLIFF, P. (1991). *Mountain Navigation*. Fourth Edition. Cordee, Leicester: 57pp. ISBN: 1871890551.
- FURSE, C. (1997) *Arctic Expedition Handbook*. Compilation of Briefing notes / field techniques and diary entries from BSES 1996 Spitsbergen Expedition and includes good section on travel techniques in glaciated areas. ISBN 0953038602.
- FYFFE, A. and PETER, I. (1990 AND 1997) *Handbook of Climbing*. Pelham Books. ISBN 720718058 & *Illustrated glossary of snow and ice*
- LANGMUIR, E. (1984) *Mountaineering and leadership: a handbook for mountaineers and hillwalking leaders in the British Isles*. Edinburgh, Scottish Sports Council; Manchester, Mountainwalking Leader Training Board. 361pp.
- MACINNES, H. (1972). *International Mountain Rescue Handbook* Constable & Company, London. 218pp.
- MACNEISH, C. (1980). *Snow Camping*. Spurbooks, Ltd: 96pp
- NEW ZEALAND ANTARCTIC PROGRAMME, *NZ Antarctic Operations Manual* (ISSN 0110-7291); *NZ Antarctic First Aid Manual* (ISSN 0110-2301); and *NZ Antarctic Field Manual* (ISSN 0110-7283). All published annually in Christchurch, New Zealand
- POLAR CONTINENTAL SHELF PROGRAMME, *PCSP Field Operation Manual* (Ottawa Canada) for PCSP supported projects.
- RAYTHEON POLAR SERVICES, *US Antarctic Program Field Manual*. Online version on Raytheon website Website: www.rpsc.raytheon.com Check this address
- SELTERS, A. (1999) *Glacier Travel and Crevasse Rescue*. 2nd Edition. The Mountaineers, Seattle, WA: 143pp
- STRONG, M (2001) *How to Climb Glaciers: The Art of Travel and the Science of Rescue*. Published by Falcon Guides.

Chapter 9: POLAR MEDICINE

The polar traveller encounters meteorological extremes: strong winds can combine with low temperatures to create conditions similar to a blast-freezer but, in contrast, a cloudless summer's day may lead to heat exhaustion, sunburn or snow blindness. Good training and risk-management procedures can reduce the dangers of these hazards. The weather often makes travel difficult and it can be difficult, dangerous and expensive to evacuate casualties. Independent groups should have sufficient medical equipment and expertise to care for casualties for several days.

9.1 Medical preparations

All expedition members should be instructed in basic first aid, personal hygiene and the hazards of the area they are to visit before departure. The expedition medical officer (MO) should contact the emergency services, if they exist, in the area to be visited and find out how they can be contacted and how casualties could be evacuated. Satellite beacons (emergency position indicating beacons – EPIRBs) may be worth taking if there are sophisticated emergency services in the area. Avalanche transceivers are required if you plan to travel in mountainous areas. You must have adequate medical insurance and some countries demand that expeditions hold search-and-rescue insurance.

All travellers should have medical and dental examinations well before the date of departure so that any necessary treatments can be completed. Conditions such as toothache or piles which are merely a nuisance at home can become a serious problem on an expedition. People with a stable medical condition such as well-controlled hypertension, diabetes or epilepsy can take part in expeditions, but the expedition leader and the MO should be aware of their condition as worsening of the disease could cause problems to everyone. Several separate sets of their usual drugs should be carried in case some are lost. People with unstable medical conditions, for example those prone to hypoglycaemic attacks, grand-mal epilepsy or inflammatory bowel disease, should not travel to remote areas unless comprehensive medical support will be available nearby. The condition may worsen under stress and the infirmity of one expedition member may threaten the lives of all. People with poor peripheral circulation in the cold (Raynaud's disease) are more likely to suffer from cold injuries in severe conditions.

9.1.1 Eyes

Anyone whose vision is so poor that they always need to wear glasses or contact lenses must plan to avoid the difficulties that might arise from loss or breakage: as a minimum, a spare pair should be taken. When the air temperature is below -20°C glasses invariably mist over. Metal-rimmed spectacle frames can become very cold and cause frostbite if they are in direct contact with the skin; opticians sell silicon sheaths to cover the side arms of the currently fashionable metal spectacles. Plastic-framed glasses or snow goggles are preferable. For the same reason, exposed metal studs and earrings should not be worn in extreme conditions.

9.1.2 Infectious diseases

These are uncommon in polar areas. However, some sledge dogs carry rabies and a course of rabies inoculations is advisable if the expedition is to work with these animals. Other immunisations may be needed for the journey to and from the expedition base. It is always sensible to ensure that you are covered against tetanus.

9.1.3 Medical supplies

Medical supplies must be compatible with the potential needs of the party. Drugs and dressings are both bulky and expensive, and over-enthusiastic ordering of medical supplies may deprive the team of funds better spent elsewhere. Some aqueous drugs crystallise and degrade in the cold; therefore powdered preparations and plastic containers should be selected whenever possible. Careful packing is essential to prevent breakages. Most medical supplies will be stored together, but a standby kit should be available in case the bulk of the supplies is lost in an accident.

9.2 FIELD ARRANGEMENTS

At base camp the MO should be responsible for supervising the water supply and sanitary arrangements. Fresh water can usually be obtained by melting snow, and this is safe to drink unless it comes from an area frequented by animals or birds. Deer and beaver live near to many apparently pristine melt streams. They can contaminate the water with giardia spores which, if drunk, cause chronic diarrhoea and crampy abdominal pain. Beware of glacier outwash streams, which contain fine, highly abrasive rock dust in suspension (see B. Dawson, 1994); this is a powerful laxative. If in doubt, boil water or use a filtration and sterilising system. Bathing in cold climates is a masochistic pastime, but both people and clothes must be washed whenever possible as skin infections are common among sweaty, unwashed individuals.

Toilet facilities and rubbish dumps should be well demarcated and sited downwind and downstream of the campsite and water supply. In cold climates human waste and packaging materials break down very slowly and are your gift to future generations. As far as possible all waste should be removed from the area you visit. It may be hidden by a covering of snow during winter and spring, but it will be horribly visible at the end of the summer melt. There is now evidence that exposing excrement to direct sunlight results in less environmental pollution than hiding it away, as UV light sterilises harmful bacteria. Some North American National Parks are now recommending “smearing” rather than “digging” for small groups in very remote areas, but a properly designed field latrine is necessary whenever groups are bigger and stay longer.

9.2.1 Dehydration

Because polar air is very dry, sweat evaporates quickly and it is easy to underestimate the amount of fluid that is lost. Dehydration is a risk during the first days of an expedition, and everyone should be encouraged to drink enough to ensure that they produce plenty of urine even if they do not feel thirsty. A combination of malaise, headache and raised body temperature is common when parties first arrive in the cold, and this may be a mild form of heat exhaustion.

9.2.2 Food

Food is a much discussed topic on any expedition. It is necessary to balance variety with the need to obtain sufficient energy. While at base camp, or travelling using motorised transport, energy requirements will be similar to those of an outdoor worker in the UK (3,000cal/12,000kJ per day), but heavy outdoor work such as hauling sledges is an extremely energetic pastime requiring two or even three times this energy intake. In cold climates a greater proportion of the diet is likely to be made up of fatty foods. In the past polar expeditions have lived off the land, but nowadays many animal and bird species are protected and licences required before they are hunted. The internal organs of many polar animals contain toxic amounts of vitamin A and must be discarded; they are in any case not a gastronomic treat.

9.2.3 Fuel

As well as for heating food, fuel is required in polar areas to melt drinking water and dry clothing. It takes twice the energy to boil ice from -30°C as it does to boil water from 0°C . These additional energy demands must be considered when fuel needs are calculated.

9.2.4 Travel

Skidoos must be used with caution in areas where there are fences as garrotting injuries are a recognised risk. Tracked vehicles are usually noisy and should not be approached when moving. Expeditions should define safety procedures before entering avalanche and crevasse zones. Snow is an opportunity for recreation. Travellers on polar trips should enjoy themselves, but expeditions may need policies to limit the risks of leisure activities. A ski injury that would merely be a nuisance in a resort may threaten life in the wilderness.

9.3 MEDICAL PROBLEMS SPECIFIC TO POLAR REGIONS

Cold injury is a risk whenever it is cold and windy. The risk of frostbite is low when air temperature is above -10°C , but becomes significant whenever the air temperature falls below -25°C . Prevention of cold injury requires constant vigilance on the part of expedition members who should be paired off in the “buddy” system to check each other regularly for the telltale signs. Peripheral parts of the body such as fingers, toes and ears may become chilled causing frostnip or frostbite or, far more seriously, the victim may be unable to maintain his or her body temperature and become hypothermic.

9.3.1 Hypothermia

Hypothermia is a fall of the victim’s core temperature to an extent that the ability to function normally is impaired. Normal core temperature is $36.5\text{--}37^{\circ}\text{C}$, and a fall below 35°C usually causes symptoms. Hypothermia is uncommon in a properly clothed, fit person, but may develop if someone is injured, or if clothing is inadequate or wet. It usually develops insidiously over several hours, although it can happen within minutes if someone falls into cold water. The symptoms are similar to drunkenness: poor co-ordination, falling over, confusion. They may shiver uncontrollably, but do not always do so. They may vehemently deny that anything is wrong and refuse help. Untreated, they will eventually become comatose and die. In the field diagnosis can be difficult, but anyone whose torso feels “as cold as marble” should be treated as a cold casualty.

FEATURES OF HYPOTHERMIA

Body core temperature (°C)	Associated symptoms
37	Normal body temperature
36	
35	Judgement may be affected; poor decision-making Feels cold, looks cold, shivering
34	Change of personality, usually withdrawn – “switches off/doesn’t care” Inappropriate behaviour – may shed clothing Stumbling, falling, confused
33	Consciousness clouded, incoherent Shivering stops
32	Serious risk of cardiac arrest Body cannot restore temperature without help Limbs stiffen
31	Unconscious
30	Pulse and breathing undetectable
29	
28	Pupils become fixed and dilated
27	
26	
25	
24	Few victims recover from this temperature
23	
22	
21	
20	
19	
18	Lowest recorded temperature of survival

Experts have disagreed about the best treatment for severe hypothermia and this has led to conflicting advice in textbooks. E. L. Lloyd gives an excellent review of these controversies in his 1996 article (see References and Further Reading). However, the controversies are irrelevant to most expeditions as they are unlikely to have the types of advanced resuscitation equipment that some mountain rescue groups now carry. The aim of treatment is to restore the body heat of the victim.

TREATMENT FOR HYPOTHERMIA

- Seek shelter
- Remove damp outer clothing
- Wrap casualty in additional dry insulation such as a sleeping bag
- Lie down and insulate from the ground

If conscious:

- Restore body heat by providing warm drinks, warming the air with a stove and sharing the body heat of unaffected rescuers
- Chemical heat pads can be helpful if they are available, but ensure that they do not cause burns
- Do not give alcohol
- Ensure casualty rests and is kept under close supervision for at least 24 hours

If unconscious or body temperature is very low: evacuate urgently, if feasible

Rescuers must be careful not to put themselves at risk by giving up too much of their own clothing. Even after body temperature has been restored the casualty may remain confused.

Severe hypothermia is most likely to be encountered following a serious accident, for instance an avalanche. All cases of severe hypothermia should be evacuated urgently. In hospital, the policy is that all cold casualties should be re-warmed, but in the mountains a more pragmatic approach is needed, particularly if there are several casualties. The Scottish Mountain Safety Forum in 1997 produced guidelines to assist with decision-making see table above.

9.3.2 Frostnip

In contrast to hypothermia, which usually develops quite slowly, peripheral cold injury can develop within seconds. The earliest change is termed frostnip and is a numb, waxy white patch of skin most commonly seen on the earlobe or over the cheekbone. It is painless and its onset is usually unnoticed, although some experienced polar travellers may detect a sudden burning “ping” as it develops.

