aurora expeditions

Antarctic Primer

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To anyone who goes to the Antarctic, there is a tremendous appeal, an unparalleled combination of grandeur, beauty, vastness, loneliness, and malevolence —all of which sound terribly melodramatic — but which truly convey the actual feeling of Antarctica. Where else in the world are all of these descriptions really true?

—Captain T.L.M. Sunter, 'The Antarctic Century Newsletter

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Adélie penguins in the Antarctic Peninsula

I. CONSERVING ANTARCTICA

Antarctica is the largest wilderness area on earth, a place that must be preserved in its present, virtually pristine state. Many governments and non-governmental organizations - and all the principal companies arranging tourist expeditions to the region – are working together to ensure that Antarctica's spectacular scenery, unique wildlife and extraordinary wilderness values will be protected for future generations to enjoy.

Expeditions to these fragile and unique habitats are operated in an environmentally responsible manner. Aurora Expeditions and other members of the International Association of Antarctica Tour Operators (IAATO) adopted a voluntary code of conduct for visitors to Antarctica. This action by the tour operators met with widespread approval, and led to adoption of the following guidelines by the Antarctic Treaty parties.

These internationally agreed guidelines apply to all visitors to Antarctica, including scientists and support staff working for governmental research programs, as well as participants on organized cruises and other expeditions, and individual visitors. The essential provisions are already reflected in national laws, or soon will be, so violations may be subject to legal sanctions – including fines or even imprisonment.

The leaders and staff on your expedition are familiar with these guidelines and will explain the reasons behind them. They will help you to adhere to them. But you, too, have a part to play.

By encouraging your fellow visitors to follow your own environmentally-conscious behaviour, you will help us to ensure that Antarctica will remain pristine for the enjoyment of future generations.

We appreciate your cooperation.

Guidance for Visitors to the Antarctic

Activities in the Antarctic are governed by the Antarctic Treaty of 1959 and associated agreements, referred to collectively as the Antarctic Treaty System. The Treaty established Antarctica as a zone of peace and science.

In 1991, the Antarctic Treaty Consultative Parties adopted the Madrid Protocol on Environmental Protection to the Antarctic Treaty, which designates the Antarctic as a natural reserve. The Protocol sets out environmental principles, procedures, and obligations for the comprehensive protection of the Antarctic environment, and its dependent and associated ecosystems. It also prohibits either searching for or extracting mineral resources (to be reviewed in 2041). The Madrid Protocol entered into force in 1998. As of 2013, 34 countries have ratified the articles of the protocol. Another 11 countries have signed but not ratified it.

The Environmental Protocol applies to tourism and non-governmental activities, as well as governmental activities in the Antarctic Treaty area. It is intended to ensure that these activities do not have adverse impacts on the Antarctic environment, or on its scientific and aesthetic values.

This Guidance for Visitors to the Antarctic is intended to ensure that all visitors are aware of, and therefore able to comply with, the Treaty and the Protocol. Visitors are, of course, bound by their own national laws and regulations applicable to activities in the Antarctic.

Protect Antarctic Wildlife

Taking or harmful interference with Antarctic wildlife is prohibited except in accordance with a permit issued by a national authority.

- Do not use aircraft, vessels, small boats, or other means of transport in ways that disturb wildlife, either at sea or on land.
- Do not feed, touch, or handle birds or seals, or approach or photograph them, in ways that cause them to alter their behavior. Special care is needed when animals are breeding or molting.
- Do not damage plants, for example by walking, driving, or landing on extensive moss beds or lichen-covered scree slopes.
- Do not use guns or explosives. Keep noise to the minimum to avoid frightening wildlife.
- Do not bring non-native plants or animals into the Antarctic, such as live poultry, pet dogs and cats, or house plants.
- Currently the use of UAVs/Drones is prohibited for recreational use. This is being reviewed each year so the policy may change. Any use of drones requires an appropriate permit from your national Antarctic authority.

Respect Protected Areas

A variety of areas in the Antarctic have been afforded special protection because of their particular ecological, scientific, historic, or other values. Entry into certain areas may be prohibited except in accordance with a permit issued by an appropriate national authority. Activities in and near designated Historic Sites and Monuments and certain other areas may be subject to special restrictions.

- Your expedition guides will advise you of the location of areas that have been afforded special protection and what restrictions regarding entry and activities apply.
- Observe applicable restrictions.
- Do not damage, remove, or destroy Historic Sites or Monuments or any artefacts associated with them.

Respect Scientific Research

Do not interfere with scientific research, facilities, or equipment.

- Obtain permission before visiting Antarctic science and support facilities, reconfirm arrangements 24–72 hours before arrival, and comply with the rules regarding such visits.
- Do not interfere with, or remove, scientific equipment or marker posts, and do not disturb experimental study sites, field camps, or supplies.

Be Safe

Be prepared for severe and changeable weather and ensure that your equipment and clothing meet Antarctic standards. Remember that the Antarctic environment is inhospitable, unpredictable, and potentially dangerous for the unprepared.

- Know your capabilities, the dangers posed by the Antarctic environment, and act accordingly. Plan activities with safety in mind at all times.
- Keep a safe distance from all wildlife, both on land and at sea.
- Take note of, and act on, the advice and instructions from your leaders; do not stray from your group or designated area.
- Do not walk onto glaciers or large snow fields without the proper equipment and experience; there is a real danger of falling into hidden crevasses.
- Do not expect a rescue service. Antarctica is remote and rescue is very difficult. It is important to reduce risks with sound planning, quality equipment, and trained personnel.
- Do not enter emergency refuges (except in emergencies). If you use equipment or food from a refuge, inform the nearest research station or national authority once the emergency is over.
- Respect any smoking restrictions, particularly around buildings, and take great care to safeguard against the danger of fire. This is a real hazard in the dry environment of Antarctica.

Lemaire Channel , Antarctic Peninsula

Keep Antarctica Pristine

Antarctica remains relatively pristine, the largest wilderness area on earth. It has not yet been subjected to large scale human perturbations. Please keep it that way.

- Do not dispose of litter or garbage on land. Open burning is prohibited.
- Do not disturb or pollute lakes or streams. Waste must be disposed of properly.
- Do not paint or engrave names or graffiti on rocks or buildings.
- Do not collect or take away biological or geological specimens or man-made artefacts as souvenirs, including rocks, bones, eggs, fossils, and parts or contents of buildings.
- Do not deface or vandalize buildings, whether occupied, abandoned, or unoccupied, or emergency refuges.

Antarctica's Historic Heritage

The oldest buildings in Antarctica are the two huts of the Borchgrevink expedition of 1899, while the other huts of the Heroic Age date from the period 1901–1912. They are all designated Historic Monuments, and strict rules apply to visiting them. The huts at Cape Adare, Hut Point, Cape Evans, and Cape Royds are locked, for security reasons, and can only be visited with a designated guide, normally provided through the New Zealand Antarctic Program Conservation and restoration work at the above sites are undertaken by the Antarctic Heritage Trust, a private charitable organization. Those wishing to contribute to the cost of maintaining these important sites are welcome to do so by writing to: The Administrator, Antarctic Heritage Trust (NZ), Private Bag 4745, Christchurch Airport, Christchurch, New Zealand. Tel: +64 3 358-0200.

Visitors to the Cape Denison Historic Site (Mawson's Hut) must follow official Visitor Guidelines. None of the huts may be entered. For further information, contact The Australian Antarctic Division, Channel Highway, Kingston, Tasmania 7054, Australia. Tel: +61 3 6232 3209.

Captain Robert Scott's hut, Cape Evans, Antarctica

1. Abandoned huts, refuges, and supply depots in other parts of Antarctica are much more recent in origin. Nevertheless, they may also be of great historical interest. They are normally the responsibility of the relevant national governments. However, the UK Antarctic Heritage Trust helps the New Zealand Antarctic Heritage Trust to preserve the Scott and Shackleton huts, and preserving at least two early British scientific stations in the Antarctic Peninsula region. For information or to make contributions, contact: The U.K. Antarctic Heritage Trust (www.heritage-antarctica.org).

South Georgia

South Georgia is another area of great importance. It is sovereign territory of the UK, so it is not covered by the Antarctic Treaty or the Madrid Protocol. Instead the UK government has similar regulations for protecting the environment and the same IAATO rules apply to visitors there. Your expedition team will brief you on a few additional restrictions that apply in South Georgia. The South Georgia Heritage Trust (SGHT) works to preserve the island's natural and historical heritage for future generations. One important aspect of South Georgia is that after 200 years of decimation by introduced rats, the island was declared rat free recently.

Biosecurity

Because of the importance and pristine nature of the Antarctic environment, IAATO has developed a series of procedures to prevent the introduction and spread of introduced species. South Georgia is also concerned for its biosecurity, especially to avoid re-introducing rats. Every visitor to Antarctica will be asked to clean all of their clothing and equipment and vacuum out their day packs to prevent the introduction of seeds. In addition, before and after every shore excursion you will be required to wash your boots in a disinfectant to prevent the possible spread of disease between landing sites. In South Georgia you will also be asked not to put backpacks on the ground or leave them open when you go on shore. You expedition team will explain all these procedures before you begin your landings.

Sunrise Dhainaut Island, Antarctica © E.Evans

II. THE PHYSICAL ENVIRONMENT

Antarctica

There is no single definition of the Antarctic, though the phrase 'The Antarctic' generally means the continent of Antarctica, together with its surrounding ice shelves, islands, and seas. In geo-political terms, the Antarctic encompasses the whole area south of the 60th parallel, which is the area to which the Antarctic Treaty applies.

The word 'Antarctica' is sometimes used to mean just the continent itself. From a scientific point of view, the oceanographic and biological boundary formed by the Antarctic Convergence might be the most appropriate outer limit. The Antarctic Circle (at latitude 66° 33'S) is not very useful in this respect, since some parts of the continent itself are north of this line.

Antarctica is the fifth largest continent with an area of roughly 14 million square kilometers (5.3 million square miles). Most of this area, however, is made up by a vast permanent ice sheet averaging 2,000 meters (6,600 feet) in thickness. Only about two percent of the total landmass is ice free, as mountains and coastlines.

The continent is divided into two parts. The largest, semi-circular part is called Greater (or East) Antarctica, and much of its edge lies conveniently along the Antarctic Circle in the Atlantic, Indian, and western Pacific Ocean sectors. The curved tail, which is made up of an expanded land mass at its base known as Lesser (or West) Antarctica and a long narrow Antarctic Peninsula, extends some 1,200 kilometers (744 miles) towards the southern tip of South America and is located in the eastern Pacific Ocean sector.

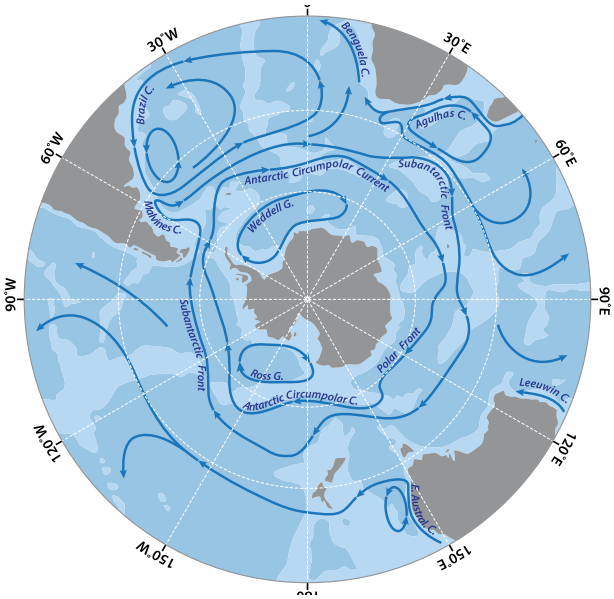
Greater Antarctica is mostly covered by ice, but in some coastal areas jagged mountains project through this covering. The Antarctic Peninsula, on the other hand, is a long chain of alpine mountains, topped by an ice plateau and sculpted by many active glaciers. Most of the coastline consists of ice cliffs, but some areas, particularly on the Pacific Ocean side, consist of exposed rocky shorelines.

The Southern Ocean

The Southern Ocean consists of a broad band of generally turbulent surface water surrounding Antarctica. Its northern limit is about 40°S latitude. Persistent westerly winds create a strong surface current called the Antarctic Circumpolar Current (ACC) or the West Wind Drift. This current moves massive amounts of water from west to east all around Antarctica. This involves water from the surface down to about 3,000 meters (9,900 feet) stretching over a distance of some 24,000 kilometers (14,200 miles). Some 130 million cubic meters of water per second are continuously on the move, four times that of the Gulf Stream, and 400 times that of the Mississippi.

