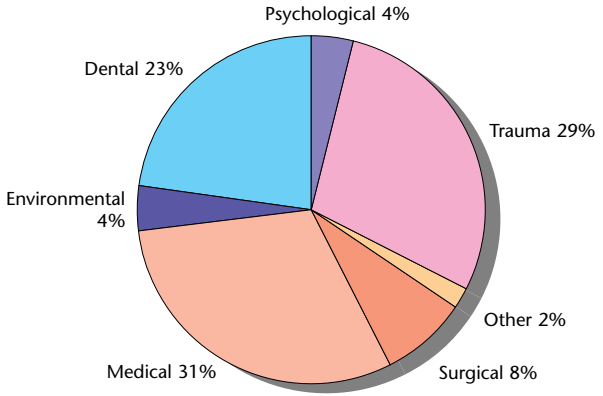
Risks to human health in Antarctica

Resource LW1



Illness and injuries experienced by BAS staff between 1944 and 1979

BAS

Ambient temperature °C

-40 -30 -20 -10 -5 0 +5

Equivalent temperatures °C and danger of hypothermia for a properly clothed person

Wind speed mph	great exposed flesh may freeze			increasing			little
46	–87	–71	–54	–38	–29	–21	–13
35	–84	–68	–52	–36	–28	–20	–12
23	–77	–62	–49	–31	–24	–16	–9
12	–62	–49	–36	–23	–16	–10	–3
6	–48	–37	–26	–15	–9	–3	+1
0	–40	–30	–20	–10	–5	0	+5

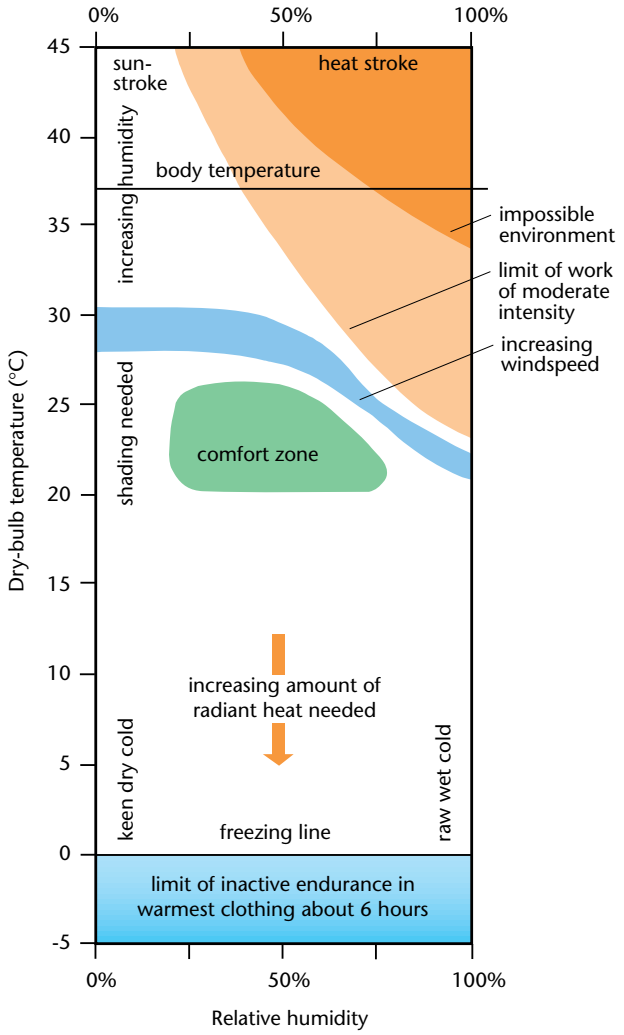
The windchill index

BAS

Body temp °C	
37	Normal body temperature
36	Judgement may be affected.
35	Definition of hypothermia threshold. Dangerous hypothermia below 35°C. Feels cold, looks cold, shivering.
34	Change of personality (usually withdrawn – 'switches off'). Stumbling, falling, confused. Inappropriate behaviour, e.g. sheds clothing. Lack of appreciation – 'doesn't care'.
33	Consciousness clouded. Shivering stops. Incoherent.
32	Heart stoppage now very much a risk. Heat loss will continue unless protected. Limbs stiffen up.
31	Moves into unconsciousness.
30	Unlikely to detect breathing or pulse.
28	Fixed, dilated pupils (no constriction to light).
24	Survival unusual if any colder.
18	Lowest temperature of accidental hypothermia with recovery.
9	Lowest temperature of deliberate hypothermia with recovery.