Treatment

Rewarm the body part by covering it with a gloved hand or blowing warm exhaled air over the skin. Do not rub nipped skin. No permanent injury is done if skin is nipped and quickly rewarmed, although redness and swelling may persist for a day or two. In some Scandinavian countries, ointments are sold that it is claimed have a protective effect against cold injury. The evidence is that they are not effective and indeed may increase the risk of injury.

9.3.3 Frostbite

Frostbite – freezing of the underlying tissue – is the progression of the superficial injury of frostnip if it is left untreated. A frostbitten part should be thawed only if the victim can rest for a prolonged period afterwards. Although it is desirable to protect a damaged limb, it is possible for the victim to walk to safety on a frostbitten foot, but once thawed the limb will be useless.

Treatment

- Rewarm the affected body part by putting it in clean water.
- Slowly warm the water to 40°C.
- Give strong painkillers as this process can be very painful.
- Protect body part from pressure and do not allow to refreeze.
- Cover raw areas with sterile dressings and change regularly.
- Take the tops off white blisters, but not blood blisters (see Auerbach, 1995).
- Give penicillin and painkillers (e.g. ibuprofen) regularly.
- Evacuate as soon as possible.

After circulation has been restored, the affected part will look red, blistered and severely swollen. Once treatment has begun, the damaged part must be protected against all forms of pressure and must not be allowed to refreeze. Severe frostbite takes months to heal, and the patient should be evacuated to a hospital used to dealing with the problem. Most doctors have seen dry gangrene associated with poor circulation; this causes death of the digit or limb from the inside. Frostbite injuries look similar, but are less serious as they are generally associated with superficial damage while the core of the limb is healthy. Unless infection develops, amputation should be undertaken only when a line of demarcation between healthy and dead tissue has become obvious. Improved scanning

techniques and anti-prostaglandin drugs are improving the outlook for hospitalised patients with serious frostbite injuries.

9.3.4 Sunburn

Solar energy is intense in polar areas with strong reflection off the snow, and the radiation may exceed that in equatorial regions. High latitude (owing to thinning of the ozone layer) and altitude increase the risk of sunburn and a high factor sun cream should be applied liberally. Sunburn is particularly uncomfortable when rays reflected upwards off the snow burn the eyelids and underside of the chin and nostrils. Lips are particularly vulnerable to chapping and a suitable protective cream should be used.

9.3.5 Snowblindness

This is the term given to sunburn of the surfaces of the eye. The sensation is similar to having sand ground into the eyes. It can be extremely debilitating, being painful but more importantly causing a significant reduction in vision. In mild cases, the eye surface will heal in a few hours; however, in severe cases, where the eyelids may swell up and close, the patient may be incapacitated for several days and should rest in a darkened room or tent.

Treatment

- Rest in a darkened room or tent.
- One dose of local anaesthetic eyedrops (e.g. amethocaine) relieves the initial discomfort, but further painkilling tablets will be required.
- Eyedrops that prevent spasm of the ciliary muscles of the pupil (e.g. tropicamide) can help, but repeated use of local anaesthetic drugs is no longer recommended.
- Chloramphenicol ointment can be used to soothe the eye, applied four times a day.

Ultraviolet light can penetrate cloud and snowblindness may develop even on overcast days. Expedition personnel should wear goggles or dark glasses with side protectors whenever they are working in bright conditions. If sunglasses are lost or damaged, an eye covering fashioned by making a couple of small horizontal slits in a sheet of card will provide an effective emergency alternative. Some experienced polar travellers have found that they are almost immune to snowblindness, but their apparent resistance should not entice newcomers to discard their eye protection.

9.3.6 Other hazards

Other polar hazards include the risk of suffocation or carbon monoxide poisoning in snowed-in tents and snow-holes. Ventilation holes must be checked regularly to ensure that crystals of water vapour do not block them. Some polar expeditions climb high enough for mountain sickness to be a problem (this topic is covered in Chapter 26). Although wildlife in the southern hemisphere is usually friendly, the same cannot be said of grizzly and polar bears which may take an unwanted interest in your presence; seek local advice and, if recommended, take a firearm.

Medical personnel attached to government polar research groups have studied many aspects of medicine and physiology, but the results of their investigations may be difficult to obtain as they are published in specialist professional journals. It is difficult to conduct field research in extreme conditions, but there remain opportunities for an enthusiastic MO

to undertake a small research project. *Man in the Antarctic* (see References and Further Reading) is a good place to start reading about polar medical research.

The major hazard of the polar environment lies in its unfamiliarity. Once the hazards have been realised and guarded against, the cleanliness, beauty and remoteness of the polar wilderness provide inexhaustible pleasure for those fortunate enough to venture into it.

Evidence base

This article was based upon information from major textbooks on the subject including those by Auerbach (1995) and Lloyd (1986), updated following a search of Medline articles for 1990–2000 using the keywords “accidental hypothermia” and “frostbite”.

RECOMMENDATIONS FOR EVACUATION OF COLD INJURED

	Criteria	Action
Definitely alive	Conscious	Insulate from heat loss Rewarm Monitor regularly Evacuate
Definitely alive	Unconscious Respiration and/or pulse present	Insulate from heat loss Rewarm only once in hospital Maintain airway Evacuate in recovery position
May be alive	No respiration No circulation (1 min) Clear airway No obvious fatal injury. Temperature below 32°C	Radio/phone for medical advice with evacuation plan Rewarm only once in hospital
Definitely dead	No respiration No circulation (1 min) Airway blocked Obvious fatal injury Temperature below 32°C	Evacuate as dead

Bibliography

- ADAM, J. M. (1981) *Hypothermia: Ashore and Afloat*. Aberdeen University Press, Aberdeen
- AUERBACH, P. S. (1995) *Wilderness Medicine. Management of Wilderness and environmental emergencies*. 3rd edition. Mosby, St Louis
- DAWSON, B. (1994) “The removal of rock flour from glacial streams”. *Island: Bulletin of the Iceland Unit, Young Explorers’ Trust* 7: 7–8
- LLOYD, E. L. (1996) “Accidental hypothermia”. *Resuscitation* 32: 111–24

- LLOYD, E. L. (1986) Hypothermia and Cold Stress. Croom Helm, London
- MILNE, A. H. and Siderfin, C. D. (1995) Kurafid. 4th edition. British Antarctic Survey, Madingley Road, Cambridge. Advanced first aid for well-equipped expeditions
- RIVOLIER, J., Goldsmith, R., Lugg, D. J. and Taylor, A. J. W. (1988) Man in the Antarctic. Taylor & Francis, London. A summary of research work in polar areas
- WEISS, E (1997) Comprehensive Guide to Wilderness and Travel Medicine. Adventure Medical Kits, USA. Hip-pocket sized field medicine manual used by American Antarctic Program.
- WILKERSON, A.J. (1986) *Hypothermia, frostbite and other cold injuries: prevention, recognition and pre-hospital treatment*. The Mountaineers, Seattle, WA: 105pp.

Chapter 10: PHOTOGRAPHY UNDER POLAR CONDITIONS

Except in extreme cold, most cameras will operate adequately in the polar environment and indeed in most cases will be spared the horrors of sand. Whatever equipment you choose, it is well worthwhile designating one of your party as prime photographer. Invariably the most interesting pictures will stem from times when unless the right priorities are pre-arranged, no-one is thinking of taking pictures.

In times of minor (or even major) crisis when everyone feels they should be pitching in, the designated photographer should not feel guilty but ensure that possibly the most exciting moments of the expedition are captured on film. His role is critical and it is for the other members of the group to remember that he has a place and not resent his apparent lack of contribution to the hard work at times. It is a difficult role with conflicting responsibilities.



It is far better to duplicate on film, rather than afterwards. Copy transparencies are always poorer quality and more expensive to produce. Before the expedition starts, agree who will keep and own the photographs taken.

Much of this chapter refers to extreme cold but the section on exposure applies to all snow conditions.

10.1 Extreme cold

Extreme cold stresses cameras, film, and other equipment, as well as the photographer. In Polar regions winter temperatures can fall to -40°C or lower. Under such conditions, camera shutters can become sluggish and unreliable, or even fail completely. Lens diaphragms and auto-focus mechanisms often bind, and film-transport mechanisms stiffen. Lens elements contract and may separate. Batteries lose efficiency and deliver only a small portion of their energy. Battery-operated flash units, motor drives, exposure systems, and motion-picture camera drives may not function. Film may become brittle and break in the camera.

If you are likely to encounter such problems, fully selecting your equipment and keeping it warm, and, perhaps, winterizing it, will provide more reliable operation and better photographic results. The advantage of a compact camera is that you can keep it close to your body core, only bringing it out for very brief periods.

10.2 Selecting cameras

The camera that you select is a matter of personal choice. Do not, however, expect reliable performance from equipment that has not been tested under the particular working conditions you expect to encounter. Shakedown testing ahead of time will usually uncover any malfunctions or problems.

Thoroughly understanding your equipment and knowing that you can rely on it allows you to concentrate on lighting, composition, and other photographic aspects.

Each type of camera has its drawbacks, and no one type seems to be superior. You should select a camera that is compact, lightweight, easy to use, dependable, and adaptable to various needs. A manual camera with a built-in meter will not be susceptible to electronic failure like an automatic camera. If you use an automatic camera, make sure it allows you to manually override automatic exposure and automatic focus systems.

10.2.1 35mm cameras

Most 35mm single-lens-reflex (SLR) cameras fill the basic requirements for polar photography and offer the advantages of interchangeable lenses and a wide choice of film types. The 36-exposure rolls minimise roll changes under adverse conditions.

A good selection of equipment for your expedition might be two identical 35mm camera bodies with interchangeable 28mm, 55mm, and 135mm lenses. Take along an ample supply of black-and-white and colour film in 36-exposure rolls. The Nikon FM2 is probably the best fully manual camera on the market and available second hand. Try and talk to others who have been in similar conditions to those you expect to encounter.

10.2.2 Compact cameras

You may consider an all-weather, point-and-shoot camera as a spare. Although these compact, lightweight autofocus cameras are tightly sealed for protection from water and snow, they are designed for everyday snapshotting. Thus they tend to feature auto-exposure, auto-film advance and rewind, built-in flash, and easy-to-use controls. Snow-filled scenes will cause an auto-only camera to underexpose the film, a situation which may be very difficult to overcome because most of these cameras lack exposure override controls.

To minimise exposure problems, use a negative film and move in close to your subject. Camera power demands combined with cold temperatures will drain battery power, so carry extra batteries. Keep your camera warm under your parka to preserve battery power and to avoid film breakage and static discharge from the camera's auto-advance and rewind.

10.2.3 Roll-film reflex cameras

Some single- and twin-lens-reflex cameras that use 120- or 220-size roll film have many of the conveniences of 35mm cameras, plus advantages of a larger film format. Some of the considerations that apply to 35mm cameras also apply to the larger film format cameras.

Many of the SLR models suitable for polar photography will accept a fairly broad range of accessory lenses. Most of these lenses have automatic diaphragms.

The more versatile SLR cameras have interchangeable magazine backs that hold 12- and 24-exposure rolls. With only one camera and a few extra backs, you can readily switch from one film type to another. Since the backs are small and lightweight, you can easily carry them inside your parka, where the film will be warm and ready to use.

A SLR camera with interchangeable 40mm, 80mm, and 150mm lenses, and three extra magazine backs loaded with black-and-white, colour negative, and colour transparency film, can be a relatively lightweight, reasonably compact, and highly versatile outfit.

10.2.4 Motion picture cameras

Electrically powered motion-picture cameras are generally better than spring-driven models if a generator or another source of electricity is available. Batteries are not dependable when exposed to extreme cold for extended periods.

Film in rolls is less likely to break in the camera than film in magazines. You can load magazine and cartridge type motion-picture cameras easily and quickly in the field, but there is no practical way to winterize magazines and cartridges. We recommend keeping each day's working reserve as warm as possible inside your parka. Another way to keep camera and film warm is to carry it in an insulated thermal bag with a few small hand warmers. Place the hand warmers in plastic bags to protect the film from potentially damaging fumes.