Farther south, close along the coast of the continent, easterly winds cause a westward-flowing current– the East Wind Drift. Along much of the coast, particularly East Antarctica, this is a relatively narrow band, but where it is deflected by deep embayments, such as the Weddell, Bellingshausen, and Ross Seas, it forms clockwise gyres that become important in how ice travels through the system.

The Southern Ocean is also important as a driver of the entire worlds ocean systems. During the seasonal cycle Antarctica nearly doubles in size as a massive area of sea around the continent freezes in the winter. As that sea ice forms, much of the salt in the sea water is excluded from the growing ice crystals resulting in the water just below the forming ice becoming much more saline. This salty and cold water is heavier than the surrounding water and huge amounts sink around the continental slope and becomes the Antarctic bottom water current. When that hypersaline cold water sinks from the surface, mid-level water is pulled up at the coast as upwellings to replace it and a current spreads outward from the coast. This surface current is a north flowing current that radiates our from the coast. As it travels north, it eventually encounters the warmer subantarctic water to form the Antarctic Convergence.



Map of the Antarctic Circumpolar current

A ship sailing south to Antarctica will encounter a sharp drop in temperature between 49° and 55°S latitude. Both the water temperature and the air temperature normally drop a few degrees. At that point one can usually detect subtle changes in both the ocean and the atmosphere. This is the Antarctic Convergence, a zone that surrounds the continent. During the southern summer, the sea temperature may drop from 7°C to 3°C (45°F to 37°F) at the convergence. During winter months the difference in sea temperatures may be as great as 10°C (18°F).

Antarctic Convergence

The Antarctic Convergence is a natural boundary between the relatively warm subantarctic surface water and the cold Antarctic surface water. Here cold, dense Antarctic surface water dives beneath the warmer waters coming from the north without much mixing. The location of the convergence is not a precise line, but varies slightly throughout the year or from year to year, or even century to century. Because there is so little mixing of the currents, the Convergence is characterised by that relatively sharp change in temperature (and salinity) making the zone of convergence an important biological boundary. The Convergence effectively isolates the surface waters of Antarctic and influences the distribution of plankton, fish, and birds. The species found are quite different as one travels across it.

The water south of the convergence is often referred to as the Antarctic Ocean. This covers an area of about 35,000 square kilometers (13,500 square miles) or 10 percent of the world's oceans. It contains the coldest and densest water on earth and is notable for its high biological productivity. It plays a major role in influencing oceanic circulation in the southern hemisphere, and indeed in governing the climate of the planet.

Antarctic waters run deep. Much of the water around Antarctica is more than 3,000 meters (9,900 feet) deep. The deepest trough in the Atlantic sector, located east of the Scotia Arc, is 8,000 meters (26,400 feet) deep.

Three water layers

The Antarctic Ocean is made up of three distinct masses of water in different layers which differ in their temperatures, salinities, and directions of flow. The three sandwiched layers are driven by westerly winds in constant, eastward-flowing spirals around Antarctica. The upper and lower layers also move gradually northward, carrying cold waters from the Antarctic to the tropics, while the middle layer flows southward (replacing the water lost to the other two currents) and brings nutrients and warmer water from temperate and tropical regions.

Antarctic surface water

The top layer, or Antarctic surface water, is the water which most directly affects Antarctic plants and animals. It originates at the Antarctic Divergence, the narrow zone of upwelling in the most southerly waters near the continent. This layer is constantly chilled by ice and cold air from the continent. In winter it remains below -1°C (30°F), but for a short time in the summer it may warm up to about 3°C (37°F) near its northern boundary at the convergence. The Antarctic Surface Water is characterized by low temperature and low salinity caused by summer melting of sea ice and icebergs.

As the Antarctic surface water reaches the Antarctic Convergence it comes into contact with the warmer and saltier subantarctic surface water. There is very little mixing between these two bodies of water. At the point of contact the Antarctic water sinks below the subantarctic water and continues moving northward with a new name—the Antarctic Intermediate Current. This current cools the coasts of New Zealand, southern Australia, and many oceanic islands. It can still be detected north of the equator in the Atlantic Ocean.

Warm deep water

The middle water layer, or Warm Deep Current, is a southward flowing water mass originating from the surface waters of the Atlantic, Pacific, and possibly Indian oceans. This current wells up at the Antarctic Divergence and is characterized by a high salinity and a relatively high temperature. When this water layer reaches the surface it cools. Some of it takes on a lower salinity and begins to move back northwards as the Antarctic surface water.

Antarctic bottom water

The remainder of the Warm Deep Current water is pushed toward the continent where it becomes much colder. It then sinks down along continental slope and flows away from Antarctica along the ocean floor in a northward direction as the lower layer of the sandwich, or Antarctic bottom water. This water has a low temperature (-0.5°C or 31°F) and high salinity, and spreads very far into the Atlantic and Pacific Oceans carrying south polar water into the northern hemisphere.

THE CRYSTAL DESERT: SUMMERS IN ANTARCTICA.

Campbell, David. 1992. Boston: Houghton Mifflin, 308 pp.This splendid portrait of Antarctica, the land and history — and especially its marine life — was written by a biologist who worked three summers at Admiralty Bay on King George Island.

The Continent

Taking the ice cap into account, Antarctica is the highest of the world's continents. The highest peak is at Vinson Massif (4897 meters or 16 067 feet) in the Ellsworth Mountains near the coast of the Weddell Sea in Lesser Antarctica. There are many mountains over 3000 meters (9900 feet), but most are smothered by ice. The ice sheet covering most of Greater Antarctica reaches a height of 4200 meters (13 860 feet), while the ice plateau of Lesser Antarctica has an average elevation of less than half that height.

The Transantarctic Mountains – the most extensive mountain system in Antarctica – stretches for over 4,000 kilometers (2,500 miles) from Coats Land on the Weddell Sea to Victoria Land on the Ross Sea, on the opposite side of the continent. The central section is exposed for nearly 2,000 kilometers (1,240 miles) where it holds back the huge ice sheet. However, some of the glaciers manage to flow over the range and eventually merge into the Ross Ice Shelf.

Gentoo penguins, Antarctic Peninsula © G.Miller

Enormous mountain ranges in Greater Antarctica and along the coastal areas of the Atlantic and Indian Ocean sectors are mostly covered by the ice sheet. But some do appear as isolated peaks and rock cliffs in the ice. These isolated peaks are called nunataks, a word of Inuit origin.

Between these vast mountain ranges are extensive low-lying plains and basins, which are covered by some of the thickest ice on the continent. The South Pole itself is 2,800 meters (9,240 feet) above sea level on top of a layer of ice of about that same thickness. The underlying bedrock is almost at sea level. In some areas of Greater Antarctica the bedrock has been depressed well below sea level by the weight of the overriding ice.

It appears that much of the Antarctic bedrock has been depressed by several hundred meters due to the sheer weight of ice lying above it. According to some studies, if the ice covering were to be removed completely, Greater Antarctica would rise by 1,000 meters and Lesser Antarctica by 500 meters. At the same time, the water produced by melting ice would raise the level of the earth's oceans by about 60 meters (200 feet), flooding huge areas of the world.

Geology

Antarctica's geology has not been studied in nearly such great detail as other parts of the world, for the very good reason that so little of its surface is free of permanent ice. Only in the last few decades have seismic and radio-echo sounding techniques enabled scientists to obtain an idea of what lies beneath the ice.

Greater Antarctica

Greater Antarctica is basically a giant shield of metamorphic rocks dating from Precambrian and early Paleozoic times, as much as 3,800 million years ago. This basement rock contains more recent intrusions, and is overlain by sedimentary rocks in many areas. Basement rocks are exposed in Queen Maud Land and the coastal mountains in the Indian Ocean sector. The younger sedimentary rocks, or Beacon Series, were formed from marine muds, estuarine and fresh water deposits, shales, coal measures, and desert sandstones dating from 400 to 200 million years ago.

The Beacon Series is about 2,500 meters (8,250 feet) thick, and is best seen in the Transantarctic Mountains which were uplifted within the last 35 million years. One can see numerous layers of dark dolerite which were injected long after the sandstone was formed. The fossils of freshwater fish, reptiles, and certain kinds of vegetation confirm that this area once had a temperate climate.

Lesser Antarctica

Lesser Antarctica and the Antarctic Peninsula are much younger, dating from only about 200 million years ago. Together they consist primarily of two separate mountain ranges made up of metamorphosed sedimentary rocks that were formed in deep sea and contain beds of volcanic ash and lava intrusions. The alpine mountain range forms the Antarctic Peninsula and extends

from the tip of the Peninsula to Lesser Antarctica, but disappears under the ice of Ellsworth Land and Marie Byrd Land where it becomes much more widespread. Many of the mountains in this range extend above the ice and form the isolated peaks and outcrops which are seen today in Lesser Antarctica. Many of these mountains are small, detached crustal plates that were probably once parts of the larger supercontinent called Gondwana. A second line of mountains runs along the north-western coast of the peninsula which forms Adelaide Island, the Biscoe Islands, the Palmer Archipelago, and the South Shetland Islands. A chain of islands and the connected sea floor ridges link the South Shetland Islands with the South Orkney Islands, the South Sandwich Islands, South Georgia Island, and the South American continental shelf. This area is referred to as the Scotia Arc, which has a long history of volcanic activity and earth movements. Here the earth's crust is divided into a complex series of tectonic plates.

The mountains of Lesser Antarctica display a tremendous amount folding, uplifts, and erosion and deposition, starting in Precambrian times. During the late Cretaceous or early Tertiary (70 to 60 million years ago) violent upheavals and volcanic activity lifted both the archipelago and the islands of the Scotia Arc. This pronounced volcanic activity continued until about 35 to 40 million years ago.

Several islands in the South Shetlands (e.g. Deception Island) and the South Sandwich group (Zavodovski) are volcanically active even today, and much of Lesser Antarctica still commonly experiences earthquakes. Greater Antarctica is more stable, but it does have two very confined areas of volcanic activity (Mount Erebus on Ross Island and Mount Melbourne in Victoria Land). Fossils found in the Antarctic Peninsula, southern South America, Tasmania and other areas provide evidence of continental drift, and reveal how all of these regions were joined together in the past to form the supercontinent known as Gondwana. Amongst fossil finds are an extinct marsupial called Polydops (also known from Patagonia), extinct penguin species, tree ferns, and cycads like palm trees. Fossilized pollen grains have been found from trees similar to the southern beech (which is found today in Tierra del Fuego and Tasmania), and the monkey-puzzle tree (a native of Chile).

Different poles

The South Pole that is referred to in everyday conversation is the Geographical South Pole, which is the southernmost end of the earth's rotational axis (the earth rotates around a line, or axis, drawn between the north and south geographical poles). But there are other 'poles' of interest to scientists.

The magnetic South Pole was first reached during Shackleton's British Antarctic Expedition (1907–1909) by Professor Edgeworth David and Sir Douglas Mawson (Australian geologists) and Alistair Mackay who claimed the surrounding Victoria Land for the British Crown. At that time the magnetic pole lay within the Antarctic continent at latitude 71.6°S and longitude 152°E. As of 2015 the pole lay far out to sea at latitude 64.28°S and longitude 136.59°E and travels 10 to 15 km north-westerly each year. Electric currents and the rolling motion of the liquid iron core of the Earth dictate the position of the magnetic poles. The pole wanders daily in a roughly elliptical path around this average position, and may be as far as 80 km away from this position when the Earth's magnetic field is disturbed.

The Pole of Relative Inaccessibility is the center of the continent as measured by its distance from the coasts. It is located at latitude 82° 06'S, longitude 54° 58'E, also in the Australian sector. The Russian Vostok Station is sited near the pole of inaccessibility.

AMUNDSEN SCOTT STATION

The United States built the first Amundsen Scott Station at the South Pole in 1956.

Set on the Antarctic Ice Sheet, the station moves about 30 feet per year with the ice sheet. Now on its third incarnation, the newest station was inaugurated in 2008. It was built 'upstream' from the geographic South Pole so that it will cross over the pole in the coming years.

Climate

Weather observations have been a mainstay of Antarctic research since the first explorers brought scientists to study the mostly unknown continent. The first permanent weather station was set up on Laurie Island in the South Orkney Islands by William Spiers Bruce on the Scottish National Expedition. That site remains the longest continuous record of weather in Antarctica. Widespread and detailed information on Antarctica's climate is relatively recent, however. Harking back to the International Geophysical Year or 1957-1958 when many countries cooperated to set up scientific stations all around the continent. Many of those stations became permanent and today, meteorological research is an important part of the work – sometimes the main work – of almost every station in the region and data is accumulating rapidly.