Features of hypothermia

BAS



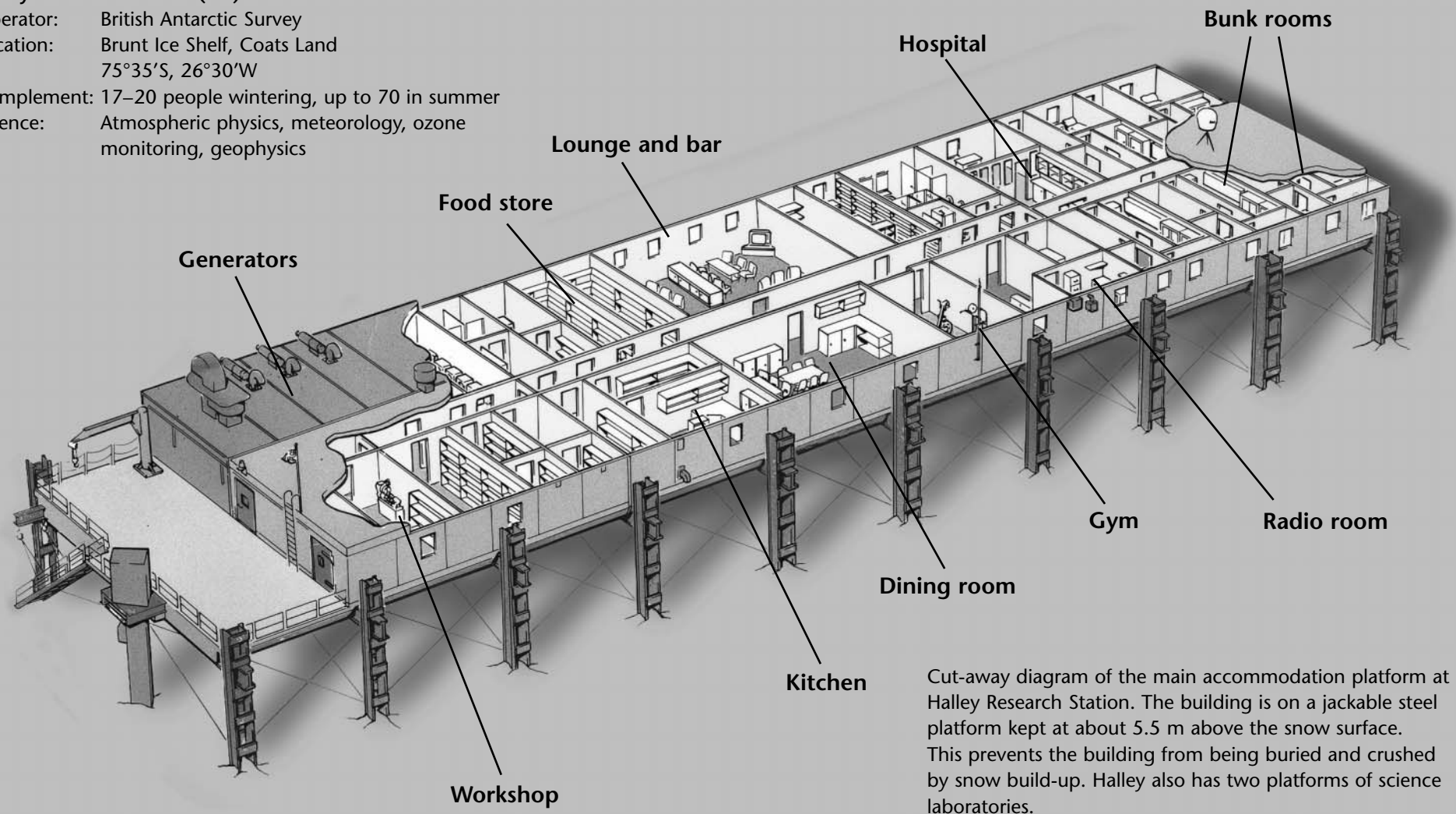
Human tolerance of climatic ranges

Taken from The Built Environment (1973) Open University Press

Halley Research Station

Resource LW2

Halley Research Station (UK)
Operator: British Antarctic Survey
Location: Brunt Ice Shelf, Coats Land
75°35'S, 26°30'W
Complement: 17–20 people wintering, up to 70 in summer
Science: Atmospheric physics, meteorology, ozone monitoring, geophysics



