

Arctic History & Exploration

Since the earliest days of exploration people have attempted to reach the farthest-flung corners of the earth, and for many years the polar regions remained an elusive goal. The vast expanse of the Arctic was *terra incognita* and this was as much a part of its allure as the quest for new shipping routes, financial reward, geographical discovery and personal recognition.

Long before the early explorers headed north, though, the indigenous people of Asia had settled there. New Stone Age artefacts found in the Yana River Valley in Siberia, 500km north of the Arctic Circle, suggest that humans may have been hunting big-game animals in the region 30,000 years ago. When a fall in sea levels at the height of the last Ice Age formed a land bridge between the Russian Far East and North America, the distant ancestors of the Native Americans followed the mammoth herds across to the New World (see p263). Anthropologists believe that a second migration, this time of the ancestors of the Na-Dene people (see p45), occurred 12,000 to 15,000 years ago. The Inuit (see p39) were the last group to migrate east, making their way to Alaska 7000 to 8000 years ago.

The history of the Arctic's indigenous people reflects the harsh and unforgiving landscape in which they choose to live. Life was always a struggle against the elements, but the arrival of the *qablunaq* (white man) created a whole new array of problems. The early explorers had no idea how devastating their contact with local people would be: disease decimated the indigenous populations (see p20) and the influence of their culture began the transformation of the traditional way of life.

The Arctic's extreme weather and environments and newcomers' ignorance of how best to survive them have meant that the history of exploration in the region is pitted with accounts of tragedy and the many expeditions that never returned. Inaccurate maps, cruel temperatures, fluctuations in the extent of sea ice and the arrogant belief by some that rank, class and formal education were more important than practical experience led to the downfall of many.

In the winter, perpetual night severely limited any surveying; in summer, navigation was difficult because the stars were invisible against the midnight sun. The travelling season was short, there was scant knowledge of compass deviation, and sea ice severely constrained movement. Despite the best efforts of countless brave explorers, it was 1948 before the first person stood on the North Pole and 1977 before a surface vessel managed to reach it.

The indigenous people of the north were largely considered savages by explorers, and their knowledge and experience was ignored. However, the Inuit were familiar with vast swaths of land and could draw highly accurate maps. Their dog teams, meat diet and fur clothing could have

DID YOU KNOW?

The word Eskimo means 'eaters of raw meat' and is now considered offensive in some parts of the Arctic.

TIMELINE 30,000 BC

Evidence of ancient Siberian hunters in the Russian far north

4800–5400 BC

The first migration of Inuit to North America

saved many lives if only the early explorers had deemed them fit for their lofty endeavours. Later explorers who adopted traditional Inuit ways and consulted the local people on travel routes found much greater success.

THE SPECULATIVE PERIOD (TO 1595)

The voyage of the early Greek explorer Pytheas to ‘Ultima Thule’, as it was known, in about 325 BC, was the first recorded journey to the far north, but exactly how far north he reached is unknown. Later accounts tell the story of the 5th-century Irish monk Saint Brendan, who made the voyage north to Iceland and possibly as far as Newfoundland in a skin boat. At around the same time a Buddhist monk, Hwui Shan, was making his way up Russia’s Kamchatka Peninsula and on to Alaska.

The next landmark in Arctic exploration goes to Erik the Red, who was exiled from Iceland in 982 and later founded a settlement in what is now known as Qassiarsuk (see p104) in Greenland. A wealth of Norse ruins covers the area today. At much the same time, the Europeans came into first contact with the Siberian Yup’ik and the first missionaries arrived among the Sami of northern Scandinavia.

For centuries little more was known about the Arctic, and it was 1555 before Oleaus Magnus, the last Catholic Archbishop of Uppsala in Sweden, wrote a detailed account of the area. His monumental publication, *A Description of the Northern Peoples*, is a mixture of fact and fantasy but still served as the chief source of knowledge about Arctic regions for over two centuries.

By the 16th century Spain and Portugal had monopolised the lucrative southern trade routes to the Orient and charged hefty levies for anyone wishing to pass. Rumours of a Northwest Passage to Asia gripped England and in 1576 a group of London merchants employed Martin Frobisher to find the route on their behalf. Over the next three years Frobisher traversed uncharted territory around Greenland and the eastern Canadian Arctic but he failed to find the fabled route.

Between 1585 and 1587, John Davies also attempted to find the elusive trade route; although he too was unsuccessful, he mapped the coast of Greenland, Baffin Island and Labrador, and was the first to keep detailed notes on ice conditions, flora and the indigenous people. He was also the first person to bring attention to the sealing and whaling possibilities in Davis Strait, thereby heralding a new era for both Europeans and the Inuit. Meanwhile, in northern Scandinavia the Sami were beginning to trade with southern Scandinavians and thus to pay taxes. As zealous missionaries flocked north and began a major push to educate the northern people, the Scandinavian monarchies were able to establish and assert political control over the area.

MARINE CARTOGRAPHY (1600–1700)

Most early voyages searched doggedly for the fabled Northwest Passage. Adventurous investors ploughed money into the quest, intent on making a fortune from a successful discovery, while the prospect of fame fuelled explorers’ daydreams of discovering new land. However, Arctic charts were a highly inaccurate mix of real and hypothetical lands, and progress was slow.

Although each expedition carried a cartographer and many companies produced their own charts, these were mostly kept secret so as not to give competitors any commercial advantage. The pressure on early cartographers to return home with new maps was immense, yet there was no accurate way to determine longitude and compass variations were unknown. Any land spotted was the subject of an educated guess as to actual location. The season was short, fog was common, and *fata morgana* – realistic mirages on the horizon that occur where there are alternating warm and cold layers of air near the surface of the water – were often taken for land and recorded. It took several hundred years of Arctic exploration before accurate charts were finally published.

Despite the lack of accurate maps, fishermen and whalers had been plying the northern waters for many years. Whalers knew the seas from Novaya Zemlya in the Russian Arctic to Baffin Island in the eastern Canadian Arctic from the late 1500s, and they reported finds of Russian Orthodox graves and wreckage of ships, proving that others had exploited the resources of the area before them. The whalers accumulated great knowledge and experience of Arctic waters during their trips, but this was largely ignored by the gentlemen discoverers, and the whalers had neither the social standing nor the connections to publish details of their discoveries themselves.

More accurate mapping became a reality thanks largely to the Dutch and the voyages of Jan Rijp, Willem Barents and several others searching for a route to China. By the 17th century, exploration and mapping of the Eurasian and American Arctic began to diverge. The wide seaways, open water and fewer islands of the Eurasian Arctic meant that this area became reasonably well mapped more than a century before the American Arctic, where explorers struggled with a patchwork of small, inaccessible islands that were difficult to navigate and often locked in by sea ice.

RUSSIAN EXPANSION (1640–1830)

Russia’s long-term campaign to extend its empire and conquer new territory was highly successful, but in the 17th century the northern regions of the country still remained largely unknown. That is, until Russian explorer Semyon Dezhnev rounded the extreme eastern cape of Asia, now Cape Dezhnev (p293), in 1648.

Peter the Great, founder of the Russian navy, became even more intent on expanding his empire after Denmark began the colonisation of Greenland in 1721. He set in motion a series of explorations that culminated in the Great Northern Expedition of 1733–43, led by the Dane Vitus Bering. The expedition was to establish the practicality of the Northeast Passage, an easterly sea route to India and China across the northern Russian coast, and travelled mostly by land using dogsleds to cross the tundra. In 1741 another Russian explorer, Semyon Chelyuskin, reached the most northern point in Asia (later named Cape Chelyuskin) and by 1743 almost the entire Eurasian Arctic coast had been mapped. Only a few outlying archipelagos remained to be discovered. Encouraged by the success of their mission, the Russians then moved on to Alaska, where the tsars ruled until the province was sold to the USA in 1867.

Nanook of the North (1922), directed by Robert Flaherty, was the first major anthropological documentary set in the Arctic. It follows Nanook and his family for a year, showing a culture practically untouched by European influence.

DID YOU KNOW?

Around 1000 BC the Ancient Greeks named the Arctic after Arktos (the bear) for its position under the Great Bear constellation.

DID YOU KNOW?

In 1867 the United States bought Alaska for \$7.2 million, about two cents an acre.

2400 BC

Suspected first arrival of Canadian Inuit peoples in Greenland

AD 982

Erik the Red sails for Greenland

1000

Greenlander Leif Erikson becomes the first ‘European’ to land in North America

1261

Greenland is annexed by Norway

The Great Northern Expedition produced maps that were detailed and informative but also proved convincingly that the Northeast Passage was not suitable for navigation at that time. The pressure to find an efficient route to China from Europe this way relaxed. However, a fortune in furs was brought back from the region and Russian and British traders flocked to the area, exploiting the resources and often cruelly suppressing the local people.

As more regular contact was made with the indigenous people across the Arctic, waves of smallpox, mumps, influenza and chickenpox epidemics formed a sadly familiar pattern, decimating communities and seriously affecting the demographic composition of the region.

THE NORTHWEST PASSAGE (1700–1910)

At the beginning of the 1700s, the central American Arctic was an unknown: whalers had never travelled this far west, and the Russians had never ventured further east than Alaska. Investors were happily accumulating enormous wealth from fur in northern Canada, though, and were less willing to get involved in the more risky business of Arctic exploration. The British Royal Navy, long experienced in naval expeditions, and stuck with a very large and inactive fleet after the end of the Napoleonic Wars, soon got involved instead.

In 1734 the Admiralty set aside £20,000 for the discovery of the Northwest Passage. A year later the invention of the chronometer allowed longitude to be accurately measured for the first time, and a second prize of £5000 was offered to the first past 110°W latitude in an effort to chart the Central Canadian Arctic, an area as yet unexplored. When the Great Northern Expedition failed to open a new sea route, commercial interest in charting the area and discovering the fabled Northwest Passage increased even further. The race was on.

Numerous expeditions set out over the years, but naval insistence on the superiority of rank and the importance of wearing uniform, the refusal to use dogs as a means of transport and the complete lack of interest in Inuit knowledge and experience meant a constant struggle against frostbite, amputation, snow blindness, scurvy and starvation.

One notable explorer of this period was William Scoresby, who had the unusual combination of a Cambridge education and experience as a whaling captain. Although he too failed to find the elusive route across the north, he was noted for his respect for both his crew and the indigenous population. Later explorations that proved highly successful in discovering vast new swaths of the High Arctic, but not the passage itself, were led by William Parry and James Ross.

In 1845 Sir John Franklin's expedition disappeared, and the search for his remains, largely funded by his widow, gripped England. Several dozen search parties scoured the High Arctic for traces of the expedition – it was eventually found on Beechey (p247) and King William islands in the central Canadian Arctic – and in the process produced the first accurate maps of the area. During this time Robert McClure made the first transit of the Northwest Passage by transferring between two boats by sled. It was not until 1903–07 that one ship, *Gjöa*, commanded by Roald Amundsen, made the transit in one vessel. By then the route had been

deemed commercially unviable, interest had waned and his achievement received little attention.

Today global warming and climate change (see p27) have brought the possibility of a commercially navigable Northwest Passage back into discussion. Predictions of a possible summer-long, ice-free route cutting thousands of kilometres off the journey between Europe and the Orient have shipping magnets planning ahead and military strategists exploring the implications of an ice-free Arctic.

It is interesting to note that at the same time that the Europeans were exploring the Arctic, the Inuit themselves were traversing their own land. In 1856, Qitdlaq, an outlawed shaman in Baffin Island, dreamt of Inuit people living far to the north. He persuaded a group of about 40 people to leave Baffin and try to find them. Half the group turned back mid-way but those that continued eventually arrived in Etah in North Greenland in 1863 where they met a group of local hunters who had managed to survive the Little Ice Age (1450–1850). The climate change had drastically altered the numbers and distribution of animals on which they relied, and the group had lost many of the skills commonly used by the Baffin Islanders. The visitors taught the polar Eskimo how to build and use kayaks, use bows and arrows, hunt caribou and fish for Arctic char.

Meanwhile, in northeast Canada gold had been discovered in the Klondike Basin in the Yukon, and thousands flocked to make their fortunes in the hills. Dawson (see p238) became the 'Paris of the North' and saw an intense but short-lived boom.

OCEAN EXPLORATION & NAVIGATION (1860–1930)

By the latter part of the 19th century, only the extreme northern lands, several parts of the High Arctic archipelagos and some isolated islands remained undiscovered. In 1878 a Swedish expedition led by Adolf Nordenskiöld set off aboard the *Vega*, a vessel equipped with a spanking new invention, the steam engine. The voyagers left Stockholm, proceeded round Norway and, after spending one Arctic winter in far eastern Siberia, returned triumphant around Asia and through the Suez canal.

In addition to detailed surveys of the route, the expedition conducted a comprehensive scientific programme. Scientific endeavour was reaching new heights across the globe, and since 1875 Karl Weyprecht, an Austrian army officer and Arctic explorer, had been campaigning for international cooperation and more valid goals in Arctic exploration. By 1882 he had established the first International Polar Year (see the boxed text, p32), persuading 11 countries to set up 12 Arctic stations for a year of scientific observation.

For explorers the focus was now shifting to attaining the North Pole, a dream largely held by the Americans. In 1879 the American polar explorer George De Long took the *Jeanette* through the Bering Strait in an attempt to reach the Pole. The ship got stuck in the pack ice and drifted slowly westwards around Wrangel Island (p293) and the De-Long Islands (named by subsequent search expeditions), where it was crushed and sank on 2 June 1881. Only 13 of the crew of 33 survived.

Three years later Inuit kayaking off southern Greenland found relics of the *Jeanette*. The find generated great interest in the scientific community

The journal of the first European woman to spend a winter in the Arctic, *The Distant and Unsurveyed Country*, edited by W Gillies Ross, provides a unique insight into life on a whaling ship and the relationship between the Inuit and Europeans.

DID YOU KNOW?

On one Arctic expedition in 1875, sailors with any old wounds were refused work, as the symptoms of scurvy could reopen them.

Ice-men, by Mick Conefrey and Tim Jordan, traces the voyages of explorers from Franklin and the Northwest Passage to the attempts on the Pole, and discusses the importance of the Arctic today and the issues facing its inhabitants.

For background information on the International Polar Year, visit www.ipy.org.

1576–8

Martin Frobisher makes three attempts to find the Northwest Passage

1605

Greenland is claimed by Denmark

1850–3

Briton Robert McClure traverses the Northwest Passage

1878–9

First transit of the Northeast Passage is made by Adolf Nordenskiöld aboard the *Vega*

DID YOU KNOW?

Fridtjof Nansen received the Nobel Peace Prize in 1922 for his work with famine victims and war prisoners in Russia after WWI.

and gave Fridtjof Nansen an idea. Nansen, who was to become one of the greatest Arctic explorers, commissioned a specially designed polar ship, *Fram* (Norwegian for ‘forward’), in 1893 and sailed through the Northeast Passage to a position near the Novosibirskye Ostrova. From here Nansen deliberately sailed north until the *Fram* became surrounded by ice. Over the next three years the drift took her as far north as 85°55.10'N, from where Nansen and his companion Hjalmar Johansen made an attempt for the Pole. They turned back at a new farthest north position of 86°13.10'N but couldn't find the *Fram* because of the continued drift. The pair had a lucky and unplanned rescue from Franz Josef Land the following summer.

The *Fram* voyage brought back vast amounts of scientific observations and proved that a suitably built and equipped ship could withstand the ice. The second voyage of the *Fram*, led by Norwegian explorer Otto Sverdrup between 1898 and 1902, led to the last mapping of the extreme north of the Canadian Arctic.

THE NORTH POLE (1895–1915)

In the two decades after the voyage of the *Fram*, polar exploration took off in a big way. The lands and oceans around both poles were explored, and two expeditions made it to the South Pole in 1911–12.

During this brief but intense period, 17 expeditions attempted to reach the North Pole by sled, balloon, ship and airship. All failed. In 1897 Swede Salomon Andree and two companions attempted to fly a hydrogen balloon, guided by drag ropes, over the Pole. They crashed and perished, their notebooks and undeveloped film lying undiscovered on the remote Svalbard island of Kvitøya until 1930.

Attempts at the Pole set off from many places, and particularly strong – and contentious – claims were made by Frederick Cook in 1908 and Robert Peary in 1909; both are now regarded as fraudulent. The subsequent outbreak of WWI ensured that attempts on the North Pole ceased for over a decade.

THE CONFRONTATION PERIOD (1910–1948)

In 1907 the Russian imperial fleet was defeated by Japan. Military reinforcements coming by way of the Suez Canal had arrived too late, and the loss prompted a survey to investigate the potential of the Northeast Passage's as a strategic waterway. Two specially built coal-fired icebreakers surveyed the Bering Strait region between 1914 and 1915, and then made the journey to Murmansk. Roald Amundsen completed the next transit of the Northeast Passage between 1918 and 1923 aboard the *Maud*. At the same time, 1921–24, Knud Rasmussen's fifth Thule expedition (see p174) was exploring the Arctic from Greenland right across North America.

By 1925 Amundsen had emerged as one of the pioneers of Arctic aviation, attempting to reach the Pole with Lincoln Ellsworth using two aeroplanes. The expedition had to land on pack ice only 2°10', or about 240km, from the Pole because of engine trouble. The following year Amundsen set off from Svalbard (formerly Spitsbergen) in an airship, and on 12 May 1926 he flew over the Pole and continued on to Teller, Alaska, where the ‘flying whale’ greatly amused the local Inuit. Amundsen had thus become

the leader of the expeditions that first saw both the South Pole and the North Pole.

In 1928 the Committee of the North was established in Russia, and the impact of new economic policies hit the indigenous people hard. Life was collectivised through the organisation of boat crews into seasonal hunting cooperatives, the hunt was monopolised, stocks were decimated and traditional subsistence culture was severely undermined.

Meanwhile, expeditions to establish Arctic research stations on Wrangel Island, Franz Josef Land, Severnaya Zemlya and several mainland sites took place, and in 1932 the Soviet icebreaker *Sibiryakov* made the first transit of the Northeast Passage in one summer. A year later Stalin commissioned a special department, *Glavsevmorput*, to concentrate on opening up the Soviet Arctic.

The number of polar stations vastly increased, and advances in shipping capabilities meant that the Northeast Passage (now known as the Northern Sea Route) became commercially navigable, opening up a trade route for Siberian fur, timber and ore. During this period the use of aviation for exploration rapidly increased. Unfortunately, the characteristic Soviet reluctance to let foreigners know what they were doing has resulted in few of these major explorations being widely known.

Flying expertise improved, long-distance flights became a reality, and in 1937 the first drift station – a scientific camp based on drifting ice – was established from Rudolf Island in the north of Franz Josef Land, its four-person crew making meteorological, hydrographic and other scientific observations. Rudolf Island soon became an important centre for air operations and a refuelling site for Soviet flights.

WWII interrupted nearly all exploratory progress, and the polar station on Franz Josef Land was cut off for almost four years. At the same time, the German navy covertly established manned and automatic weather stations in Greenland, Svalbard and Franz Josef Land to supply meteorological forecasting data for many of its operations.

Finally, in 1948, a Soviet aircraft landed at the Pole, and its occupants, Pavel Senko, Mikhail Somov, Pavel Geordiyenko and Mikhail Ostrekin, became the first to make an undisputed claim to the North Pole.

POST-WAR DEVELOPMENTS

In the 1950s and 1960s forced resettlement of the indigenous people of the north swept through the Arctic, causing huge upheaval and heralding the end of any semblance of a traditional lifestyle for many. Children were sent to formal schools far from home and in many cases they lost the ability to speak their own language.

Huge infrastructural changes also occurred. International politics became deeply set in the Cold War period of confrontation, and with the shortest route between the two main players – the United States and the Soviet Union – lying across the Arctic, it wasn't long before defences went up. US fears of attack by long-range missiles led to the construction, at immense expense, of 63 Distant Early Warning (DEW) stations by 1957. Large airfields for forward-bombing missions were also established on Graham Bell Island in Franz Josef Land and Thule (see p199) in Greenland.