The main factors influencing the climate of Antarctica are the waters of the Southern Ocean, the seasonal variations of sea ice, the ice sheet that covers the continent itself, and its high altitude and high (southern) latitude. There are considerable climatological differences between the sea, the coastlines, and the interior. For instance, the Southern Ocean has most clouds, followed by Lesser Antarctica, while Greater Antarctica, with its high, arid plateau, has the least cloud cover. The key points to bear in mind are that Antarctica is extremely cold, dry, and windy, with little precipitation.

Antarctic Sound ©E.Evans

The coldest continent

Antarctica is the coldest continent. Mean temperatures in the interior during August (the coldest month) range from -40° to -70°C (-40° to -94°F) and in the warmest month (February) range from -15° to -45°C (5° to -49°F). The lowest outdoor temperature ever recorded on earth is -89.6°C (-129.3°F), which was recorded in 1983 at the Russian Vostok station on the inland ice cap. In 2010, satellite data measured a surface temperature of -93.2°C (-135.8°F) by remote sensing. So colder temperatures may still be possible. At sea level, Antarctic temperatures are some 10°–17°C (50°–63°F) colder than in the Arctic.

Nevertheless, there are considerable variations. At the subantarctic islands, for example, temperatures may range from about – 40°C in midwinter (August) to +14°C in January or February (-40° to +57°F).

The windiest continent

Antarctica is also the windiest of the continents. Antarctica creates its own wind systems. Cold dense air essentially slides from the high interior ice fields towards the lower areas along the coasts. At the edges of the ice plateau the winds accelerate, thereby lifting and blowing clouds of snow high into the air. The strongest winds are habitually found on the long coastal slopes of Greater Antarctica.

Some coastal areas endure almost constant strong winds, whereas other areas may be quite calm much of the time and then suddenly experience hurricane force winds as air rushes down through glacial valleys. These sudden and unexpected winds are called katabatic, or down slope, winds.

The famous Australian explorer Douglas Mawson established a base at Cape Denison, Commonwealth Bay, in 1912 and recorded wind speeds for two years. This is reputed to be the windiest place on earth, because the average wind speed during that period was 72 kilometers per hour (45 miles per hour), and gusts of more than 240 kph (150 mph) were common. Nevertheless, wind speeds have been observed to drop very significantly just a few miles away from the coast.

Visitors to Antarctica should be aware that katabatic winds can occur quite suddenly, and with little warning, but then die down again just as quickly. They create dramatically low effective temperatures, due to the wind-chill factor.

In the Southern Ocean, strong gale-force winds are quite common, especially in the region between 40°S and 60°S. These cyclonic storms are caused by extremely cold air coming from Antarctica meeting the relatively warm and moist air over more northerly seas. This accounts for the fearsome reputation of the Drake Passage. The storms tend to circle Antarctica from west to east.

The driest continent

Surprisingly, Antarctica is the driest continent. By definition, most of the continent is a desert. There is very little precipitation each year in the interior, and the vast amount of ice and snow which make up the polar ice cap has accumulated over many millions of years. The mean annual accumulation for the entire continent amounts to less than five centimeters (two inches) of water equivalent, which is just slightly more than that of the Sahara Desert.

Some coastal areas, particularly the west side of the Antarctic Peninsula, receive much more precipitation. The tip of the Peninsula receives about 90 centimeters (35 inches) of water equivalent each year. Thanks to global warming, places in the peninsula and the South Shetland Islands now receive rain, sometimes quite heavily during most summers.

The harshest areas of Antarctica's climate is found on the high central plateaus of Greater Antarctic and along its coasts. Visitors to the Antarctic Peninsula region need not expect very bad weather as a matter of course. Crossings of the Southern Ocean can be quite easy and severe storms are infrequent in the southern summer months. The narrow waterways of the Antarctic Peninsula are quite protected. Likewise, sunny days are rather common in Greater Antarctica and the sun even shines among the subantarctic islands and Antarctic Peninsula. Although visitors should be prepared for cold weather at any time, it is surprising how often it can seem almost too warm to wear a parka. The average summer temperature is near freezing. Visitors to the peninsula typically experience temperatures that range from -2° to 10 °C (28.4°-50°F), though windy conditions can make it feel colder.

Atmospheric phenomena

Pillars, Halos and Sun Dogs

A variety of light-based phenomena occur in the Polar Regions because the air is often cold enough to contain ice crystals instead of water vapour. Light pillars, halos and sun dogs can be seen associated with the sun, the moon, or even bright artificial lights. They are formed by light being reflected (or refracted) by ice crystals in the air. The best time for seeing halos is in the colder—darker—winter months, but since high altitude clouds contain ice crystals even in the summer, halos are not restricted to the cold season.

A light pillar appears as a diffuse beacon of light that extends vertically above and/or below the light source. Pillars appear in the sky when snow or ice crystals reflect light forward from the source. Crystals with plate or column shapes occur in clouds, ice fog, snow virga, blowing snow and diamond dust. Because the light rays forming pillars are reflected, they take on the colour of the incident light.

Just as the name suggests, a halo is a bright ring of light surrounding the source of light. The most common halo is formed on a circle of 22 degrees from the light source. The 22-degree halo is formed by light refracting through ice crystals. There may also

Mawson Hut completetion © Mawson Hut originals

THE HOME OF THE BLIZZARD.

Mawson, Douglas. 1915. London: William Heinemann, two volumes. Account of the search for the South Magnetic Pole under extreme conditions at Commonwealth Bay.

be a 46-degree halo, which is formed in the same way, but is weaker. Sun dogs, arcs and glories form in the same way, but they are bright spots or partial halos that result from particular orientations of crystals and the angle of the light.

Nacreous Clouds or Polar Stratospheric Clouds

Nacreous clouds, sometimes called mother-of-pearl clouds, are beautiful, high altitude, ice crystal clouds that shimmer with colour like mother-of-pearl. The ice crystals reflect and refract sunlight to produce the beautiful colourful display. Because of their location, they are also called polar stratospheric clouds (PSCs). In addition to being beautiful clouds they are important components of the ozone depletion process in Polar Regions. PSCs provide a surface upon which chemical reactions involved in ozone destruction take place. PSCs are thought to be made of nitric acid and ice. In other parts of the world the stratosphere is too warm for these clouds to form, which is one reason why the ozone hole is confined to the Polar Regions.

Aurora Australis

Perhaps the most remarkable atmospheric sight is the incredibly beautiful Aurora Australis, or southern lights. This electromagnetic phenomenon is the southern hemisphere equivalent of the better known Aurora Borealis or northern lights. The aurora is caused by charged particles from the sun being ejected at high speed across space toward the earth. As the particles reach the earth, they are captured by the earth's magnetic field and come streaming along the earth's magnetic lines of force. Because the lines of the magnetic field enter and leave the earth at the poles, the charged particles are channelled toward the earth's magnetic poles. As the particles encounter the atmosphere (100-300 km high), some of them will collide with molecules of oxygen or nitrogen in the atmosphere and cause the molecules to glow—just as the neon gas in a neon light glows when excited by electricity. Because the aurora originates from particles steaming from the sun, the lights occur at both poles simultaneously. It is difficult to see on most Antarctic trips because it is rarely dark enough during the summer months.

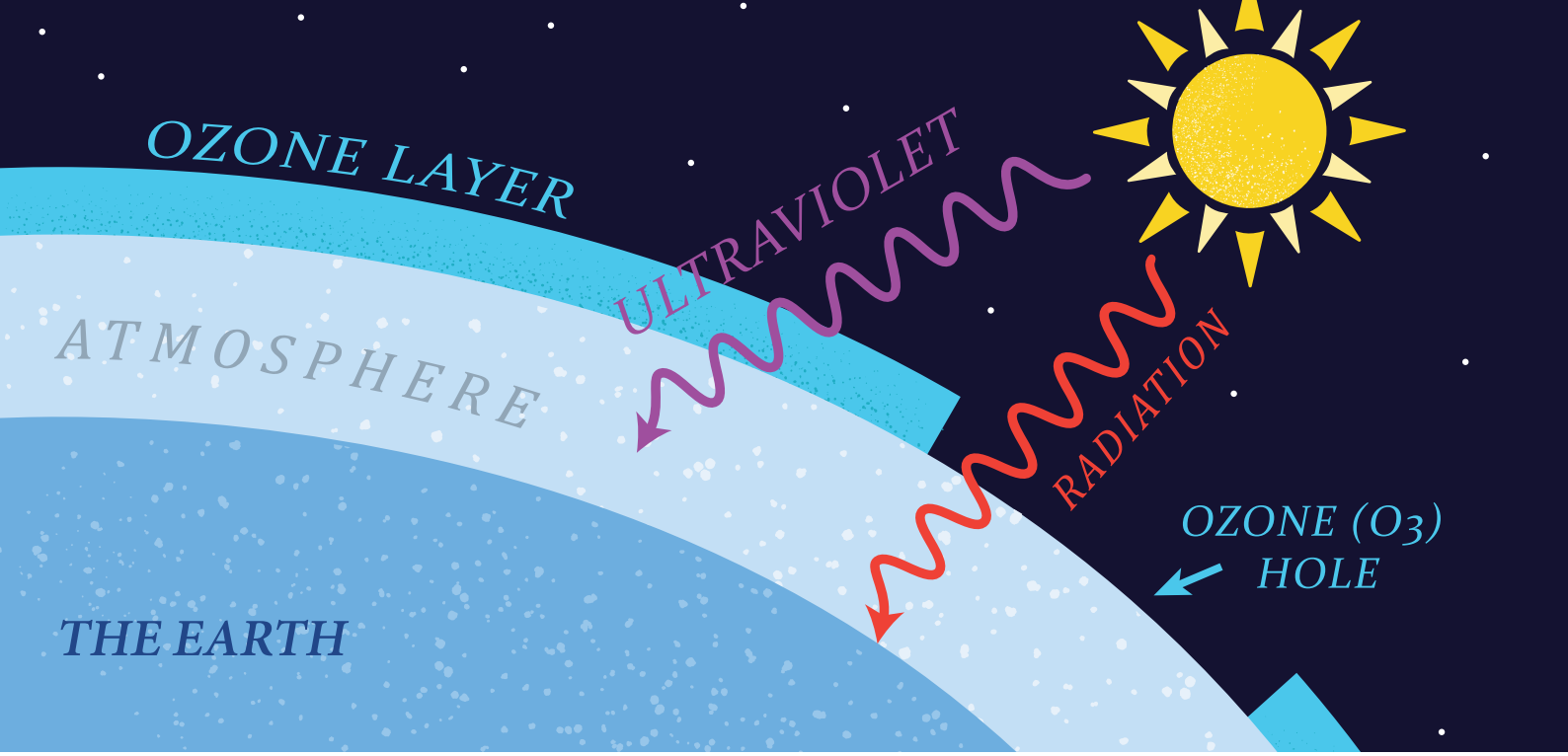
The Antarctic Circle

It is interesting to understand the significance of the Antarctic Circle and its relation to the hours of daylight. As you travel farther south in the austral summer months, the days get progressively longer. The Antarctic Circle is located at about 66° 33'S (its position varies slightly from year to year, as the earth wobbles about its axis). This circle marks the northernmost point at which the sun is visible for 24 hours a day at the summer solstice, December 21. Before and after that date, you would need to sail farther south of the Antarctic Circle to experience the 'midnight sun'. (Exactly the same – but opposite – process occurs in the northern hemisphere, of course, so that the relevant date applicable to the Arctic Circle is June 21.)

The Ozone Hole

The ozone hole over Antarctica is a well-known annual phenomenon. The phenomena that result in the formation of an ozone hole are present at both poles, but several key factors must come together to deplete the protective ozone layer. First, ozone-depleting chemicals such as chlorofluorocarbons (CFCs) must be present in the stratosphere. Second, clouds of ice crystals must be present to provide a substrate for CFCs to participate in chemical reactions. Finally, the weather in the stratosphere must be stable enough so that all the factors will accumulate in the cold and dark of winter and still be present in the spring when the sun returns. Atmospheric studies have shown that during the winter months wind patterns above both poles isolate and stabilize the air masses over the poles. The isolation is most complete when the air temperatures are at their coldest. When the sun returns in spring, the chemical reactions are initiated and the ozone is depleted. It then takes months before the stratosphere warms sufficiently to break up the stable wind pattern and mix the polar air with less depleted air. Above the South Pole the cycle lasts about five months.