Cut-away diagram of the main accommodation platform at Halley Research Station. The building is on a jackable steel platform kept at about 5.5 m above the snow surface. This prevents the building from being buried and crushed by snow build-up. Halley also has two platforms of science laboratories.

BAS

RRS *James Clark Ross*


BAS

The RRS *James Clark Ross*, launched in 1990, is one of the world's most advanced marine research vessels, as well as a cargo and personnel carrier. The ship has a service speed of 12 knots and can be driven at a steady 2 knots through level sea ice one metre thick. To assist passage in heavy pack ice a compressed air system rolls the ship and prevents the ice from squeezing the hull.

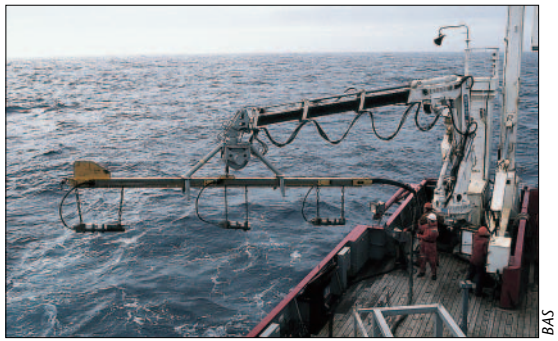
RRS *James Clark Ross* is equipped for geophysical studies, with gantrys aft and midships for deploying a wide range of equipment including a seismic air gun array and sediment corers.

For biological studies, the vessel can deploy a wide range of sampling gear, including large nets for studies of fish stocks of commercial importance. The vessel also has modern echo-sounders and a large suite of laboratories (400 m^2) for scientific research.

The ship is designed with an extremely low noise signature to allow sensitive underwater acoustic equipment to operate effectively and has bow and stern thrusters for precise positioning. A computer Local Area Network (LAN) enables communication throughout the ship and, via the satellite communications system, with shore-based facilities.


BAS

The rear crane deployed


BAS

Air guns are deployed from the rear deck

Ice classification
Lloyds 100 A1 Ice Class Super.

Dimensions
Length 99.04m, Breadth 18.85m, Draught 6.30m.

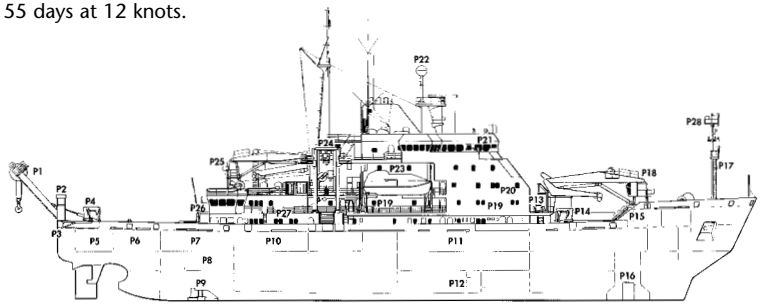
Speed
Passage speed 12 knots.

Endurance
55 days at 12 knots.

Cargo capacity
1500 m^3 of general cargo, 250 tonnes bulk aviation fuel, 300 tonnes diesel fuel.

Scientific areas
Laboratories 400 sq m^2.

Accommodation
Officers 11, crew 15, staff on passage 50.