Ultima Thule, by Jean Malaurie, is a beautifully illustrated book offering a fascinating insight into the history of European and American exploration in the Arctic and its impact on the Inuit.

1908–09

Frederick Cook and then Robert Peary claim to have reached the North Pole – both are eventually discredited

1926

Roald Amundsen flies over the Pole in a dirigible balloon

1948

A Soviet aircraft lands at the North Pole – its occupants make the first undisputed claim to have reached it

1953

Greenland becomes a county of Denmark; modernisation drive is in full swing

At the same time, the US was developing nuclear-powered submarines. The first, USS *Nautilus*, made a transit of the Arctic from the Bering Sea under the North Pole to the Greenland Sea in 1958. On 17 March 1959 the USS *Skate* surfaced at the North Pole, and in 1961 the first Soviet submarine did the same. Covert voyages beneath the pack ice then became regular, with constant improvement of cat-and-mouse techniques between nuclear submarines of the Soviet, US and British navies.

Although icebreaker and submarine operations became increasingly common, all were conducted in great secrecy. The Russian Arctic became virtually closed to foreigners, and few Soviet scientists were permitted to visit the research stations, which became essentially military. One exception was for the experiments of the International Geophysical Year in 1957–8, where an unprecedented amount of cooperation in both the Arctic and the Antarctic greatly advanced science.

Unfortunately, the isolation of parts of the Arctic also made it ideal as a test site for nuclear weapons. In 1954 the small civilian population of Novaya Zemlya was unceremoniously removed and a large atomic testing region established instead. The area was used from 1956 to 1989, and 132 bombs were tested. The islands and their coasts have also provided disposal sites for radioactive waste.

Elsewhere in the Soviet Union, Nikita Khrushchev was campaigning for the Northeast Passage to become a route for mass transport. With relations with the West deteriorating rapidly, having a viable sea route to the east became even more important. In 1956 two shipping companies were established to undertake this, and nuclear-powered icebreakers were developed to ply the icy waters.

NORTH POLE ATTAINED

During this period, two notable private expeditions reached the North Pole by surface travel. In 1968 American Ralph Plaisted, with three companions, used snowmobiles to get there, abandoning the machines on the ice and flying out. A year later, Briton Wally Herbert led the first surface crossing of the Arctic Ocean. The four-person team reached the Pole by dogsled while crossing the pack ice from Alaska to Svalbard.

Subsequently, several expeditions have crossed the Arctic on the pack ice and many have made one-way surface journeys, leaving by aircraft. In 1977 the Russian *Arktika* became the first surface vessel to reach the North Pole.

At much the same time, oil was discovered in the Arctic – a factor that changed the face of exploration in the region for ever. The discovery of vast reserves of oil and gas at Prudhoe Bay on North Slope in Alaska and the start of mining operations for lead and zinc in North Baffin and Little Cornwallis islands meant increased infrastructure and flights, the construction of thousands of kilometres of pipeline, and untold amounts of industrial waste, all of which have had negative impacts on Arctic wildlife. Faced with oil and gas development in the Mackenzie Delta, the Inuvialuit formed the Committee of Original People's Entitlement (COPE) in 1969, and in 1971 the Inuit Tapirisat of Canada (ITC) was founded in Ottawa as a voice for Inuit throughout Canada's north. For a people only allowed to vote since the 1960s, the Inuit were beginning to find their political feet.

DID YOU KNOW?

A 56-megaton bomb, the most powerful atomic weapon ever tested, was used in a controlled explosion in Novaya Zemlya in 1963.

DID YOU KNOW?

Japanese explorer and mountaineer Naomi Uemura became the first person to reach the North Pole in a solo trek across the Arctic sea ice in May 1978.

OPEN PERIOD (1990 TO THE PRESENT)

By the late 1980s the cost of maintaining Arctic stations had become unjustifiable for individual nations, and the softening of international politics paved the way for the establishment of the International Arctic Science Committee (IASC) in 1990.

Social and political upheaval in the Soviet Union in 1991 had profound effects on the Arctic in general and the Russian Arctic in particular. DEW line stations closed and military bases in Greenland were handed back to local communities. Tourist traffic began to flow to the North Pole from Russia, and many groups visited the magnificent islands and coasts along the Northern Sea Route. International cooperation and scientific research greatly benefited from the Russian 'openness', and access for foreigners allowed observations of global importance to be made for the first time. In 1994 three icebreakers – the *Yamal* from Russia, the *Louis S St-Laurent* from Canada and the *Polar Sea* from the USA – met at the North Pole in the newfound spirit of cooperation.

However, for the indigenous populations of the Arctic, increased access and influence from industrialised nations hasn't all been beneficial. As Arctic people turn more and more to a Western lifestyle, smaller settlements are abandoned for economic reasons and the indigenous populations struggle to adjust to the new hybrid lifestyle. Dramatic social change and large-scale economic development prompted the Canadian Inuit to press for self-determination – with varying degrees of success. In 1975 the Inuit of northern Quebec signed a land-claim agreement against the backdrop of controversy surrounding hydroelectric development in James Bay. Nine years later the Inuvialuit Final Agreement gave over 90,000 sq kms of the Northwest Territories to the Inuvialuit, together with financial compensation, and gas, petroleum and mineral rights across 13,000 sq kms of land – in return, they had to surrender their right to any further territorial claims.

However, it was the creation of Nunavut (Our Land) in April 1999 that was most closely monitored by aboriginal groups from around the world. The agreement handed over one fifth of the land mass of Canada to the indigenous Inuit, making it one of the largest and richest land-claim agreements ever made. It was an enormous leap forward for the area, granting the Inuit subsurface mineral rights on 36,257 sq km of territory. The land chosen contains 80% of Nunavut's known resources of copper, lead, zinc, gold and silver.

In other Arctic areas land claims are still hotly contested, and indigenous people battle for the right to protect areas of vital importance to their traditional culture: in Greenland the people of Qaanaaq fight to return to their original home, which is now being used as a US military airbase (see p200); across Scandinavia the Sami fight for self-determination and protection for their caribou herds (see p44); and the Gwitch'in of the northern Yukon continue to fight the US administration and oil companies to protect the birthing ground of the 152,000-strong Porcupine caribou herd across the border on Alaska's North Slope (see p47).

In Arctic Russia, horrific environmental problems are causing international concern as decommissioned nuclear subs and industrial waste wreak havoc on the land. The situation has become so alarming that an

For more information on the territory of Nunavut, visit www.nunavuttourism.com.

1962

Canadian Inuit are allowed to vote for the first time

1979

Home rule begins in Greenland

1977

The *Arktika* becomes the first surface vessel to reach the North Pole

1985

Greenland withdraws from the European Community but remains part of Denmark

international aid package, estimated at US\$40 billion, has been pledged to help the Russians clear up the far north.

As the struggle to protect the traditional lifestyles of the Arctic's indigenous people continues and scientists rush to figure out the puzzle of global warming, the tradition of polar exploration goes on. In 1986 Ann Bancroft became the first woman to travel to the North Pole on foot; in March 2003, Briton Ben Saunders at the age of 25 became the youngest person to make an unsupported return trip to the North Pole. A record-breaking long-distance skier, Saunders has made several trips to the Arctic and in 2004 attempted to become the first person in the world to make a complete crossing of the frozen Arctic Ocean – a journey of nearly 2000km – solo and unsupported. The expedition was a traumatic one, with conditions described as some of the worst on record. Saunders noticed temperatures up to 15°C warmer than on a previous expedition in 2000 and vast, unprecedented areas of thinning ice and open water. Now a campaigner, Saunders continues to raise international awareness of the extent to which climate change is affecting the Arctic.

Read about Ben Saunders' 2004 expedition at www.sercotransArctic.com/home.

1999

The Nunavut land claim hands over one fifth of the land mass of Canada to the indigenous Inuit

2003

Ben Saunders (25) becomes the youngest explorer ever to make an unsupported return trip to the Pole

Arctic Research

Although it's sometimes hard to see the connection, scientific research in the Arctic is of paramount importance to the rest of the world. Next time you sit down to dinner with a glass of red wine, spare a thought for that bunch of windswept researchers on the Beaufort Sea looking at climate change. Their findings ultimately influence the types of grapes planted by European winemakers.

The Arctic holds the key to many scientific conundrums, but even with increased cooperation, international projects and better organisation the region remains one of the least studied and least understood on earth.

The first serious Arctic research took place during the first International Polar Year in 1882–3 (see the boxed text, p32), and since then scientists have battled the extreme climate, political boundaries and short season to pursue information that provides clues to life across much of the planet. The establishment of the **International Arctic Science Committee** (IASC; www.iasc.no) in 1990 and the **Arctic Council** (www.arctic-council.org) in 1996 have led to unprecedented international cooperation and coordination of all aspects of Arctic research, with multidisciplinary teams feverishly studying every possible aspect of the environment to better understand the region and its effects on the rest of the world.

CLIMATE CHANGE

At the root of almost all Arctic research is the urgent quest for more knowledge about climate change. The Arctic is seen as an early-warning system for what will happen in the rest of the world, as Arctic ecosystems are extremely sensitive. Already the Inuit are noticing bad sea-ice conditions, that the polar bears appear to be getting thinner, and that summers are warmer. The Sami are reporting changes to reindeer grazing pastures, and people across the Arctic are reporting new species. Predicting the nature of these changes and identifying whether natural cycles or man-made problems are the cause are key areas of research.

Warmer weather will mean that fish stocks will fluctuate, ice and permafrost will thaw, vegetation growth will be disrupted, and migration routes of Arctic animals may change – all of which will affect the traditional lifestyles of indigenous people in remote settlements. Changes in the Arctic will have knock-on effects for the rest of the world, too, as many of the world's wind and water currents are driven by the difference in temperature between the Arctic and hotter parts of the world. The freezing temperatures of the Arctic Ocean during winter create sea ice and cold, salty water that sinks deep and drives ocean circulation. If surface waters grow warmer and ice does not form as well in winter, these processes could be constrained or eliminated, reducing oceanic effects such as the warming influence of the Gulf Stream (see p30) and thus drastically altering the global climate. And as more open water is created, wind speeds pick up and severe coastal erosion becomes likely.

Predicting the effects of global climate change is very difficult, but projects such as the **Arctic Climate Impact Assessment** (ACIA; www.acia.uaf.edu) and the five-year **North Pole Environmental Observatory Program** (<http://psc.apl.washington.edu/northpole>) have been set up to track long-term changes using an array of automated instruments that collect year-round data on ice thickness, cloud cover, air temperature, ocean currents, water temperature and salinity.

Watching Ice and Weather Our Way, by Conrad Oozeva et al, illustrates the importance of traditional knowledge for researchers investigating climate change in two Yup'ik communities in Alaska.

DID YOU KNOW?

Parts of Russia, Alaska and western Canada have warming trends up to 10 times greater than in other parts of the world.

THE CORE OF THE MATTER IN KANGERLUSSUAQ

As a former military installation, Kangerlussuaq (p162) is a natural site for scientific research and over the years wildlife and climate change have been key areas of study. The Greenland Icecore Program (GRIP), sponsored by a consortium of eight European countries, set up a core-drilling operation at the thickest point on the inland ice, 800km northeast of Kangerlussuaq, and in mid-1992, after four year's work, the operation finally reached bedrock at a depth of 3028.8m. The 5799 ice cores extracted, each measuring 55cm, represent a historical record reaching back thousands of years and have played a key role in climate reconstructions of the Northern Hemisphere.

Further research is being done on the vast peatlands of Siberia, where the permafrost holds ancient stores of carbon and methane. Peatland vegetation doesn't decompose fully, and much of the carbon dioxide taken in by living plants isn't returned to the air. If the permafrost were to thaw, large amounts of methane and carbon dioxide could be released and accelerate the warming process substantially. Already, melting permafrost is destabilising buildings and roads and threatening oil pipelines. Scientists also predict that changes in permafrost could affect migration routes, food chains, wildlife interaction and species composition.

The Day After Tomorrow, directed by Roland Emmerich, graphically shows the catastrophic effects of abrupt climate change.

ICE CORES OF THE GREENLAND ICE SHEET

The Greenland icecap, the largest Arctic glacial mass, holds 10% of the world's total freshwater reserves, and understanding it is fundamental to climate study in the northern hemisphere. To accurately predict future climate change, scientists need to better understand the climate of the past, and two ice cores drilled from the icecap in the 1990s have presented scientists with highly valuable environmental records spanning thousands of years.

Studies of the ancient ice retrieved by the European GRIP (Greenland Ice Core Programme, see the boxed text above) and the US GISP2 (Greenland Ice Sheet Project 2) have provided critical information about past temperatures and precipitation levels, and the composition and properties of ancient atmospheres. Scientists have even been able to estimate historic volcanic activity, sea-ice extent, fires and marine storms.

However, the chronology of the oldest and deepest sections of the cores remained uncertain, and the **North Greenland Ice Core Project** (NGRIP; www.gla.ac.uk/gyfj.ku.dk/ngrip/hovedside_eng.htm), led by the Danish Research Council, began drilling again in the late '90s. After seven years it reached bedrock at a depth of 3085m and retrieved ice frozen 120,000 years ago. The 10cm cores contain a wealth of information that will provide vital data on the global climate over the entire period.

So far the ice has yielded over 15 new species of ultra-micro bacteria and what appear to be pine needles or leaves in the muddy layers between the ice sheet and the bedrock. If confirmed, it will be the first organic material to be recovered from a deep ice-core drilling project. It could be several million years old.

GLACIOLOGY

Glaciers and ice sheets can be effective indicators of environmental change and are of particular interest to researchers. The **Mass Balance of Arctic Glaciers and Ice Sheets** (MAGICs; www.iasc.no/ProjectCatalogue/magics99.htm) project is assessing the current state of Arctic glaciers and icecaps in order to improve predictions of the effects of climate change on the evolution of polar ice sheets, future rises in sea levels and freshwater input to the sea.

ARCTIC RESEARCH STATIONS & CENTRES

The first Arctic research stations were established in the last decades of the 19th century. Today they offer hi-tech support to international teams across the north.

In Alaska the **Toolik Field Station** (www.uaf.edu/toolik) is a national research facility for the study of biology, geology, hydrology and ecosystems. In Barrow the former Naval Arctic Research Laboratory (UIC-NARL) and the Arctic Research Facility provide venues for research on bowhead whales, fisheries and waterfowl. Also in Barrow, the **National Oceanic and Atmospheric Administration** (www.noaa.gov) operates a key Arctic climate-change research facility. The **University of Alaska Fairbanks** (www.uaf.edu) conducts Arctic and subarctic studies and supports the Geophysical Institute, the **Alaska Satellite Facility** (www.asf.alaska.edu) and the International Arctic Research Centre.

In Canada the **Polar Continental Shelf Project** (<http://polar.nrcan.gc.ca>) runs bases at Resolute Bay and Tuktoyaktuk supporting over 150 scientific groups throughout the Canadian Arctic. The **Nunavut Research Institute** (<http://pooka.nunanet.com/~research>) centres in Iqaluit and Igloodik focus on linking Inuit traditional knowledge with Western science. The **Aurora Research Institute** (www.nwtresearch.com) in Inuvik is an additional support organisation for long-term data collection.

In Greenland the Danish Polar Centre (DPC) runs the Zackenberg Arctic Field Station. The field station is home to ZERO (Zackenberg Ecological Research Operations), which conducts the world's only integrated long-term monitoring of animals, plants, climate, geology, geomorphology and permafrost. The DPC also supports KISS (Kangerlussuaq International Science Support), a logistics base for researchers that operates year round. In Nuuk the **Greenland Institute of Natural Resources** (www.natur.gl, in Greenlandic) focuses on gathering scientific data on selected species valued by Greenland's society. The Arctic Station, a research base in Qeqertarsuaq, Disko Island, runs all year. It's owned and operated by the University of Copenhagen, which also operates the small field station Sermilik, near Tasilaq. At the top of the Greenlandic ice sheet the permanent research and monitoring facility Summit is operated by the United States' National Science Foundation.

Ny Ålesund in Svalbard, Norway, is the site of year-round research by the **Norwegian Polar Institute** (<http://npiweb.npolar.no/>). The Norwegian Institute for Air Research has an atmospheric research station here and the Norwegian Mapping Authority runs a high-precision space geodesy observatory. Other research stations in Norway include the **Svanhøvd Environmental Centre** (www.svanhovd.no), which gathers and distributes information about the Barents Region, and the Norwegian Polar Institute headquarters in Tromsø, one of the world's leading polar research centres.

Sweden maintains the **Abisko Scientific Research Station** (www.ans.kiruna.se), which has a long-running meteorological observatory and a focus on plant ecology. In Kiruna the **Swedish Institute of Space Physics** (www.irf.se) conducts an atmospheric research programme in addition to running an environmental satellite data centre and maintaining a climate impacts research centre.

Finland's major Arctic research institute is the **Arctic Centre** (www.arcticcentre.org), which is run by the University of Lapland and based in Rovaniemi. The centre's area of specialisation is the exploration, understanding and communication of the effects of global changes on the societies and environments of the Arctic.

Russia's Academy of Sciences operates the **Kola Science Centre** (www.kolasc.net.ru) in Apatity and the **Murmansk Marine Biological Institute** (www.mmbi.murman.ru). Research on migratory birds is also carried out at the Willem Barents Biological Station on Medusa Bay, while Arctic ecosystems research, environmental monitoring and management are conducted from the Lena-Nordenskiöld Biological Station. In general you need to apply in writing and have some scientific reason for visiting. However, the more remote stations, such as those in Greenland, will usually accept visits arranged through the tourist office. You can arrange guided tours of Svanhøvd by appointment, and the Arctic Centre's **library** (☎ 10am-5pm Mon-Fri) and information centre (see p314) can be visited.

DID YOU KNOW?

Long-term data from tree rings, ice cores, sediment and lake-bed pollen indicate that the Arctic is warmer now than at any time during the last 10,000 years.

Currently, there is much debate about whether the Greenland ice sheet has lost or gained mass. Although new snow has been deposited at the summit, ice is melting fast around the edges.

In Norway researchers work inside and underneath the Svartisen Icecap (see p301) in a series of tunnels built by the state power company, which generates hydroelectric power from glacial meltwater. Some of these tunnels provide access to the base of the glacier, offering scientists a unique opportunity to observe a glacier from below. One focus of the team's research has been glacier movement, and scientists have discovered that debris in the ice at the glacier's base creates large amounts of friction, which slows advances. However, glaciers in general are slipping towards the sea faster than expected as meltwater from the surface trickles to the base and lubricates the sheet from below. So far this effect has not been considered in computer models predicting ice sheet response to climate change.

SEA ICE RESEARCH

Sea ice is a dominant feature of the Arctic Ocean, and studies of changes to its extent, drift, chemistry and composition are highly important, as they can be early indicators of environmental change. However, increasing losses in the thickness of sea ice are causing serious concerns. Arctic ice has lost as much as 40% of its thickness in the past 50 years, and the area it covers has shrunk more than 25%.

Conditions hit an all-time low in 2002, when sea-ice cover was 15% below the current average. The difference would have covered an area roughly twice the size of Texas. In 2003 ice shelves jutting into the ocean from Greenland's Petermann Glacier were found to be 45m thinner than in the previous year, and the Ward Hunt Ice Shelf on Ellesmere Island, the largest ice shelf in the Arctic, fractured and released all the water from the freshwater lake it dammed. The rare and unusual ecosystems supported by the epishelf lake, and the historic climate information they may have contained, have now been lost.