In 1985 the British Antarctic Survey published the results of a continuing study of Antarctic atmospheric conditions begun in 1957. In the late 1970s, the ozone measurements from the British Faraday Station (now the Ukranian-Vernadsky Station) dropped so low that the scientists on site thought their instrument was broken. They called for technician, John Shanklin, to come and recalibrate the machine. He did so, but the measurement was still low enough to alarm the scientists. From that they reviewed the data from the past 20 years and discovered that each year since records have been kept there was a dramatic depletion of ozone September to November. At its maximum, the annual 'ozone hole' above Antarctica now covers an area greater in size than the United States of America.



Ozone layer diagram

Ozone is found in small amounts in the stratosphere. It is, however, very important to life because ozone shields the earth from lethal ultraviolet, or UV, radiation. This radiation can be divided into UV-A radiation and UV-B radiation, based upon their respective wavelengths (with UV-B being shorter wavelengths). UV-B is the more harmful with regard to life. In humans it causes sunburn and skin cancer, and has been linked to cataract formation. It is also harmful to plants, ranging from bacteria to food crops.

Studies from the American Palmer Station on Anvers Island, in Antarctica, indicate that increased UV-B radiation reduces the photosynthetic productivity of phytoplankton and that smaller species (diatoms) of phytoplankton may be killed. Any such change affecting the base of the simple Antarctic food chain could have far-reaching effects on the entire ecosystem. Similar studies have shown increased UV-B radiation kills at least some species of copepods (tiny planktonic crustaceans), but it is not yet known what long-term effect it may have upon krill.

Montreal Protocols. The passing of the Montreal protocols in 1987 created international controls on the emission of ozone-depleting halogens. Now after over 30 years, the world has phased-out 98% of Ozone-Depleting Substances (ODS) worldwide. It seems to be working too. Most ODS have either stabilized or depleted. Scientists estimate that ozone levels stabilized by the mid-1990s but will take another 50 years to recover fully.

Climate Change

Most of the radiant energy from the sun that reaches the earth is reflected or radiated back into space. Certain gases in the lower atmosphere, such as water vapor, carbon dioxide, methane, and chlorofluorocarbons (CFCs), trap some of the heat before it escapes. The effect of these gases is similar to that of glass windows in a greenhouse, and is therefore often referred to as the Greenhouse Effect. This trapped heat is necessary to keep the earth's climate warm enough for life to exist. But there must be a balance to ensure the earth has a liveable temperature.

The amount of greenhouse gases in the atmosphere has varied considerably over the history of the Earth and the climate has varied as well. Since the beginning of the Industrial Revolution (the past 200 years), the rate of accumulation of greenhouse gases has accelerated to many times the rate that has ever occurred. Carbon dioxide, the most abundant trace gas in our atmosphere, has increased some 25 percent in this period. It is produced through the burning of wood and fossil fuels, such as coal and petroleum products. It is also released by volcanoes, oceans, and decaying plants. There is no doubt that the massive clearing and burning of tropical rainforests occurring today is releasing an increasingly significant amount of carbon dioxide into the atmosphere.

Methane, the second most abundant greenhouse gas, is produced as a by-product of the decomposition of organic material. The most common known sources are swamps, rice paddies, livestock (especially cud-chewing animals), termites, and the use of natural gas. The level of methane is growing at about one percent per year.

The level of CFCs in the atmosphere is small by comparison, but these compounds are thousands of times more potent in absorbing heat. They are man-made chemicals and are also implicated in another potentially serious climactic problem, the depletion of the ozone layer.

It has been estimated that the present level of greenhouse gases may double sometime in the 21st century, and could raise the average temperature of the earth by as much as 5°C (9°F).

The average climactic temperature of the earth has increased by 0.5°C (1°F) during the past 100 years, and none of the hottest ten years on record have all been since 2005.

The average temperature in the Antarctic Peninsula has risen about 3° C (5 ° F) in the past 50 years resulting in less sea ice in the winter and more snow accumulation. It is clear that Gentoo penguin populations can take advantage of this change and have been expanding their range and growing their population on the Antarctic Peninsula. Meanwhile, the Adelie and Chinstrap penguin colonies have diminished over the same period.

British Antarctic Survey scientists have noted a significant increase in plant growth as the climate has warmed. The number of flowering Antarctic hairgrass plants around the Ukraine station, Vernadsky, in the Peninsula region, has increased by 25 times in the last 30 years, while the Antarctic pearl wort has increased six-fold in abundance at Signy station in the South Orkneys.

Ships making voyages to and from Antarctica sail along the Beagle Channel, near the tip of South America. There has been a very noticeable retreat of the glaciers lining the north shore of the Beagle in the past decade. It is now clear that mot of the glaciers along the Antarctic Peninsula are also retreating—while flowing faster than previous years. Furthermore, the Larson ice shelf has experienced two major collapses since 2000. Both of these are believed to be partly due to the excessive surface melt caused by global warming.

Human activities clearly contribute significantly to the earth's heat budget. We may well have started a global warming trend which is irreversible – at least, not without drastic changes in our present way of life.

While precise figures are lacking, and there is much disagreement about the finer details, it is clear that if the earth's average temperature rises just a few degrees, both the Greenland and Antarctic ice sheets would certainly be affected. If the Antarctic Ice Sheet were to melt completely, sea level would rise about 60 meters and would flood most coastal cities; displacing about half the world's human population.

Sea Ice

Sea water freezes at about -1.8°C (28.8°F), depending upon its salinity; the higher the salt concentration, the lower the freezing temperature. Ice which forms slowly on the sea surface under calm conditions generally is much less salty. Pure water molecules form crystals that exclude salt molecules so the salt tends to concentrate in the remaining liquid.

The sea surface around Antarctica freezes each winter, forming a layer of ice 1–3 meters (3–10 feet) thick and extending 100–200 kilometers (60–120 miles) offshore, and may extend about 800 kilometers (500 miles) from the coast in some areas. This enormous seasonal process effectively doubles the area of the Antarctic ice blanket with 4 million square kilometres (2.5 million square miles) of sea ice in summer to 19 million square kilometers (11.8 million square miles)of sea ice during the southern winter. It has a major effect on world climate by increasing the amount of reflection of incoming radiant energy from the sun, and reducing its penetration into the sea.

As autumn advances, the air cools and eventually ice crystals start to appear as the water surface approaches the freezing temperature. In calm conditions, the crystals join together, thicken, and form a fibrous , yet flexible, structure called Young Ice or Frazil. Very often a slight swell occurs will break the young ice into small pans which then continue to bump and grind against one another. This action forms roughly circular pans of thin ice with raised edges called Pancake Ice.

As time progresses and air temperatures remain low, more crystals form and the pancakes eventually freeze together to create a solid layer several centimeters thick. Sea ice typically forms along the shoreline earliest in the season because the water is shallow and then continues to thicken and spread until late August each year. Sea ice that is attached to shore is called Fast Ice. It is held fast by the shoreline and generally lasts through the winter. Meanwhile, tidal movements, swell, wind, and currents buckle and crack the fast ice; this produces free-floating ice pans with open water areas (leads) between which gives access to penguins, petrels, seals, whales, etc.

HOW DO WE STUDY THE ANCIENT CLIMATES?

The easiest way to answer this question is to describe the lifetime scientific work of Claude Lorius, one of the first scientists to be concerned about global warming. Claude Lorius is a French glaciologist who began his career in 1957 with an ice coring project at Charcot Station, a small isolated station inland from the French station at Point Martin, Adelie Land. In that first year Lorius and his colleagues succeeded in extracting a few dozen meters of ice cores for the Antarctic ice sheet. Very quickly in the ensuing years they discovered that they could easily age the ice because it formed in layers each year. They can simply count the layers to age ice. They also discovered that the tiny bubbles trapped in the ice contained samples of the atmosphere from those ancient times. And finally they discovered that the ratios of hydrogen and oxygen isotopes in the samples tells them what the temperature was when the snow fell that later transformed into the ice. Using those three simple tools, the only challenge was/is to drill the oldest possible ice cores. In 2017 scientists announced they successfully extracted an ice core that goes back 2.7 million years! That core is still being analysed, but we already have records running back to 1.7 million years thanks to the pioneering work by Claude Lorius and his colleagues.

Pack ice

Because the ice is so extensive during the winter, most of it is free-floating ice floes—or pack ice—that gradually melts each summer. The pack moves freely so it follows the currents discussed above. Near the continent, the general drift of the pack ice is toward the west, but north of 65°S latitude it drifts toward the east. Pack ice is at the mercy of winds as well as currents so it often drifts contrary to these general trends. A large pan of pack ice can develop considerable momentum when it is pushed by local winds so when these pans collide with the shore, or with each other, they can form quite large piles of push ice on the coast, or rough pressure ice with many pressure ridges offshore.

The rate of build-up of sea ice in autumn and winter (February– September) is much slower than the rate of decay (October-January). The faster rate of decay is probably caused by the presence of layers of pigmented algae that develop in the sea ice over winter. By absorbing solar radiation in summer, the algae accelerates the melting; a remarkable example of the influence of microscopic life on the world's climate. In some areas a cold spring season may allow fast ice to remain in place for more than one year. It is then called Bay Ice. Bay Ice which persists for several years is termed Shelf Ice, and may become many meters thick. Shelf Ice accumulates thickness not only from freezing sea water, but also from snow fall, and very often from glacial ice which moves to the coasts from higher areas on land.

Polynyas, are areas of the sea that remain ice-free all winter. They can be the result of exceptional wind conditions that keep blowing the newly forming ice away from some area, or similarly by currents that functions in the same way. In these cases, no matter how fast ice is forming, the wind or current removes it and new, unfrozen water takes its place. Some polynyas only occur is some years, but there are other polynyas that are reliable from year to year. For example, there is a regular polynya in Prydz Bay near the Australian Davis Station and another one northeast of Ross Island in the Ross Sea. These predictable polynyas are very important to seals, whales and seabirds that stay in the Antarctic year-round.

Animals and ice

Most animals of Antarctica are adapted to living with sea ice. Crabeater seals, Ross seals and leopard seals all give birth on floating pack ice. Weddell seals use fast ice through the winter and mostly give birth to their pups on fast ice if it is present.

Emperor penguins breed on sea ice in the winter, and form colonies as soon as the ice is strong enough (in April). The other penguins all breed on land, during the summer, but they live on the edge of the pack ice for the rest of the year. It greatly extends their feeding ranges.

The underside of sea ice is a substrate where algae grows through the winter (see above) and that algae is extremely important as food for Antarctic krill through the winter. During the winter the krill are dispersed under the ice to graze on the algae found there. Consequently, Adelie and Chinstrap penguins that rely on krill also forage on the underside of pack ice where they can find krill. During the summer they can find krill in dense reproductive swarms in open water. Many other seabirds use the ice for roosting, as well as a base for hunting. On the other hand, the presence of ice discourages plants and animals from settling in shallow coastal waters and intertidal zones. Algae, seaweeds, marine worms, sponges, sea stars, brittle stars, sea urchins, etc., flourish lower down on the continental shelf where ice does not scour the sea bed.

Sea ice prevents the ocean waters from warming the coasts significantly. It is important to note that islands within the limits of winter pack ice (such as the South Shetlands and South Orkneys) compare closely with the continent in seasonal temperatures, soils types, flora, and fauna. Islands located outside the range of pack ice (such as South Georgia and Macquarie) have permanent open waters, milder winters, longer growing periods, and much more diversified and advanced flora, and to a great extent, a different fauna.

THE ICE: A JOURNEY TO ANTARCTICA

Pyne, Stephen. 1988. New York: Ballantine Books, paper, 434 pp. Dense, philosophical meditation that integrates information on the history of exploration, geophysics of the ice, and the symbolic meaning of this white continent in art and literature.

The Antarctic Ice Cap

Throughout most of the earth's history, not only have the differences between polar, temperate, and tropical climactic zones been much less distinct than they are today, but also the polar regions were free of permanent ice. But the poles have always received their quota of the sun's radiant energy at a low angle, and therefore have always been cooler than the equatorial region. Why, then, are things so different today?