P1 Aft gantry
P2 Trawl post
P3 Hydraulic boom
P4 Scientific crane
P5 Scientific power pack room
P6 Seismic compressors
P7 Scientific hold
P8 Trawl winch room
P9 Stern thruster
P10 Traction winch room
P11 Gravity meter room
P12 Transducer space
P13 Precision echo sounder gantry
P14 Ship's stores crane
P15 Scientific crane
P16 Bow thruster
P17 Foremast
P18 Main cargo crane
P19 Cabins
P20 Scientists/officers' lounge
P21 Wheelhouse
P22 Satellite communications
P23 Chief scientist's suite
P24 Midships gantry
P25 Aft crane
P26 Gilson winches
P27 Laboratories and control rooms
P28 Meteorological platform

BAS

Food, clothing and field equipment used by BAS

Resource LW4

Comparison of sledging rations – 1912 and 1998

Sledging rations for one person per day provided for Scott's party in 1912, who were man-hauling their sledges, compared with those provided by BAS (1998) for field parties travelling by snowmobile.

Energy value in kilo calories

Food	Scott 1912	BAS 1998
Biscuits	1728	530
Pemmican	2004	–
Meat and fish	–	779
Soup	–	40
Porridge	–	22
Muesli	–	138
Vegetables	–	120
Butter and cheese	452	701
Sugar	336	197
Chocolate	–	529
Jam	–	66
Milk	–	226
Cocoa	73	–
Drinking chocolate	–	46
Tea and coffee	–	–
Dried fruit	–	201
Rice	–	84
Pasta	–	171
Other (e.g. Marmite)	–	164
TOTAL	4593	4014
Protein	257 grams	175 grams
Fat	210 grams	170 grams
Carbohydrate	417 grams	465 grams

Source: BAS

Deep-field scientific parties use snowmobiles which have small petrol engines. The pyramid tents and camping equipment are towed on wooden Nansen sledges. The design of these sledges has not changed since the original ones produced in the 19th century. The camping equipment includes several boxes of sledging rations, a kitchen utensils box, a high-frequency radio equipment box, a medical box and a sleeping bag, sheepskin mat, insulating ground mat and an inflatable airbed. Cooking is done on a pressurised paraffin stove.

BAS

BAS

The modern polar clothing system used by BAS. This involves several layers rather than a few thick garments.

BAS

Teamwork and morale on Antarctic stations

Resource LW5

Teamwork and morale

Antarctic stations are isolated and remote, but in terms of social contact the people living there are not. The nature and activities of the ships and Antarctic stations do not lend themselves to solitary individual existence. Time for privacy is important. Prolonged, nearly constant contact with others who are initially strangers with differing backgrounds, experience, interests and age, is one of the most rewarding yet exacting aspects of an Antarctic tour. Tolerance and a good opinion of yourself and others linked with sensitivity and humour will overcome potential difficulties. Carrying out one's tasks, an uncomplaining willingness to do more at times and an acceptance of others foibles and recognition of one's own all help. Self discipline and good manners contribute substantially to strong morale.

Group dynamics

Groups and communities can be considered to pass through five stages during their development. Each stage is necessary for the functioning of the group and it is helpful for the individual to have some understanding as to what is going on. It has been suggested that the five stages are:

1. Forming
2. Storming
3. Norming
4. Performing
5. Mourning

BAS

Saturday dinner at Rothera Research Station

1 Forming

During this stage greetings are exchanged and bits of information about each other are shared. Individuals get to know about the group, its purpose, nature and boundaries. There is a personal checking of individual roles and the appropriateness of inclusion in the group. This is a settling in period.

2 Storming

This is a necessary, but often uncomfortable stage. Each individual overtly or covertly strives to gain their perceived position in the group. People test each other. There may be assertiveness and domination along with physical or mental withdrawal. It is a period of rebellion against leaders or organisation in terms of ground rules and the way things are done.

This stage is a needed sorting out process and will largely determine the nature of the later stages of the group's life. Conflicts need to be contained and worked through in order to allow individuals to come to terms with their position and role within the group.

3 Norming

This is a period of agreement on ways to function (norms) without disruption from undue conflict.

4 Performing

In a well functioning group this is a stage of cooperation, achievement and well-being. The group nurtures (individuals show interest and support), energises (individuals enthuse, challenge and consider new approaches), performs and relaxes.