10.2.5 Video and digital cameras

Much the same rules apply for the newest technologies particularly with respect to battery care. With much higher battery usage, give extra consideration to keeping them warm and to re-charging facilities. Digital technology usually has different light compensation abilities so manual adjustment should not be necessary.

10.3 Winterising equipment

10.3.1 Cameras

Winterizing involves dismantling the camera and lens to remove all lubricants. A qualified technician should do this. If your camera is an older model or will be exposed to *extreme* cold for prolonged periods, winterizing may be necessary. Winterizing a camera is expensive and should not be done without first consulting your camera manufacturer's representative. Once the lubricants have been removed, you cannot use the camera under normal conditions without damaging it. A practical alternative to winterizing is simple preventive maintenance and cleaning of the camera body and lens.

Current 35mm SLR cameras usually need not be winterized. Lubricants in them will continue to work for brief periods in extreme cold. However, it is important to prevent the camera from cold soaking. Cold soaking occurs when the camera cools to the ambient air temperature; complete soaking takes several hours. Protect your camera and lens from prolonged exposure to the cold. When you are not taking photographs, keep the camera and lens under your parka. Some camera companies offer cases to deaden camera noise and also insulate the camera.

10.3.2 Meters

Photoelectric exposure meters do not require special winterizing. They are usually reliable, although the batteries in CdS and silicon blue meters can cause problems. You should carry replacement batteries and protect them from very low temperatures.

If your meter or camera has an LCD (liquid crystal display), low temperatures will make the LCD pulsate and decrease the angle of view. You will have to look directly down at the LCD to see the display. As temperatures near 14°F (−10°C), the display will stop operating. Since the display will freeze very quickly, expose the meter to cold for only a very short time, and keep it under your parka when not using it. You may also want to carry a selenium-cell meter (which does not use batteries) to make comparison readings or provide a backup.

10.3.3 Batteries

Batteries need to be kept warm to function properly. The three most popular types of batteries used in cameras are lithium, alkaline, and silver-oxide or button batteries. Battery manufacturers test their batteries to determine their operating temperature ranges. Batteries will not give full power at the low end of the range. Lithium batteries have a range of 70° to −40°C and may be the best performers in the cold. Alkaline batteries have an operating range of 54° to −20°C and are good under heavy use. The range for silver-oxide batteries is 54° to −12°C. They are used in many older cameras with metal bodies; cold transmitted through the camera body can cause the batteries to freeze rather quickly.

All batteries contain electrolytes to carry the electrical current. At temperatures below −40°C, the electrolytes will freeze, rendering the battery useless. Cold temperatures combined with camera power requirements drain battery power very quickly; carry extra batteries and keep them warm or use an external battery pack that connects to your camera's battery housing via a long cable, allowing you to keep the pack warm next to your body. You could also attach a small chemical hand warmer to the outside of the battery housing to keep the battery temperature within the operating range.

10.3.4 Flash units

Extremely low temperatures also have a detrimental effect on electronic flash units. You can't predict the exact effect of cold weather on the output of a flash unit accurately. Efficiency will vary from one unit to another because of the differences in capacitors and batteries.

Nickel-cadmium batteries operate at approximately 60% capacity and yield fewer flashes per charge at −4°F (−20°C). Don't recharge these batteries at temperatures below 50°F (10°C) because this causes venting and permanent damage.

Flashbulbs may not be a good alternative to electronic flash because they are bulky and take up valuable storage space. A battery power supply may not be a good choice either, because it may lose efficiency in extreme cold.

10.3.5 Films

After you load film into a camera and subject it to extreme cold, the film will lose some of its moisture and may become brittle and break as you advance it. Advance the film slowly from one frame to the next with a steady movement of the transport lever or crank. By carefully advancing the film, you lessen the strain on it and reduce the likelihood of breakage or static discharge. Rewind 35mm film magazines slowly to help minimise static discharges that can show on the film after it is processed. Don't use a motor drive, because

rapid winding contributes to static markings on the film. If your camera has a built-in drive, set it so that it advances only one frame at a time.

With motion-picture films, a rapid loss of moisture at low temperatures may cause curling and brittleness. You can minimise these problems by using films coated on an ESTAR Base. These films maintain their flexibility and strength better than films coated on an acetate base.

Cold temperatures may reduce the effective film speed and alter the colour balance of colour films. Exposure meters may not give accurate readings. You can minimise these problems by keeping your film and camera warm under your parka. If you can't keep them warm, we recommend bracketing exposures by several stops from the meter reading, since you can't accurately predict the extent of these changes.

10.3.6 Film type

Most Arctic photographs are taken on colour reversal films. Kodachrome, Kodak Ektachrome, and Fuji Velvia are excellent choices for colour transparencies. Whatever you choose, try to stick to the same type so you get consistency across all your pictures. You may like to discuss this with the rest of the team as if you mix and match slides for a show, they will be more consistent. You may also want to use colour negative or black and white negative films as well for documentary or snapshots.

10.4 Procedures and precautions

You should be able to alleviate the problem of polar photography caused by extreme cold by keeping materials and equipment as warm as conditions permit.

Whenever possible, carry film, cameras, lenses, and other accessories under your clothing, where they will be kept warm by body heat and be protected from the wind. Don't leave equipment out in the cold any longer than necessary; condensation will occur when you put the equipment back under your clothing. Be careful not to breathe on your equipment, because your breath will form a layer of frost. But make it accessible also to ensure you take enough pictures.

Protect against blowing snow when you reload roll and 35mm cameras. With a little practice, you'll find you can load film under a parka. You can also use a towel or a blanket to protect the open camera from flying snow.

You should keep the ever-present danger of frostbite in mind, particularly when your hands and face come into direct contact with a metal camera body. Cover the exposed metal areas on cameras that you use at eye level and must hold close to your face. You can use heavy electrical tape, plastic foam, or some other insulating material to do this. Under no circumstances should you touch a camera with wet hands; your skin will freeze fast to the cold metal almost instantly.

Avoid taking a cold camera unprotected into a warm room/tent. Condensation will form on both the outside and the inside of the camera and possibly inside the lens. With electronic cameras, the condensation could very well cause malfunctions. Before entering a warm room/tent with a cold camera and lenses, place the camera and lenses in a plastic bag, squeeze out the air and tightly secure the bag. Allow the equipment to warm up to room temperature (an hour or two) before removing it from the bag. If your camera is in a

tight-fitting case, the condensation will form on the outside of the case. Allow the camera to reach room temperature before you remove it from the case. Better still, leave it outside.

If condensation forms on your camera, you can let it air-dry, or you can place it in a covered container with some activated silica gel.

When you are outdoors, do not clean lenses and viewfinder by breathing on them. The moisture from your breath will freeze on the lenses and viewfinder and be quite difficult to remove. Use a camel's-hair brush or lens-cleaning tissue to clean lenses and viewfinders. If you drop a camera into the snow, pick it up and shake it to remove the snow or brush it off. Don't try to blow the snow from the camera, because your breath will freeze on it.

10.5 Pictorial effects

We recommend using back or side-lighting for the best pictorial effects when you photograph snow scenes. This lighting gives a feeling of depth by capturing the sparkle of sunlight striking individual snow granules. You can enhance the beauty of some snow scenes you photograph in black and white by using a light- or medium-yellow filter. This darkens sky tones and increases overall contrast by absorbing some of the blue skylight that illuminates blue shadow areas. Using red filter over the lens exaggerates the contrast of sparkling white snow and its grey shadow tones against an almost black sky for special effects.

Colour films can capture the best pictorial results. Photographs taken during the period one hour after sunrise to one hour before sunset will give excellent colour rendering. Shades of yellow, orange, and red will predominate in scenes photographed early or late in the day, including sunrises and sunsets.

You seldom need to use filters with daylight colour films unless you want to produce special colour effects. You can use a haze (skylight) filter to reduce excessive bluishness. This filter will also protect the camera lens.

Try using polarising filters to create special effects and to darken the tone of blue skies in colour photographs without affecting the colour rendition of the other subjects. The darkening effect is greatest when you photograph subjects under a clear sky with the sun at a right angle to the lens axis. Experiment with the filter to obtain the effect you want. Always use a lens hood to avoid flare from the sun and the snow.

10.6 Exposure

10.6.1 Meter readings

Make exposure readings frequently, even though the lighting conditions and subject matter don't appear to change much. The meter will indicate only half, or even a quarter, of the actual exposure you should use. Exposure meters are fooled by snow because they are calibrated for the usual proportion and darkness of shadows, which do not occur in snow scenes. The best procedure is to take the meter reading from a grey card. Use a lens opening $\frac{1}{2}$ a stop larger than the meter indicates as a basic setting for a front-lighted scene; then apply the adjustments listed in table below. Under overcast conditions, the meter reading from the grey card can be used directly for subjects of average reflectance.

10.6.2 Film instructions

Use the suggested exposures given in the instructions for your film to photograph snow under bright sunlight. In higher latitudes, the angle of the sun is an important consideration. If the sun is lower than 30°, increase exposure by ½ to 1 stop. Snow is a good reflector for the shadow side of subjects that are side- or backlit. This effect reduces the need for changing your exposure when the lighting direction changes.

10.6.3 Bracketing

If you are using slide film, take additional photos of each scene giving ½ to 1 stop more, and ½ to 1 stop less exposure than your meter indicates. This is called bracketing. Because negative films have much greater exposure latitude than slide films, you normally don't have to bracket them. You can get an acceptable print from a negative overexposed up to 3 stops or underexposed up to 2 stops. If the meter seems to be malfunctioning, expand the bracket range up to 2 or even 3 stops.

10.6.4 Exposure corrections for bright sun on snow**Adjustments from normal readings**

<i>Lighting source:</i>	<i>Front</i>	<i>Side</i>	<i>Back</i>
<i>Scenics</i>	1 stop less	1 stop less	1 stop less
<i>Medium distance, people</i>	1 stop less	1 stop less	None
<i>Close-ups of people</i>	None	½ stop more	1 stop more

(Data courtesy of Eastman Kodak Co.)

11. APPENDICES

11.1 UK Polar Expedition Resources

Your starting point should be the huge volume of polar information on the web (see below). Contact one of the polar libraries for more depth or detail. The Scott Polar Research Institute, part of Cambridge University, has one of the best polar libraries in the world. Call to discuss your research needs. For a small fee they will search their accessions database and send you an annotated bibliography, saving hours of work at the library.

Amongst those UK organisations which have particular expertise in polar regions are:

British Antarctic Survey

High Cross, Madingley Road, Cambridge CB3 0ET, UK.

Tel: +44 (0)1223 221400; fax: +44 (0)1223 362616; email: information@bas.ac.uk

Website: www.antarctica.ac.uk/

BSES Expeditions, 1 Kensington Gore, London SW7 2AR, UK. Tel: +44 (0)20 7591 3141; fax: +44 (0)20 7591 3140; email: bses@rgs.org, website: www.bses.org.uk.
Runs youth expeditions to polar regions.

Expedition Advisory Centre, Royal Geographical Society (with IBG), 1 Kensington Gore, London SW7 2AR, UK. Tel: +44 (0)207 591 3030; fax: +44 (0)207 591 3031; email: eac@rgs.org; website: www.rgs.org/eac

Polar Regions Section, Foreign and Commonwealth Office

King Charles Street, London SW1A 2AH, UK. Tel: +44 20 7008 3543, fax: +44 20 7008 2086. Arctic and Antarctic Advice and Antarctic permits.

Email: Prs.fco@gtnet.gov.uk, Website: www.fco.gov.uk,

Provide permits and impact assessment information for expeditions to Antarctica.

Poles Apart, David Rootes and Nick Lewis, PO Box 89, Bourn, Cambridge CB3 7TF, UK. Tel & fax: +44 (0)1954 718044; email: polesapart@polesapart.org; website: www.polesapart.org. As commercial consultants, Poles Apart are the primary environmental and logistics group specialising in the polar regions. They publish an annual legislation review which provides essential information on permitting.