Sea ice affects the penetration of light into the water and any changes to its extent will affect the productivity of algae and plankton and their part in vital marine systems. Polar bears are also at risk, as they depend on the sea-ice edge as a hunting ground. As the ice disappears, bears cannot find suitable food and must swim longer distances to areas with remaining sea ice, burning up precious energy reserves and lessening the adult bears' sex drive and thereby their ability to reproduce.

But it's also bad news for the rest of us, as Arctic sea ice is one of the fundamental components of the earth's climate system. Sea ice reflects 80% of solar radiation, whereas open water reflects only 20%. As ice thins, its albedo (reflectivity) is reduced and more solar radiation is absorbed, causing temperature increases in the Arctic Ocean and the Greenland Sea. This may affect the course of the Gulf Stream which in turn could drastically alter climate conditions from the east coast of the United States to Western Europe. Research into sea temperatures in the Fram Strait, which is part of the West Spitsbergen Current, has revealed that waters as deep as 2000m are already showing significant increases in temperature.

Satellites have been used to monitor fluctuations in Arctic sea ice for the past two decades, but with the launch of **IceSat** (Ice, Cloud and land Elevation Satellite; <http://icesat.gsfc.nasa.gov>) in 2003 data collection made a leap in accuracy. The satellite sends pulses of light to earth 40 times a second, and a telescope collects the reflections and creates maps that can show changes as small as one centimetre a year. The findings are revolutionising the way scientists study ice sheets.

DID YOU KNOW?

Analysis of air bubbles in the ice shows that carbon dioxide concentrations in the atmosphere are now higher than at any time in the last 400,000 years.

DID YOU KNOW?

As ice melts and more soil, rock and open water becomes visible, the planet absorbs more solar radiation and the extra heat accelerates the melting process.

ATMOSPHERIC RESEARCH

Ozone Depletion

Thinning of the stratospheric ozone layer in Arctic areas has been studied since the 1970s, and readings indicate 10% to 40% decreases in some areas. Satellite monitoring has shown that in the Arctic small 'holes' occur at different times during the late winter and early spring. Several research sites have been established throughout the region to better understand the reasons for ozone destruction and to monitor the long-term effects of UV radiation on humans and Arctic ecosystems.

In 2004 a cooperative project involving NASA and scientists from Alfred Wegener Institute for Polar and Marine Research in Potsdam, Germany, released the results of a 12-year study of the relationship between Arctic ozone loss and changes in the temperature of earth's stratosphere. If the upper reaches of the Arctic atmosphere get colder – which is likely to happen as a result of climate change – then the rate of ozone depletion could be three times greater than forecast. Climate models currently vary widely, and the new research should lead to much more accurate simulations of conditions and analysis of data. Current studies by International Arctic Research Center (IARC) Alaska aim to improve large-scale climate models and use them to predict local variations in weather and climate.

The Polar Vortex

The polar vortex – a massive whirlpool of air above the North Pole – has sped up in recent years, and researchers believe that the increased rate of

DID YOU KNOW?

A temperature rise of 2.7°C would be enough for the Greenland icecap to start melting faster than it can be replaced.

ATMOSPHERIC RESEARCH – THE AURORA BOREALIS

The Inuit thought they were the souls of the dead, and their shamans called upon them to cure the sick; Scandinavian folklore described them as the final resting place for the spirits of unmarried women; and the Japanese believed that a child conceived under the dancing rays of the aurora borealis would be fortunate in life. Modern science, however, has reduced these romantic notions to a more prosaic explanation.

The magical natural phenomenon that creates the curtains of colour that streak across the northern night sky can be explained as the result of solar wind – a stream of particles from the sun that collides with oxygen and hydrogen atoms in the upper atmosphere. The collisions produce the greens and magentas of the aurora as the earth's magnetic field draws the solar wind particles toward the polar regions. (The website www.northern-lights.no has information about the best times and places to view the aurora, and tips for photographing it.)

An increase in solar flares (sudden releases of magnetic energy from the solar atmosphere) usually means more dramatic displays, but the solar wind also distorts the earth's magnetic field and disrupts high-latitude communications, electric power grids, satellite orbiting and defence systems. Research is focused on predicting such disturbances, largely with what are known as incoherent scatter radar systems.

These systems study disturbances in the earth's magnetic field and upper atmosphere caused by solar winds. Three such systems are operated by seven-nation international group **EISCAT** (www.eiscat.com) in Northern Scandinavia, and the US Stanford Research Institute operates another at Kellyville in Kangerlussuaq (p162).

In Alaska the highly controversial **HAARP** (High-frequency Active Auroral Research Program; www.haarp.alaska.edu) uses a high-power, high-frequency radio transmitter to stimulate a small region of the ionosphere in order to survey the artificial effects produced by radio transmission. However, opponents argue that the transmission can also be used to interfere with radio communication and systems anywhere in the world and could be used to produce severe physiological disruption or disorientation, weather modification and unexpected drag forces on missiles. For more information on the campaign against the facility visit www.earthpulse.com/haarp.

spin is a result of global climate change and may explain some of the dramatic changes now being observed in the Arctic. The winds can break up the ice and force it away from the Pole while also driving warmer water into the Arctic. As leads of open water occur they absorb more solar radiation and accelerate the whole process, which may explain the unprecedented lows in pack ice since 2002.

The Carbon Cycle

Arctic atmospheric research also looks at the role of the carbon cycle – the movement of carbon between the atmosphere, the oceans, living organisms and the earth itself. For decades scientists thought that sea ice prevented the Arctic Ocean from exchanging gas with the atmosphere, creating a carbon sink – or store of carbon – in the icy water. But new research suggests that the opposite is true, radically altering science’s understanding of how the Arctic Ocean fits into the world’s climate cycles. Understanding the carbon cycle is critical, as rising levels of the gas are responsible for the greenhouse effect. Results show that concentrations of carbon dioxide in the Arctic Ocean alter dramatically at different times of the year, which suggests that in spring and summer it becomes a previously unknown and very significant sink of atmospheric carbon dioxide, but in winter can be a source. The new information will greatly alter the way in which computer simulations project climate changes.

ARCTIC OCEANOGRAPHY

Although the Arctic Ocean is almost landlocked, it plays a fundamental role in the circulation of ocean currents worldwide. This in turn influences the earth’s climate system, as water flows out of the Arctic into the northern Atlantic Ocean, whose circulation drives our climate.

Siberian Seas

Regular international research expeditions in the Siberian seas have been possible since the 1990s, and scientists have used the opportunity afforded by increased access to record data on land and ocean ecosystems. In 2004 a research expedition focused on the interconnection of the Pacific, Arctic and Atlantic Oceans, and the effects of fresh water arriving from the estuaries of the Lena, Kolyma and Indigirka Rivers. Studies of coastal erosion and sediment displacement were combined with immediate

testing of water samples to record information on everything from pH and chemical levels to temperature and salinity. Changes in salinity can affect ocean circulation and, in turn, global climate. Results will be shared with teams working in Fairbanks and Vladivostok to improve understanding of the ocean’s role in global climate change.

Also in 2004, a Russian drift station was deployed off the Novosibirsk Islands in the Arctic Ocean for a two-year project to resume hydro-meteorological monitoring of the Arctic basin, which is vital for the regional economy. It will also allow the physical processes that determine global and regional climatic changes to be studied.

Beaufort Sea

Researchers on the **Beaufort Sea Climate Change** (www.beaufortseadatechange.com) project are exploring how changing ocean circulation affects airborne and waterborne contaminants and how climate change is affecting ice cover and the habitats of ice-dependent species such as polar bears and seals. The project also looks at how climate change may affect the now healthy population of beluga whales in the area. Studies of the impact of climate change on fish and marine mammals in the Beaufort Sea, and their adaptation to it, have led to applications as diverse as European coastal and marine management, and assessment of European climate change and its impact on wine production.

Sea Bed Sampling

Researchers in Queen Maud Gulf in the Canadian Arctic are taking samples of sediment on the ocean floor as part of an intensive study of the Arctic marine ecosystem. A record of climate change is laid down year by year in the sediment, so researchers can peer at the last 10,000 years. Micro-organisms and fossils in the sediment carry a record of the temperature, salinity and ice content when they were deposited, allowing researchers to document changes to the environment since the time the creatures were alive.

Further north, on the Lomonosov Ridge – an area 250km from the North Pole – the **Arctic Coring Expedition** (ACEX; www.iodp.de) has begun a series of ocean-drilling programmes. Sediment from the top of the ridge is believed to contain a continuous climate record dating back 50 million years, and scientists hope it will provide critical information about how the Arctic Ocean has evolved and how long the Arctic sea ice has been there. Without accurate data on how much ice there was in the past, it’s very difficult to model climate change for the future. Research on fossilised algae found on the first expedition in 2004 has shown that temperatures in the ocean were once 20°C, forcing a re-evaluation of the early history of the Arctic Basin.

Census of Marine Life

Another international team is working on recording and listing species living deep in the Arctic Ocean as part of the 10-year **Census of Marine Life** (www.coml.org). It is an urgent task, as species information is essential to discussion of climate change. Research will take place at different levels of the ocean, but one key area is the Canada Basin, a huge and largely unknown submarine hole 3800m deep. The area, immediately north of the Yukon and Alaska, is covered by ice and linked to the Pacific through the Bering Strait, a mere 70m deep. Many species in the extremely cold depths of the Canada Basin never travel to shallower waters and are thought to have been isolated there for millions of years. Another focus will be the

Visit <http://Arcticcircle.uconn.edu> for information on all things Arctic, from scientific research to impacts on local communities.

INTERNATIONAL POLAR YEAR

The first **International Polar Year** (IPY; www.ipy.org), held in 1882–3, was inspired by Karl Weyprecht (see p21), who argued that scientific study rather than exploration should drive polar expeditions. Eleven countries took part, kick-starting a new era of scientific discovery. Fifty years later the second International Polar Year saw 40 nations conducting research, and in 1957–8 the third International Polar Year (also known as the International Geophysical Year) brought together polar researchers from 67 nations.

The fourth International Polar Year will take place in 2007–09 and more than 130 countries are expected to participate. The internationally coordinated campaign will attempt to piece together the puzzle of environmental change at the poles with multidisciplinary and interdisciplinary projects looking at everything from global warming to the depletion of the ozone layer and the thinning of sea ice. It is planned that international projects will not duplicate research activities that are already underway in polar regions; instead, they will include elements from a wide range of scientific disciplines in order to draw more attention to changes taking place around the poles and their effects on the rest of the world.

diversity of life around the mouths of Canadian and Russian rivers. Russian cooperation is seen as central to the project's success, as sea-bed areas rich in raw materials or used for dumping nuclear waste are frequently off limits to research, for political reasons.

Ocean Circulation

Researchers in the Nansen and Amundsen Basins Observational Systems (NABOS) and Canadian Basins Observational Systems (CABOS) are looking at ocean circulation and water-mass transformation. Major changes in the Arctic Ocean in the past few decades have been linked to extreme amplification of the polar vortex (see p31), but understanding the changes, their links to external climate systems and the processes involved is an ongoing process. Long-term observations are critical to deepening our knowledge in this area and predicting the evolution of the Arctic environment. IARC Alaska has deployed a set of moorings along the shelf slope of the basins, where major transports of water, heat and salt occur.

FRESHWATER STUDIES

About 77% of the earth's fresh water is locked in as polar ice. What happens to it and to the polar oceans is of immense importance to the rest of the world. Some of the world's largest and biologically richest freshwater ecosystems are present in the Arctic and are vital to millions of birds and to the stabilisation of seasonal waterflow from mountain and glacier to sea. Studies of how river systems, wetlands and lowland areas will handle the increased flow of meltwater, combined with more rain instead of snow, are vitally important.

Recent studies have been looking at the role of large river basins in delivering fresh water to the Arctic Ocean. Although the ocean contains only 1% of the world's ocean water, it receives about 11% of world river runoff. In the last 10 years the amount of fresh water flowing into the Arctic Ocean has increased dramatically, possibly as a result of global warming, and scientists fear that this will reduce the ocean's salinity, possibly causing the Gulf Stream to shut down and plunging Europe into a mini Ice Age.

In 2004 studies found that animals in the Mackenzie River Delta in Canada have mercury levels up to four times higher than those of animals living in Lancaster Sound to the east. The Mackenzie is one of the largest river systems in the world, and there's significant industrial development in parts of the watershed. Researchers are hoping to discover if the contaminants are travelling downstream in large quantities or if climate warming and melting permafrost could be responsible.

CHEMICAL POLLUTANTS

Despite its reputation as a pristine wilderness, the Arctic has become highly polluted by chemicals produced in industrialised nations to the south. The Arctic acts as a final 'sink' where pollutants become trapped; the long, dark winters and cold temperatures inhibit the breakdown of chemicals. Air and water currents carry the toxins north, and once there they begin to build up in the food chain, a process known as bioaccumulation.

Animals with a long lifespan and significant proportions of fat for insulation tend to accumulate the chemicals, and both polar bears and humans have been shown to carry unusually high levels of toxins, including dioxins, PCBs and newer compounds like those now used as flame retardants and stainguards. Nearly all Inuit tested in Greenland and more than half of those in Canada have levels of PCBs and mercury exceeding international health guidelines.

The Age of the Arctic, by Gail Osherenko and Ora R Young, looks at global controversies involving the Arctic, and the conflicts and relationships between the military, industry, environmentalists and indigenous people.

MARS ON EARTH

As the most life-friendly extraterrestrial planet, Mars attracts lots of scientific attention, but research has always been carried out from a distance. In 1997 NASA began exploring Devon Island, a polar desert in the Canadian Arctic, which is home to a meteorite impact crater 24km in diameter. The plan was to learn about Mars by geologic comparison. In 2000 the project expanded into a virtual mission to Mars with the construction of the Mars Arctic Research Station, where scientists began to study geology and microbiology, equipment and robot use, and communications systems while constrained by bulky space-suit simulators. The project enables scientists to develop appropriate field tactics and to test equipment and psychological impact before a real mission. A second station was opened in Utah in 2002 and a third in Iceland in 2004.

Greenland bears the brunt of the world's contaminants because it is in the path of winds from European and North American cities. In 2003 the **Arctic Monitoring and Assessment Programme** (AMAP; www.amap.no) found mercury levels in umbilical-cord blood and breast milk in remote Greenland villages to be 20 to 50 times higher than in urban areas of the United States and Europe.

Scientists are now trying to establish a link between accumulated chemicals and health effects. Many of the toxins are endocrine disrupters, which can impair reproduction, cause developmental or skeletal abnormalities, weaken immunity and trigger neurological problems. In Canada researchers are also investigating whether pollutants can be blamed for the high number of Inuit women suffering from osteoporosis.

Research in Svalbard in 2004 indicated that polar bears are already showing changes in their hormone and immune systems. High levels of PCBs lead to low levels of antibodies and increased chances of infection, while altered hormone levels could result in a wide range of negative health impacts. Cubs are particularly vulnerable; polar-bear milk is about 30% fat, so any contaminant stores are passed down to the young. In 2000, scientists on Svalbard said that more than 1% of the islands' bears were hermaphroditic, showing the reproductive organs of both sexes.

In the Norwegian Arctic, where pollution from brominated flame retardants is concentrated, the bear-cub survival rate is half of that in Canada and Alaska, and sea-bird eggs are contaminated with high levels of PCBs, dioxins and some of the new contaminants. Studies on Bear Island, just to the south of Svalbard, found dead and dying gulls with PCB levels in their brains a hundred times higher than in healthy birds. And it's not just industrial chemicals that are to blame. A Norwegian study in 2003 found that fish in Arctic waters are exposed to an unexpectedly strong cocktail of caffeine and painkillers from local sewers, and samples taken near a psychiatric hospital showed measurable amounts of anti-epileptic drugs and antidepressants.

In May 2004, 151 countries signed the Stockholm Convention on Persistent Organic Pollutants, which seeks to phase out the use of 12 of the most dangerous persistent organic pollutants as soon as possible. However, for many, it may be too little too late.

ARCTIC ECOLOGY

Since 1990 the **International Tundra Experiment** (ITEX; www.itex-science.net) has conducted extensive studies in Arctic ecology. The main objective of ITEX is to assess the potential impact of global warming on Arctic and alpine vegetation. The experiment attempts to simulate the climate that may exist in 2050. Results show that in increased temperatures there is evidence of a disintegration of the plant communities on the tundra and, with new plants

Mars on Earth, by Robert Zubrin, tells the dramatic story of a group of space pioneers who simulated a mission to Mars on Canada's Devon Island.

slow to move into the tundra areas, animal populations using these regions will be at risk. ITEX monitoring and experimental research is ongoing and should provide more long-term understanding of the Arctic botanical processes at work during climate change.

OIL & GAS EXPLORATION

The Arctic is rich in fossil fuels and has long attracted the attention of companies keen to stake a claim to a fortune. However, drilling and mining have proved hugely damaging to the Arctic environment (see p60). In the light of plans for oil and gas development in Canada's Beaufort Sea – a largely untouched expanse of water – scientists are using satellite-based radio tracking to trace marine wildlife in offshore feeding areas and migratory corridors, and local Inuvialuit are working with the **WWF** (www.wwf.org) to identify and reserve key marine areas for conservation. Other recent studies have tested bearded seals, walrus and bowhead whales for petroleum hydrocarbon contamination from crude oil. Meanwhile, huge investments are being made by Denmark, Russia and Canada to survey the Arctic sea bed in an attempt to claim ownership of the area and secure rights to the natural resources in the sea floor, which may be worth millions of dollars.

THE FUTURE OF ARCTIC RESEARCH

Never before has Arctic research been so important. Changes to the environment of the far north are now visible to the layperson, and although significant progress has been made in the last decade, climate-change indicators, human-health impacts and ecosystem alterations are increasingly worrying factors.

Umbrella organisations facilitating and organising research projects are key to continued success in this area, as new technologies and more accurate data collection revolutionise scientific understanding of the far north. The International Polar Year 2007–09 (see p32) heralds new research in the area, with international cooperation and improved sharing of regional environmental data, facilities and logistics.

In the meantime the 2005 launch of **CryoSat** (www.esa.int/export/esaLP/cryosat.html), Europe's radar altimetry mission, will mean a leap forward for ice-sheet research, with unprecedented accuracy in measurements helping to determine whether or not our planet's ice masses are thinning due to global warming. **EUMETSAT** (www.eumetsat.de), Europe's first polar orbiting meteorological satellite, is on target for launch at the end of 2005 and will greatly enhance the ability of scientists to monitor the global climate and weather systems. Instruments on board will measure winds and temperature at the surface of the sea and will monitor global ozone distribution, pressure and water vapour in the upper atmosphere.

For the indigenous people of the Arctic, localised studies of climate change and their related impacts on the region's human population are of the utmost importance. What scientists predict the rest of the world will face in the future the indigenous people of the north are experiencing right now. Although the residents of the far north have survived against the odds for thousands of years, they are powerless against the onset of climate change while being the first to feel its effects.

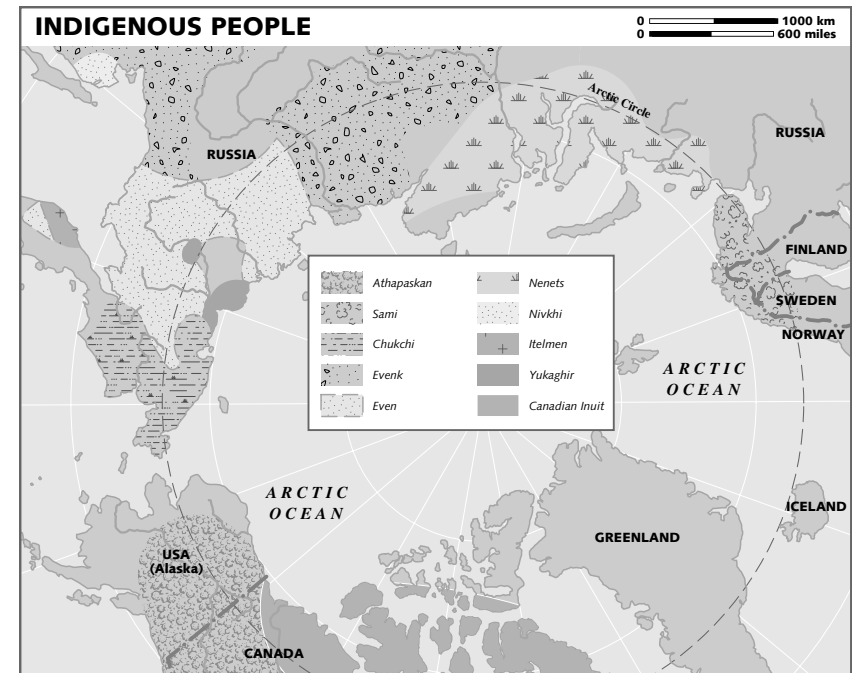
For excellent links and news on Arctic research and findings, visit www.dpc.dk.