5 Mourning

As the dissolution of the group approaches, the bonds begin to loosen and individuals may distance themselves from the group. Some may feel a sense of personal loss or dissatisfaction with personal relationships or group tasks. It is important to complete unfinished business and to have a celebration before departure.

There is little that cannot be achieved when individuals display openness, understanding and regard for themselves and others within the group.

BAS

Greenpeace views on station environmental impacts

Resource LW6

Antarctic sprawl

The ice-free coastal areas that support most of Antarctica's wildlife and plants make up less than two per cent of the continent. Each tiny area is like an oasis, except these Antarctic oases are separated by huge expanses of ice rather than sand. They range from the rich moss-covered fields on the Antarctic Peninsula to the abundant seabirds and seals at places like Cape Royds, Halfmoon Island and Pointe Geologie.

These oases on the Antarctic rim are the easiest sites on which to set up bases, so that human activities inevitably compete for space with plants and animals. Base construction can destroy geographic features such as rare rock formations and the delicate soils that take so long to form in the harsh Antarctic conditions. This encroachment on ice-free areas means both that the number of stations should be restricted, and that perimeter limits need to be set to prevent this Antarctic version of urban sprawl.

The building and operation of large bases have all had significant adverse impacts on the environment, including local flora and fauna. At one site an entire station was built on land that had been designated a Specially Protected Area (SPA). Once this SPA was breached, three other countries moved in, and the Fildes Peninsula is now one of the most heavily polluted and damaged parts of Antarctica. Additionally, since the construction of the four Fildes bases a network of linking roads has been constructed and vehicles have frequently been driven over much of the peninsula's lush cover of moss. A similar thing has happened in the Larsemann Hills on the other side of the continent. Road construction and poor waste disposal have caused a number of environmental impacts. The location of three stations within two kilometres of each other shows a high degree of redundancy.

Abandoned bases

Abandoned facilities are a special type of waste problem. Over time, debris and waste can become frozen and embedded in ice, posing a permanent hazard to wildlife. Fuel drums and tanks left at abandoned sites inevitably deteriorate and leak. The Environmental Protocol calls for all nations to remove their disused facilities. Removing potential hazards from abandoned bases still needs to be given a higher priority. Greenpeace estimates that there are over 35 abandoned bases and facilities that will require clean up.

Airstrips

The construction of landing strips and associated buildings has involved the levelling and dynamiting of large areas,

BAS

The Greenpeace vessel MV *Gondwana*

and the modification of entire shorelines. Construction can directly displace wildlife and takes over scarce ice-free land. Air traffic creates air and noise pollution which can disrupt breeding wildlife and requires increased fuel storage. Further, by opening up access to an area, an airstrip facilitates expansion of the programme in question, thereby increasing the impact far beyond the immediate disturbance of the airstrip.

Waste

Waste management and disposal have come a long way since Greenpeace first inspected Antarctic bases in 1986. At that time much of the wastes generated, such as old discarded machinery, rubbish, food scraps, and sewage, was dumped down the nearest gully, burned in the open, pumped out to sea or left on sea ice to fall to the sea floor as the ice melted in summer. Fortunately, these days very few stations still practice open dumping, and the Environmental Protocol has increased standards still further. However, a drastic change in attitude is still necessary in order to reduce and eliminate waste at source.

The worst legacy of past waste disposal practices are the disused dump sites which are now a problem at many of the older stations. At some sites, everything from plastic packaging to fuel and hazardous chemicals were dumped, despite this being prohibited by the Code of Conduct on Waste Management agreed in 1975, long before the Protocol was negotiated.

Raw sewage is a particular problem as most stations continue to discharge raw, or partially separated sewage, into coastal waters. This can cause a number of problems. Bacterial and viral contamination has implications for both human and ecosystem health and it has become apparent that some bugs may survive in seawater for much longer than previously thought. Sewage discharges also contain high concentrations of nitrate and phosphate, which can overload the ecosystem with nutrients. In addition, the deposition of solid materials and sewage discharges can smother the sea floor, destroying communities of bottom-dwelling animals. Chemical contamination with solvents, toxic metals and detergents can also cause problems.

This is a summary of the views of Greenpeace as expressed in Szabo, M. (1994) State of the Ice: An Overview of Human Impacts in Antarctica. Greenpeace International, Amsterdam.