Scott Polar Research Institute (SPRI)

Lensfield Road, Cambridge CB2 1ER, UK. Tel: +44 1223 336540, fax: +44 1223 336549; email: enquiries@spri.cam.ac.uk; website: www.spri.cam.ac.uk

SPRI has the best polar library in the UK (and possibly the world). Extensive book and reprint collection of all disciplines relating to Arctic and Antarctic regions and a good starting point for research. Library includes expedition reports, maps and archive collection. Open to the public by appointment only. Excellent on-line resources. See their website for worldwide listing of International Polar Institutes.

Snowsled, Marketplace Mews, The Green, Tetbury, Gloucestershire GL8 8DN UK. Tel & fax: +44 (0) 1666 502731; email: polar@snowsled.com; website: www.snowsled.com. Suppliers of specialist polar equipment including pulks and polar tents.

Tangent Expeditions (UK) offers various guided trips onto the Greenland ice cap as well as providing logistics for independent expeditions. Tangent Expeditions International, 3 Millbeck, New Hutton, Kendal, Cumbria LA8 0BD, UK. Tel: +44

(0)1539 737757; fax: +44 (0)1539 737556; email: paul@tangent-expeditions.co.uk; website: www.tangent-expeditions.co.uk

The Polar Travel Company, Wydemeet, Hexworthy, Yelveton, Devon PL20 6SF, UK. Tel: +44 (0)1364 631470; fax: +44 (0)1364 631270; email: info@polartravel.co.uk; website: www.polartravel.co.uk. Organised McVities Penguin Polar Relay North Pole Expedition. Offers guided trips to the Arctic and Antarctic, polar expeditions training courses and consultancy services.

UK Antarctic Heritage Trust

Address: c/o Administrato, Kingcoed Farm, Usk, South Wales. NP15 DS.
Tel. 01291 690305. Email: ukaht@dircon.co.uk
Website: www.heritage-Antarctica.org/ahtuk

Polar Expedition Reports

Dozens of expedition reports to Polar Regions are available for consultation at the Royal Geographical Society (with IBG) in London. Various polar expedition reports also held at the libraries of the Scott Polar Research Institute, Cambridge, and the Danish Polar Centre in Denmark.

Useful websites:

<i>Location</i>	<i>Description</i>	<i>Notes</i>
www.lonelyplanet.com/destination/antarctica/antarctica/read.htm	Lonely Planet on-line guide to Antarctica	
http://npolar.no	Norsk Polar Institut	Administers expeditions to Svalbard
http://www.arcticphoto.co.uk/	Arctic Photographers (Bryan and Cherry, Alexander)	Great site for polar images
http://www.crrel.usace.army.mil/library/crrel_library.html	Cold Regions Research & Engineering Laboratory Library	Vast collection of cold regions scientific and technical literature.
www.caff.is	Conservation of Arctic Fauna and Flora	Arctic conservation site – based in Hafnarstraeti 97, 600 Akureyri
www.cia.gov/cia/publications/factbook/	Central Office of Intelligence, USA	World Fact book – good starting point for research
www.dpc.dk	Danish Polar Centre	Administer expeditions to Greenland
www.grida.no/amap	GRID-AMAP	Arctic Monitoring and Assessment
www.urova.fi/home/arktinen/polarweb/polarweb.htm	Polar Web	Guide to Arctic and Antarctic internet resources.

Grant giving organisations

See list of ‘grant giving organisations’ on the Royal Geographical Society (with IBG) website for complete list of expedition-related grants: www.rgs.org/grants

11.2 Regional information on polar areas

Some of the references cover several regions so you should glance at them all to avoid missing anything. The very nature of this manual is that it will go out of date as soon as it is published, especially the web sites. The RGS-IBG Expedition Advisory Centre hopes to publish and update these references on their web site. We would therefore be grateful to be notified of any changes or inaccuracies. These have been divided into the following sections:

I	Arctic Ocean/North Pole
II	Arctic USA (Alaska)
III	Arctic Canada & Nunavut
IV	Greenland (and Iceland)
V	Svalbard
VI	Russia
VII	Antarctica

I. Arctic Ocean/North Pole

Expeditions to the various North Poles and surrounding ocean have become increasingly popular. Access tends to be either through Canada via Resolute in Nunavut or the Russian Federation via Moscow, Katanga and then the Severnaya Islands.

The likelihood of failure for most first attempt expeditions is high. Chance of success would be increased by a serious training expedition to somewhere like Iqaluit (Frobisher Bay) in Canada or Svalbard in the winter months. An easier option would be to participate in one of the many 'Last Degree' or North Pole Light expeditions now on offer through the following expedition organisers:

Expedition Organisers

- **Stonbee**
- **The Polar Travel Company** (www.polartravel.co.uk).
- **Northwinds** (www.northwinds-arctic.com) Paul Landry and Matty McNair
- **Borge Ousland**. (www.ousland.com).
- **Agency VICAAR Ltd**, See listing under Russia.
- **Cerpolex and Grand Nord Grand Large**. French companies based in Paris and offering guided trips to polar regions.

Books

- ETIENNE, J.L. (2002) *Mission Banquise*. Seuil, Paris, France. A French text account of 1 month in a floating pod at the North Pole. 224pp.
- ETIENNE, J.L. (1986) *Le Marcheur du Pole*. Robert Laffont, Paris: 253pp. ISBN 2-221-05227-7. French text account of first solo air-supported sled haul trek to the North Pole by Dr Etienne.
- FIENNES, R. (1983) *To the Ends of the Earth*. Hodder & Stoughton, London: 368pp. ISBN 0-340-36834-9. Account of 3 years circumnavigation of the earth including both the South and North Pole (using skidoos) - The Transglobe expedition.

- HERBERT, W. (1969) *Across the Top of the World: the British Trans-Arctic Expedition*. Longmans, UK: 209pp. ISBN 582-10801-2. Account of 18 month trans-Arctic ocean crossing by dog teams in 1969.
- HEMPLEMAN-ADAMS, D. (1997) *Toughing it Out: the adventures of a polar explorer and mountaineer*. Orion Publications: 263pp. ISBN 0-75281-1576. Accounts of his various expeditions includes a Geomagnetic North Pole Expedition, a Magnetic North Pole Expedition and a Geographical North Pole Expedition.
- HEMPLEMAN-ADAMS, D. and ULIG, R. (1998) *Walking on Thin Ice: in pursuit of the North Pole*. 271pp. ISBN 0-75281-797-3. Account of 2-man joint British and Norwegian Geographical North Pole Expedition.
- HUBERT, A (2004) *Chaos sur la Banquise*. Account of attempted ski crossing of Arctic Ocean from Russia to Canada. English text version due on Hubert website soon.
- HUBERT, A (2004) *L'Enfer Blanc*. French text account of 1999 North Pole Trek.
- JOHNSON, C. (1995) *The Devils Labyrinth - Encounters with the Arctic*. Swan Hill Press, Shrewsbury: 144pp. ISBN 1-85310-211-3. Account of authors' various sled hauling expeditions to reach the North Pole.
- McNAIR, M. (1999) *On Thin Ice: A woman's journey to the North Pole*. 155pp. ISBN 0968534309. Account by the lead guide of the 1997 McVities Penguin Polar Relay Expedition to the North Pole.
- OUSLAND, B. (1994) *Alone to the North Pole*. Drammen, Oslo: 136pp. Account of 1994 solo and unsupported sled haul trip to the North Pole.
- OUSLAND, B (2002) *Alone across the Arctic*. Account of Borge 2001 crossing of arctic ocean from Russia to Canada.
- RICHES, S. and V. (1998) *Frigid Women*. Travellerseye Ltd, Bridgenorth: 236pp. ISBN 0-9530575-2-6. Mother and daughter account of their participation in the 1997 McVities Penguin Polar Relay Expedition to the North Pole.
- STEGER, W. and SCHURKE, P. (1988) *North to the Pole*. Macmillan, London. ISBN 0-333-47490-2. Account of 1986 Steger International North Pole Expedition (an unsupported dog sled expedition).
- SWAN, R. (1990) *Icewalk*. Jonathon Cape, London: 254pp. ISBN 0-224-02793-X. Account of International North Pole air supported sled haul trek to the North Pole in 1989 with student's expedition at Base camp.
- WEBER, R., DEXTER, L., HOLLOWAY, C. and BUXTON, M. (1990) *Polar Bridge: an Arctic odyssey*. Key Porter Books Ltd, Toronto. ISBN 1-55013-199-0. Account of joint Soviet-Canadian air supported trans-polar ski expedition from Russia to Canada in 1988.
- WEBER, R. and MALAHOV, M. (1996) *Polar Attack: from Canada to the North Pole, and back*. McClelland & Stewart Inc., Toronto: 222pp. ISBN 0-7710-8902-3. Account of staggering 1995 2 man unsupported sled haul trek from northern Canada to the North Pole and back.

Films

- **To the Ends of the Earth**. Film of 1979-82 Trans-globe expedition which circumnavigated the world via both poles. (55 mins); Ranulph Fiennes.
- **Polar Attack**. Film of 1995 Weber/Malakhov North Pole Expedition.
- **To the Ends of the Earth**. Film of 1997 British Trans-Arctic Expedition (55 mins).
- **Transarktis**. Film of 1992 Norwegian Trans-Arctic Expedition (32 mins; Norwegian narration).

II. Arctic USA (Alaska)

Although the state of Alaska includes Arctic areas it is not a common access point or area for polar expeditions. Arctic Alaska is separated from the remainder of the State by the Brooks Range.

Travel by air is a way of life in the largely roadless Alaska. *Alaska Public Lands Information Centre* in Anchorage can supply listings of reputable air taxi operators in the state. Alaskan Division of Tourism in Juneau produces an annual "Travel Planner" with information on Adventure outfitters in Alaska.

Contacts USA

6th Avenue Outfitters 520 W.6th Avenue, Anchorage, Alaska Tel 1 907 276 0233 or 1 800 276 0233 www.6thavenueoutfitters.com large outdoor store within 2mins walking distance of downtown Anchorage

Accupoint Inc. 7125 Old Seward Highway. Anchorage, Alaska Tel 1 907 522 1600 www.accupoint.com Stock a large range of GPS products!

AlaskaGuideBook.com, 64999 Easterday road, Homer AK 99603. Tel. (907) 235-1963, Fax. (907) 235 1563, Website: www.alaskaguidebook.com. Email: info@alaskaguidebook.com. Alaskaguidebook.com is seeking to become the source of information about places and things to do in Alaska.

Alaska Public Lands information centre, 605 W. 4th Ave., Anchorage 99501, Alaska. Tel & fax: +1 907 271 2744.

Alaska Divison of Tourism, Box 110801, Juneau, 99811 Alaska, U.S.A.

American Polar Society www.oaedks.net/amerpolr.html

Nomads, 40 Franks Way, Grand Marais, Minnesota 5560, U.S.A. Tel & fax: +1 218 387 1411; website: www.polarhusky.com. Offer trips to arctic regions including dog sledge travel.

The NorthWest Passage, 1130 Greenleaf Ave, Wilmette, IL 60091, U.S.A. Tel: +1 847 256 4409; email: info@NWPassage.com; website: www.nwpassage.com/. Offer adventure travel trips to Arctic and Antarctica.

Wintergreen, Paul Schurke, 205 E. Sheridan Street, MN 55731 U.S.A. Tel: +1 218 3656602; fax: +1 218 365 3088; www.dogsledding.com Email: info@dogsledding.com. Website: www.dogsledding.com. Specialises in dog sledding in the USA.

Veco Polar Resources, 7175 W. Jefferson Ave, Suite 1200, Lakewood, Colorado 80235 USA. Operate science camps in Alaska and Greenland. www.vecopolar.com

Books

ALASKA ALMANAC (Annually Updated) An impressive array of facts and information on everything from weather to Native culture, wildlife, state parks, agriculture, dog mushing and politics. 240pp.