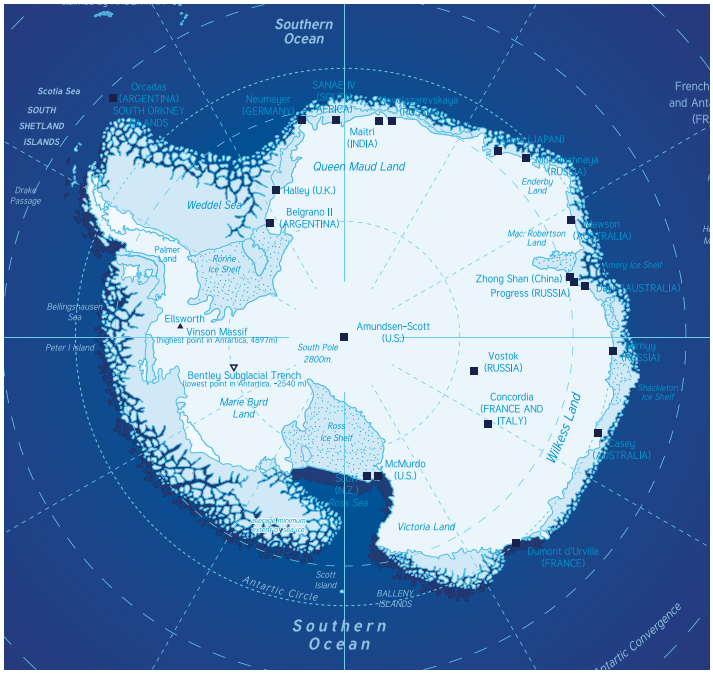
The polar ice caps developed after a long period when the earth was gradually getting cooler. This cooling began some 150 million years ago. The mean surface temperature of our planet dropped from about 20°C to about 10°C (68°F to 50°F) during this period. The drop was probably caused by changes in the distribution of land masses and open water in the polar regions themselves.

The polar regions did not become cold enough for permanent ice formation until continental land masses, land-locked seas, or in the case of Antarctica, the development of the Antarctic Circumpolar Current, blocked the transport of warmer water toward the poles. As the ancient supercontinent of Gondwana broke apart into the separate continents we know today, it finally separated from South America with to formation of the Drake Passage. The exact timing is unclear, sometime between 49 and 17 million years ago, but it is generally accepted that once that happened, the continuous circumpolar current was able to isolate Antarctica and prevent warm water from reaching the continent to moderate its climate.

Prior to that, Antarctica was cool enough to have mountain valley glaciers in some areas, but not cold enough for a complete ice cap to develop.

At least in the early stages, the total precipitation over each year was greater than we see today, but it is still impressive how a small amount of snowfall can accumulate over millions of years to such an impressive mass. The ice sheet covering 98% of Antarctica holds about 61% of all the fresh water on Earth—and all of it is moving!

Despite how it feels when you fall on it, ice is not completely rigid. The tremendously thick ice cap of Antarctica is slowly oozing its way out from the highest point near the pole of inaccessibility. Most of the ice is carried toward the coast in fast moving ice streams, and where those streams are channelled by mountain ranges such as the Transantarctic Mountains, they take the familiar form of glaciers. When those glaciers float out onto the sea, the ice spreads out when it is released from their valley constraints. If there are several glaciers, they may join and form a large floating platform of ice, called an ice shelf. Once an ice shelf forms, it begins to accumulate snow (which changes to ice) in its own right so the surface becomes flatter and more uniform. The Ross Ice shelf is the largest in the world with a floating platform of ice the size of France.



The effects of the formation of the Antarctic ice cap were felt throughout the world, but the ice age in the northern hemisphere began somewhat later – between two and three million years ago – when permanent ice appeared in central Europe and Asia, and also covered the mountains of North America, Greenland, and Iceland. The ice sheets have fluctuated considerably in the northern hemisphere during the last million years, but the Antarctic ice cap has remained relatively stable.

Minor changes in the Antarctic ice cap have occurred, however, as shown by glacial moraines and ice-caused scratches on mountain peaks which are now high above the surface of the ice. Much of the continent is surrounded by a ridge of moraine some 100–300 kilometers (60–185 miles) offshore and in waters up to 500 meters (1,650 feet) deep, which indicates a former edge of the ice mantle.

One of the most remarkable discoveries of the twentieth century was the existence of lakes of liquid water deep below the surface of the ice cap. First proposed by a Russian scientist at the end of the 19th century, and using seismic surveys from 1959 and 1964 to measure the thickness of the ice sheet, it was not until 1993 that the existence of Lake Vostok was finally confirmed. At 250 km (160 mi) long by 50 km (30 mi) wide at its widest point , Lake Vostok is the 16th largest lake in the world by area and 6th by volume. But this lake also lies beneath nearly 4,000 m (13,100 ft) of ice, which places it at approximately 500 m (1,600 ft) below sea level. Since the realization that such lakes exist, over 400 additional lakes have been discovered using ice-piercing radar surveys. Water retrieved from Lake Whillans (800 m below the surface) has proven the existence of a microbial ecosystem in those lakes. It is thought that a combination of extreme pressure, which lowers the freezing point of water, and some geothermal input keeps the water in a liquid state in these lakes. Now they are being eagerly studied as analog environments for life on other planets.

Still in an Ice Age

The massive bulk of the ice cap probably would have protected it from changes caused by minor climactic fluctuations, but changes in world sea levels generated by glaciations in the northern hemisphere would have caused the coastline of Antarctica to expand and contract considerably, allowing its ice mantle to change size as a result. The northern ice sheets began retreating about 20,000 years ago, and have since uncovered vast areas of land which now consist of tundra and taiga. Antarctica, on the other hand, is still locked in its ice age.

The Antarctic ice cap contains about 90 percent of the world's ice, representing about 61 percent of all the fresh water on earth. It is estimated to weigh about 24,500 million billion kilograms (27 million billion tons), and each year it receives 1,800 trillion

kilograms (2 trillion tons) of new snow and ice. However, it loses about the same amount of ice each year through various causes including melting, evaporation, snow that is blown out to sea, and of course, the ice which breaks away from ice shelves and glaciers and drifts away to sea.

Icebergs

Wherever Antarctic ice reaches the sea, there is an opportunity for pieces to fall off (calve) into the sea. The glaciers in the peninsula region are mostly short in length and come to the sea down a steep slope so they are usually highly fractured. Those characteristics result in relatively small and very irregular icebergs. Around East Antarctica it is more common that a large area of the ice sheet moves to coast through less steep terrain so the ice is less fractured and quite large icebergs can calve off. The largest bergs come from the massive ice shelves, such as the Ross Ice Shelf or Larson Ice Shelf with huge expanses of ice already floating on the sea surface. There are 44 identified ice shelves in Antarctica and they extend to cover about 44% of the coastline. It's these massive ice shelves that give us large tabular bergs. Recently, there have been a few cases where an ice shelf has collapsed.

Tabular bergs

Occasionally, huge pieces of floating ice shelves break loose and drift away in the currents. These pieces of ice are called Tabular Bergs or Tabular Icebergs, and can be enormous, perhaps hundreds of square kilometers in surface area, and may drift for years before melting or becoming grounded. These are not to be confused with regular icebergs, which break off from glaciers that reach the sea.

The largest iceberg ever recorded was designated B-15. It broke off the Ross Ice Shelf in March of 2000 and measured 295 kilometers (183 miles) long and 37 kilometers (23 miles) wide. It had a surface area of some 11,000 sq kilometres (4,200 sq miles). This behemoth stayed close to the Ross Ice Shelf for the first three years then slowly made its way up the Victorialand coast and into the southern ocean. Scientists put a GPS monitoring system on the largest part of the iceberg in 2001 and tracked it for years. As the iceberg broke up, the different pieces are designated with an extra letter (e.g. B-15-A). The last big piece is now drifting northeast of South Georgia after a semi-circumnavigation of Antarctica from the Ross Sea westward around past the Weddell Sea and then north past South Georgia.

Smaller icebergs

Not all Antarctic icebergs are of such huge proportions. Many are much smaller, for icebergs are simply pieces of ice, large or small, which have broken (calved) off the ice sheet, ice shelves, or glaciers, and float in the sea. By definition, however, an iceberg measures more than 100 square meters (1,100 square feet) in area, and stands more than five meters (16 feet) above the sea surface.

Most icebergs have between one-eighth and one-tenth of their mass above water depending on their shape and density. They can erode from both above and below the waterline, but the greatest erosion is along the waterline. Indications of an iceberg's

Icebergs in Antar ctic Peninsula ©J.Bornholdt

history can be gleaned by observing its shape, color (which depend on age, density, and air content of the ice), or dark bands that reveal the presence of glacial moraines or volcanic ash, or its general shape and sculpturing. When an iceberg floats in the sea, wave action quickly cuts a ridge or shelf right at the waterline. If a piece breaks and the iceberg rolls, either partly or completely, that ridge is a record of where the waterline once was on the iceberg. It's common to see such lines spreading like the ribs of a fan, or even crossing and intersecting as the iceberg shifted from one side to the other. Blue ice is really ice that has few (or no) air bubbles present. One way for that to form is for the ice to experience extreme pressure so that the usual small air bubbles literally get pressed so hard that the air molecules disperse into the ice matrix. The other way is for the usually white glacier ice to melt and then that bubble-free liquid water can re-freeze as a pool or in a crevice.

A Short Glossary of Ice Terms

Anchor ice	Submerged ice that is attached to the sea bed.
Bergy bit	Floating ice that has less than 5 meters (16 feet) but more than 1 meter (3 feet) showing above the surface.
Bergschrund	A crevasse at the head of a valley glacier that separates the ice from the rock behind it.
Brash	Fragments of floating ice smaller than 2 square meters in area.
Calve	When a block of ice breaks away from a glacier, an ice front, or an iceberg.
Cirque	The hollowed or rounded recess occupied, or more usually once occupied, by a glacier on a mountain side.
Crack	A fracture in floating sea ice, narrow enough to jump across.
Crevasse	Fissure formed in a glacier, often covered by a snow bridge.
Fast Ice	Sea ice attached to land.
Frazil	The first stage as sea water begins to thicken before freezing; as more crystals attach together, the mixture looks soupy, and is called grease ice or slush.
Glacier	A mass of snow and/or ice moving from higher to lower ground. Sometimes a glacier can float out onto the sea.
Glacier berg	Opaque white iceberg formed from a glacier, with soft green or blue coloring, and often crevassed.
Growler	An iceberg that is smaller than a 'bergy bit' but larger than 'brash'. Growlers float low in the water, barely showing above the surface. They can be dangerous because they are difficult to detect on ships' radar.
Hanging valley	Side valley isolated by a large glacier moving along a newly created valley at its base.
Ice blink	Silvery-white glare caused by the reflection of distant pack ice on the clouds.
Ice floe	A stage in the formation of pack ice, when pancake ice coalesces into larger units, but before it forms a solid sheet of pack ice. Alternatively, caused when fast ice breaks up in summer.
Lead	Navigable passage between ice floes.
Moraine	Ridge or deposit of rocky debris carried along by a glacier; a terminal moraine marks the farthest advance of a glacier, which is then left behind when the glacier melts and retreats.
Nunatak	A rocky spur or mountain peak projecting from and surrounded by a glacier or ice sheet.
Pack ice	Extensive sheet of sea ice.
Polynya	Russian word meaning a patch of open water in sea ice.
Pressure ridge	Ridge formed on sea ice by pressure of one ice floe on another by tidal or current movements.
Shelf ice	Fast ice which has remained attached to land for a period of years, or the seaward extension of a glacier. Shelf ice may be floating or may be grounded on the bottom. It can be very high.
Tabular berg	An iceberg that is flat-topped and more or less parallel with the waterline, and with no evidence of having rolled over. Formed by calving off an ice shelf.
Young ice	First stage in the formation of sea ice, when ice crystals start to appear in calm water and join together.

Gentoo Penguins with chicks ©T.Gordon

III. THE BIOLOGICAL ENVIRONMENT

Life in Antarctica

Antarctica is very cold, dry, and windy. These three qualities inhibit life to a great extent. The harsh climate tends to desiccate and freeze living organisms. In addition, only 2% of the continent is free from the thick ice sheet. These conditions help prevent the formation of mature soils. Normally, as rocks are broken down into gravel, sand, clay, and silt, bacteria and algae generate a basic flora in the mineral soil. In other parts of the world higher plants then move in to colonize the new soil and through chemical processes cause the release of various minerals which can then be used by the growing plants. The glacial history of Antarctica is another important factor because the complete glaciation of the continent essentially scraped all the previous life forms off the continent a few million years ago and its current separation by a minimum of 1000 kms (620 mi) from the nearest source of biological propagules has made the process of colonization extremely slow.