Living and working in Antarctica

Worksheet 3

Antarctica has no native human population. The people who live and work on the continent are nearly all scientists and support staff living at research stations. In order to survive they must bring in food, fuel, shelter and clothing from outside. This worksheet explains how people live and work in Antarctica using case study material from the British Antarctic Survey (BAS).

Task 1 Think about the problems of living and working in Antarctica. Tabulate your ideas across three columns labelled 'environmental characteristics', 'problems for living and working', and 'solutions to problems'. For example, the long dark winter season is a characteristic of the environment. A lack of daylight hours for research and logistical support might be a problem and working long hours in the summer would be a solution. You could add a fourth column entitled 'costs' – in this case they might include lack of sleep and exhaustion. Are the problems you identify due to the harsh environment, the lack of local resources or the remoteness of Antarctica? One of the ways in which suitability for living and working can be shown is by plotting a human 'comfort zone'. Such a diagram is shown in Resource LW1. Describe the Antarctic environment in relation to temperature and humidity.

Supporting life in Antarctica

Considerable logistical effort is needed to maintain life in Antarctica. Everything needed at a research station has to be taken there by ship or aircraft, so careful planning is essential. However, ships and aircraft can only reach the continent during the summer months because of the sea ice and severe weather in winter.

Research stations in Antarctica

There are no cities or large towns in Antarctica, only research stations. The largest station is McMurdo (US) with about 300 people in winter and 1200 in summer. During the 1998 winter 25 research stations were active in Antarctica, operated by 18 different nations.

The BAS has four research stations: three in the Antarctic and one on Bird Island, just off South Georgia. Two of the BAS research stations in the Antarctic, Halley and Rothera, are operated throughout the year, while the third, Signy, opens in the summer only.

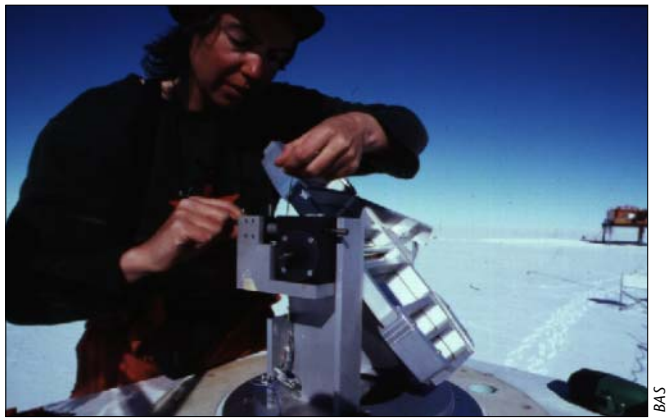
Task 2 Locate the BAS research stations on the map shown in Resource N1. With reference to the data given in Resource C1, suggest how Rothera and Signy may differ in terms of climate and accessibility.

A cutaway diagram of the BAS Halley Research Station is shown in Resource LW2. It is built on a floating ice shelf about 150 m thick. The station is a self-contained community. As well as living and working space, there is a kitchen with large food stores, workshops, and a small hospital. The station makes its own electricity using diesel generators, and communicates with the outside world using a satellite link.

Task 3 Look at Resource LW2. Suggest the reasons for the layout of the platform. Identify the high fire risk areas. Why does Halley have a small hospital? Where would you store emergency rations and supplies? Why? What staff, other than scientists, would be needed to run the station?

Life in the field

Not all research can be carried out at the stations and field work is necessary. Scientists and field assistants travel further afield by air or snowmobile. Field parties live in small huts or pyramid tents (see photograph in Resource LW4) for up to four months in the summer season.



BAS

In 1998, Vicky Auld became the first female Base Commander of the BAS Halley Research Station

Task 4 In what ways would camping in Antarctica differ from that on an organised campsite in the UK? What extra precautions would you need to take in the Antarctic?

Logistical support

Transport and communications in Antarctica have changed greatly since the early 1900s. Wooden sailing ships have been replaced by powerful ice-strengthened ships for research and the transport of supplies. Sledges are now pulled by snowmobiles rather than by dogs, which were banned from Antarctica in 1994. Aircraft are used to transport people and equipment, and to resupply some stations.