ALASKA NORTHWEST BOOKS (1991) *The Alaska Wilderness Milepost*. Bothell, WA, USA: 454pp. ISBN 0-88240-290-0. A detailed description of 250 towns and bush villages in Alaska. ANB distribute numerous other books on Alaska and can provide a catalogue of them.

- BELETSKY, L & PAULSON, D (2001) *Alaska, The Ecotravellers' Wildlife Guide*. Field guide to the most commonly encountered Alaskan wildlife. Includes short overview of conservation and parks.
- FEDSTON, J (2002) *Rowing to Latitude-Journeys along the Arctic Edge*. North Point Press. 312pp.
- FLOWERS, P (2001) *Alone Across the Arctic: One Woman's Epic Journey by Dog Team*. Alaska Northwest Books. 120pp. Flowers sledged 2500 miles from Barrow Alaska to Repulse Bay.
- LONELY PLANET PUBLICATIONS (Ed: Du Fresne, J.) (2000) *Alaska. A travel survival kit*. Lonely Planet Publications, London. ISBN 0864427549
- MORTON, K. (1997) *Planning a wilderness trip in Canada and Alaska*. Rocky Mountain Books, Calgary, Canada.
- RODAHL, k. (1954) *North* Heimemann Ltd UK 244p Account of the set up of the ice island T3
- RIDDLES, L & JONES, T (1988) *Race Across Alaska: First Women to Win the Iditarod tells her Story*. Stackpole Books. 240pp.
- SCHURKE, P (1989) *Bering Bridge: The Soviet-American Expedition from Siberia to Alaska*. Pfiefer Hamilton. 227pp.
- SCOTT, A. (1990) *Tracks Across Alaska: a dog sled journey*. John Murray: ISBN 087113389X. Account of dog sled journey from Manley Hot Springs to Nome.
- STRUZIK, E (1991) *Northwest Passage: The Quest for an Arctic Route to the East*. Kay Porter Books.
- WARBURTON LEE, J. (1996), *Roof of Americas Expedition*. Swan Hill Press, England. This book which is an account of a British Army Expedition from North to South America includes one chapter covering a winter journey down the Yukon river with dog team and snowmachine and then up northwestern Alaska coastline.
- WAYBURN, P. (1998) *Adventuring in Alaska*. Sierra Club, San Francisco: For anyone planning major canoe, kayak or rafting expeditions in the state of Alaska.

III. Arctic Canada

Despite the comparatively low latitude of Canada's southern states, the country offers significant scope for polar travel and adventure.

Permissions

There have been major changes in Canada since the April 1999 when the new territory of Nunavut came into being, taking in the central and eastern portions of the Northwest Territories. So make sure you know which part you want to visit. National parks in Canada have restricted access.

Travel

Yellowknife, NWT and Iqaluit, Nunavut serve as the main administrative and access points into the Canadian Arctic.

- *Canadian North*, part of Canadian Airlines flies Boeing 737 jet aircraft to Resolute from Edmonton through Yellowknife and Cambridge Bay.
- *First Air* has regular flights north from Ottawa and Edmonton up into Canadian arctic and serves Broughton Island, Cape Dorset, Clyde River, Hall Beach, Igloolik, Kimmirut, Pangnirtung, Pond Inlet, Resolute, Grise Fiord, Nanisivik, Arctic Bay,

Sanikiluaq, Rankin Inlet, Kugluktuk, Pelly Bay, Taloyoak, Gjoa Haven and Cambridge Bay. In 2002 they moved out of Twin Otter operations

- *Kenn Borek Air* Resolute office: from Resolute flights to Grise Fiord, Arctic Bay, Nanisivik and Pond Inlet plus other charter options.

Other smaller operators fly into some of the smaller arctic settlements not listed above see www.arctic-travel.com/flypage for details of these.

Contacts Canada

Canadian Arctic Expeditions, 363 Pritchard Rd, Alcove, Quebec, JOX 1A0. Canada. Richard Weber and his wife Jose Auclair also provide logistical advice/ support and specialist polar tents and sledges. Tel & fax: +1 819 459 1794

Email: info@CanadianArcticHolidays.ca, Website: www.canadianarcticholidays.ca

Canadian North (part of Canadian Airlines International). Tel: +1 800 665 1177 or +1 416 798 2211; fax: +1 905 612 2838; *website*: www.cdnair.ca

Dept. of Renewable Resources, (Govt. of Northwest Territories), Box 21, Scotia Centre 600, 5102 50th Ave., Yellowknife, NT, X1A 3S8, Canada. Can supply information sheets on safety in bear country, etc.

First Air, 3257 Carp Road, Carp, ON, XOA 1L0, Canada. Tel: +1 613 839 3340; fax: +1 613 839 5690; *website*: www.firstair.ca

Kenn Borek Air (Resolute office), PO Box 210, Resolute, NT, X0A 0V0, Canada. Tel: +1 867 252 3845; fax: +1 867 252 3777. Website: www.borekair.com. Large Twin Otter fleet, many of which operate in the Antarctic during the austral summer.

Northwest Territories Tourist Information, Box 2107, Yellowknife, NT, Canada X1A 2P6.

North Winds (Paul Landry and Matty McNair), PO Box 820, Iqaluit, Nunavut, X0A 0H0, Canada. Tel: +1 867 979 0551; fax: +1 867 979 0573. email: north@northwinds-arctic.com; *website*: www.northwinds-arctic.com

Nunavut Tourism, PO Box 1450, Iqaluit, NT, X0A 0H0, Canada. Email: nunatour@nunanet.com; *website*: www.nunatour.nt.ca

Parks Canada (Nunavut District), PO Box 353, Pangnirtung, Nunavut X0A 0R0

Polar Continental Shelf Project (PCSP), Natural Resources Canada, 615 Booth St, Room 487, Ottawa, ON, K1A 0E4, Canada. Tel. +1 613 947 1650; fax +1 613 947 1611, Email: pcsp@NRCan.gc.ca Logistic support to approved scientific research in Canadian arctic.

Tourism Yukon, PO Box 2703, Whitehorse, Yukon, Y1A 2C6, Canada.

Canadian Weather Forecast. Website www.msc-smc.ec.gc.ca/index.html

High Arctic International Arctic Explorer Services Ltd, CP200 Resolute, Nunavut X0A 0V0, Canada. Tel: 867 252 3875, fax 867 252 3766. Run by Terry Jesudason. has provided logistic support for many N. pole expeditions.

Books/ Publications

COCKBURN, B (2004) *Canoeing Canada's Northwest Territories – A Paddler's Guide*. Annick Press.

COWPER, D.S. (1993) *Northwest Passage solo*. Seafarer Books, London: 212pp. ISBN 0-850364-29-9. Account of 1988 journey through NW Passage in 42' lifeboat.

DEPT OF RENEWABLE RESOURCES *Safety in Grizzly and Black Bear Country & Safety in Polar Bear Country*.

DUNBAR, M. and GREENAWAY, K.R. (1956) *Arctic Canada from the air*. Canadian Defence Board, Ottawa: 541pp. An old and rarely found but excellent reference source covering the Canadian Arctic coastline and Arctic Ocean with sections on early exploration, topography and weather. Lots of detailed regional information.

FIENNES, R (1979) *Hell on Ice*. Hodder & Stoughton. London. 256pp. Account of Ranulph Fiennes' British North Pole Expedition of 1977, where he reached 87°n using skidoos.

FLECK, S (1988) *Polar bear conflicts with humans – Contract Report Number 3*. Dept of Renewable Resources, Yellowknife, Canada.

- FREDSTON, J. *Rowing to latitude- Journeys along the Arctic Edge*. North Point Press 312pp
- FREUCHEN and SALOMONSEN (1959) *The Arctic Year*. Jonathan Cape, London. A somewhat dated and now out of print book, but with tremendous detail on the arctic environment of the Canadian Arctic.
- HEMPLEMAN-ADAMS, D. (1997) *Toughing it Out: the adventures of a polar explorer and mountaineer*. Orion Publications: 263pp. ISBN 0-75281-1576.
- KURALT, C. (1969) *To the Top of the World: the First Plaistead Polar Expedition*. Hutchinson. London
- MORTON, K. (1997) *Planning a wilderness trip in Canada and Alaska*. Rocky Mountain Books, Calgary, Canada.
- NUNATSIAQ. *The newspaper of Nunavat*. Website: www.nunatsiaq.com
- NWT TOURIST INFORMATION *The Explorers guide* A useful info source on the Northwest Territories, also published yearly by Nunavat Tourism.
- THE NUNAVUT HANDBOOK (1999) Successor to The Baffin Handbook (published 1993 by Soubliere, M.), this volume covers most of the Canadian Northwest Territories including the newly created Nunavat territories. Available from Box 8, Iqaluit, NT, X0A 0H01, Canada. Fax: +1 613 727 6910. A new edition is due in July 2004, \$35 which can be ordered online via www.arctictravel.com.
- SHACKELTON, E. (1937), *Arctic Journeys: the Story of the Oxford University Ellesmere Land Expedition*. Hodder & Stoughton. London
- STARKELL, D (1996) *Paddle to the Arctic*. 313pp. An account of the first person to kayak the NorthWest Passage solo from Hudson's Bay to Alaska.
- TOURISM YUKON *Canada's Yukon*. Published annually. A useful information source for the Yukon Territories.
- TURK, J (1998) *Cold Oceans-Adventures in Kayak, Rowboat and Dogsled*. Harper Perennial, New York. Includes accounts of a rowing boat journey down the MacKenzie River and along the NorthWest passage to Panlatuk; a dogsled journey from Iqaluit to Broughton Island (Eaffin Island), a kayak journey from ----- (Greenland).
- VARIGAS, F. (1983) *Dix Chiens pour un Reve*. Albin Michael. Pari. French text account of solo dogsled exped of 7,000 km from Frobisher Bay (Baffin Island) to Dawson (Yukon Territory) in 1 year.
- WATERMAN, J (2002) *Arctic Crossing-One Man's 2,200 mile Odessey Among the Inuit*. The Lyons Press. 376pp.

IV. Greenland (and Iceland)

Greenland was granted home rule from Denmark in 1979 and has a population of some 55,000 people, the bulk of whom live on its west coast.

In 2002 the Danish Polar Centre approved approx. 38 sporting expeditions to Greenland of which some 17 expeditions were icecap expeditions and a further 8 or so mountaineering expeditions.

Permissions

Contact the Danish Polar Centre in Copenhagen. The Centre adheres strictly to the deadlines set for the submission of applications. They do not unfairly withhold permission for expeditions providing they can demonstrate competence on the application. They will also need details of the expeditions Search and Rescue (SAR) insurance.

Travel

SAS fly to Sondre Stromfjord and Narsarsuaq from Copenhagen several times a week. *Icelandair* fly from Reyjavik to Narsarsuaq a few times a week. *Greenlandair* offer a DASH 7 link from Reyjavik Iceland to Kulusuk in East Greenland and Sondre Stromfjord. Once in Greenland, helicopter and smaller fixed wing aircraft connect with the other Greenlandic settlements.

The charter division of Flugfelag Islands (Air Island), formerly operating under the name of *Flugfelag Nordurland*, operates charter service between Iceland and Greenland and has two ski-equipped Twin Otter aircraft with a payload of approx. 900kg to Greenland. They also have Metro and Fokker 50 aircraft, the latter with a 4.5 tonne payload to Greenland.

Once in Greenland, movement between settlements or to expedition areas is possible using local boats. Hagglings can usually secure a craft of any size.

Useful Institutes/Organisations for Greenland Expeditions

Colorado University Greenland Weather (stations). This web site provides hourly transmission from 10+ weather sites on the Greenland ice cap including DYE II, the DEW line station which was manned during the 2000 season and supplied by ski-equipped C130 aircraft /c of the New York Air National Guard operating from Sondre Stromfjord.