Indigenous Peoples & Cultures of the Arctic

An estimated 650,000 indigenous people have made the great expanse of the Arctic their home. For thousands of years these nomadic tribes survived in almost total isolation before the missionaries, traders, whalers, explorers and colonial governments arrived and slowly tore their world apart.

For many who travel north the modernity of contemporary life for Arctic people is a surprise – supermarkets stock everything from instant noodles to age-defying night creams, housing is modern and satellite TV beams as much drop into Arctic homes as it does elsewhere. However, what is easily forgotten is that these very same people lived a life almost wholly dependent on hunting as a food source until 50 years ago.

The rapid social, cultural and economic change that has swept across the circumpolar north has not been without its problems. When education became compulsory, nomadic life was halted, families became dislocated, children were taken far away to residential schools, and home and family life deteriorated. The skills that were once so important on the land suddenly became redundant, and the consequent loss of identity meant that many once-proud hunters began to drown their feelings of shame and inadequacy in alcohol. For many, self-esteem is still despairing low, and across the Arctic suicide rates are particularly high.



It was difficult for the indigenous people to assimilate into the Western world, and there is a constant struggle to adapt to the new life while still maintaining aspects of the old. No-one wishes to block out the influence of the south altogether, but so much has changed in such a short space of time that many are lost in the half-world between two cultures, unsure of where they belong. Life is a complicated and contradictory world where women clean and chew caribou or sealskin as they watch American sitcoms and reality TV.

TRADITIONAL CULTURE

The indigenous peoples of the Arctic can all trace similar origins in Central Asia (see p17). These nomadic hunters gradually moved across Canada, eventually reaching Greenland about 4500 years ago. Today distinct groups exist in different areas. In Alaska they are the Inupiat and Yup'ik Inuit, and the Alutiiq (Aleut), while the Athapaskans of the Alaskan interior cross over into the Yukon; in Canada and Greenland they are the Inuit; in Scandinavia the indigenous population is the Sami; and in Arctic Russia indigenous groups include the Chukchi, Even, Evenk, Sami, Nenets, Nivkhi, Itelmen, Yup'ik and Yukaghir.

Although each group has evolved its own distinctive culture, all share the same respect for the Arctic environment. Their culture, education and lifestyle depended on it and the nomadic hunters traditionally regarded the environment as simply an extension of their being. Despite the changes in their lifestyle, few local people, even the young and talented, wish to forsake their communities for the bright lights of southern cities. Despite satellite TV beaming in images of the Western world, almost all of those who live in the far north do so because they choose to, because relationships with family are extremely important, and because of the land and what it signifies for the people.

THREATS TO INDIGENOUS CULTURE

Just as they share aspects of their history and culture, the indigenous peoples of the far north face similar threats to their cultures. Low educational standards mean the road to self-determination is pitted with problems, and the influence of the dominant languages and cultures of neighbouring southern

ALCOHOL & THE ARCTIC

Alcohol abuse is a huge problem in the far north, and it's readily apparent in most communities at weekends and after payday. The long months of winter darkness, a sense of hopelessness from being caught between cultures, and genetic intolerance due to low supplies of the amino acid that breaks down alcohol have all been blamed.

As a result many communities are now 'dry': no alcohol is sold, and in many cases the ingredients needed to make home brew are also banned. However, this can result in a move to solvent abuse or in creative, but particularly dangerous, batches of home brew appearing instead. In other towns the problem is curtailed by restricting the hours in which alcohol may be sold or the strength of beer available.

Unfortunately, children are often the biggest victims, and child mortality and foetal alcohol syndrome rates are alarmingly high. Violence and domestic abuse influenced by alcohol cause enormous family problems, and for many young people binge-drinking at weekends becomes a way to deal with it all. Sadly, falling asleep in a snowdrift on the way home can mean the loss of limbs, and careering around town on a snowmobile when drunk can often prove to be fatal. Most communities have some form of alcohol treatment programme and support groups for reformed drinkers. However, in remote communities it can be difficult to resist temptation.

'nomadic hunters traditionally regarded the environment as simply an extension of their being'

populations has meant a gradual but systemic erosion of traditional culture. Oil and gas exploitation (see p60), ozone depletion (see p31) and climate change (see p27) pose enormous threats to traditional lands, livelihoods and cultures. Industrialisation threatens ecosystems and wildlife migration routes, and the accumulation of environmental contaminants – particularly persistent organic pollutants and heavy metals in the food supply – means that the traditional diet is no longer safe to eat (see p34). At the same time, the wholehearted acceptance of processed foods and Western lifestyles means that first-world diseases such as diabetes, obesity, heart problems and cancer are now prevalent among Arctic communities, and alcohol abuse and liver disease are on the increase.

THE INUIT

The Inuit occupy a vast geographical area stretching from Chukotka in the Russian Far East, across Alaska and Canada to the east coast of Greenland. A scant 150,000 people make this area their home, and although different dialects exist, they all speak largely the same language.

The oldest archaeological sites identified as Inuit are in southwest Alaska and the Aleutian Islands and date from around 2000 BC. The Inuit adapted extremely well to the harsh conditions they found themselves in, hunting whale, seal, caribou, muskox and bear for survival. Today, most Inuit hunt to supplement their income only, and commercial fishing, the service industry and oil and mineral extraction have become the main earners in most communities.

LIFESTYLE

Although life in most Inuit towns and settlements resembles that of the Western world, with supermarkets, satellite TV and Internet access, many smaller settlements have few facilities, no running water and a much more traditional and generally impoverished lifestyle.

Wherever you go, however, the veneer of modern life is fairly superficial and tradition influences many daily activities. Family groups are still incredibly important, and in most towns there is a complex network of family relations; often a few extended families make up the whole population. The elderly are taken care of by the extended family and, in line with tradition, children are not disciplined. Children inherit the name and the name soul (see p41) of their ancestors, so disciplining a child shows disrespect for the deceased elder. Children are expected to learn from the repercussions of their mistakes, not from the anger of their parents.

The attachment to the land is also incredibly important, and animals as well as traditional hunters are highly respected. Although commercial whaling and trapping changed the Inuit's relationship with the animals, a powerful respect for nature still exists, and the power of the land to take life is never underestimated.

The economy in most areas has moved from its traditional hunting base into either commercial fishing, as in Greenland, or mining and exploitation of mineral rights, as in Canada and Alaska. However, in some areas, such as the settlements in northern Greenland, and for the Inupiat on Alaska's North Slope and the Yup'ik of southwest Alaska, hunting is still the main form of income. In all others it is a much-needed source of food and the most popular pastime.

In practically all Inuit communities there is a dependence on government subsidies and benefits, and living on welfare is common in modern

'The oldest archaeological sites identified as Inuit...date from around 2000 BC'

ESKIMO OR INUIT?

The term Eskimo, which means 'eaters of raw meat' in the Athapaskan language, is now seen as a derogatory term in Canada and to some extent in Greenland, although in Alaska it is quite acceptable. To avoid offence it's best to refer to the indigenous people of these areas as Inuit (singular Inuk). The name covers the diverse Inuit groups: the Kalaallit and Inughuit in Greenland (where the word Eskimo usually refers to early aboriginal Greenlanders); the Inuit and Inuvialuit Innuinuktun in Canada; the Inupiat, Yup'ik and Alutiiq in Alaska; and the Yup'ik in Siberia.

Inuit society. Unfortunately, so is a host of social problems ranging from alcohol and solvent abuse to domestic violence and teenage pregnancies. The traditional Inuit tolerance of infidelity has led to a casual attitude to sex and long-term relationships. Sexually transmitted infections are incredibly common, and all sorts of complicated blood ties can bind several families together. However, the situation is open and accepted, and children who are adopted into new families or are born of fleeting relationships are generally fully aware of their true parentage.

Although the culture and lifestyle of the Inuit of North America and Greenland share many characteristics, the majority of Inuit in North America now speak English as a first language. Although the first few years of primary school are taught in a local dialect, language skills are being lost quickly. Dog teams have largely been forsaken for snowmobiles, and it takes a trip to a small outpost to find anyone living a vaguely traditional lifestyle. By contrast, in northern Greenland dog teams are everywhere, Greenlandic is spoken throughout the country and life maintains a less tenuous connection with tradition. However, most Inuit children must leave home to get a high-school education, and homesickness means that many return without graduating.

TRADITIONAL CULTURE

In traditional Inuit society, social organisation was built around the immediate kin group, and social obligations to help one's family and to share meat and fish were key cultural principles. Groups were generally small, travelling to favoured hunting and fishing grounds in summer and creating a semipermanent settlement of stone-and-sod houses or a snow-block *iglo* (the Inuit word for house) in winter. Women and men were on an equal footing but there was a sharp division of labour. Men went out to hunt while women cleaned the skins, made clothing, cooked and looked after the children. Today, this distinction is much less apparent, and men and women are treated as equals.

The Inuit depended on the land and its animals for everything, and this relationship with nature was the basis of Inuit culture, spiritual beliefs and religious practices. For the Inuit everything had a spirit, and a complex set of taboos and rituals dictated behaviour on a hunt to ensure that the souls of the animals received proper treatment and respect. Disregarding the rules would mean death, famine or severe misfortune. Traditional myths describe this intricate relationship between humans, animals and the environment, the preparation for a successful hunt, and the appeasement of animal spirits.

The shaman, someone who had the knowledge and power to influence and control the spirits, was a prominent figure in all Inuit communities. Shamans acted as intermediaries between humans and animals, and through trances and journeys to the spirit world they could bargain with the animals' guardian for their release to be hunted. The shamans also

depended on a variety of helping spirits, usually animals, to carry them silently through the air or aid them to swim effortlessly to the bottom of the sea to perform their duties.

The Inuit commonly believed that a person consisted of three souls: the personal soul, the free soul and the name soul. After death the personal soul travelled either to the underworld – a place overflowing with animals where the souls of dead kin and friends are reunited – or to an upper world of starvation and cold. The free soul, however, could leave the body at will and had to be retrieved by a shaman if it strayed too far and caused illness. At death the name soul was set free until it was called back to reside in the body of a newborn child. While waiting to be reborn these souls combined to form the northern lights. Even today, when an Inuit child receives a name some of the good personal qualities of the deceased are believed to be inherited.

After a person's death elaborate taboos were observed to appease any malevolent spirits. These spirits were often depicted in the carving of *tupilaks*, and were made by the shaman to cast misfortune and even death on enemies. In Greenland modern *tupilaks* are sold as art and souvenirs (see p86). Some represent polar bears, birds or marine mammals, but most are just hideous imaginary beings. In North America stylistic curvilinear carvings made from soapstone are popular. In Canada communities such as Cape Dorset (see p249) are famous for their master carvers.

The best time to see traditional cultural activities or clothing is at community festivals. The arrival of the first light in spring has always been cause for celebration, and many communities hold welcome events for the return of the sun. Later in the year spring festivals feature traditional sports and games, and extended families travel for kilometres to meet at these events. Some of the most popular include the blanket toss, where a large group hold a tarp (traditionally a hide) taut and literally toss another person into the air; traditional competitions of strength and dexterity; and elaborate string games. In the evenings dances are usually held, featuring traditional drum dancing, jigging and throat singing, a guttural performance by two women looking eye to eye.

THE INUIT TODAY

The Inuit today seem caught in a constant battle with outside forces over which they can exert little control. Activities in the industrialised world are having a huge effect on what remains of their traditional culture. Climate change (see p27) is one of the most pressing concerns, as sea-ice conditions are deteriorating quickly and hunters can no longer travel to traditional spring hunting grounds. Couple that with health warnings advising Inuit not to eat their traditional food sources because of bioaccumulation (see p34), and Inuit culture faces a considerable challenge.

Despite this, the Inuit have begun to take much more control over their destiny. A growing political awareness has created a heightened sense of group identity and a concerted push for land rights and political self-determination. In 1971 the US Congress passed the Alaska Native Land Claims Settlement Act (ANCSA), giving the indigenous people effective control over one-ninth of the state. The Greenlanders won home rule in 1979, and the Canadian Inuit's homeland of Nunavut (see p25) was created in 1999.

The **Inuit Circumpolar Conference** (ICC; www.inuit.org) was established to give the Inuit a voice in order to tackle environmental threats to their culture, and through it they challenge the policies of governments, multinational corporations and environmental movements, arguing that adequate systems

DID YOU KNOW?

In Greenland dogsleds always have the right of way.

Atanarjuat (The Fast Runner), directed by Zacharias Kunuk, is a beautifully shot action thriller recounting the tale of an Inuit blood feud and the supernatural powers of the local shaman.

For more information and to view a gallery of work by Canadian Inuit artists, visit www.ccca.ca/inuit.

DID YOU KNOW?

The blanket toss developed from a traditional method of tossing a hunter into the air to survey the land for distant herds of game.

Learn how to play traditional Inuit string games at www.isfa.org/arctic.htm.

For an insight into the political, cultural and economic development of the Canadian Inuit as well as a look at their history and culture, visit www.tapirisat.ca.

of environmental management and the most appropriate forms of sustainability are only possible if they are based on local knowledge and Inuit cultural values.

In Nunavut, where the Inuit have taken control of their own political future, low levels of education mean a system of positive discrimination is needed to employ local people. Many Inuit welcome the system as a step in the right direction, but others suggest that employing local, but less qualified, public servants could hinder the fledgling territory's progress in the long term.

THE SAMI

The Sami people live in Fennoscandia (more often known as Lapland), a vast swath of northern Norway, Sweden and Finland, and the Kola Peninsula in Russia. Approximately 80,000 people make up this indigenous group and, although they are linguistically related to the Finns, Hungarians and Estonians, the culture and lifestyle are distinctly their own.

Coastal habitation was established in northern Scandinavia about 10,000 years ago and, as the people moved inland, hunting cultures dependent on elk and wild reindeer developed. Hunting and fishing remained the basis of Sami culture for several hundred years, and it was only in the 1600s that reindeer were domesticated and some Sami began to follow the herds on their annual migration routes. However, not all Sami became nomadic reindeer herders, and today the majority do not use reindeer herding as a main source of income. Despite this, it is reindeer and reindeer herding that have come to define and symbolise Sami culture.

LIFESTYLE

The Sami first encountered southern missionaries in the 11th century, and by the 17th century they were having to fight the loss of traditional reindeer-grazing ground to organised colonisation for farm land. By the 1870s Sami-language newspapers and magazines were being published, and in 1946 the first Sami broadcast was made. Today the Sami are inevitably more westernised than other indigenous groups, and living and social conditions for most Sami today are close to those in the rest of Scandinavia: housing is modern, men and women are treated equally and standards of living are high.

Today those Sami who continue to herd reindeer are firmly in the minority. A constantly shrinking habitat in which to herd, the deterioration of grazing lands due to environmental disturbances, increasing legislation, and an alien capital-intensive focus on producing as much meat as possible have made it difficult for traditional subsistence herders to compete or even survive. Others have embraced new technology and business models, turned to reindeer breeding as opposed to herding, or made use of snowmobiles, ATVs (all-terrain vehicles) and even helicopters to make this traditional way of life profitable in modern society. Most other Sami work in fishing, farming, forestry or mining operations, often combining them with more traditional livelihoods.

Traditional reindeer-herding families have also been affected by policies of 'modernisation' that aimed to raise living standards by settling Sami in permanent communities. Cultural and economic integration, intermarriage with Norwegians, Swedes and Finns, and (in Norway) restrictions on the use of the Sami language have all resulted in a gradual erosion of traditional culture.

Although in core areas the Sami language is in daily use, in coastal regions the pervasive influence of the dominant Scandinavian languages means that Sami is losing ground. Some Sami communities provide both daycare and primary schooling in the native language, but at secondary and tertiary levels access to education in the Sami language is difficult to find.

TRADITIONAL CULTURE

Traditional Sami culture is inexorably linked to reindeer-herding practices and, like the Inuit, the Sami have a very strong bond with the land. They name almost every tree, river, stream, lake, mountain, valley and meadow with names that contain information not only about physical features but also about community history and mythological events. For the Sami many of these places are sacred, and in the past reindeer antlers would have been placed at sacred sites and adorned with gifts. *Seiteh* (sacred stones) were also placed on mountaintops and near lakes and rivers.

For the Sami all elements of nature were imbued with a spirit, and great care and attention went to ensure that spirits were appeased and placated. The Sami *noaidi* (shamans) played a central role in this. Although the *noaidi* acted as diviners and spiritual facilitators of the hunt, their primary role was as healer. With the help of guardian spirits such as fish, birds or reindeer, the spirit of the *noaidi* would travel to hidden spirit worlds either to bargain with the deities to ensure good weather and good hunting or to retrieve a soul that may have wandered from a person's sick body. Although traditional medical carers could treat minor diseases and illnesses, only the *noaidi* had the power to win back a lost soul. Sometimes, depending on the nature of the ailment, the sacrifice of a reindeer, goat or lamb would be offered to the deity or spirit. While many shamans were killed for being in league with the devil during the fervent conversion to Christianity in the 16th and 17th centuries, shamanism survived in some isolated places until the 20th century.

For entertainment the Sami developed a rich oral tradition of storytelling, and an enormous number and variety of legends are part of Sami culture. A particularly distinctive form of this oral literature is the poetry that accompanies the traditional forms of Sami music. Three modes of traditional singing exist: the *joik*, highly personal and deeply felt *a capella* songs which were originally an integral part of Sami shamanism; *Laavloer*, songs with words or lyrics; and *vuelie*, storytelling songs about a person or an event. Although technically incorrect, the word *joik* is often used to describe all of these. All three modes are still used, and in recent years there has been a revival of interest in traditional singing methods.

Traditional drumming, flute playing and bullroaring accompanied the songs. The bullroarer was made from a specially shaped piece of horn or wood that was swung around the head on a string; by varying the length of the string and the speed of the swing the player could create different sounds. Modern *joiks* show the influence of Western rock music, and the most famous Sami singer, Mari Boine of Norway, sings a type of minimalist folk-rock with *joik* roots. *Joiks* and other Sami styles have also been used by non-Sami artists such as Enigma and Jan Garbarek. *Joiks* are often performed in the theatre, and the Sami theatre group Beavvvas, based in Kautokeino, regularly perform them.

Sami festivals are also a good opportunity to see culture in action. The National Sami Day on 6 February is celebrated with traditional games and events, and is a good opportunity to see the Sami in traditional ceremonial dress – embroidered red and blue felt clothing with pearl and ribbon crowns for the women. Although many reindeer herders still dress in traditional

DID YOU KNOW?

The name Lapp means 'piece of cloth' or 'patch', and is now considered a derogatory term. The name Sami derives from the people's own name for themselves and is much preferred.

Pathfinder, directed by Nils Gaup, is an Oscar-nominated film about the legend of a young Sami boy whose village is invaded and his quest to outsmart the enemy.

DID YOU KNOW?