Task 5 Resource LW3 describes the BAS research vessel the RRS *James Clark Ross*. Compare the specification of the RRS *James Clark Ross* with those of the RRS *Discovery*, which is shown in Resource S1.

Food

Food is one of the most important aspects of survival in the Antarctic. The food at BAS stations provides a balanced diet similar to that found in the UK, except that fresh fruit and vegetables are only available when supply ships or aircraft call. Generally meat is frozen, dried or tinned.

Sledging rations

A person camping out in the field will need 3500 calories per day, which is about double the intake of an average adult in the UK. This is because people need more energy from their food, both to keep warm and to undertake heavy physical work. This energy is provided by foods which are high in carbohydrate and fat. Foods must also be compact and light for easy transport.

Task 6 Resource LW4 shows a table comparing the modern sledging rations used by BAS with those used by Scott in 1912. Compare the rations and comment on them in terms of diversity, balance, palatability and changes in food technology. How might a vegan modify these rations to provide the necessary energy?

Clothing

Modern polar clothing uses several thin layers, rather than a few thick garments. The layers trap air to provide insulation, but at the same time clothing can be removed or added in response to different conditions. Recent advances in fabrics have allowed the production of outer garments which are waterproof but still 'breathe'. This prevents the build-up of moisture from perspiration. Photographs of the modern polar clothing used by BAS can be seen in Resource LW4.

Task 7 Describe some of the problems of using scientific equipment or repairing a vehicle when kitted out in multi-layered clothing.

Physical and mental health

All BAS staff have to undergo extensive medical examinations before acceptance for service in Antarctica. This is not only to protect them, but also their colleagues who could be placed at risk if someone were to become dangerously ill. Although all BAS ships and stations are medically equipped, the smaller ones do not have doctors and only the RRS *Bransfield* has a dentist. Evacuation of personnel, particularly in winter, is often impossible. It is essential, therefore, not only for staff to be healthy but also to be trained in first aid and medical care.

Task 8 Imagine you are an interviewer working for BAS. Draw up a list of psychological characteristics that you would want in a potential employee who was to winter in Antarctica. Note also those that you would wish to avoid.

Health risks

Resource LW1 shows a pie chart which summarises the illness and injuries experienced by BAS staff between 1944 and 1979.

Task 9 Comment on the pattern shown. What do you think causes the trauma (injury) conditions? Why do you think dental problems are common?

The main causes of injuries are accidents, particularly when skiing, but there are also environmental risks, notably frostbite and hypothermia. Risk of infection is relatively low in Antarctica except at staff changeover time.

Task 10 Resource LW1 shows the risks of hypothermia in relation to temperature and wind speed. Describe the relationships between them. How can people reduce the risks? Resource LW1 also shows the features of hypothermia. Explain why the condition may not be obvious to someone working in the field. How can this be overcome?

Teamwork and morale

In Antarctica working as a team is critical to survival and to the safe operation of research stations.

Task 11 Resource LW5 outlines the advice given to BAS staff regarding teamwork and morale. In pairs, discuss whether each of you is well suited to the lifestyle of an Antarctic station. Explain why. As a class discuss at which of the five stages of group dynamics you have reached. Give examples of behaviour to support your selection. How might you use this approach to plan your success as a group?

Gender issues in Antarctica

Early expeditions to Antarctica were male and often based on naval discipline. Women were excluded because of the lack of privacy, the extreme environment and the harsh physical working conditions. Since the 1970s, increasing numbers of women are living and working in Antarctica and on some stations they have become station commanders.

Task 12 As a group discuss the advantages and disadvantages women might have over men in living and working in the Antarctic.

Impacts on the environment

The establishment and operation of research stations in Antarctica cannot be done without any environmental impact. However, the environmental 'footprint' of these stations is small. For example, Rothera Research Station, the largest UK station, has a 'footprint' of only 3 km^2.

Task 13 Refer to Resource LW6 which shows the views of Greenpeace on station environmental impacts. Produce a set of bullet points that summarise the impacts. Are they significant? Consider some of the ways in which major impacts might be prevented or minimised.