Primitive soils

Low temperatures, frost, winds, and surface streams of melt water make it difficult for immature soils to become stabilized. This causes much of the soil to remain 'ahumic' and poor, and therefore unsuitable for colonization by either plants or animals. Many inland peaks contain mineral soils which are virtually sterile, and some of the dry coastal areas contain small amounts of only the simplest microscopic organisms in the sand and gravel.

The Dry Valleys of south Victoria Land contain ahumic soils and appear to be totally barren – so much so that NASA has studied them for their resemblance to the soils of Mars. The Viking Mars probe was actually tested in the Dry Valleys.

The Antarctic Peninsula region, and some of the coastal areas which receive heavy snowfall, hold much richer soils. On top of that, the coastal areas are affected by the presence of nesting birds. Nearly everywhere around the continent where there is access to ice-free terrain penguins have created their colony sites. They bring huge amounts of fish and krill and deposit them as excrement in large areas. These are referred to as ornithogenic soils because the organic content comes entirely from bird guano. Most of the mature soils in Antarctica are ornithogenic, but there are some areas (e.g. South Shetland Islands) where algae, lichens, and mosses managed to get started and have grown to fairly extensive areas.

Land plants and animals

Considering the harsh climactic conditions and the poor soils, it makes sense that Antarctica has so few species of plants and animals: 360 species of algae, 400 species of lichens, 75 species of mosses and no ferns. Just two species of flowering plants occur in the warmer maritime region of the Antarctic Peninsula: the Antarctic hairgrass (Deschampsia antarctica) and the Antarctic pearlwort (Colobanthus quitensis). All Antarctic plants grow slowly, and only a few species grow taller than 3 cms (1.25 inches). The sparsity, small biomass, and slow growth of the plants preclude the existence of the usual assortment of herbaceous animals. The only terrestrial herbivores to be found are tiny insects and mites which feed mainly on algae, fungi, and rotting plant material. Likewise, the only terrestrial carnivores are springtails, mites and nematodes which feed on the herbivorous mites and insects. Besides mites, the invertebrate fauna includes two midges, springtails, ticks, rotifers, tardigrades, and nematodes.

NATURAL HISTORY OF THE ANTARCTIC PENINSULA.

Moss, Sanford. 1988. New York: Columbia University Press, 208 pp. Marvelous introduction to the environment and wildlife of the Peninsula. Excellent bibliography, line drawings.

Abundant marine life

The seas surrounding Antarctica, however, abound in productivity. Seabirds and marine mammal are found in tremendous numbers around the coastal areas during the summer, and on the sea ice during the rest of the year. The reasons for the abundance of life in Antarctic waters are threefold: first, the sea water is cold (cold water holds dissolved gases, such as carbon dioxide and oxygen, much better than warm water); second, the storm-tossed seas with their upwellings and strong currents keep essential nutrients, such as phosphates, nitrates, minerals in suspension where they can be easily utilized by the immense growths of phytoplankton; and third, the long hours of daylight during the summer months promote almost continuous photosynthesis. The latter process encourages algal blooms which form the underlying basis of the Antarctic food chain.

The phytoplankton of Antarctica consists mainly of tiny diatoms (unicellular plants with cell walls made of silica) and dinoflagellates. The Antarctic Convergence forms a biogeographic boundary, with higher productivity on the colder, Antarctic, side. North of the Convergence the sea floor is primarily calcareous silt formed from the empty shells of countless protozoans. South of the convergence the sea floor consists almost entirely of the siliceous remains of diatoms.

Biological productivity

The biological productivity in Antarctic waters is the highest in the world. This productivity can be measured in two ways. The first is the standing crop of phytoplankton, which is a measure of the amount of chlorophyll in a given sample of surface water. The second is the yield, or water productivity, which is calculated by assessing the amount of Carbon 14 assimilated by a given sample of plants.

Both the standing crop and the yield are highest near the islands and along coastal areas because of upwellings and turbulence, and lowest in the mid-oceanic regions. The inshore waters of the Antarctic Peninsula contain a standing crop which is as much as 10 times greater than neighboring waters, while the yield is as much as five times greater.

The standing crop and yield of Antarctic phytoplankton are at their lowest between April and July, when the sun is low or below the horizon, sea ice spreads, and the planktonic populations descend to sub-surface layers. In October, after the ice starts to break up and drift, algal blooms begin and spread south as the ice front recedes.

The ocean south of the Antarctic Convergence comprises about one-twentieth of the world's sea water, but contains a remarkable one-fifth of the world's marine biological production of carbon.

Adapting to the Cold

All the organisms living in and around Antarctica must deal with very harsh living conditions. Under normal conditions, the temperature limits for animal activity range from slightly below 0°C (32°F), when body fluids freeze, to 45–50°C (113–122°F), when proteins coagulate and dissolved albuminoids break down. In both water and on land animal diversity decreases where conditions approach those biological limits, such as in polar areas, deserts, and high mountains.

Animals can be divided into two broad types – those whose internal body temperature, and therefore metabolism, varies according to the ambient temperature, poikilotherms; and those whose internal body temperature remains relatively constant, homeotherms.

Variable body temperature

The invertebrates and fishes of Antarctica are poikilotherms, and so are directly affected by the ambient temperature. This means that the lower their body temperature, the lower is their metabolic rate. It also means that they run the risk of freezing.

Terrestrial Animals

In Antarctica, terrestrial animals must endure tremendous variations in temperature, whereas the aquatic animals live in a more uniform environment. In order to survive freezing an insect or mite must prevent ice crystals from disrupting its cells, and at the same time allow ice to form slowly within the rest of its body, including the contents of the gut, the blood, and the spaces between the cells. Some of them appear to become dehydrated when exposed to low temperatures, and this causes the salts, sugars, and other constituents to concentrate in tissues, thereby reducing the freezing point.

If the cells are not ruptured during freezing the animal stands a good chance of surviving. Freeze-tolerant insects and mites produce 'cryo-protectant' chemicals, such as glycerol, which allow body tissues to survive freezing by reducing the proportion of body water locked up in ice.

The marine Antarctic environment is very stable, but its temperature is close to or below the freezing temperature of fresh water. Many marine invertebrates deal with this situation by accumulating salts and organic compounds, such as glucose and amino acids, which lower the freezing point of their tissuess.

Crabeater seal © C.Goldrick

Antarctic Fishes

The fish, like marine fishes everywhere, maintain a body salinity slightly lower than that of the sea water in which they live. Theoretically, one would therefore expect them to freeze at a slightly higher temperature than does sea water (which freezes at -1.8°C, or 28.8°F). Some Antarctic fishes can lower their freezing point by accumulating antifreeze compounds in their body tissues.

The enzyme systems of Antarctic fishes are so efficient that they are able to maintain a high level of activity even in these extremely cold waters. One family is able to synthesize glycoproteins, which act like an antifreeze by inhibiting the normal growth of ice crystals within their tissues. The content of dissolved oxygen is so high in the cold Antarctic waters that many fishes are able to survive with little or no red blood cells. This gives them a white, or nearly colorless appearance. If these fish come into direct contact with sea ice, their tissues will freeze and death results.

Constant body temperature

The birds and mammals of Antarctica, on the other hand, are homeotherms. They are able to maintain an optimal internal temperature regardless of the cold. Living at the optimum temperature means that their life processes, such as nerve transmission, muscle contraction, digestion, etc., operate at their most efficient rates – but at a high metabolic cost. In order to maintain stable high internal body temperatures, these animals must insulate themselves from the cold. The two groups – birds and mammals – accomplish this in different ways. Air is a very poor heat conductor and is readily available as an effective

insulator. The birds take full advantage of this by using feathers to retain a layer of air around their bodies. Coverts and contour feathers cover fluffy down which holds the air close to the body. Those birds with flexible wings can hold their wings close to the body and receive even more protection from wind and low temperatures.

Feathers

Birds must prevent their feathers becoming waterlogged. Most seabirds have a well-developed oil gland at the base of the tail. When they preen, the birds rub this oil all over their plumage in order to make it water resistant.

Penguins are the most aquatic of the seabirds, their plumage has evolved into a highly effective insulation covering. Most birds grow feathers in narrow tracts, and then fluff them out to cover all the exposed skin. Penguins, however, have no feather tracts and many more feathers. The entire body surface is covered with a dense, tightly packed feathers. The scale-like outer parts overlap, and are almost impermeable to wind or water. And on the lower shafts grow tufts that form an insulating layer of fluffy down. Besides feathers, penguins also have a thick layer of fat or blubber just below the skin.

Antarctic penguins are so well insulated that they are poorly equipped to cope with warm temperatures. The skin of their feet have more blood vessels than other birds, and the underside of their flippers have a very thin insulation, When they are hot, they hold their flippers up and away from their bodies. Their feet and flippers turn nice and pink as they lose heat through those areas.

Insulating blubber

All the mammals found in Antarctica (except humans, of course) are aquatic. The cetaceans (whales and dolphins) protect themselves from heat loss with a thick layer of subcutaneous fat, or blubber. Unlike most mammals, the cetaceans have virtually no hair and so cannot use air for insulation. They are unable to come out of the water occasionally in order to preen, clean, and aerate their fur.

Fat serves a dual purpose since it is not only an excellent insulator, but also stores energy to allow the animals to survive when food is scarce. But in general, animals that maintain a constant body temperature need to consume more food, to maintain heat production, when ambient temperatures are low. They need about 50 percent more food in winter than in summer, but food is harder to come by in winter. Therefore, many of the cetaceans –– migrate to lower latitudes and a warmer climate during the Antarctic winter. All the Antarcitc penguins and most of the seals are able to cope with the conditions year round. They simply move from the coastal areas, where they spend the summer, to the edge of the sea ice in winter.)

The Antarctic seals and fur seals (collectively known as pinnipeds) have a thick layer of insulating fat, like the cetaceans, but they also have fur as an added protection against the cold. As much as 50 percent of the body weight of some seals is skin and fat. In fact, seals have such efficient protection against heat loss that they cause little or no visible melting on the ice even after lying in one spot for several hours, and will retain a high internal body temperature many hours after death.

Warm fur coats

The fur of seals and fur seals consists of two different types of hair: long, coarse guard hairs and short, woolly underfur. Most seals have from two to five underfur hairs for each guard hair, which provides a fur coat of relatively low insulation value, so they rely mostly on their fat to prevent heat loss.

Fur seals, however, have as many as 70 underfur hairs for each guard hair, and this gives them a fur coat with superb insulation. Unfortunately, the dense, luxurious coat of fur seals was highly valued as a commercial commodity. In fact, it was the ever-widening search for new fur seal populations, as the known populations were progressively decimated, which led to much of the early exploration of Antarctica in the early 19th century.

The Kingdom of Krill

The zooplankton (animal plankton) of Antarctica is relatively diverse in species, and contains many of the creatures found in other oceans, such as copepods, larval crustaceans, jellyfish, larval sea urchins and sea stars, arrow worms, larval fish, etc. However, the dominant species within the zoo-plankton are the krill.

The word krill is of Norwegian origin and means very small fish, or whale food, but krill are actually crustaceans. There are some 85 species of krill worldwide, and 11 of these are found only in Antarctic waters. The best known and most important of these is the largest, the 5 cm-long (2 inches) *Euphausia superba*. It is extremely abundant, and is the basis for the larger animal life in Antarctica.

The Antarctic food chain is much simpler than those found in other oceans in that there are fewer levels to go through from the primary producers (diatoms) to the top level carnivores (sea birds, seals, whales, etc.). Krill feed directly upon the phytoplankton at the base of the food chain and consequently form a major link in that food chain. Krill is the primary food for the millions of

fish, squids penguins, albatrosses, petrels, some seals, and the large baleen whales which inhabit the Southern Ocean. In fact, virtually all the marine animals that visitors encounter in Antarctica are completely dependent upon the vast populations of krill for their livelihood, either directly or indirectly.

Krill outweigh humans

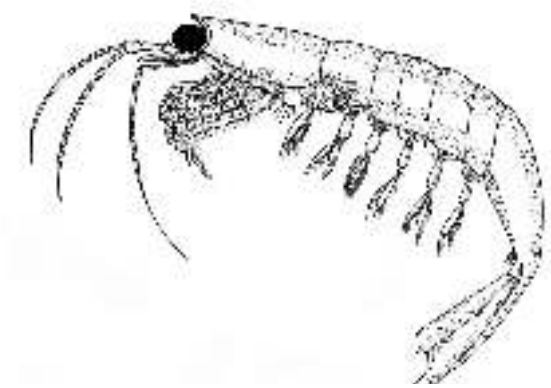
The population of Antarctic krill has been estimated at 600 000 billion, and their average density is around 19 million per square kilometer (11.8 million per square mile). However, in the summer they tend to concentrate in 'swarms' in certain areas. The total weight of krill in the world's oceans is thought to weigh more than the entire human race.