Chart hit *Return to Innocence*, by Enigma, features a backing track of Sami *joik* singing.

tasselled hats and brightly coloured tunics, they are definitely not out to be a tourist attraction and don't appreciate being treated as such. The other major Sami festival time is Easter, when the Sami celebrate the end of the dark winter months and the beginning of a pilgrimage north for new pasture. In Kautokeino the celebrations include an annual Reindeer Racing Championship (see p322). It's also a very popular time for weddings.

Sami *duodji* (handicrafts) were originally for domestic use only, but today they are produced in large quantities for the tourist market and provide an important source of income for many families. Men generally work in horn or wood, producing bowls, knives, beads and carvings, while women work in leather, pewter, thread and spruce roots. Contemporary Sami art features strong influences from Sami culture and shamanic symbolism. The outstanding drawings and prints by John Savio, Nils Nilsson Skum, Lars Pirak and Iver Jåks are some of the best to look out for.

THE SAMI TODAY

Although reindeer herding is central to Sami culture, only a minority depend on it today and many of those who do are supported by government subsidies. The expansion of agriculture, the development of mining, tourism, forestry and hydrocarbon projects, and changes in herding and breeding practice have all encroached upon Sami reindeer-herding lands and put further pressure on this way of life.

Across the Sami homeland, environmental problems and resource development are among the biggest issues, and the Sami believe that the only way to protect their traditional livelihoods and culture is to grant them special rights to land and natural resources. However, national governments rarely subscribe to this view, and conflicts over sustainable land use are common. Although the Sami of Finland, Norway and Sweden have their own parliaments to deal with issues relating to their culture and economy, they are severely limited in their powers, especially in relation to determining land rights and resource use. The Sami Council, which represents Sami interests in national, regional and international arenas, is working to protect its people in response to plans by the dominant Norwegian, Swedish, Finnish and Russian nation-states to exploit the vast natural resources of Fennoscandia.

Minor victories came with the EU, Finnish and Norwegian governments' acknowledgments of the Sami as a distinct people, but in Sweden the 20,000 Sami face continuing problems. Although Swedish Sami technically have the right to graze their herds on private land, the law is unclear, and in 1990 three Swedish forestry companies and several private landowners successfully sued five reindeer-herding communities for doing just that. Since then others have also been victims of this legal loophole.

The Sami of the Kola Peninsula are also demanding self-government and regional autonomy. They have formed their own organisation, the Kola Sami Association, to promote and defend Sami interests and to work for a degree of self-determination, but they face the stiffest challenges of all Sami groups. After the collapse of the Soviet Union and collectivism, few Sami could afford to buy or own a reindeer herd; for those that could, controversies over grazing rights and limited markets for reindeer meat have meant a constant struggle to survive. The Kola Peninsula is also the most industrially developed part of the Russian Arctic and is suffering a severe ecological crisis.

Pollution from mining, commercial fishing and timber production, together with the presence of nuclear submarines and nuclear bomber bases, threatens the entire northern part of Scandinavia and poses great dangers

to the Sami communities' economies and health. As a result of industrial activity, about 100,000 hectares of the Kola Peninsula have almost no vegetation, and acid rain is devastating forests. Reindeer pasture is under great threat; lakes and rivers are polluted; land is expropriated by oil, gas, mining and timber companies; and local economies are in danger of collapsing. As the environmental crises force rapid social, economic and cultural change, the future for the Kola Sami looks bleak.

THE ATHAPASKANS

Northern Athapaskan peoples inhabit a huge expanse of coniferous forest both above and below the Arctic Circle that stretches across Alaska, the Yukon and the Northwest Territories, and down into northern British Columbia, Alberta, Saskatchewan and Manitoba. Many northern Athapaskans now call themselves Na Dene, which means 'human beings'.

Since 1997, researchers working in Canada's Yukon have found a host of archaeological sites in the melting snowfields with perfectly preserved artefacts ranging from 800 to 9000 years old. As traditional Athapaskan houses, tents, boats, and hunting and fishing equipment were made from wood and animal hides, they left no trace on the forest floor for contemporary archaeologists to discover. These finds high on the mountains should provide much information on the lifestyle of the people of the northern forests.

LIFESTYLE

The Athapaskans have lived in harmony with their environment for thousands of years, the forests and rivers of Alaska and northern Canada providing them with a rich variety of resources. Traditionally, life in Athapaskan communities revolved around seasonal hunting, gathering and fishing. In smaller remote communities this system has changed little over the years.

Moose and caribou are especially important animals for many communities, and for those on the banks of a river the annual salmon run is the highlight of the year. In traditional times, Athapaskan society was highly mobile; although everyone now lives in settled communities, travelling long distances to hunt or to see friends and family is still an integral part of life. In spring and summer – traditional times for trapping muskrats, hunting caribou and netting salmon – whole villages will virtually empty as families flee the settled life and head to traditional camps where old roles come in to play. Labour is sharply divided between men and women, who each have specific tasks to ensure a successful season and the proper curing of meat or fish. Children grow up with these traditions and learn young how to shoot a gun, skin an animal and prepare hides. For the Athapaskans these sustained periods of life in the bush are the happiest times of year. In autumn the gathering of berries is still an important part of the culture.

During the winter months many women spend their time beading elaborate geometric and floral patterns onto moose hide or caribou skin. Poker games are a favourite for many men. In all respects today Athapaskan women are treated as equals to men, but the influence of traditional roles is still visible. Men chop wood for the fire, look after snowmobiles or dog teams and hunt and fish, while women bead and sew and are the primary caregivers for children.

Athapaskan communities today are generally made up of one tribal band led by a chief and several councillors. Successful land claims have

'The Athapaskans have lived in harmony with their environment for thousands of years'

For information on the lives, culture and contemporary issues of the Sami people, visit www.sametinget.se, the website of the Swedish Sami Parliament.

Sami Potatoes, by Mike Robinson and Karim-Aly Kassam, is a testament to the cultural and political strength of the Russian Sami of the Kola Peninsula as they struggle to gain control of their traditional lands.

meant that many Athapaskan bands are financially stable and not reliant on government handouts, but many worry that unwise investments mean an unsustainable future for some communities.

As with other northern communities, alcohol and solvent abuse is common, and tribal leaders struggle to contain the associated social problems. Children often have to travel long distances to go to school, and English is used by all but the elders. Despite this, traditions are generally strong, and seasonal hunting and trapping remain priorities in most communities.

TRADITIONAL CULTURE

Traditional Athapaskan culture revolved around the hunting of land mammals such as moose, caribou and bear, and fishing for salmon and northern pike. Social organisation was based on small, mobile kinship groups, and communities generally consisted of several nuclear families, often connected through various relationships and alliances. Regional kinship ties could make up a group or band of several hundred people.

Athapaskan culture has an immensely rich spiritual and cultural heritage. Oral history and mythology describe how landscape features and the moon, sun, wind and stars were originally human beings, whose spirits are now embodied in aspects of the natural world. To this day a fundamental theme in the Athapaskan world view is respect for nature and animals. Traditionally, humans and animals were not clearly distinguished, and stories tell how they often lived in the same communities, even sharing households.

Accounts of Distant Time, a remote and ancient time, describe the origins of the world, the elements and the animals. The Raven is a central figure in these stories; it was he who created the world by banishing the darkness, revealing the daylight and creating the first people. From the Distant Time stories people learn the proper rules and behaviour for interacting with animals and the natural world. If animals are not respected and treated properly, vindictive natural spirits can endanger the whole community. Like other indigenous peoples, the Athapaskans had shamans who called to game in times of starvation, cured the sick, and appeased malevolent spirits.

The Athapaskan respect for animals is perhaps most vividly illustrated by the fact that animals such as bears and wolverines are given funeral rituals after they are killed. Traditionally, after a moose is killed, the hunter punches out the eyeballs so that the moose's spirit can escape and the animal cannot see what is then done to its body.

One of the most famous Athapaskan traditions is the potlatch, a ceremony that honours the dead and the connection between ancestors and the living. The potlatch is also the elaborate, highly ritualised exchange and distribution of gifts, and was often the primary way by which an individual achieved prestige in and beyond their community.

Traditional arts revolve largely around local natural materials. Decorated birch bark containers, porcupine-quill work, moosehair tufting, and beading are the most popular crafts. Intricate beading patterns adorn everything from hair clips to moccasins, jackets, mitts and bags. Contemporary Athapaskan music focuses on the fiddle, and the lively tunes that are now considered traditional resemble a cross between Cajun and Scottish styles.

THE ATHAPASKANS TODAY

Dramatic changes swept through Athapaskan villages over the course of the 20th century. Education delivered through formal schooling, together with policies of modernisation and assimilation into mainstream

American and Canadian society, meant that traditional knowledge and activities were lost. Language skills are now particularly vulnerable: the dominant influence of English and a lack of suitably qualified local teachers to deliver schooling in Athapaskan languages mean that whole generations of children are growing up without learning their native tongue.

However, cultural survival has been made possible through land claims and degrees of self-determination. Some bands have fared particularly well and invested wisely, while others find themselves embroiled in difficulties. However, even successful communities are racked by social problems – as in other Arctic villages, alcoholism, domestic and sexual abuse, suicide, and low educational standards mean that tribal leaders face an enormous set of challenges in the future.

PROTECTING THE PORCUPINE CARIBOU

For more than 30 years the Gwich'in people of the northern Yukon and Alaska have been fighting to protect the calving grounds of the Porcupine caribou herd on which they depend for basic sustenance and cultural survival. Since oil was discovered at Prudhoe Bay on Alaska's North Slope, the prospect of finding more reserves in the neighbouring Arctic National Wildlife Refuge (ANWR) has tantalised the US.

The reserve, however, is one of the most ecologically sensitive areas in the Arctic and is home to the calving grounds of the 152,000-head herd, the world's largest. In Canada these calving grounds are protected within Ivvavik National Park (see p244) and extend into Alaska, where they are part of the Arctic National Wildlife Refuge (see p254). The herd migrates through the tiny Yukon village of Old Crow, where the whole traditional culture revolves around the annual migration. It is the Old Crow residents and a group of hardy environmentalists who have taken on some of the biggest oil companies and the US government.

Their Alaskan neighbours, the North Slope Inupiat, are in favour of drilling, saying that the project could be managed to minimise the impact on the environment. Prudhoe Bay has an average of 400 spills a year, however, and the pollution has destroyed thousands of acres of wildlife habitat and caused declines in wildlife populations. The field is beginning to run dry, though, and for the many Inupiat who rely on oil-related wages as their main source of income, the financial benefit of leasing the oil-rich land to the multinationals is worth the risk. For the Gwich'in subsistence hunters, any development is a threat to their whole culture, and the continued difference of opinion puts the two native communities at odds.

Although the US government estimates that reserves in the ANWR could yield 60,000 barrels of oil a day, environmentalists argue that this figure has never been substantiated and that, even if it were true, it would take over 10 years for the oil to reach the market. They also argue that if Americans could just get three miles per gallon more out of their cars than a million barrels of oil a day would be saved.

In 1995 President Clinton vetoed proposed legislation that would have allowed oil and gas drilling on the Alaskan portion of the calving grounds, but – as environmentalists feared – the Bush administration had different ideas. Despite protestations from the Canadian government, the US plans to go ahead with a 'small' development. However, as the oil is concentrated in pockets, this would also mean a system of roads and airstrips to link sites. If this development goes ahead, one of the world's last great animal migrations could disappear. In 2003, by a narrow margin, US senators voted against opening up the ANWR lands for drilling, but with Bush re-elected to the White House and the majority of members of the House of Representatives supporting a bill to open up the refuge to drilling, the future looks bleak. In January 2005 the newly elected chair of the Senate Energy and Natural Resources Committee, Senator Domenici, made a point of holding an immediate press conference to make public his support for 'responsible' development of the ANWR. At the time of writing, it looked as if pushing through legislation to make this happen was likely to be one of the headlines of 2005.

For more information on the Arctic National Wildlife Refuge, visit <http://arcticcircle.uconn.edu/ANWR/>.

Two Old Women and Bird Girl & the Man Who Followed the Sun, by Velma Wallis, retell the legends, life stories and tales of survival of the Gwich'in people, one of 11 Athapaskan groups.

THE CHUKCHI

The Chukchi live in isolated and remote villages in the northeastern corner of Siberia, in the Chukchi Autonomous Oblast (an administrative territory within the Russian Federation), although small numbers also inhabit the Koryak Autonomous Oblast and Yakutia. The Chukchi call themselves the Lyg Oravetyan ('the true people'), and are closely related to the Koryak and Itelmen peoples of northeast Siberia. The Russian name Chukchi comes from the Chukchi word *chauchu*, meaning 'rich in reindeer'.

Although a minority of Evens, Koryaks and Yakuts also live in the Chukchi Oblast, all these peoples are far outnumbered by Russian settlers, who were drawn to the region by the development of mining for tin, gold, tungsten, mercury and coal.

LIFESTYLE

Traditionally, the Chukchi have been divided into two groups: the nomadic Reindeer Chukchi, who inhabit the interior and the Chukchi Peninsula, and the Maritime Chukchi, who are settled hunters and fishers living on small peninsulas jutting off the Arctic Ocean and Bering Strait coasts. The groups relied on each other for trade (reindeer skins were traded for whale blubber, sealskins and walrus hides), and were linked through marriage and other forms of alliance.

The Russian policy of forcibly assimilating indigenous people into the political, cultural and economic mainstream of the country caused many problems for the Chukchi and almost eliminated all traditional nomadic and subsistence activities. Reindeer herding was collectivised, the Russian language became essential, and both traditional Chukchi and Russian Orthodox religious ceremonies and festivals were prohibited.

Today the Chukchi are no longer nomadic, reindeer herds are domesticated, and modern technology and scientific breeding techniques have been developed to make the traditional way of life sustainable in modern times. The Maritime Chukchi subsist on a diet of fish and marine mammals; the boat crew, a group of five or six related families who work together to hunt large mammals, is still central to social organisation.

Adapting to this settled life was difficult for many, and unemployment exacerbated the problem. Menial jobs that required no qualifications were all that were open to the Chukchi and, as with many other indigenous communities, excessive alcoholism and high suicide rates became accepted as part of the new life. The change to shop-bought food brought new-world diseases, and the effect of nuclear testing in the Russian far north has been devastating. Today, practically the whole community is ailing. Tuberculosis, cirrhosis of the liver and cancer of the stomach and lungs are common complaints, and child mortality rates are alarmingly high. The indigenous Chukchi population is steadily dropping, and many fear for the future of the nation and its culture.

Most Chukchi children are sent to boarding schools, as educational facilities are not available in all communities. As children return home for school holidays only, several generations have already missed out on the opportunity to learn traditional customs. Russian is spoken at school, in hospitals and in shops, and its influence is pervasive. An increase in mixed marriages, sometimes attributed to Chukchi women hoping for healthier children with a Russian partner, means that Russian has also invaded home life.

However bleak things look for the Chukchi, *perestroika* and *glasnost* ushered in a new era of political freedom and a renewed sense of hope for

Arctic Russia's indigenous people. Topics that had previously been taboo became the object of open discussion, and where once the Chukchi were resigned to their fate they began to hope and fight for a better future. The Chukchi played an active role in the formation of the Russian Association of the Indigenous Peoples of the North, and today small steps have been made to redress the problems in Chukotka. The number of schools teaching Chukot is increasing, Chukot newspapers and fairytales for children are now published, and Chukot radio and TV broadcasts have grown more frequent.

TRADITIONAL CULTURE

Like many other Arctic peoples, the Chukchi believe that the universe is populated with spirits. Everything in the world, be it animate or inanimate, has a life force and shares the same spiritual nature. In traditional Chukchi religion, shamanism was important for healing and divination, and the shaman made journeys to the spirit world to retrieve the wandering souls of the sick.

Chukchi celebrations and rituals revolved around the annual cycle of hunting and harvesting. Traditionally, the Chukchi believed that great spirits – the Reindeer Being and the Master of the Sea – protected the animals they hunted and herded, and supervised their correct ritual treatment after being slaughtered. Mistreatment of the souls of the animals would result in failure in the hunt.

Each Reindeer Chukchi family also has a guardian spirit in the form of a sacred wooden fireboard, which is used to light the fire in the hearth of each home. The fireboard represents the deity of the family fire, which protects the family, the home and the hearth from malevolent spirits. Fire ceremonies play an important part in Chukchi culture: the Supreme Being is said to have pulled the first reindeer out of a sacred fire; the return of reindeer from pasture is celebrated in a fire ceremony; and when Chukchi sacrifice a reindeer, its blood is collected in a ladle and fed to the fire.

Traditional legends and folk tales tell of good and evil, animal spirits, and traditional hunting practice. The bear in particular holds a pre-eminent place in Chukchi mythology, and in Siberia the bear festival is an elaborate form of animal ceremonialism. After a bear has been hunted, a feast is held during which the dead bear is treated as an honoured guest and people ask its forgiveness for slaying it. Rituals, myths and stories surrounding the bear and bear hunting clearly express both the desire of the hunter for the bear and the anxiety that surrounds a kill.

Many of these myths and ceremonies are kept alive by Ergyron (meaning 'dawn'), a Chukchi–Yup'ik theatre company. The company uses traditional forms of dance, song and ceremonial costume-making to bring indigenous legends and ceremonies to life. Recordings of Chukchi and Yup'ik vocal traditions are also available.

THE CHUKCHI TODAY

The Chukchi suffered terribly under Soviet colonial policy, and since the 1950s massive industrial projects such as mining and resource exploitation have threatened the traditional homeland of the Chukchi and their reindeer-herding economy. Huge numbers of settlers and migrant labourers arrived, the Yup'ik were forcibly settled in Chukchi villages, and life changed irreparably. Although massive incomes were generated by the rich mineral resources of Chukotka, such as coal, gold, tungsten, lead and mercury, the indigenous Chukchi got nothing except a badly polluted environment. Rivers once rich in fish were made barren and pasture for

For more information on the Chukchi people, visit www.chukotka.org.

Northern Tales: Stories from the Native People of the Arctic and Subarctic Regions, edited by Howard Norman, is a collection of over 100 folk tales from 35 tribes ranging from the Chukchi of northern Siberia to the East Greenland Inuit.

Antler on the Sea, by Anna M Kerttula, looks at contemporary ethnic rivalries between the Yup'ik and the Chukchi of the Russian far east and how traditional customs and beliefs changed the relationship between the two communities.

the reindeer was ruined. Consequently, land use and self-determination are the most complex and unresolved issues in the area.

The Chukchi have been placed in a very vulnerable position and they believe that autonomy and control over their own future are the only ways to ensure their cultural and economic survival. However, any government will face huge challenges. Devastating environmental pollution needs to be addressed, the appropriation of land by oil and gas companies places great strain on herders, indigenous communities are afflicted by a disturbing range of health problems, and local economies have collapsed. Women in particular have borne the brunt of this economic collapse. Many have lost their jobs, or seen their income drop substantially, and childcare facilities have been withdrawn in many communities.

The economic crisis caused by the collapse of the Soviet Union has forced the Maritime Chukchi to turn to traditional subsistence activities. Cut off from western Russia and essential supply lines, they have turned to marine mammal hunting, which has again become vital to eke out extremely short supplies of food. Local hunters who had not harvested whales for many years had no choice but to resume whaling. Although hunting skills had almost disappeared in Chukotka and many had inadequate equipment, help was found through Alaska's North Slope Borough, which initiated a project to assist the Chukchi in relearning traditional activities and skills. Funds have also been used to establish native whale-observing posts along the coast of Chukotka, and the figures recorded should generate a more accurate estimate of whale stock in the area.

The future of the Chukchi is dependent on the revitalisation of whaling and reindeer herding, the strengthening of indigenous organisations, the implementation of local wildlife-management strategies, the development of small-scale community-based business initiatives, and the achievement of a degree of self-determination. However, whole generations have become used to comfortable village life and lack the skills and stamina to return to a traditional lifestyle. Persuading them that this is the way forward may be the biggest challenge that any governing body will face.