Website: http://cires.colorado.edu/steffen/aws/current_GC-Net_plots.html

Danish Polar Centre, Strangade 100H, DK-1401 Kobenhaven K, Denmark. Tel: +45 32 880 100; fax: +45 32 880 101; email: dpc@dpc.dk; website: www.dpc.dk. Library and co-ordination of all sporting and scientific projects visiting Greenland. DPC and DPC website have forms one needs to apply for sport or science expedition to east or north coast, or the Greenland icecap. See www.dpc.dk/Res&Log/start.html for listing or previous years expeds and approved projects

Greenland Tourism, Denmark Office, PO Box 1139, Pilestraede 52, DK-1010 Copenhagen, Denmark.

Greenland Guide. Website: www.greenland-guide.gl

Hvitserk, Ullern Allé 41, N-0381 Oslo, Norway. Tel: +47 24 12 62 30; fax: +47 24 12 62 31; email: post@hvitserk.no; website: www.hvitserk.no

Tangent Expeditions (UK) offers various guided trips to Greenland and Svalbard as well as providing logistics for independent expeditions. Tangent Expeditions International, 3 Millbeck, New Hutton, Kendal, Cumbria LA8 0BD, UK. Tel: +44 (0)1539 737757; fax: +44 (0)1539 737556; email: paul@tangent-expeditions.co.uk; website: www.tangent-expeditions.co.uk/

Contacts Greenland

Atuagkat Bookstore PO Box 1009, DK-3900 Nuuk, Greenland. Tel: +299 321737, Email: atuagkat@greenet.gl, Website: www.atuagkat.gl. Greenland's largest bookstore.

Chief Constable of Greenland, PO Box 1006, Nuuk, DK-3900, Greenland. Provider of Firearms permits.

Greenlandair, PO Box 1012, DK-3900 Nuuk, Greenland, Tel: +299 34 34 34 * Fax: +299 32 72 88, Email: info@airgreenland.gl, Website: www.greenland-guide.gl/gla/default.htm

Greenland Telecom, PO Box 1002, DK-3900 Nuuk, Greenland. Tel: +9 299 23120; fax: +9 299 23130. Greenland Radio Licensing authority.

Greenland Tourism, Greenland Tourism a/s, Head Office, PO Box 1552, Hans Egdesvej 29, DK-3900 Nuuk, Greenland. Tel: +9 299 22888, fax: +9 299 22877. Denmark: tel. +45 33 136975; fax: +45 33 933883.

Hotel Nansen PO Box 48, DK-3913 Tasilaq, Greenland. Tel: +299 982101, Fax: +299 982201, Email: nansen@greenet.gl, Website: www.nansen.gl. The hotel has 2 person rooms and kitchen facilities. It caters for B&B, Half Board or Full Board, and has a storage/working area for expedition kit. It costs approximately 400DK per person per night (accom only), depending on whether it is high/low season.

Kangerlussuaq Tourism PO Box 49, 3910 Kangerlussuaq, Greenland. Tel: +299 841098, Fax: +299 841498, Email: info@kangerlussuaqtourism.gl. Website: www.kangerlussuaqtourism.gl. They can deliver/collect groups to and from the icecap. They also offer some bunk room accommodation in Old Camp (2km from Sondre Stromfjord airport.)

Mt Forel Expedition Support, c/o Dr Hans Christian Florian Box 116, DK-3913 Ammassalik, East Greenland. Tel: +9 29998 13 20, fax: 299 98 13 73, email: florian@greenet.gl; www.ammassalik.gl/MFES/frame1.html. Provides logistic support and guiding for East Greenland.

Contacts Iceland

Please note that from spring 2004 Flybus (airport bus) departures and drop offs unless you are going from or to one of the major hotels occur at the main BSI bus terminal in Reykjavik on north side of the Reykjavik airport instead of the Loftleider Hotel.

Iceland Express Surdurlandsbraut 24, 108 Reykjavik, Iceland. Website: www.icelandexpress.com. Runs daily scheduled flights between Denmark, Iceland and the UK. One way tickets possible for as little as £60, earliest bookings get the best ticket prices

- Flugfelag Islands/Air Island (Charter Division)**, Box 400, 602 Akureyri, Iceland. Tel: +354 460 7080; fax: +354 460 7090; email: airice@est.is; website: www.airiceland.is. Provide charter flights from Iceland to East Greenland.
- Glacier Tours Ltd**, PO Box 66, Hofn, Iceland. Tel: +354 478 1000; fax: +354 478 1901. Glacier Tours have a mountain hut (Joklasel) at 843m altitude on the edge of the Vatnajokull ice cap, offering safe and easy vehicle access onto Vatnajokull. Tel: +354 478 1001. www.vatnajokull.com
- Guesthouse Aurora**, Freyjugata 24, Reykjavik, Iceland. Tel: +354 552 5515; fax +354 551 4894. Cheapish accommodation in central Reykjavik including dormitory room.
- Icelandair Cargo**, Reykjavik. Tel: +354 5050 409; fax +354 5050 350.
- Icelandic Telecom Inspectorate**, Malahofdi 2, IS-112 Reykjavik, Iceland. Fax: +354 5872429. Radio licences for Iceland.
- Nanoq** Kringlan Mall, Krinlunni, IS-103 Reykjavik, Iceland. Reykjavik's main outdoor equipment store. Tel 354 577 6600 for Kringlan's main office for Nanoq phone no.
- Nonni Travel**, Brekugata 5, IS-602 Akureyri, Iceland. Tel: +354 461 1841. Fax 354 461 1843. Run trips to Scoresbysund in East Greenland and can provide load shares on aircraft to Greenland. www.nonnitravel.is nonni@noonitravel.is
- Snorris Guesthouse** Snorrabraut 61, Reykjavik, Iceland. Tel: 354 552 0598
- Xnet.Is Internet Café**, Noatun 17, Reykjavik, Iceland. Tel: +354 562 9030.

Books/Publications

- AMERICAN ALPINE JOURNAL 1988* has listing of mountaineering expeditions to Greenland from 1977–86.
- ARMS, M (1998) *Riddle of the Ice: A scientific adventure into the Arctic*. A narrative of a voyage along the Labrador and West Greenland Coast in a 50' sailboat.
- BENNETT, D (1972) *Stannings Alps* (Climbing Guide to Stannings Alps).
- BONINGTON, C and KNOX-JOHNSTON, R (1992) *Sea, Ice and Rock*. Hodder & Stoughton, London. ISBN 0-340-57619-7. An account of sailing and climbing trip.
- DUPRE, L (2000) *Greenland Expedition: where the ice is born*. Northwood Press, USA. Account of Greenland circumnavigation expedition by kayak and dog sled
- ESCRITT, T. (1985). *Iceland, A Handbook for Expeditions*. Iceland Information Centre Ltd, London. Available through the Expedition Advisory, London.
- FUCHS, A (1998) *Der Weg in die Wiese Welt*. Bielefeld, Germany. 383pp. An expedition to North East Greenland using a yacht, hot air balloon and skis to retrace earlier Greenland Expeditions Travels.
- GOVERNMENT OF GREENLAND (2000) *This is Greenland 2000-2001-the Official Directory-Country, Products and Services, Atuagkat Aps, Nuuk, Greenland*. 416 pages of information on Greenland, its infrastructure, and contact details for all Greenland organisations and companies.
- HERTLING, B (1993) *Greenlandic for Travellers*. Atuakkiorkfik, Nuuk, Greenland. Pocket-sized book with English and Greenlandic phrases.
- JOHANSEN, A. T. (1988) *Påski over Gronland 100 år Etler*. Metope, Norway. 167pp. A Norwegian text account of a team re-doing Nansen's route 100 years on, using the same clothing and equipment. The expedition was accompanied by a film team on skidoos.

- KAALALIT NUNAT ATLAS – GREENLAND. (1993) ISBN 87-558-0685-6 English and Danish Text plus topographical maps covering most of the coastline. Lots of useful general facts about Greenland.
- LINDSEY, M. (1935) *Sledge*. Cassel & Company Ltd, Toronto. London (UK) 342 pp. Account of British Trans Greenland Expedition 1934
- LONELY PLANET PUBLICATIONS (1997) *Iceland, Greenland & the Faroe Islands. A travel survival kit*. 3rd Edition. Lonely Planet Publications, London. ISBN 0-86442-453-1.
- MIKKELSEN, P. S (2000) *Sirius Gennem 50 år*. 333pp. A Danish text account of 50 years of Danish sledge patrol in Greenland.
- MIKKELSEN, E (----) *Two Against the Ice*. Travel Book Club, London. 224pp. An account of Ejnar Mikkelsen and Iver Iversen's journey's from Shannon Island up to Independence Fjord, searching for signs of the Mylius-Erichsen Expedition.
- OLESEN, E & MADSEN, K (1999) *Oqaatsinik allattorsmaffik*. Atuakkiorfik, Nuuk, Greenland. 135pp Paperback. An English –Danish-Greenlandic wordlisting including sections covering landmammals, marine mammals, fish, flowers and birds.
- PERONI, R (1984) *Der Weisse Horizont – Drei Männer durchqueren Grönlands uneforschte Eiswüste*. Hoffman und Campe. Hamburg, Germany. pp.237. An account of a 1400 km long Greenland icecap crossing from 70°N30'N eastward across to Nugssuaq.
- SHPARO, D & SHPARP, M (2001) *Challenging Greenland*. 160pp. ISBN: 5-264-00412-9. An expedition book of a 3 man Russian team, including 1 paraplegic that skied across the Greenland ice-cap.
- SPENCER CHAPMAN, F (1932) *Northern Lights: The British Arctic Air Route Expedition 1930-31*. Chatto and Windus. London. 304pp. An account of Gino Watkins' first expedition to East Greenland.
- STAIB, B (1963) *Across Greenland in Nansen's Track*. Allen and Unwin, UK. 144pp. A 2 person crossing with dog teams.
- TILMAN, W. H. (1964) *Mischief in Greenland*. Hollis and Carter, London.
- TILLMAN, W.H (1987) *The Eight sailing/Mountain Exploration Books*. Diadem Books (UK) 956 pages. This book covers all of Tillmans trips in arctic and antarctic
- YDEGAARD, T. (1990) *Trekking in Greenland*. Skarv/Hoest & Son, Copenhagen: 176pp. ISBN 87-14-20034-1.

Films

- **Those Greenland Days**. Film of 1982 BSES East Greenland Expedition (50 mins.) available from *BSES Expeditions*, RGS-IBG, London;
- **Chasing the Midnight Sun**. Film of 1995 Australian Trans-Greenland Expedition (55 mins.); available from www.wildreleasing.com.au. Produced by Orana Films.
- **L'Essai du Pole, Groenland 88**. A film by Laurent Chevalier of the 1989 South to North Traverse Expedition made by Steger's team in preparation for Antarctic expedition (30 mins.).
- **Unknown Title**. BBC? Film of Jim Lowther's expedition to the Lemon Mountains in the 1980's.
- **Challenging Greenland**. A film of the Russian team of 3, including one paraplegic, that skied across the Greenland icecap in 2000.

V. Svalbard (Norway)

All groups planning to visit should make contact with the Governors office Longyearbyen to ascertain what level of information they will need to provide for their planned visit. BSES Expeditions at the RGS-IBG in London have extensive experience of running expeditions to Svalbard's main island of Spitsbergen.

All expedition require the Sysselman's (Norwegian governor) approval and are required to have proof of adequate rescue insurance. At all times of the year outside inhabited areas you are required to carry polar bear safety gear including large bore rifle and bullets, trip wires and pen flares. These can all be hired in Longyearbyen.

Snowmobiles are restricted only in certain areas and are common around Longyearbyen and as a result it can be demoralising if you're on foot/ski. You are well-advised to begin your journey by chartering a snowmobile to drop you off outside the area.

Permissions

Contact the *Sysselman pa Svalbard* (Norwegian governor's) office in Longyearbyen in Svalbard for info.