Antarctic krill only inhabit water with a temperature below 4°C (39°F), and live for seven years or more. When phytoplankton is less available in the winter, the krill are dispersed and cling to the underside of sea ice to graze on the algae growing on the underside of the sea ice. When there is not enough to eat, the krill will shrink during the winter. Once the ice begins to melt away in spring and the phytoplankton blooms get started, krill form massive swarms, regrow their sexual organs and begin the reproduction cycle again. Females produce up to 6000 eggs in a season, which they deposit in open water. The eggs sink to about 750 meters (2500 feet), then hatch into larvae which are similar to tiny tadpoles.

They take some time to mature and must molt 12 times before they become adults. When Antarctic krill are in their large swarms during the summer, predators take advantage and prey on krill heavily, whales, seals, penguins and other seabirds focus on krill.

Whale food

The great baleen whales migrate to Antarctic waters every summer to spend several months feeding on krill in order to build up their body mass and accumulate fat which gets them through the rest of the year when food is much more difficult to come by. The baleen whales increase their body weight by as much as 50 percent during this period of intensive feeding. An adult blue whale can consume up to 5 tonnes of krill in a day. It has been estimated that the baleen whales consumed 180 million tonnes of krill annually, before whaling so drastically reduced their numbers. Today, it is estimated that whales take 30 million tonnes every year.



Krill illustration

Scientists believe populations of seabirds and seals have greatly increased with the destruction of the great whales – and increased food supply. The crabeater seal (which feeds on krill, not crabs) is the most numerous seal in Antarctica, and probably consumes more than 100 million tonnes of krill annually. Seabirds take another 40 million tonnes, while fish and squid probably consume 150–200 million tonnes of krill each year. Therefore, roughly 350 million tonnes of krill are consumed by these animals each year.

Potential value

Krill has a protein content of about 55 percent, so it has a high potential as a fishery. It has some problems though, it must be processed immediately after death because a highly active enzyme causes the protein to break down very quickly. Krill also take in fluorine from their food and they sequester it into their chitinous exoskeletons. Consequently the shell must be removed to reduce the fluorine to acceptable level. The former Soviet Union and Japan initiated commercial krill fisheries as long ago as the 1960s. Other European and Asian nations have subsequently started similar operations.

In 1982 the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) came into force as part of the Antarctic Treaty. Its role is to regulate the harvest of various fisheries in Antarctica to allow sustainable harvesting. Currently the total allowable catch for the southwest Atlantic is about 5.6 million tonnes each year, but they also set a 'trigger' level of 620,000 tonnes. Currently the top countries harvesting krill are Russia, Japan, China, South Korea, and Norway with a total catch of about 125,000 tonnes. Krill is used primarily for animal feed (e.g fish farms), but it is also used in the production of Omega 3 oil nutritional supplements and for mixing with other meats to produce sausages and fish balls. In Japan it is sold as cheese, soup mixes, a flavoring, a paste, and a drink.

It is vitally important to determine how much krill can safely be harvested by humans without causing adverse effects on the simple and fragile ecosystem – and that the harvest is not unduly concentrated in particular areas.

King penguin in South Geogria © D.Sasse

IV. THE WILDLIFE

Antarctic Squids

Squids are abundant in the Southern Ocean, an important, but little studied part of the Antarctic ecosystem. Major predators on krill, they, in turn, are an important component in the diets of toothed whales, seals, the larger sea birds, and fishes.

Squids, and their relatives the octopuses (which are much less important in Antarctic waters), are invertebrates. Together they are known as cephalopods, and are related to snails, slugs, clams, oysters, etc. However, their highly evolved nervous and sensory systems make them comparable to many of the large predatory vertebrates. With their two fleshy fins, squids can manoeuvre and swim slowly, but underneath the head is a funnel tube through which the animals can squirt water under pressure, thereby creating a water jet. This allows them to move very fast either forward or backward, and it helps them greatly when catching prey or avoiding predators.

The squids normally grab their prey with the two longest tentacles (there are ten altogether). Suckers on each tentacle help them to hold the struggling prey. The victim is then shifted to the mouth and sliced up into small pieces by a powerful, horny beak before being swallowed.

It is difficult to study the biology and ecology of squids because they are fast, strong swimmers with excellent eyesight and can easily avoid nets. Also, many occur in deep water. Most studies must focus upon the nearly indestructible squid beaks which are retrieved from their predators. A single sperm whale was found to have no less than 18,000 squid beaks in its stomach. Even less is known about squids in Antarctic waters than elsewhere; several Antarctic species are known only from their beaks.

At present, there is virtually no information available on life cycles, growth rates, or reproductive biology of Antarctic cephalopods. However, it has been estimated that sea birds, whales, and seals may consume some 34 million tonnes of squid per year. On this basis, the total Antarctic squid stock is likely to be at least 100 million tonnes.

Commercial squid fisheries

Large-scale squid and octopus fisheries have existed for generations in the Mediterranean, Southeast Asian, and Japanese waters. Japan has operated a fleet of commercial squid fishing boats in the waters around New Zealand since the late 1960s. Fishing vessels from several European and Asian nations are now catching large quantities of squid in the waters around the Falkland Islands and off the coast of Argentina.

Because of the ever-increasing search for new and unexploited fisheries and fishing areas, many scientists are concerned about the likely development of squid fisheries in Antarctic waters. Much more research is needed to accurately determine stocks and work out reasonable management plans. This is a major goal of CCAMLR (The Commission for the Conservation of Antarctic Marine Living Resources).

Antarctic Fishes

Almost all the fishes in Antarctica are bottom dwellers and rarely encountered. For convenience, the species may be divided into two distinct groups: deep-sea fish and coastal fish. The coastal group contains the better known species, including the ice fishes, eel pouts, Antarctic cods, plunder fishes, and dragon fishes, which accounts for about 60 percent of the species and 90 percent of the individuals. Most of the coastal species are unique to the region, but most deep-sea fishes occur elsewhere as well.

As expected, the species diversity is low (only about 200 species have been identified so far), but the number of individuals in these nutrient-rich waters is high. The marine environment they inhabit is very uniform with regard to temperature, but they must deal with the extremely low – though constant – water temperature.

No scales and white blood

The ice fishes have practically no scales, and lack the oxygen-carrying protein haemoglobin, which is common to all other vertebrate animals. They have a pale, nearly colorless appearance. Although their blood is not red, but a translucent yellowish color, their ancestors were probably red-blooded because they still have non-functional red blood cells. The cold waters hold a high level of dissolved oxygen, and these fishes take it in through their gills as do other fishes, but it is carried in solution in the blood plasma.

Many species appear rather sluggish. Even so, they are able to maintain considerable activity in these low temperatures because of the presence of very efficient metabolic enzymes. Slow growth rates and long lifespans seem to be characteristic of the Antarctic fish fauna. Most species are small in size.

Commercial fisheries

Several nations harvest the fishes of Antarctica. Most attention has been focused on about a dozen species which are the largest and commonest fishes encountered around the continental coast and the Scotia Arc.

The first fish species to be over-exploited was the South Georgia cod, which measures up to 90 centimeters (nearly three feet): catches peaked at 400,000 tons in 1970–71. Before fisheries are developed on too large a scale it is important to evaluate the gross potential of the resources, study their population dynamics, develop systems to monitor fish stocks which are exploited, and evaluate the effects of such fisheries on other elements of the ecosystem

CCAMLR, established in 1977 as a result of the increasing commercial exploitation of Antarctic marine resources, monitors populations of fish, krill and squid.

ANTARCTIC AND SUB-ANTARCTIC. WASHINGTON:

Watson, George E. 1988. American Geophysical Union. Excellent field guide and detailed introduction to Antarctic environments. Includes geographic account and range maps. A volume in the AGU Antarctic Research Series.

Antarctic Birds

The most obvious and commonly seen animals of Antarctica are the birds. The species diversity is very low, for reasons already explained. Only 43 species of birds occur south of the Antarctic Convergence, nearly all of them seabirds. Many ornithologists believe that Wilson's storm-petrel, which breeds by the millions in Antarctica, may be the most numerous bird in the world.

Penguins

Penguins are symbolic of Antarctica. Although the 17 species of penguins are all found in the southern hemisphere, most of them live north of the Antarctic Convergence; the Galapagos penguin actually lives at the equator. Of all the penguins, only the emperor and Adélie are restricted to Antarctic habitats. All penguins are flightless and adapted for life in cold water, so even those found in the low latitudes are dependent upon cold water currents for their livelihood.

Penguins are the most aquatic of the seabirds, and they spend most of their lives at sea, except when molting or rearing young. Their ancestors were flying birds, as shown by the similarities in their pectoral girdle to that of modern flying species. The main reasons why birds fly are to search for food, evade predators, and migrate; penguins fly underwater.

The wings of penguins are reduced in size, stiff and flat. They are adapted to propel the birds through the heavy medium of water. Penguins swim by flapping their wings underwater and use their feet for steering or swimming slowly at the surface.

Penguins are quite similar in appearance and behavior to the flightless great auk of the northern hemisphere (which became

extinct in 1844). That bird had long been known by the name 'penguin' in English, so when the first British sailors arrived in the southern oceans they transferred the name to the newly discovered flightless birds, simply because they looked like the familiar great auk. Flying birds have lightweight bones, light fluffy feather body to help reduce body weight and decrease the wing loading. Penguins, instead, have dense bones, and thick dense feathers to help them dive. They can be remarkable divers, going to great depths for such small birds.

Their bodies are very streamlined. When travelling at the surface, the most efficient way for them to take a breath without stopping their momentum is to simply leap into the air to breathe. This type of swimming is called porpoising . Because water is so dense compared to air, it is also the fastest way to swim. This may also be useful in escaping from a marine predator, such as a leopard seal. As it turns out, penguins can fly a bit in the air. When porpoising to avoid capture by a leopard seal, they can alter their direction some while they are out of the water.

Most penguins can dive for 5–7 minutes, but the largest species (the emperor penguin) can submerge for up to 18 minutes. The emperor penguin has been recorded diving to 630 meters (2,070 feet). Most other species do not normally go deeper than about 100 meters (330 feet). Penguins' maximum swimming speed is probably about 24 kph (15 mph), but because of their small size they often seem to be traveling faster.

Gentoo penguins © A.Halsall

Penguins generally feed on prey captured near the surface, either close to shore or near the edge of the pack ice. In Antarctica, the larger species feed primarily on squid, while the smaller species feed mostly on krill, with some fish and squid. During the summer months, however, krill is the main food item for all – as is evident from their typically pink-colored excrement.

Virtually all penguins are social and nest in colonies. In Antarctica, most species use open nests lined mainly with pebbles, but also other debris such as bones and feathers. The pebbles are collected from the beach or stolen from other nests. Both sexes share in incubating the eggs and feeding the young. The two largest species, the emperor and king penguins, make no nest at all. They hold a single egg on their feet to incubate the egg. Unlike other penguins that nest on land, emperor penguin colonies are on sea ice. The females lay one egg in winter(May-June) and the male incubates it for 62 days. When the female returns in late winter, the male has a chance to go to sea to replenish his body fat and stays away for about a month while the female protects and feeds the chick. Once the male returns from his first foraging trip, they take turns until the chicks fledge by the end of summer.

Most of the other penguin species gather at their shore-based colonies in early summer. The males typically begin to build a nest and display to claim a nest position. Over the first couple weeks, the pairs form and much mating occurs. In the smaller species, incubation is around 35 days and both sexes take turns. Once the chick hatches, both parents alternate feeding/guarding the chicks and returning to sea to collect more food. At least one of the adults is present constantly for about 3 weeks, then the chick is large enough to withstand the weather on its own and can even protect itself some from skua attack. In many penguin species the young form groups, or creches, in which the young ones huddle together closely. Mostly a protection against the cold and a defence against predatory skuas. The adults spend another 7-10 weeks feeding the chick(s) before they abandon

them to molt themselves and prepare for winter. The chicks also molt then fledge by heading out to sea with their cohorts.

Penguins typically have very strong feet with large, well developed claws with which to climb slippery rocks or ice. Feathers account for about 80 percent of the penguins' insulative properties, while fat provides the other 20 percent. Penguins have a very high internal body temperature (about 38°C or 101°F) as well as a high metabolic rate. They have no problem surviving – indeed, thriving – in the cold, harsh climate of Antarctica.