The Arctic Environment

Few who experience the fragile beauty of the Arctic are unmoved by it. Whether you visit the dramatic peaks of Alaska and eastern Canada, the magnificent icefjords of Greenland or the vast tracts of flat and frozen tundra that sweep across northern Russia you will be amazed at the diversity of life in this cold and inhospitable land.

In the perpetual darkness of mid-winter it can be a desolate place: frigid winds scream over snow-clad mountains and barren rock. But to experience this and then witness the richness of life and the tenacity of those plants and animals that make this region their home verges on the miraculous.

THE LAND

The Arctic covers a vast geographical area and boasts a wide and diverse array of habitats. The Arctic is not a clearly defined area but, for the purposes of this book, it is the area north of the Arctic Circle (above the latitude of 66°30'). It can also be defined by vegetation, the presence of permafrost or by temperature. It's worth noting that there are two north poles: the geographic north pole (also known as true north) fixed at 90° north latitude, the northernmost point of the earth's axis; and the magnetic north pole, the place where the earth's magnetic field lines point vertically downwards. All compasses point to the magnetic north pole but it is not a static position – between 2001 and 2003 the magnetic north pole moved an average of 41km each year.

At the southern reaches of the Arctic is the taiga, an area of vast spruce and birch forests that are home to a rich variety of life. North of this lies the tundra, a great treeless swath of land that is home to sedges, herbs and dwarf shrubs. The meadows here are often boggy, and they blaze with colour each summer as saxifrage and Arctic poppies bloom in carpets of yellow, red and pink. Further north again is the Arctic Basin, with its frozen sea fringed by a polar desert of bare, shattered bedrock and barren gravel plains. Here you'll find pingos, conical hills that often have a crater lake in the centre, formed by ice expanding in the ground. Throughout the region vast ranges of mountains rise – great jagged spines of rock that have been gouged and carved by glaciers and weathered over the centuries by the wind, ice and rain.

For information on ice in all its forms, see p88.

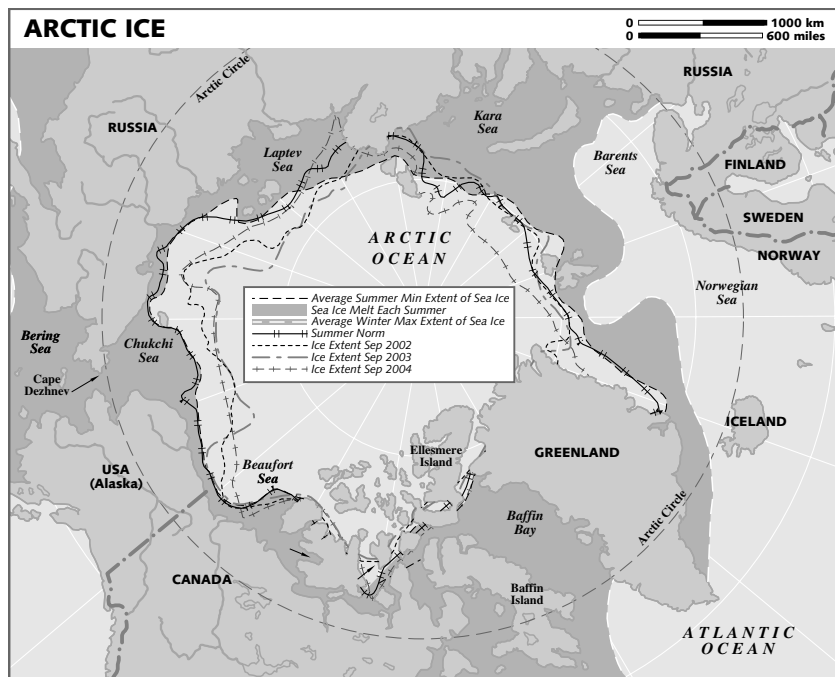
Arctic North America

Arctic North America makes up a vast tract of land sweeping from Alaska right across Canada to Greenland. The area comprises a diverse range of habitats and is home to a magnificent variety of wildlife. Above the Arctic Circle in Alaska and Canada, vast flat, marshy and lake-ridden boglands dominate the scenery, while just south of this is taiga forest, dotted with thousands of lovely lakes and cut by countless wild rivers.

In Alaska the jagged peaks of the Brookes Range lord over the vast flatlands of North Slope, an area exploited for its oil reserves. Much of Alaska's north is protected by a series of vast national parks (see p58).

On Canada's western border is the mighty Mackenzie River, which flows 1800km from Great Slave Lake in the southeast to the Beaufort Sea near Inuvik. Near its mouth it fans out into one of the world's largest deltas, with hundreds of channels and islands covering an area of 16,000 sq km. The delta is known as one of the world's climate-change hot spots and it has

The Arctic and its Wildlife, by Bryan Sage, describes the Arctic climate, geography and biology, and discusses in detail the ways in which plants, insects, birds and mammals have adapted to and exploited the region.



been the subject of many scientific studies over the years. Also in this area, on the eastern coast of Cape Bathurst, are the Smoking Hills (see p244), an area of slow-burning shale fires sustained by pyrite or organic material in the cliffs coming into contact with the air.

Further east is the Canadian Shield, a vast glaciated plain covered with lakes and taiga forests and rich in stores of oil, gas, diamonds and gold. To the north is the vast Arctic Archipelago, made up of enormous islands and vast flat swaths of tundra. In the far east a massive range of mountains rises from the plains, making Baffin and Ellesmere Islands stunningly picturesque. Further east is Greenland; its venerable geology is described on p88.

Arctic Russia

The vast expanse of Arctic Russia has long been shrouded in secrecy and has taken on a mysterious allure for many travellers. In physical terms the land is tempered by the last gasp of the North Atlantic Gulf Stream, and low coniferous forest covers much of northwestern Russia. As you move east the trees diminish in size and eventually give way to the tundra that dominates all of northeastern Russia and the various archipelagos.

All the major rivers of northern Russia flow northward into the Arctic Ocean, and in spring the river water melts before the fast ice (sea ice which forms and attaches to the coast) on the northern shore, and vast swamps and marshes flood much of western Siberia.

Five major island groups dominate Russia's north shore and create six seas of the Arctic Ocean. In the far east, the Chukotka Peninsula reaches out and almost touches Alaska's Seward Peninsula (see p292; the Russian

island of Big Diomedede and Alaska's Little Diomedede lie only 3km apart, across the International Dateline), while the vast Kamchatka Peninsula dangles between the Bering Sea and the Sea of Okhotsk (both of which belong to the Pacific Ocean).

Arctic Scandinavia

The northern reaches of Norway, Sweden and Finland lie above the Arctic Circle but have very different land forms. To the west the coast of Arctic Norway is indented with hundreds of fjords flanked by numerous islands and vast, nearly treeless peninsulas. Mountain ranges, some capped with Europe's largest glaciers and ice fields, cover more than half of the land mass, and the only relatively level area is the lake-studded and taiga-forested Finnmarksvidda Plateau, which occupies most of southern Finnmark (Norway's northernmost province).

Svalbard, 1000km north of the mainland, is about the size of Ireland and extends to over 80°N. The islands are gripped in sea ice for most of the year, and much of their interior is covered in glaciers and ice fields.

To the east the Swedish landscape was largely shaped during the most recent glacial periods; as a result, most of the country is covered by thousands of lakes and forests, which are dominated by Norway spruce, Scots pine and birch. In the far north, however, the trees thin out into a taiga landscape. A prominent mountainous spine along the Norwegian border forms a natural frontier between the two countries, with the most dramatic fells rising in Sweden's far northwest.

RESPONSIBLE TRAVEL

Every year thousands of visitors travel north, keen to see the magnificent wilderness that is the Arctic, but the presence of tourists can have a negative impact on the environment. Increased human traffic, whether on foot, by motorised vehicle or by air, disturbs indigenous wildlife, either by frightening them away from breeding or feeding sites, or because creatures like polar bears become used to humans, resulting in encounters that can be lethal (usually for the bears). Arctic vegetation is also extremely sensitive, and a footprint on the tundra or a bog might remain for literally hundreds of years. In addition, visitors need an infrastructure to accommodate them – roads across the permafrost, airstrips, heliports, hotels, camp sites, and imported food and fuel supplies.

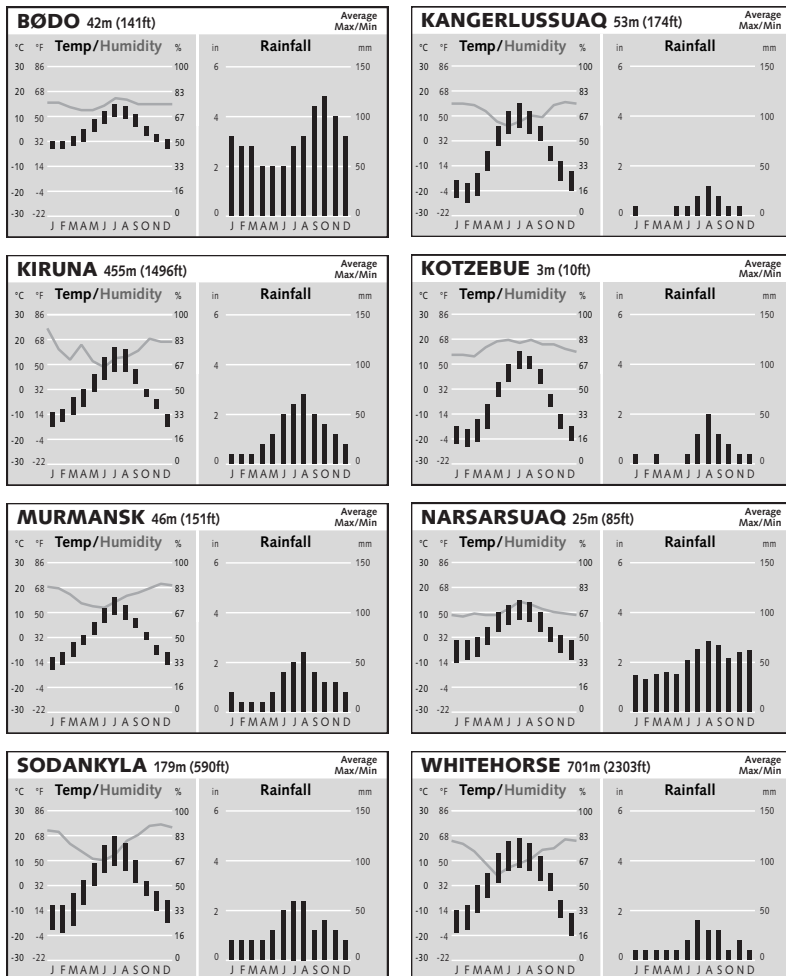
In order to minimise your impact and avoid damaging the fragile Arctic ecosystem, follow these rules:

- keep to established paths and roads
- keep a safe distance from wildlife
- question tour companies about their environmental policies and impact
- use environmentally conscious tour operators who employ local people
- remove everything you take on camping and hiking trips
- bury waste products at least 1m deep and remove all tissue paper, as it will take much longer to decompose in cold climates
- show respect for historical sites and do not remove anything from them
- buy locally produced souvenirs and food (souvenirs from Greenland should be accompanied by a CITES permit to ensure they are not made from any part of an endangered species; see p218)
- speak out against careless exploitation and industry in the far north (see www.amap.no, www.wwf.org or www.earthjustice.org for more information)

Further east, Finland is dominated by water: ponds, marshes, bogs, rivers, creeks, rapids, waterfalls and – most prominently – lakes. There are no real mountainous areas; the highest hills, or *tunturi*, are in the far north, adjacent to the highlands of northern Norway and Sweden. The highest point, Halti, in the far northwest, rises to only 1328m. By contrast, Sweden's highest point is Mt. Kebnekaise (2111m) and Norway's is Galdhøpiggen (2469m).

CLIMATE

The climate varies enormously across the Arctic; the charts below should help you to prepare for your trip.



WILDLIFE Animals

The Arctic is essentially an ocean surrounded by continents and islands, and the moderating effect of the water means that the climate, though severe, is more hospitable to human and animal life than the icelocked Antarctic, and a rich variety of flora and fauna have ingeniously adapted to the cold climate and harsh conditions.

Winter is a dormant time for many kinds of Arctic wildlife, but the brief Arctic spring and summer see everything burst into activity. Millions of migrant birds swarm in from the south to take advantage of the continuous daylight, ample food and wide choice of breeding sites. Large mammals breed and give birth, and the tundra becomes a lush and fertile place for a few short months.

Despite the variety of life in the Arctic, the environment is a fragile one, and it takes very little to destroy its delicate balance. Sudden storms, early winters and unpredictable weather can mean an unsuccessful breeding season, and in industrialised areas the damage caused by pollution might take many centuries to repair.

Details of some Arctic flora and fauna are given in the Environment section of the Greenland Snapshots chapter. A creature not seen in Greenland, but found in the rest of the Arctic, is the grizzly or brown bear (*Ursus horribilis*), the world's second-largest bear, which can be recognised from its large dorsal hump. Although grizzlies aren't common anywhere, they're often observed in the tundra and taiga regions of Alaska and northwestern Canada, and very fortunate observers may also spot them in Arctic Russia and Scandinavia. For tips on dealing with bear attacks, see p264.

Another large mammal not found in Greenland is the moose (*Alces alces*), which is often called an elk in Europe. This is the world's largest deer – an average human would not even reach its shoulder. Moose have a distinctive dewlap, and males have flat, saucer-shaped antlers. Northern Alaska and northwestern Canada are the best places for spotting them in the wild.

One of the most chilling sounds in the Arctic is the howl of a wolf (*Canis lupus*). Their favourite victims are caribou, and the movements of some wolf packs revolve around the seasonal migrations of caribou herds. Wolves hunt in a highly coordinated way, selecting the older, weaker or incapacitated animals, thereby ensuring the health of their prey stock. Wolves remain widespread in more remote regions of the Arctic, and although casual visitors are unlikely to see a large pack, odd individuals and family groups can be encountered on the islands and mainland of northern Canada and Alaska. A distinct white subspecies inhabits the remotest regions of Canada's Quttinirpaaq National Park on Ellesmere Island (boxed text p247).

ENDANGERED SPECIES

Many Arctic species are under threat, particularly the magnificent whales that ply the icy waters. The Northern Right Whale (*Eubalaena glacialis*) – so called because it was ideally the right whale to hunt, being large, slow-moving and approachable – was brought to the brink of extinction in the 19th century by the whaling industry and is now one of the world's rarest whales. Researchers believe Northern Right whales number about 300. However, it can still be encountered in Arctic waters, where it appears as a 15m-long black shape with no fin on the smooth back of its thick-set body. Its blow makes a distinctive V.

Other whales under threat include the endangered bowhead whale, which can live for up to 200 years, and grow as large as 20m long. Fortunately,

Islands of the Arctic, by Julian Dowdeswell and Michael Hambrey, is a stunning book tracing the environmental and cultural threats to the Arctic.

DO YOU KNOW?

Scientists predict that polar bears could become extinct within 100 years.

WILDLIFE WATCHING

Animal	Location	Time of year
Muskox	Kangerlussuaq, Grønødal, Dempster Hwy, Paulatuk, Aulavik, Arctic National Wildlife Refuge (ANWR), Atigun Pass	year-round
Caribou	Kangerlussuaq, Old Crow, ANWR, Aulavik, Dempster Hwy, Richardson Mountains, Paulatuk, Ivavik, Iqaluit, Gates of the Arctic, Noatak, Kobuk, Rovaniemi, Inari, Lemmenjoki, Nordkapp, Hammerfest, Kautokeino	spring and autumn
Polar bear	Svalbard, Wrangel Island, Point Barrow, Grise Fjord, ANWR	spring and summer
Whale	Aasiaat, Barrow, Pond Inlet, Tuktoyaktuk, Lofoten, Vesterålen, Narvik	autumn
Grizzly bear	Gates of the Arctic, Dalton Hwy, ANWR, Yukon	summer

it has shown an increase in numbers in the eastern Canadian Arctic in recent years.

Beluga whales are also endangered but have yet to be officially protected. Only in the eastern Beaufort Sea are their numbers considered healthy. In Baffin Bay they are under threat from Greenlandic hunters, and the population in eastern Hudson Bay is very low. Orcas in Alaska have also received special protection, as their numbers there have dwindled to single figures since the 1989 Exxon Valdez oil spill.

On a brighter note, blue whales, protected since 1965, were seen in Alaskan waters for the first time in 30 years in 2004, prompting hopes that their numbers may be returning to historical levels.

Numbers of Peary caribou, native to northwestern Canada, have dropped by more than 70% in the past 20 years, even though they are not hunted. On Banks Island, one of the worst-affected areas, caribou numbers dropped from about 12,000 in 1972 to about 450 in 1998. Global warming (see p27) is cited as a possible cause. The woodland caribou and wood bison face similar problems.

The imposing Siberian crane (*Grus leucogeranus*) is under threat, as its breeding grounds, migration stopover points and wintering grounds – in Iran, India and China – have all been disturbed by human activities. Only three isolated breeding populations are known, all in northern Siberia. The striking bird has pure white plumage, black wing-tips and red face, beak and legs. In recent years it has become a symbol of Arctic conservation, as great efforts are being made to save it.

In the 1950s and '60s the bald eagle, an impressive and inspiring bird, succumbed to pesticide poisons absorbed mainly through eating dead fish stranded on riverbanks and beaches. This resulted in infertile or thin-shelled eggs and brought the species close to extinction. Though still officially classed as threatened, these magnificent birds with their 1.8m wingspan are slowly recovering in numbers, particularly in Alaska and Canada.

Plants

Arctic vegetation is surprising varied, and in the brief summer months wildflowers can be seen everywhere. By mid-August berries have begun to ripen, and as autumn comes the tundra explodes in a blaze of colour. Above the tree line the open, bare ground of the tundra supports a variety of low-growing vegetation: shrubs, grasses, reeds, sedges, flowering plants, lichens, mosses, liverworts and algae. Plants stay low and spread sideways in order to keep a good grip on the easily eroded soil and to absorb what heat there is.

Flowers you will see in most areas include purple saxifrage (*Saxifraga oppositifolia*), whose blooms are the first harbingers of spring; moss campion (*Silene acaulis*), looking like a purple-studded pincushion; mountain avens (*Dryas octopetala*), with its yellow-and-white single flowers; and various species of gentian (*Gentiana*), pushing up their incredibly blue trumpets towards the sky.

Lichens set the bare rock of the Arctic ablaze but are incredibly slow-growing – some spread by only 1mm a year, and if conditions are unfavourable they do not spread at all in some years. Some have been estimated to be 4000 years old.

For more on Arctic flora, see p92.

INDIGENOUS CONSERVATION EFFORTS

Indigenous people have always relied on Arctic flora and fauna for survival, and they have been the first to witness the detrimental effects of industrialisation and climate change (see p27). They have also suffered at the hands of regional and federal governments who have appropriated mineral-rich land and returned little, if any, of its wealth to the indigenous people. This environmental injustice and the sight of traditional hunting or herding grounds ruined by industry has turned the native peoples of the north into environmental campaigners and conservationists. Many indigenous people have now been trained to monitor and record species numbers, environmental conditions and changes to flora and fauna. Their observations have become vital for scientists working to predict climate change and preserve the population numbers of many endangered species.

The indigenous people are also fighting hard in many regions to preserve their homelands from industrialisation, oil and gas exploitation or similar developments. In Old Crow in the Yukon the Gwich'in fight for the Porcupine caribou birthing grounds (see the boxed text, p47), the Sami of the polluted Kola Peninsula in Arctic Russia fight for autonomy in their own environment (see p44), the Nenets of the Yamal Peninsula fight to save the summer reindeer-herding pastures from a large gas complex, and the Inuit of Nunavut (see p25) now control both their homeland and the subsurface rights to valuable minerals.