Contacts Norway/Svalbard

Arctic Adventures, N-9710, Longyearbyen, Svalbard, Norway. Tel: +47 79 02 16 24, email: info@arctic-adventures.no Run by Jens Abild.

Alfa Skofabrikk A/S, N-2760 Brandbu, Norway. Tel: +47 61 334 700; fax +47 61 335 842. Nordic Ski boot manufacturer who also make specialist polar ski boots.

Borge Ousland, Norway. Email: borge@ousland.com; website: www.ousland.com. Ousland was first man solo unsupported to North Pole, across Antarctica and most recently, solo across the Arctic Ocean.

Hvitserk, Ullern Allé 41, N-0381 Oslo, Norway. Tel: +47 24 12 62 30; fax: +47 24 12 62 31; email: post@hvitserk.no; website: www.hvitserk.no

Info-Svalbard, Boks 323, N9170 Longyearbyen, Svalbard. Tel: +47 790 22303; fax: +47 790 21020.

Ingenior G. Paulsen AS. Tel: +47 79 02 32 00, Fax: +47 79 02 18 10, Email: firmapost@igp.no, Website: www.igp.no

Norsk Polar Institutt, c/o Polar Environment Centre, N-9296 Tromso, Norway. Tel: +47 77 75 0500, fax: +47 77 75 0501 (Longyearbyen, tel: +47 790 22610). www.npolar.no

Norwegian Polar Klubb, PostBoks 58, Bygdoy, N-0211 Oslo, Norway. Tel +47 22 43 7697 email mehlum@npolar.no

Nybyen Gjesthaus, c/o Spitsbergen Travel AS, Vandrehjem, Boks 500, N9170 Longyearbyen, Svalbard. Tel: + 47 790 22450; fax: + 47 790 21005. Dormitory accommodation in Longyearbyen.

Poste Restante, Post Kontorot, N9170 Longyearbyen, Svalbard.

Pyramiden, Director, 9179 Pyramiden, [Svalbard?] Tel: +47 80[missing number?] 21455. For information on area.

Svalbard Safari, (Normann Holm), Boks 490, N9170 Longyearbyen, Svalbard. Tel: + 47 790 21312; fax: +47 790 21810. Offer guided trips and logistic support in Svalbard.

Sysselman Pa Svalbard, N 9170 Longyearbyen, Svalbard, Norway. Tel: +47 790 23100; fax: +47 790 21166. Provide necessary regulations and information on visiting Svalbard. www.sysselmannen.svalbard.no

Spitsbergen Travel – a merger of Spitsbergen Travel AS and Svalbard Polar Gruppen AS. www.spitsbergentravel.no/eng_index.htm; info@spitsbergentravel.com

Sportsnett Norge AS. Website: www.sportsnett.no. Sells specialist outdoor equipment (such as ski kites and sledges) over the internet and from its shop in Oslo.

www.svalbard.com/cgi-data/links.html. This site consists of user supplied links to Svalbard as well as lots of other useful information. Weather information from Yahoo Norway: http://vaer.yahoo.no/varsel/longyearbyen_Realtime [**can't access this website**]. Temperature and other statistics for the last 24 hours from Nordlys-stasjonen (near Longyearbyen), website: <http://haldde.unis.no/vaerdata>

Books/publications

BUZZA, R (1978) *Survive the Arctic Sea*. Paul Harris Publications. 176pp. An account of a rowing trip from the Shetland Isles to Norway and up the Norwegian Coast to the North Cape.

DEN NORSKE LOS/ARCTIC PILOT (1988) Both Norwegian and English text. Contains general info on Svalbard and description of whole coastline with locality names and various photos.

FEDSTON, J (2002) *Rowing to Latitude-Journeys Along the Arctic Edge*. North Point Press. 312pp.

FURSE, Chris (1997) *Arctic Expedition Handbook*. ISBN 0 9530386 0 2. Available from BSES Expeditions, London. An excellent general source guide including ideas for science ideas.

GLEN, A.R. & CROFT, N.A.C. (1937) *Under the Pole Star*. Methuen, London. An account of the overwintering expedition.

KEMPF, C (1992) *A Journey to Svalbard-Polar Territory*. Editors Messene. ISBN: 2-911043-87-1.

LILJEQUIST, G.H. (1993) *High latitudes: A history of Swedish Polar Travels and Research*. Swedish Polar Research Secretariat, Stockholm, Sweden. English text, many maps and photos.

LONELY PLANET PUBLICATIONS (1999) *Arctic*. Includes a chapter on Svalbard.. 456pp.

MILES, H & SALISBURY, M (1985) *Kingdom of the Ice Bear*. BRC Books, London. 223pp. Chapter 2, p21-48 and chapter 9, p171-175 describe wildlife film making in Svalbard.

NORWEGIAN POLAR INSTITUTE (-----)*Place names of Svalbard*.

NUNLIST, H. (1966) *Spitsbergen* AS Barnes & Co New York. 176 pp. Account of 1962 Swiss Climbing Expedition to NW Spitsbergen

RITTER, C (1995) *A Woman in the Polar Night*. Allen & Unwin, UK. 188pp. A translation of the German book, "Eine Frau erlebt die Polarnacht".

ROBERTS, D (2003) *Four Against the Arctic: Shipwrecked for six years at the top of the World*. Simon & Schuster. 304pp.

RUDD (1997) *A Year Long Day*. Account of trapper over-wintering in Hornsund Svalbard
SVALBARDPOSTEN. PO Box 503, N-9171 Longyearbyen, Svalbard. Website: www.svalbardposten.no. Norwegian text – a weekly newspaper produced in Longyearbyen. Has monthly climate charts.

- TILMAN, W. H. (1987) *The Eight Sailing/Mountain Exploration Books*. Diadem Books (UK) Mountaineers (Seattle USA)
- SVALBARBOKA (Annual Publication) Ursus Forlag, Tromsø, Norway. Assorted chapters relating to Svalbard, history, exploration and culture
- UMBREIT, A. (1997) *Guide to Spitsbergen*. Bradt Publications, Chalfont St Peters, Bucks.
- UMBREIT, A. (due Nov 2004) *Svalbard, Franz Joseph Land, Jan Mayen: The Bradt Travel Guide*. 3rd Edition. 304pp.

Other useful websites:

- www.svalbard.com/companies.html – address listings for many Svalbard organisations
- <http://vaer.yahoo.no/varsel/longyearbyen> – weather info from Longyear
- <http://haldde.unis.no/vaerdata> – weather info from Svalbard

Films

- Orions Belt (1985) Produced by Filmeffekt A/S Norway 104 mins. A story of coldweather spies in Svalbard
- When the Light Comes Up (). Story of dutch girl over-wintering with Svalbard trapper.

VI. Russia

A huge Arctic area; travelling and working in the Russian arctic generally requires the assistance of Russian polar co-ordinators such as those found at organisations listed below. The Russian Arctic has, when compared with the North American Arctic, a considerably larger native population with more frequent and larger settlements. It has some hundreds of scientists, thousands of servicemen and tens of thousands of indigenous inhabitants engaged in old time practices of hunting, fishing and extensive reindeer herding.

Permissions:

Expeditions going to the Russian Arctic will find it almost impossible not to work through recognised polar co-ordinators/facilitators in Russia.

Contacts Russian Federation

Agency Vicaar Ltd, Marata 24a, 191040, St. Petersburg, Russia. Tel +7 812 113 2781; fax: +7 812 , email: vicar@mail.wplus.net164 6818. Headed by Victor Boyarksi who crossed Antarctica and Arctic Ocean with Will Steger. Vicaar provides logistical advice and support to polar expeditions and trips to North Pole. Web: www.vicaar.spb.ru

Arctic and Antarctic Russian Institute 38 Bering Street, St Petersburg 199397 Russia www.nw.ru/aari/nw/ru; tel: +7 812 352 1520; fax: +7 812 352 2688.

Cerpolex Cercles Polaires Expeditions, 4, Passage de la Main d'Or, 75011 Paris, France. Tel. 00 33 0143147494. Website: www.polarcircle.com. Co-ordinate the running of Barnes Ice Camp 89°N each April.

Minsk Bearing Factory, Minsk, Belarus. Suppliers of motorised wheeled buggies that have been driven to South Pole. www.mpz.com.by

Moscow Adventure Club, Rusakovskaia str 1 6ld 3, 107140, Moscow. Tel: 7 095 264 9583. Headed by Dimitri Shparo. www.shparo.com

Polus, Arctic and Antarctic Research Centre. Moscow. Operate the floating ice stations such as SP32 and SP33.

Books

BARR, S. et Al (1995) *Franz Josef Land*. Norwegian Polar Institute Polar Handbook No 8. with one page summaries in Norwegian, German, Polish, Russian and French ISBN 82-7666-095-9 175pp.

BRONTMAN, L (1938) *On top of the World: the Soviet expedition to the North Pole in 1937*. Victor Gallanex Ltd, London. English text. 281pp.

FUCHS, A (1999) *Abenteuer Russische Arktis*. Delius Klasing, Germany. 190pp. A German text account of Arved Fuchs' ICESAIL expedition by boat through the Russian Arctic.

GJELDNES, R (2001) *Dead Men Walking*. An English text account of an unsupported 2000km trek across the Arctic Ocean. Available from www.extremeplanet.com.

JACOBSON, J (2004) *Roaming Russia. An adventurer's guide to Off the Beaten Track Russia and Siberia*. IUniverse Inc. 224pp.

JOHNSON, C. (1995) *The Devils Labyrinth – Encounters with the Arctic*. Swan Hill Press, Shrewsbury: 144pp. ISBN 1853102113. Account of authors' various sled hauling expeditions to reach the North Pole. It includes one attempt from Russian side.

MAIER, F (1994) *Trekking in Russia and Central Asia*. Published by the Mountaineers, Seattle, USA. Has sections on Kamchatka, Chukotka and Northern Urals.

- OUSLAND, B. (1994) *Alone to the North Pole*. Drammen, Oslo: 136pp. Account of 1994 solo and unsupported sled haul trip to the North Pole.
- OVAKYNIKOV, N (1999) *Polar Bears: Living with the white bear*. An account of four years living amongst the Polar Bears of Wrangle Island. English text.
- SNEGIRYEV, V (1985) *On Skis to the North Pole*. Sphinx Press, New York. An account of a Russian team making the first ever ski trek to the North Pole in 1979.
- SPARKS, J. (1992) *Realm of the Russian Bear*. BBC books, London: 288pp. Follows on from BBC TV series of same name. Includes 50 pages on Russian arctic natural history.
- STROUD, M (1993) *Shadow on the Wasteland: crossing Antarctica with Ranulph Fiennes*. Jonathan Cape, London. Chapters 1 and 2 of this book cover Stroud and Fiennes' expedition to the North Pole from the Russian side in 1990.
- VANIER, N (1997) *North Adventures in the Frozen Wild*. Harry N Abrahams Inc, USA. An excellent book for anyone contemplating long duration wilderness trips in Arctic tundra and taiga regions

VII. Antarctica

Access to Antarctica can be by:

1. One of the many ships operated by groups such as *Quark Expeditions*.
2. Yachts such as Skip Novak's *Pelagic* and Jerome Poncet's *Golden Fleece* and *Damien II*
3. Flights by organisations such as *Antarctic Logistics and Expeditions (AL&E)* who took over the Adventure Network International (ANI) Antarctic operation in 2003 and remain the only non governmental supported air service provider in Antarctica.

ALE operate a austral summer office in Punta Arenas (Southern Chile) and fly an Ilyushin 76 large transport wheeled aircraft from there to a blue ice runway and base camp at 81°S 80°W in the Ellsworth Mountains. From Patriot's it is then possible to be flown on to other destinations such as Mt Vinson base camp and the South Pole using smaller, ski fitted aircraft .

The Chileans have on occasions also operated a base camp at Patriot Hills and a joint South African/Russian organisation ALCI (Antarctic Logistics Centre International) based in Cape Town fly an Ilyushin into a blue ice runway at 72°S in the Dronning Maud Land Region of Antarctica and the feeder AN2 Biplane aircraft from there.