Arctic indigenous people's organisations are now represented and voice their opinions at global talks on the environment. Although the governments of the eight Arctic-rim countries agreed to an Arctic Environmental Protection Strategy in 1991, the problems associated with natural-resource extraction and military activities were deemed too politically sensitive for discussion. Since it is exactly these issues, as well as pollution from other industrialised nations, that pose the greatest threat to the Arctic environment, making the voice of the native people of the far north heard has never been more important.

NATIONAL PARKS

A host of national parks and reserves protects the pristine and fragile Arctic environments of the far north. Those mentioned in the table (see p58) are featured in more detail elsewhere in the book.

Other parks in Norway include Forlandet in Svalbard, which protects the breeding grounds for eider ducks, geese, seals and walrus; lonely and dramatic Rago, with its high mountain peaks divided by plunging valleys and waterfalls; Reisa, which protects the dramatic Reisa Gorge, its lovely waterfalls and its varied wildlife; Saltfjellet-Svartisen, straddling the Arctic Circle and consisting of the upland moors of Saltfjellet and the two vast Svartisen icecaps; the world's most northerly pine forests at Stabbursdalen;

For background information and links to numerous related sites, visit the United Nations Environment Programme site: <http://arctic.unep.net>.

Arctic National Wildlife Refuge: Seasons of Life and Land, by Subhankar Banerjee, is a beautiful and evocative book, rich in photographs, calling for the preservation of this pristine wilderness.

NATIONAL PARKS

National Park	Features	Activities	Best Time to Visit	Page
Alaska				
Gates of the Arctic	glaciated valleys, rugged mountains; caribou, Dall sheep, wolves, bears	hiking, rafting, canoeing	Jun-Sep	256
Kobuk Valley	sand dunes, canyons; caribou, sheefish	rafting, cross-country skiing, trekking	Apr-Sep	262
Noatak	mountain-ringed river basin; caribou, moose, wolves, grizzly bears	rafting, kayaking, trekking	May-Sep	262
Canada				
Aulavik	undulating hills, upland plateaus, steep canyons; Peary caribou, muskoxen	canoeing, trekking, wildlife watching	May-Sep	244
Auyuittuq	jagged mountain peaks, deep valleys, steep-walled ocean fjords, glaciers; caribou, ptarmigan	hiking, climbing	Jun-Sep	249
Quttinirpaaq	glaciers, ice fields; wolves, foxes, muskoxen, caribou	hiking, climbing	May-Sep	247
Vuntut & Ivvavik	boreal forest, low mountains, coastal plains; caribou, grizzly bears, brown bears	canoeing, cross-country skiing, trekking	Apr-Sep	241
Sirmilik	rugged mountains, ice fields, glaciers; sea-bird colonies, whales	hiking, canoeing, climbing	May-Sep	248
Tuktut Nogait	rolling tundra, wild rivers, canyons; caribou, wolves, grizzly bears, muskoxen, raptors	hiking, canoeing	May-Sep	244
Greenland				
Northeast Greenland	vast tundra expanses, icecap, jagged peaks; muskoxen, polar bears, caribou, Arctic wolves, foxes, seals, walruses, whales	hiking, climbing, wildlife watching	Jun-Aug	213
Norway				
Øvre Dividal	spectacular jagged mountains, wide valleys; wolverines, rhododendrons, heather	skiing, hiking	May-Sep	308
Sweden				
Abisko	lakes, gentle mountains, valleys; foxes, reindeer	hiking	May-Sep	310
Finland				
Lemmenjoki	desolate wilderness, rivers, rough Arctic landscape; reindeer, foxes, bears, wolverines	hiking, gold panning, reindeer herding	May-Sep	318
Urho Kekkonen	vast forest, barren wilderness, ravines; foxes, reindeer, hares	hiking	Jun-Sep	317
Pallas-Ounastunturi	fells, forest, peatland; bears, wolverines, lynxes, wolves	hiking, canoeing	May-Sep	327
Russia				
Lapland Biosphere Reserve	tundra, alpine grasslands, marshes, jagged peaks; extensive mammal species & birdlife	hiking, wildlife watching	Jun-Sep	276
Wrangel Island	mountainous peaks, variety of tundra types; polar bears, walruses, grey whales, snow geese, reindeer, snowy owls	hiking, wildlife watching	Jun-Sep	293

Norway's largest national park, Sør Spitsbergen, which protects Spitsbergen's entire southern peninsula; Øvre Anarjåkka, adjoining Finland's wild Lemmenjoki National Park and protecting a vast expanse of birch and pine forests, bogs and lakelands; the boreal forest of Øvre Pasvik, tucked between Finland and Russia, protecting the last habitat of the brown bear in Norway; and tiny Ånderdalen, on the island of Senja, protecting the bogs and coastal pine and birch forests.

In Sweden you'll also find Muddus, which protects Lake Muddusjaure and the surrounding ancient forests and bogs; Padjelanta's high moorland, favoured by grazing reindeer; incredible Sarek with its vast plateaus, glaciers, deep valleys, sharp peaks and large tracts of birch and willow forest; Stora Sjöfallet, dominated by Lake Akkajaure and the lofty Mt Akka; and Vadvetjåkka, Sweden's northernmost national park, protecting a large river delta featuring bogs, lakes, limestone caves and a variety of bird species.

ENVIRONMENTAL ISSUES

The Arctic environment is extremely fragile, and it takes very little to unbalance the sensitive ecosystems at work there. Global warming (see p27), mineral extraction, the accumulation of pollutants (see p34) and extensive military dumping of nuclear waste all pose enormous threats to the sensitive ecosystem. The low temperatures, limited sunlight, short growing season and slow decomposition of Arctic ecosystems means they are particularly susceptible to pollutants and can take many decades to recover from damage.

While the most dramatic environmental damage is in the Russian north, many other areas are also at risk. Permafrost melt and coastal erosion are already problems for residents of Alaska's northwest. In Norway farmed reindeer have lost 50% of their habitat in 50 years, and wild herds in Canada are steadily declining in numbers, though no-one is quite sure why. Sea ice is thinning, glaciers are melting and pollution is increasing. In many Arctic towns concern about the environment is high, but interest in cleaning up one's own backyard is pretty low: rubbish is dumped everywhere, recycling is limited, and town dumps pile high and often tip into the sea.

Scientists are feverishly studying complex Arctic ecosystems in order to better understand and preserve them. Stricter controls, a separation of research projects from industry funding, and long-term environmental education seem to be the only realistic solutions to the problem. An effective compromise must be made between economic and political interests and environmental and cultural concerns if the vast Arctic wilderness is to see any kind of preservation from the ravages of pollution. To date the absence of any kind of long-term planning and legislation has been the biggest problem of all.

Arctic Russia

Serious environmental problems are readily apparent in the Russian Arctic, where high levels of sulphur dioxide from copper- and nickel-processing plants have destroyed the natural vegetation and caused acid rain, which is devastating forests. Nuclear waste, runoff of industrial chemicals and untreated wastewater leak or are pumped into Siberian rivers and eventually end up in the Arctic Ocean.

The Kola Peninsula in particular is badly affected, as it is the repository of the world's largest amount of radioactive waste. More than 100 decommissioned nuclear submarines now based around the peninsula are ageing fast, and radioactivity levels are spiralling. The testing of nuclear

Steven B Young's *To the Arctic: An Introduction to the Far Northern World* is an elegant volume covering the flora and fauna, oceans and ice, and geology and environment of the Arctic.

DID YOU KNOW?

Radioactivity levels in Andreeva Bay on the Kola Peninsula are said to be similar to those in Chernobyl.

ARCTIC WORLD HERITAGE SITES

The extreme and unique environment of the far north has been recognised at the following Unesco World Heritage sites:

- Ilulissat icefjord, Greenland (p170). One of the fastest and most active glaciers in the world.
- Laponian area, Sweden. The largest area in the world with a traditional way of life based on the seasonal livestock movement.
- The Vega Archipelago, Norway. A cluster of dozens of islands with a unique tradition of eider-down harvesting.
- Wrangel Island Reserve, Russia (p293). High levels of biodiversity, including many endangered species.

weapons at Novaya Zemlya introduced large quantities of nuclear waste into the environment in the 1960s and '70s, and the scuttling of decommissioned nuclear-powered submarines continues the theme off the coast of the island today.

Russia also plans to redirect two mighty Siberian rivers, the Ob and the Irtysh, hundreds of kilometres to the south in a bid to solve a worsening water shortage. Although the project could help refill the Aral Sea – which has shrunk to a quarter of its former size since 1960 – and offset the increasing amount of fresh water flowing into the Arctic Ocean, it will mainly be used to support the water-guzzling cotton-growing industry in Uzbekistan and Turkmenistan. Critics believe that the project will only cause more social, economic and ecological problems.

In 2003 an international project to clean up the Russian Arctic was announced. Estimated at US\$40 billion, the scheme aims to make abandoned military bases safe, explore the use of algae to clean up oil spills and involve indigenous peoples in environmental protection.

Marine Pollution

The Arctic Ocean acts as a sink for long-range pollution such as that caused by heavy metals, PCBs and other persistent organic pollutants, and as the chemicals enter the food chain they quickly accumulate to dangerous levels in the fat of Arctic animals and in the humans who eat them (see p34). This bioaccumulation threatens both the health of the indigenous people and the animal populations of the region. Polar bears have already been found to be increasingly affected by these chemicals; this, combined with thinning sea ice, means that they are now suffering a major threat to their ecosystem and feeding habits.

The Bering Sea is showing advanced effects of pollution and commercialisation, and is suffering from steep declines in marine mammals, fluctuations in sea-bird populations, and the collapse of some crab and fish stocks. As much of the Arctic Ocean is deemed international water, it's hard to pin down where the responsibility for controlling this pollution lies.

The Arctic seas are also under threat from overfishing and oil and gas development. Bottom trawling and dredging has caused considerable damage to the ocean bottom, and cod and haddock are decreasing in numbers despite regulations and controls.

Oil & Gas Exploration

The Arctic holds the world's largest remaining untapped gas reserves and some of its largest undeveloped oil reserves. At Prudhoe Bay in Alaska,

dozens of jets and planes land every day, enormous trucks scurry along the gravel roads, and hundreds of oil spills occur every year. Oil companies say they are doing all they can to protect the environment, but in the past some have been fined for illegally disposing of hazardous waste. Oil spills pose a tremendous risk to Arctic ecosystems, as there is no effective method for containing and cleaning up an oil spill in icy water.

Expansion of the hydrocarbon industries in the Arctic region would mean the building of massive infrastructure and, in turn, the opening up of new regions of the Arctic to other kinds of resource exploitation, such as logging, commercial fisheries and mining. In addition to the threat of increased oil spills, repeated seismic surveys and overflights may disturb Arctic wildlife.

The Barents Sea and the Mackenzie River Valley are key locations for development, and Nunavut is keen to get a slice of the action in order to reduce unemployment levels and secure a stronger political voice for the future. In Russia, development of the huge oil and gas deposits on the Arctic shelf is expected to increase oil transport sixfold by 2020.

A significant proportion of these oil reserves lies offshore, though, in the Arctic's fragile and biologically productive shelf seas. Employment and revenue from oil and gas companies are often central to the financial welfare of a nation or community, and the conflicting interests of local and national governments, indigenous-rights groups and environmentalists make the process tense. One government department will encourage oil exploration, whereas another will oppose it. In Norway, revenue from oil exploration supports the state pension plan, and so the Norwegian people are caught between securing their own futures and protecting their treasured environment. In Alaska, where the US government plans to open the protected birthing grounds of the Porcupine caribou herd to oil development, there is ongoing tension between one indigenous group that makes its living from oil-related employment and another across the border in Canada that relies on the herd for its survival (see the boxed text p47).

Global Warming

There is now a consensus among scientists and researchers that the warming trend seen in the far north (see also p27) is not part of a natural blip in the earth's climate but a reaction to man-made pollutants that may well change our environment forever.

The effects of this warming are most keenly felt at the poles, and visible changes to weather patterns are already occurring in the Arctic. These changes aren't just seen in the form of scientific research but are dramatic enough for local laypeople to observe. Thinning sea ice is preventing the annual hunt, melting permafrost is causing roads and buildings to subside, and sandbags are now a normal sight in many Arctic towns to prevent the progression of coastal erosion.

Glaciers are steadily retreating, and the Greenland icecap is beginning to melt. The earth's reflectivity is reduced as more bare land and open water are revealed, and so more sunlight is absorbed and the whole process amplifies itself. It has been predicted that a rise in temperatures of just 2.7°C would begin an irreversible process that would eventually raise global sea levels by 7m.

In more immediate terms, computer modelling has predicted that the Canadian Arctic Archipelago will be virtually ice-free in summer in 20 years, thanks to global warming. This would reduce the journey from England or New York to Beijing by 17,700km but necessitate the construction of navigation posts, harbours and coastal surveillance points. Europe and

For information on environmental threats in Arctic Russia, visit www.carto.eu.org/article2462.html.

DID YOU KNOW?

The elusive Northwest Passage could be virtually ice-free in summer in 20 years.

the US are already pushing for the waters to be deemed international, to take advantage of diluted environmental standards rather than adhering to Canada's stricter regulations.

Whaling & Hunting

Whaling continues to be a contentious issue, and calls for the lifting of the international ban have met with mixed reactions. Marine biologists agree that many species are no longer under threat, but environmentalists argue that some are still in dire need of protection (see p55), and indigenous communities argue that they need income from whaling to reduce their dependency on government benefits. However, campaigners are not swayed by either argument. They say that whaling involves a protracted and painful death for the animals and that the ban should remain firmly in place.

Sealing is another controversial subject in Arctic communities. The media frenzy in the 1980s following the clubbing of young seals appalled most indigenous hunters, who regarded the reports as biased and unfair. Hunters across northern Canada and Greenland who relied on the sale of furs as their main source of income lost their livelihoods overnight. In 2004 Canada increased its quota for seal hunting, to the anger of environmentalists, but Canadian seal numbers are recovering and Renewable Resource officers monitor the situation closely. A greater threat for seals is the commercial fishing industry: it has reduced fish stocks – and consequently seal food – all over the world, and its brightly coloured nets can become death traps for these inquisitive creatures.

Arctic Food & Drink

It's meat, meat and more meat on the Arctic menu, and don't expect any fanfare about it. If you're going to eat traditionally you'll be eating simple fare from the top of the food chain for the duration of your stay.

The nomadic Arctic people were dependent on the animals for their very survival and followed them through the seasons. Although every Arctic town now has a supermarket stocking everything from boil-in-the-bag seal to microwaveable plastic-wrapped burgers, traditional meat fresh from a hunt is of enormous importance and prized above all else.

Depending on where you are, this can range from a choice of whale or seal meat to plenty of fish, caribou or muskox. Although traditional meats and hunting methods may be objectionable to some for sentimental or ideological reasons, this way of life was the only choice for people living in the far north. Even though Western attitudes and values have largely been accepted, hunting is the key to maintaining cultural traditions.

The traditional Arctic diet was very healthy; before Western processed foods were introduced, the area enjoyed the world's lowest rates of cardiovascular disease. Today concerns over bioaccumulation of toxic chemicals in the Arctic food chain (see p34) have prompted health professionals to advise northern peoples to limit their intake of traditional foods.

STAPLES & SPECIALITIES

Today most Arctic people enjoy a mixed diet of Western food and traditional meats. Although processed foods are expensive and fresh fruit and vegetables are still a luxury, in many places they are readily available.

Traditional Arctic cooking is very simple, with stews and fried meat or fish being the highlight of the menu. Dried fish is popular when travelling and bannock, a simple white pan-fried bread, is common in the native communities of northern Canada and Alaska. The evening meal is usually the main meal of the day, and on special occasions traditional food is always served. In areas where caribou and muskox are plentiful this means a hearty stew or fried meat, accompanied by potatoes and other root vegetables. Fish is a staple across the Arctic. Some, particularly capelin, are dried for the winter, and salmon is normally salted and smoked. Arctic char's firm, delicious meat makes it a favourite, while halibut is softer and subtler in taste. Dried fish, caribou and muskox are eaten as snack foods, particularly when travelling.

In coastal areas, dark, rich whale meat is also popular, though it's quite salty to the unaccustomed palate. The choice cuts are served as steaks and the others often end up in a stew. Whale blubber (*mattak* or *muktuk*), which is relatively tasteless and difficult to chew, is rich in vitamins and fats that the body uses efficiently to retain heat. Even a thin slice will provide several hours of jaw work. Although it is unlikely that you will be offered any meat from threatened species, it's worth knowing that the beluga, northern right and bowhead whales are considered endangered and these meats should be avoided. Seal is sold at all harbour markets and supermarkets in Greenland and is often available in hotel restaurants across the Arctic. It tastes more fishy than whale does.

A welcome crop of berries and mushrooms supplements traditional Arctic diets, and in late August and early September you'll see locals out on the hillsides gathering huckleberries (small blueberries), crowberries and, in some areas, lowbush cranberries.

Visit www.visi.com/~wick/axe/cookbook.html for a selection of traditional recipes from indigenous groups.

Faith, Food, and Family in a Yupik Whaling Community, by Carol Zane Jolles, describes the complex cultural interconnections in a Yup'ik community.

DID YOU KNOW?

To make a toast in Greenlandic, use the word *Kasugta*.

Angelica grows in many areas, wild chamomile is abundant, and wild thyme makes an excellent tea and seasoning. In late summer, common harebells (*Campanula greseckiana*) and rosebay willow herb are common in the North Atlantic region, and the sweet, slightly fragrant flowers are delicious. Many varieties of Arctic seaweed are also edible – the slimy species known as sea lettuce is particularly prized.

A surprising number of mushrooms grow in Arctic areas and several edible varieties exist, though correct identification is essential. The most delicious Arctic mushroom is the slippery jack – a large, chocolate-coloured mushroom with a spongy centre. Reaching its peak in early August, it grows mainly in damp tundra and scrub forest all over the North Atlantic region. In well-drained taiga areas of Alaska and Canada, springtime brings a good crop of morels. These convoluted mushrooms have a strong and delicious flavour, but beware of the false morel, which looks similar but is poisonous.

DRINKS

There are few special drinks indigenous to the Arctic. Tea and coffee are drunk everywhere, and alcohol is often overindulged in, leading to many ‘dry’ Arctic communities where alcohol is banned. Local *imiaoq* (home-brewed beer) often surfaces in these and other areas, but its quality and safety can be pretty dubious – it’s often brewed in old oil drums.

VEGETARIANS & VEGANS

Sorry, folks, you’re plain out of luck in the Arctic. Diets were traditionally meat based, and not much has changed in terms of cooking or attitude. Other than self-catering you’ll have few options. However, most supermarkets, even in small towns, stock a good selection of basic vegetables and fruit, plenty of dried goods such as rice and pasta and the makings of simple vegetarian meals. Even at tourist hotels the menus typically have only three or four dishes, all meat-based. Vegetarianism is unknown to local people, and you’ll get a quizzical or just plain blank look when you say *Neqitorneq ajorpunga* (‘I don’t eat meat’) and little assistance in finding something meat-free to eat.

HABITS & CUSTOMS

Getting fed in the Arctic was never a sure thing, so when there was a successful hunt it was time for celebration. Traditionally, the meat was distributed evenly among the families in the village.

Although Western foods are now seen in every household, traditional meat and fish is the favoured fare, and the successful hunter is a respected man. For special occasions extended families gather together and enjoy leisurely meals of several courses. Dried meats are commonly eaten when people are out on the land; on hunts, meat is fried or boiled without much fuss and is often eaten with the hands.

If you’re invited to a private home for a *kaffemik* (a Greenlandic coffee party) or other occasion, there are few unusual customs to observe. In all Arctic areas people take their shoes off before entering a house, but apart from that common sense should see you through. Try not to grimace if your food seems unrecognisable. You’ll often find offal and bits of animal hair in stews. If you can, avoid picking at your food; however, pulling all the meat off the bone – even with your hands – is seen as a compliment to the cook. If you really can’t stomach something, most people will understand. As an outsider you’re expected to be less enthusiastic about some things.

Food in South Greenland, by Finn Larsen and Rie Oldenburg, gives background information on traditional food sources, and modern recipes in English, Greenlandic and Danish.

DID YOU KNOW?

Traditionally, dog teams were fed before humans, and if there wasn’t enough for everyone you just had to go hungry.

Touring the Arctic

To travel in the Arctic you need lots of patience: weather plays havoc with schedules, a broken engine on one flight can mean the cancellation of yours three days later, and local culture is laid back and used to it all – your complaints about bad service or having connections to make will often fall on deaf ears.

Arranging an organised tour is one way to avoid the hassle – or at least it's a way of letting someone else deal with it. In sensitive parts of Russia, joining a tour is often the only easy way to get the necessary travel permits, notably for visiting Chukotka. As part of a tour you won't need to arrange accommodation at every stop or make contact with local ferry companies, airlines or (in Russia) bureaucratic offices who don't answer the phone or have a website in English. The tour companies vet hotels and arrange side trips, and you can just sit back and enjoy the scenery while someone else worries about that missed connection. However, you do lose all independence and any possibility of spontaneity, as tours don't leave any room for changes. You may arrive and realise that you could have done it all yourself for half the price – or that your new companions for the two-week trip are your worst nightmare.

ORGANISED TOURS

The following list (arranged by the company's base location) includes companies that provide sightseeing tours, transport and Arctic cruises for holiday-makers. If you'd prefer more strenuous activity-oriented options, see Adventure Tours, p66. Local outfitters offering regional tours are listed in the destination chapters.

North America

Amazing Cruises & Travel (☎ 973-898 0188; www.amazing-tours.com) Offers two-week cruises to the North Pole from Helsinki (US\$15,950), 12-day Greenland and Hudson Bay cruises (US\$4295), 14-day tours of Russia's far east and Wrangel Island (US\$9850), 19-day Northwest Passage cruises (US\$12,150), 14-day cruises of Canada's High Arctic and Greenland (US\$8550), and 15-day cruises of Ellesmere Island and Greenland (US\$9950).

Borton Overseas (☎ 800-843 0602; www.borton.com/overseas.html-ssi) Outdoor adventure travel in Scandinavia

TRAVEL TO THE NORTH POLE

For travel to the North Pole you can choose from packages such as leisurely cruises aboard nuclear icebreakers, fly-in trips, skiing and dogsledding expeditions, skydiving, and marathon running at the Pole. Routes and possible itineraries for trips to the Pole from North America, Russia and Scandinavia are covered in more detail in the Travel Routes chapters.

and Greenland, including six-day polar safaris in Lapland (US\$1470), six-day Arctic adventures in Kangerlussuaq (US\$1756), seven-day adventures to Ilulissat (US\$2196) and five-day dogsledding tours in Lapland (US\$894).

Circumpolar Expeditions (☎ 907-272 9299; www.arctictravel.net/tourprov.htm) Alaska-based agency that organises cruises of the Chukotka coast. Tours cost US\$1384 for three days, US\$2995 for nine days and US\$3495 for 12 days.

Great Canadian Ecoventures (☎ 867-920 7110; www.thelon.com) One-week fly-in canoeing, kayaking and Arctic wildlife photography expeditions with an ecological theme (C\$3900 to C\$7800).

Mountain Travel Sobek (☎ 888-687 6235; www.mtsobek.com) Operates an 11-day circumnavigation of Svalbard (US\$2750 excluding airfares).

Quark Expeditions (☎ 203-656 0499; www.quarkexpeditions.com) Two-week cruises to the North Pole (US\$16,450), two-week cruises to Russia's far east and Wrangel Island (US\$9850), 19-day Northwest Passage cruises (US\$12,750), and 15-day cruises to Ellesmere Island and Qaanaaq (US\$11,450).

Scantours (☎ 800-223 7226; www.scantours.com) Extensive range of short tours in Scandinavia, including an 18-day grand tour (US\$4285) and an 11-day North Cape Finnish tour (US\$2915).

TCS Expeditions (☎ 800-727 7477; www.tcs-expeditions.com) Runs 17-day cruises through the fjords of Greenland, Scandinavia and Svalbard (US\$32,950).

Zegrahm Expeditions (☎ 800-628 8747; www.zeco.com) Two-week cruises from Kamchatka to Nome (US\$8290), in Russia's Sea of Okhotsk (US\$7690) or circumnavigating Baffin Island (US\$12,580).

Russia

North Pole Adventures (www.northpole.ru) Runs week-end trips to the Pole from Moscow (€6000) with opportunities to attend the North Pole ballooning festival or ice-sculpture festival, or go skiing for six days to reach the Pole.

Intourist Ecotours (☎ 95956-4206; www.ecotours-intourist.ru) Offers several unique exploration possibilities in Chukotka; 11-day trips including flights from the UK cost £1199.

South Kola Tours (☎ 81555-74178; www.kolaklub.com/southkola) Small, specialist agency offering mineral-finding, mountain-biking and cultural tours to lesser-known areas of the Kola Peninsula. Four-day snowmobile tours cost US\$1557. It also has a friendly Nevada (USA) office.

Scandinavia

Albatros Travel (☎ 3698 0000; www.albatros-travel.com) Operates an 11-day cruise from Nuuk to Upernavik (€3200) and five-day winter tours to Kangerlussuaq (€990 to €1075).

Greenland Travel (☎ 321 205; www.greenland-travel.dk) Greenlandic company offering tours all over Greenland, including boat and dogsledding trips, visits to the inland ice, summer cruises and hiking. Prices range from Dkr4000 for a weekend tour to Kangerlussuaq to Dkr32,000 for multiday dogsledding trips to Thule. The average tour costs Dkr10,000 to Dkr15,000. (See p225 for other Greenland transport options.)

Other

AUSTRALIA

Aurora Expeditions (☎ 02-9252 1033; www.aurora-expeditions.com.au) Offers 16-day North Pole cruises (US\$15,950), High Arctic cruises to Svalbard, Iceland and Greenland (10 days A\$4250, 12 days A\$5150), and 17-day trips through Kamchatka (A\$8900).

UK

David Oswin Expeditions (☎ 01228-75518; www.expeditions.co.uk) Photographic and adventure holidays in Greenland, including five/six/nine-day dogsled tours (£1292/£1376/£1781) and tailor-made tours.

Saga International Holidays (☎ 0800 096 0801; www.saga.co.uk) Cruising for the over-50s, including 15-day tours along the coast of Norway and on to Svalbard and Iceland (£2369) and 18-day cruises to the Faroes, Iceland and Greenland (£2849).

Wildwings (☎ 0117-984 8040; www.wildwings.co.uk) Booking agent for Arctic cruises including eight-day tours to Svalbard (£1479 to £2485), and two-week trips to Greenland (£2649) and Arctic Canada (£2769).

ADVENTURE TOURS

These tours are generally for those who are prepared to face the elements without any luxuries. Many of the trips require high levels of fitness and stamina, though most of these companies also offer softer options.

North America

ABEC's Alaska Adventures (☎ 877-424 8907; www.abecalaska.com) Good value one- to three-week backpacking

expeditions in Noatak, Gates of the Arctic and the Arctic National Wildlife Refuge (ANWR), including an eight-day backpacking trip through the ANWR to witness the caribou migrations (US\$2050), 10 days rafting on the Kongakut River (US\$3300), eight days kayaking along the Arctic coast (US\$2800) and eight-day kayaking or hiking trips to Gates of the Arctic National Park (US\$1800).

Adventure Canada (☎ 905-271 4000; www.adventurecanada.com) Canadian Arctic specialist offering 11-day cruises across Arctic Canada and Greenland with Inuit artists and culturalists (C\$3795); two-week High Arctic cruises between Baffin Island and Greenland, focusing on wildlife and photography or explorers and archaeology (C\$3795); and nine-day spring photography trips to the floe edge at Pond Inlet (C\$4295).

Alaska Discovery (☎ 800-586-1911; www.akdiscovery.com) Offers eight-day hiking tours (US\$3695) and 12-day rafting tours (US\$4150) in the ANWR.

Arctic Kingdom (☎ 416-322 7066; www.arctickingdom.com) Runs two-week wildlife-spotting trips to Arctic Bay, one of most prolific areas of wildlife in the Arctic; two-week ice-climbing trips to Pond Inlet; and 10-day trips to Igloodik. Trips include the possibility of scuba diving, ice diving or snowmobiling. Tours cost US\$5500 to US\$8300. Individual itineraries and custom rock- and ice-climbing expeditions can also be arranged.

Arctic Treks (☎ 907-455 6502; www.arcticreksadventures.com) Adventurous rafting, hiking and fishing wilderness trips in Arctic Alaska's national parks and preserves. Seven- to 10-day trips cost US\$2575 to US\$3475.

Black Feather Trailhead (☎ 705-746 1372; www.blackfeather.com) Offers comprehensive canoeing, kayaking and hiking trips across Canada's Yukon and Northwest Territories. Sample trips include a 10-day canoe trip on the Nahanni, Coppermine and Hood Rivers (C\$3095); two weeks kayaking in Greenland and the High Arctic (C\$3495 to C\$4495); and hiking on Ellesmere and Devon Islands, in Auyuittuq National Park and Greenland (two weeks from C\$5895). It also does tailor-made trips.

Canadian Arctic Holidays (☎ 877-272 8426; www.canadianarctic.holidays.ca) Adventurous outfitter offering one-week ski trips to the North Pole (€16,500), two-week ski tours of Ellesmere Island (C\$6500), one-month ski tours from the North Pole to Ward Hunt Island (US\$29,900) and eight-day snowmobile polar-bear viewing trips (C\$3900).

Global Expedition Adventures (☎ 850-217 9974; www.north-pole-expeditions.com) North Pole specialist offering 11-day skiing expeditions to the North Pole (US\$15,000), sky-diving at the North Pole (US\$9400) and champagne flights to the Pole (US\$8000).

Mountain Spirits (☎ 208-788 2344; www.mountainspirits.com) Organises one-week heliskiing (US\$10,000) and ski-touring trips (US\$4000) to Maniitsoq in West Greenland. Two-week summer trekking, sea kayaking, fishing and glacier exploration costs US\$2500 per week.

ICEBREAKERS – THE NORTH POLE & THE NORTHEAST & NORTHWEST PASSAGES

Once the preserve of those on secretive Cold War missions, travel on a Russian icebreaker is now possible for anyone with enough cash and a sense of adventure. These specially designed ships have reinforced bows and powerful engines that allow them to cut through pack ice by riding up onto the surface of the ice on their rounded keels and then crushing it with their weight. When the ice is particularly thick, the vessel rams its way through. On a North Pole voyage in 1998, one Russian icebreaker encountered a 12m-high pressure ridge in the pack ice that required 28 attempts before the ship was able to break through.

Most icebreakers operating today are diesel powered, though some nuclear-powered vessels, which can stay at sea for longer periods, also operate in the northern seas. The largest of these is the Arktika class: 150m long, 55m tall and boasting 75,000HP engines. Working icebreakers are used to keep open the Northern Sea Route, a shipping lane that links Russia's northernmost ports. The Canadian and American icebreaker fleets also maintain shipping lanes through ice-choked waters during winter, particularly in connection with the developing oil and gas industries in the Arctic Ocean.

Tourist travel on icebreakers includes cruises to Svalbard, Greenland and the Bering Strait, crossings from Alaska to easternmost Russia, 'circumnavigations' of the Arctic, and the grinding two-week voyage to the North Pole. Accommodation is in the comfortable if relatively basic cabins originally designed for senior officers and crew. Chefs and imported food provide sustenance, and passengers are generally welcome on the bridge. Trips to the Pole cost from about US\$15,000 per person for a shared cabin, including some helicopter or Zodiac tours.

Even at this price, attaining the Pole can never be guaranteed. In a heavy ice year not even 75,000HP engines can cut a path to the top of the world. However, few who invest in a shipboard trip to the Arctic are disappointed. You'll still see deeply crevassed glaciers tumble into still, blue-green fjords and desolate mist-swathed islands occupied only by birds and seals. You'll become mesmerised by the great white space and its distances, and spend hours watching your ship plough through 1m-thick ice like a knife through butter – a truly unique experience.

Nahanni Wilderness Adventures (☎ 403-637 3843; www.nahanniwild.com) Runs white-water rafting and canoeing trips; samples are a 21-day trip on the Nahanni River (C\$4495) and a two-week canoeing or rafting trip on the Coppermine, Hood and Thelon Rivers (C\$4195 to C\$5035).

NorthWinds (☎ 867-979 0552; www.northwinds-arctic.com) Runs serious Arctic adventures, such as 30-day kiting (C\$14,000) and 28-day dogsledding expeditions in Greenland (C\$14,000). Trips to the North Pole include a 60-day skiing expedition and a 52-day skiing and dogsledding trip. Pole trip costs (C\$250,000 to C\$350,000) are divided among the tour participants. Each tour has a maximum of six participants.

Sourdough Outfitters (☎ 907-692 5252; www.sourdoughoutfitters.com) Wilderness trips in Gates of the Arctic and Noatak National Parks, and in the ANWR, including nine-day backpacking, fishing and canoeing trips (US\$2700), five-day caribou-viewing trips (US\$2595), and 11-day dogsledding trips (US\$3995).

Whitney & Smith Legendary Expeditions (☎ 403-678 3052; www.legendaryexp.com) Operates guided trips with an emphasis on Inuit culture and Arctic wildlife. Two-week options include Greenland dogsledding and kayaking (C\$7300 to C\$14,000), hiking and kayaking on Ellesmere Island (C\$4995 to C\$5995), and kayaking the Thomson River on Banks Island (C\$6195).

Russia

K2 (☎ 3812-693075; http://extreme.k2.omsknet.ru/eng) A small but very reliable adventure-travel agency that concentrates on the Altay region but also has projects on the Putorana Plateau. Offers 11-day rafting trips (US\$980), 12-day trekking trips (US\$845), and 18-day climbing and trekking trips (US\$780).

Kola Travel (☎ 287 1311; www.kolatruvel.ru) Dutch-run tour agency based in Monchegorsk offering treks into the Lapland biosphere reserve (€245 to €893).

Sakha Tourist Agency (☎ 41122-422652; www.yakutia.travel.com) Arranges Lena River tours and homestays in villages right across Sakha including Tiksi.

Tours to Russia (☎ 095-921 8027; www.tourstorussia.com) This Moscow-based company offers 18-day rafting adventures in Chukotka (US\$1600).

Scandinavia

Hvitserk (☎ 2412 6230; www.hvitserk.no) Offers three- and four-week tours across the Greenland icecap on skis or by dogsled (price on application), and two-week expeditions to climb East Greenland's GUNNBjørnsfjeld (€7500) and Mt Vinson.

Nonni Travel (☎ 461 1841; www.nonnitravel.is) Greenland expeditions from Ittoqqortoormiit, including 10-day

dogsledding trips (€2795), 10-day kayaking trips (€4880), two-week kayaking trips from Ammassalik (€3600) and expedition support for trips to the Northeast Greenland National Park.

Pasvik Tours (www.nonnitavel.is) Norwegian agency specialising in cross-border trips into the Kola Peninsula (five-day trips cost from Nkr6500).

Spitsbergen Travel (☎ 7902 6100; www.spitsbergen.travel.no) Svalbard travel specialist offering one-week adventure cruises to the northwest (Nkr7100), one-week expedition cruises to the northeast (Nkr18,300), 12-day cruise-and-trekking trips (Nkr16,600), two-week expeditions to Mount Newton (Nkr20,500), four-day winter snowmobile tours (Nkr14,200), five-day winter dogsledding tours (Nkr10,300), and 12-day summer cross-country skiing tours (Nkr16,800).

Svalbard Wildlife Service (☎ 7902 5660; www.wildlife.no) In addition to booking a range of day tours from Longyearbyen in Svalbard, this agency operates three-day snowmobile excursions to the east coast (Nkr9200), one-week winter skiing and snowmobiling expeditions to the Atom Mountains (Nkr21,500), one-week summer skiing tours from Longyearbyen to Ny Ålesund (Nkr13,200), eight-day summer hiking trips (Nkr12,800) and four-day kayaking tours (Nkr7350).

Topas Travel (☎ 868 9362; www.greenland-discoverer.com) Minimum-impact tours in Greenland, including a two-week crossing of the icecap (€2600), two-week trekking trips (€1984 to €2532), and 10-day kayaking and dogsledding trips (€2233 to €2600).

Tuning Incoming Agency (☎ 299-981650; www.tuning-greenland.de) Highly recommended ecoconscious sustainable-tourism company offering tailor-made hiking, skiing, kayaking, dogsledding, mountaineering and boat tours in East Greenland with local and international guides.

Ultima Thule (☎ 567 8978; www.ute.is) Organises wilderness sea-kayaking trips through the fjord systems and by the incredible glaciers of East Greenland (US\$1690 to US\$4100).

Other FRANCE

Grand Nord Grand Large (☎ 01-40 46 05 14; www.gngl.com, in French) This wonderful French company operates a mind-boggling host of adventure tours focusing on remote locations throughout the far north. Sample trips include one-week wildlife watching in Pangnirtung (€2250), 16-day descents of the Porcupine River (€2195) and 10-day tours of Svalbard (from €2500).

Polar Circle Expeditions (☎ 01-48 08 64 94; www.polarcircle.com) North Pole specialist offering a fly-in champagne trip (US\$8000) and a one-week ski-the-last-degree trip (US\$10,000).

GERMANY

Polar Travel (☎ 8105-22909; www.polar-travel.de) Runs 18-day trips through remote fjords of East Greenland (€3115), 17-day North Greenland dogsledding expeditions (€6495), 17-day summer expeditions in Thule (€3850), 22-day tours of Kamchatka (€2990), and trips around Svalbard (nine days €3995, 17 days €6995). Those wishing to take part in extreme trips will need to join a shorter trip first as a test of suitability.

NETHERLANDS

Finslapland (☎ 020-6110762) Expert one- to 12-day cross-country skiing treks through the wilds of northern Finland and Russia to meet local Sami people and live off the land (€598 to €1275).

UK

Arctic Experience (☎ 01737-218801; www.arctic-experience.co.uk) Has an extensive list of tours to Arctic Scandinavia and Greenland, including 16-day treks (€2357), 10-day kayaking trips (£2111), 20-day crossings of the Greenland icecap (£2357) and six-day dogsledding trips (£1376). Other tours include wildlife encounters, ice hotel trips, northern lights trips, tailor-made excursions, and rafting, fishing and horse riding in Scandinavia.

Arcturus Expeditions (☎ 01389 830204; www.arcturus.expeditions.co.uk) Highly recommended company offering cruises to Svalbard, Greenland, Russia's far east, Wrangel Island, the Northwest Passage, the Canadian High Arctic, Ellesmere Island and Franz Josef Land; dogsledding and skiing trips to Scandinavia, Kamchatka and the North Pole; and walking, trekking and sea-kayaking tours. Sample prices are £1850 for nine days of dogsledding in Lapland, £2950 for a 10-day trip with Inuit hunters in East Greenland and £1990 for a nine-day cruise of north Svalbard.

Tangent Expeditions (☎ 015395 737757; www.tangent-expeditions.co.uk) Mountaineering specialist focusing on lesser-known or unnamed peaks and first ascents. One-week climbing expeditions cost £2950 to £6950 in Greenland, and £3950 to £7750 on Ellesmere and Baffin Islands. The company also runs Greenland icecap crossings (£4950 to £7450), ski-touring and mountaineering expeditions to Svalbard (£3200), last-degree skiing trips to the North Pole (£10,000 to £12,000), and various dogsledding tours.