Websites with good Antarctic links include

www.antartic-circle.org, www.south-pole.com, www.70south.com

Contacts

IAATO (International Association of Antarctic Tour Operators) www.iaato.org lists those organisations who comply to certain environmental standards and protocols with their operations in Antarctica

Antarctic Logistics & Expeditions 4350 North Fairfax Drive, Suite 840, Arlington, Virginia 22203, USA. Website: www.antarctic-logistics.com. Tel toll free 888 463 3113 Fax 1 703 524 7176

Golden Fleece Expeditions, Beaver Island, Falklands Island . Tel +500 42316 www.horizon.co.fk/goldenfleeceexp. golden.fleece@horizon.co.fk Veteran Antarctic sailor Jerome Poncet operates 2 ice strengthened yachts *Damien II* and *Golden Fleece*, which have supported expeditions and film companies operating in Antarctic Peninsula and South Georgia. Email:

Mission Antarctica Run by Robert Swan using a steel yacht called 2041 Mission Antarctica ran a major environmental clean up operation on King George Island www.inspia.org

Pelagic Run by former round the world yacht skipper Skip Novak. Website: www.pelagic.co.uk

Students on Ice Run by Geoff Green takes one cruise to Antarctica each year with young adventurers supported by a team of educationalist and scientists. www.studentsonice.org

Permissions

Under the Antarctic Treaty it is law that individuals or groups planning to travel to Antarctica must receive a permit from their relevant Antarctic body. British based individuals or groups planning visits other than with registered tour operators should contact the *Polar Regions Section of the Foreign and Commonwealth Office* in London for required details.

Books:

- ARNESSEN, L & BANCROFT, A (2003) *No Horizon's so far: Two women and their Extraordinary journey across the Antarctic*. DaCapo Press. 253pp.
- BANCROFT A. (2000) *Four to the Pole!: The American Women's Expedition to Antarctica, 1992-1993*.
- BOWERMASTER, J (1991) *Crossing Antarctica*. ISBN 0-593-02186X. Account of 7 month 3,500 miles dog sled expedition (1989/1990 Steger International Transantarctic Expedition) which crossed longest axis of Antarctica from Antarctic Peninsula to South Pole and then to Vostok and finishing in Mirny Station
- BROWN, I (1999) *Extreme South: Struggles and Triumph of the first Australian Team to the Pole*. Dumme, Australia. 255pp. An account of the 1997/98 Australian Team of 3, manhauling from Berkner Island to the South Pole. ISBN: 1-86276-031-4
- CORR, J (1993) *The Snotsicle Travers*. 215pp. Account of a 2 person ski trek from the South Pole to the Ross Ice Shelf.
- DE LA FERRIERE, L. (2000) *Seule dans le vent des glaces* [Alone in the Wind of Ice]. Robert Laffont, Paris: 230pp. ISBN: 2221092007. French text account of 2875km, 57 day solo trek from the South Geographic Pole to France's Dumont d'Urville station on the coast of Adelie Land in 1999-2000.
- FIENNES, R. (1993) *Mind Over Matter*. Reed Consumer Books Ltd, London: 230pp. ISBN 1-85619-375-6. English text account of 1992-93 unsupported sled haul trek across Antarctica.
- FOTHERGILL, A. (1993) *Life in the Freezer: a natural history of Antarctica*. BCA, London.
- FUCHS, A (2001) *In Shackletons Wake*. Sheridan House Publishers, USA. A translation of Arved Fuchs' book 'im Schatten des Pols'. 193pp. ISBN: 1-57409-138-7. 26 colour and black and white photos.
- FURSE, C (1986) *Antarctic Year-Brabant Island Expedition*. Croom Hill Publishers Ltd. 223pp. An account of an 18 month British military expedition including first tented overwintering on Brabant Island
- GILDEA, D (1998) *The Antarctic Mountaineering Chronology*. A list of first ascents in Antarctica 1817-1998.
- HALL, L (1989) *The Loneliest Mountain: The dramatic story of the first expedition to climb Mt Minto, Antarctica*. Mountaineer Books. 232pp. NB there was a documentary film made about this trip
- HAMILTON, C, (2000) *South Pole 2000: five women in search of adventure*. Virgin Publishing, London: 259pp. ISBN 1852278285. An account of the M&G ISA British Women's 1999 South Pole Expedition. Also published in Dutch and Italian.
- HAUGE, O (1995) *The Impossible Journey: unarmed to the South Pole*. Pax Forlag AS, Oslo: ISBN: 8253017596. English text account of unsupported Norwegian trek to South Pole. One of the participants had lost both his arms in an accident when he was 14 years old.

- HEMPLEMAN-ADAMS, D (1998) *Toughing it Out: the Adventures of a Polar explorer and mountaineer*. 308pp. This book includes sections on ascent of Mt Vinson, an unsupported ski trek to the South Pole, and a yacht expedition to the magnetic South Pole.
- HILLARY, P (2004) *In the Ghost Country: A lifetime spent on the Edge*. Free Press. 352pp. Book which includes amongst his mountaineering expeditions Peter Hillary's account of his participation in the 1998-99 Expedition that retraced Robert Falcon Scott's route to the South Pole.
- HØIBAKK, R and MØRDRE, S (1991) *Sydpolen på Tvers Den Norsk Sydpolekspedisjonen 1990*. Gyldendal Norsk Forlag, Oslo: 157pp. ISBN 82-05-20220-6. Norwegian text account of little known 1990 Norwegian Trans Antarctic Expedition that used dogs as far as the Pole and sled hauling assisted by Upski parachutes for second half of the journey.
- HOSKING, E. and SAGE, B.L. (1982) *Antarctic Wildlife*. Croom Helm Ltd., London.
- HUBERT, A & DANSERCOER, D (2001) *In the Teeth of the Wind-South through the Pole*. Bluntisham Books, UK. 224pp. Account of Two man ski crossing from Belgium base to South Pole and on to McMurdo station.
- KAGGE, E. (1993) *Alone to the South Pole*. Cappelen Forlag, Oslo: 131pp. ISBN 82-02-14107-9. English text account of Erling Kagge's solo trek to the South Pole from Berkner Island.
- KRISTENSEN (1987) *Mot 90° Pa Syd*. Grondahl, Norway. Norwegian text account of Dog sled exped to South pole retracing Amundsens route.
- LEWIS, D & GEORGE, M (1988) *Icebound in Antarctic*. Norton, New York. Account of a 6 person team in 198-? Sailing down to and then overwintering in Antarctica.
- LEWIS, D (-----) *Icebird*.
- LONELY PLANET PUBLICATIONS (1996 and 2001) *Antarctica. A travel survival kit*. Lonely Planet Publications, London: 368pp. ISBN 0-86442-415-9. Excellent publication for initial fact finding.
- MEAR, R (1987) *In the Footsteps of Scott*. Jonathan Cape Ltd, London. 306pp. Account of 3 person team making first unsupported trek to South Pole since Scott and Amundsen
- MESSNER, R. and Neate, J. (1991) *Antarctica: both Heaven and Hell*. Crowood Press Ltd, Ramsbury. ISBN 1-85223-704-X. Account of 2 person sled haul across Antarctica.
- MURPHY, J (1990) *South to the Pole by Ski*.
- MURPHY, J (1996) *To the Poles: by Ski and Dogsled*. 310pp.
- OUSLAND, B. (1997) *Alone Across Antarctica*. 160pp. ISBN 82-994379-1-1. English text account of authors 64 day solo unsupported crossing of Antarctica from Berkner Island to McMurdo station. Available from Borg Ousland at www.ousland.com
- PHILIPS, E (2000) *Ice Trek: A Journey to the south Pole*. Harper Collins, New Zealand. An account of an expedition (1998-99) that re-traced Robert Falcon Scott's route to the South Pole. ISBN: 1869503600.
- POLES APART (2004) *Polar Updates: Antarctica*. ISBN 0-9543143-1-X. Polaes Aprat, Cambridge http://www.polesapart.org/polar_updates.html. Polar Updates summarises Antarctic environmental law and visitor requirements in an accessible and simple format. Cost £138.
- PONCET, S & PONCET, J (1991) *Southern Ocean Crossing Handbook*. 60pp. Available from Miles Apart Books, UK.
- READERS DIGEST (1990) *Antarctica – The Frozen Continent*. ISBN: 0 949819 64 6.

- SALE, Richard (2002) *To the ends of the earth, the history of polar exploration*. Harper Collins, London.
- SHAPIRO, D (1997) *Time on Ice: A winter voyage to Antarctica*. International Marine/Ragged Mountain Press. 304pp.
- SOPER, Tony & SCOTT, Dafila (2000) *Antarctica, A Guide to the Wildlife*.
- STEGER, W. and BOWERMASTER, J. (1992) *Crossing Antarctica*. Bantam Press, London: 305pp. ISBN 0-593-02186X. Account of the Steger International Transantarctic Expedition.
- STONEHOUSE, B. (1990) *North Pole, South Pole – a guide to the ecology and resources of the Arctic and Antarctic*. Prion, London: ISBN 007510677.
- STROUD, M. (1993) *Shadows on the Wasteland*. Jonathan Cape, London: 182pp. ISBN 0-224-03846-X.
- TOLLEFSEN, I. (1994) *Dronning Maud Land, Antarctica*. Mortensen, Oslo: 160pp. English text account of Norwegian Climbing Expedition to Dronning Maud Land. Hard to get hold of a copy.
- TRESEDER, P (2001) *Man of Adventure*. New Holland/ Struik. 336pp. Peter Treseder manhauled to the South Pole on 2 occasions.
- VAUGHAN, N. D (1995) *My Life of Adventure*. Stackpole Books.256pp. Norman Vaughan climbed Mt. Vaughan in Antarctica aged 89.
- VENABLES, S (1991) *Island at the Edge of the World: A South Georgia Odyssey*. 177pp. An account of a mountaineering expedition to south Georgia, led by Stephen Venables.
- WOOD, G (1996) *South Pole: 900 miles on foot*. 226pp. Gareth Woods account of his trek to the South Pole in 1984/85 with Robert Swan and Roger Mear.
- WOODHEAD, P (2004) *Misadventures in a White Desert*. Hodder & Stoughton, London (2003/2004), Sceptre Presss, Paperback 2004.

Antarctic Films

- **Alone to the South Pole.** Film of Erling Kagge's solo, unsupported trek to the South Pole (28 mins.);
- **Durch die Heimat.** Film of Reinhold Messner and Vivian Fuchs' 1990 Trans-Antarctica Expedition (2 hrs 10 mins. – German narration);
- **Gjennon Stillhetens Landskap.** Film of little known 1990/91 Norwegian Trans-Antarctica Expedition (62 mins. – Norwegian narration). Distributed by Radius Films, Oslo;
- **Seule en Antarctique.** French documentary of Laurence de la Ferriere's 2875km, 57 day solo trek from the South Geographic Pole to France's Dumont d'Urville station on the coast of Adelie Land in 1999-2000;
- **Struggle for the Pole.** Film of the 1984-86 Footsteps of Scott Expedition (55 mins.);
- **To the Ends of the Earth.** Film of 1979-1982 Trans-globe Expedition which crossed Antarctica on skidoo;
- **Misadventures in a White Desert.** Film of 3 Englishman plus their Canadian guide Paul Landry on South Pole Ski Trek from Hercules Inlet to the Pole (20 mins)
- **In the Teeth of the Wind.** Film of Alain Hubert & Dixie Dansercoer's 99 day crossing of Antarctica from Belgian base to South Pole to McMurdo. Film is available in French, Dutch and English (PAL format) and US (NTSC format)

- **In the Teeth of the Blizzard.** Documentary Film about the 1998-99 Ice trek Expedition from McMurdo to the South Pole. Film produced and available from Natural History New Zealand (www.wildsouth.co.nz) 60 mins
- **Au Sud au Sud.** Film of Will Stegers International Trans Antarctic Expedition. French Narration and subtitles (100 mins)