Adélie penguin © A.Halsall

Penguins do seem to be facing some problems with conservation. Overall around the Antarctic Peninsula, the populations of Chinstrap and Adélie penguins have decreased substantially over the past 30 years or so. Gentoo penguin populations have risen slightly in the peninsula and they have increased their range of distribution recently. We believe these changes are due to the lack of ice during the winter months along the peninsula. Both Chinstrap and Adélie penguins rely on sea ice during the winter to find krill on the underside of the ice. Without ice, they have greater difficulty in find sufficient food. Gentoos are less dependent on ice and focus more on fish in the winter.

Worldwide, king and emperor penguins seem to be pretty stable, but there are concerns for both species. Changes in the climate, and in some areas perhaps commercial harvest of their food base seem to be having some effect on several populations of kings and emperors. The once large emperor colony near the French station, Dumont Durville has shrunk to less than half of its former size over 30 years. The same is true for some king penguin colonies on the Crozet Archipelago in the Indian Ocean.

Tube Noses

Albatrosses, along with petrels, prions, shearwaters, storm-petrels, and diving-petrels, are members of a group of seabirds called Procellariiformes. But they have another name which is easier to remember – 'tubenoses.' This refers to their external tubular nostrils, that are mounted on grooved, hooked bills. They remove excess salt from their systems through these nostrils, and a saline solution can often be seen dripping from them (or forcibly ejected). The tubular nostrils also indicate they have a well-developed sense of smell.

Albatrosses

At sea, albatrosses are easily identified by their large size, long narrow wings, short tails, and distinctive flight patterns. They spend most of their lives in the air, and have perfected a gliding flight which allows them to stay airborne with a minimum of effort. They seem to enjoy windy, stormy conditions, and it is great fun to watch as they swoop downwards with the wind just above the waves, then turn into the wind to gain height, before turning around to pick up speed and glide with the wind again. They seem to go on for hours like this without ever having to flap their wings. Albatrosses are usually encountered in the open sea, and they often follow ships, taking advantage of the air currents produced as the vessels move, perhaps hoping for something edible to be stirred up by the propellers. They feed mostly on squid, small fish, and krill, which they catch by landing on the surface and dipping their heads underwater.

These birds have short, strong legs and webbed feet, and will alight readily on the water to rest or swim around after food. They usually must run along the surface into the wind in order to become airborne again. For identification purposes, albatrosses can be categorized as large or small. The large species are the royal and wandering albatrosses: the latter has the longest wings of any living bird, with a total wingspan of up to 3.45 meters (11.5 feet). The small albatrosses are often called 'mollymawks' – a Dutch word meaning 'foolish gull' – and have wingspans of 2–2.25 meters (7–7.5 feet).

These big, graceful birds are noted for their long distance flights. The champion in this respect is the biggest of all, the wandering albatross. Using satellite telemetry, scientists have discovered that parent birds fly as much as 560 miles per day at air speeds of 50 miles per hour – covering anywhere from 1,800 miles to an amazing 9,300 miles in a single foraging flight! Young adult wandering albatrosses spend several years at sea before returning to land to breed at about 7 years of age.

Most albatrosses perform complex nuptial dances, and they begin to breed in late spring or early summer. They nest on islands which provide good sites for taking off into the prevailing wind. Their nests usually consist of mounds built of mud, grasses, moss, and excrement; they lay just one egg.

Incubation normally varies from 60–70 days in small species, and lasts about 80 days in the large species. Both sexes incubate the egg, and feed the chick at the nest with regurgitated food until it fledges. Most of the small albatrosses breed every year, but the two large species only breed every other year.

Albatrosses face several threats to their continuing survival. The biggest single threat is long-line fishing in the southern oceans. Long-liners deploy miles of line with thousands of baited hooks to catch Patagonia Toothfish. When the fishing boat sets hooks, albatrosses and other petrels are attracted to the ships and try to feed by stealing the baits. Many individuals get hooked and are dragged under by the fishing gear and drown. With proper equipment and procedures it is possible to reduce the losses from fishing to tiny numbers, but there is a large illegal fishery in the southern ocean so albatrosses continue to die every year. Another major problem that we are only recently becoming acutely aware of is the problem of plastics in the ocean. The Antarctic Convergence helps considerably by preventing much plastic from showing up in Antarctica, but Albatrosses range widely to find food and they still do find plastics along their way. One final serious threat to albatross in particular but Antarctic birds in general, is introduced species; rats, mice and rabbits. From the early movements of sealers around many of the subantarctic islands had unintentional introductions of rats and mice—or even some intentional introductions. Rats and mice can breed prolifically and do tremendous harm by eating eggs and chicks. We are very pleased that several large-scale projects to eradicate the introduced species have been successful: removal of rabbits from Macquarie Island; removal of mice from Campbell Island, removal o frats and mice from South Georgia. But many challenges remain, Gough Island desperately needs an eradication program to save the Tristan Albatross.

Petrels

Most petrels are small to medium-sized seabirds (with the exception of the albatross-sized giant petrel), which have long pointed wings and hooked beaks with both nostrils encased together in a single sheath. We now know that the oversized nostrils are part of their well-developed sense of smell that they use to locate prey in wide stretches of ocean.

Northern giant petrel © G.Lee

Petrels spend their entire lives at sea, except during the breeding season, and have adapted themselves to the severest storms the Southern Ocean can produce. They are often seen flying just over the surface of the sea, using the wind and air pressure along wave fronts as they glide, bank, and shear the water with their wing tips. It is thought that they can survive very long periods on the wing without true sleep.

These tube-nosed birds feed chiefly on plankton, crustaceans, squid, and small fish, which they pick up from the surface. The predatory giant petrels, however, take eggs and chicks of other birds, and will even attack weaker adult birds and molting penguins. Whalers and sealers called them 'stinkers,' based on observation of their feeding habits. They also eat carrion, and the

Petrels have webbed feet and float very high in the water as they paddle around looking for food. They can, if necessary, dive a short distance below the surface. However, White-chinned petrels can manage to dive 50 m and as a result are particularly affected by long-liners because they can follow the baits down quite far. Most species are gregarious, and some of them form huge colonies during the breeding season. Most nest in burrows, rocky crevices, or on rock ledges, while a few (including the giant petrel) actually construct a nest out of pebbles, feathers, and other available materials.

All species normally lay a single egg, and both sexes share in the incubation and feeding of young (usually one mate is away feeding while the other tends the egg or chick). Incubation ranges from 6–8 weeks, depending on the species. The chick is fed by regurgitation, and often the food consists of a very aromatic and oily secretion. Some species, notably the fulmar, can defend themselves by spitting this oil at intruders. Fledging takes 7 to 8 weeks in most species, but 14 to 19 weeks in the largest species.

Storm-petrels

These are the smallest of the oceanic seabirds. Storm-petrels are about the size of swallows, and are often called sea swallows. Another common name given them by seafarers of old was 'Mother Carey's chickens.' This name, applied especially to Wilson's storm-petrel, has an interesting origin. Fishermen used to fear them, as their appearance was thought to herald an approaching storm. Portuguese fishermen would cry out Mata Cara! ('Dear Mother!' in reference to the Virgin Mary) when they saw them. English-speaking whalers changed the words Mata Cara to Mother Carey.

Storm-petrels have a fluttering flight that is much more erratic and weaker than the true petrels. Most species are dark bodied with a white patch on the rump, but some lack the white rump, and others have white bellies and underwings.

The name petrel itself is derived from St. Peter, and refers to the biblical story of Peter walking on water. The storm-petrels have a habit of facing into the wind with outstretched wings, and do appear to walk or dance on the water as they pick up tiny food items from the surface. They feed on very small copepods and isopods, but will even eat small oil droplets.

Like the albatrosses and true petrels, they are often encountered far out to sea in windy and stormy conditions. It is surprising to see such tiny birds in the open ocean, often hundreds of kilometers from the nearest land. In fact, they are superb long-distance flyers. Wilson's storm-petrel rivals the Arctic tern in this respect (though in reverse), migrating north from its Antarctic breeding sites to spend the northern summer as far away as Newfoundland or Ireland.

Most species breed in loose colonies and nest in protected places such as crevices, under rocks, and within cavities or burrows which they may excavate themselves. Both sexes incubate the single egg, but the eggs and young are often neglected for varying periods during development. Incubation usually lasts 5–6 weeks, but may take longer if the egg has been left unattended for extended periods. Both parents feed the chicks, which grow large and fat before their juvenile feathers appear. Fledging normally takes 8–10 weeks.

Diving-petrels

The diving-petrels are only found in the southern hemisphere. They are small stubby birds, and the four species are almost identical in shape, plumage, and flying traits. The basic diving-petrel appearance is a black upper body, with white under the body; short wings, legs, and tail; and small bills with separate nostril tubes which open upward instead of forward.

Diving-petrels do not fly very well, or very far. They usually erupt from the water and fly for a short distance with a rapid whirring flight, before diving back into the water. In outward appearance they are very similar to the little auks, or dovekies, of the northern hemisphere and indeed seem to be the southern equivalents. Although they may range far from their breeding grounds they are rarely seen away from inshore waters.

They feed almost entirely on small fishes, which they chase and catch underwater with their short, hooked bills. Like penguins, they swim underwater by propelling themselves with their wings, not their feet

Diving-petrels have nearly lost the power of flight, and when they molt they are completely flightless and spend several weeks behaving like penguins. They breed on islands, nesting in long burrows which they dig themselves. Like all other tube-noses, they only lay one egg which is incubated alternately by both sexes for about eight weeks. The chicks are fed daily by the parents, and fledging lasts 7–9 weeks.

ANTARCTIC BIRDS: ECOLOGICAL AND BEHAVIORAL APPROACHES.

Parmelee, David. 1992. Minneapolis: U of Minnesota Press. This book features Dr. Parmelee's illustrations, photographs and well-wrought prose: a comprehensive treatment of the birds of the Antarctic Peninsula.

Cormorants (Shags)

Cormorants are medium-sized birds with long necks, long hooked beaks, long rounded wings, and long wedge-shaped tails. They are strong fliers, usually traveling in straight level paths, and often in V-shaped groups, much like geese. Some species are called shags, from an Icelandic word meaning beard, and refers to their crest of feathers in the breeding season. Most cormorants are black, but in the southern hemisphere many species are black and white in coloration.

There has been considerable confusion about the three very similar birds found in Antarctica and adjoining South American waters. Various common names are used, such as imperial, king, and blue-eyed; also the words cormorant and shag are used interchangeably. Most biologists agree that the Antarctic cormorant is a distinct species and that all cormorants in Antarctica are conspecific i.e. they are all one and the same species. So we shall adopt just one name, and call it the Antarctic blue-eyed shag. The blue eye-ring is conspicuous.

They are essentially coastal seabirds, although they can and often do make long trips over open water. This explains how they reach Kerguelen, Crozet, Macquarie, South Georgia, and other isolated islands as well as Antarctica itself during the breeding season. Cormorants are expert divers, and can reach considerable depths. They float very low in the water, and when they go under to pursue their prey (usually fish but also squid) they dive with a characteristic forward leap or jack-knife manoeuvre. They propel themselves underwater with their large webbed feet, and often partly open their wings to aid in steering and making sharp turns when chasing fish. Unlike most seabirds, which have webbing between the three forward projecting toes, cormorants have webbing which connects all four toes. This is a much more efficient swimming foot.

Cormorants snatch fish with their strongly hooked beaks and then surface in order to position the fish so as to swallow it head first. An important difference between cormorants (and their relatives the pelicans, boobies, frigatebirds, tropic birds, and anhingas), and other seabirds is that they have no external nostril openings. They must breathe through their open mouths, and often seem to be panting when the gular pouch vibrates during their breathing.

Cormorants are colonial breeders, and in Antarctica often nest near or among penguin colonies. They build large, bulky nests containing mud, kelp, rocks, feathers, and any other convenient material. The clutch is normally 2–5 eggs, and both parents share the 4-week incubation. The young fledge after about 5–6 weeks. The parents feed them by regurgitation, and it is fascinating to watch the young birds thrusting their heads deep inside the adults' throats to obtain food. Like penguins, the immature birds often form creches.

Waterfowl

Only two species od ducks occur in the Antarctic region and they are very similar in appearance. The South Georgia pintail is closely related to the South American yellow-billed or brown pintail, and probably represents a fairly recent natural colonization.

A resident of South Georgia, this pintail may also show up occasionally in the South Shetland Islands. It is very typically duck-like in appearance, is a strong flier, and takes off from the water nearly vertically. The males have sharp tail plumes, and both sexes have a metallic speculum on their secondary flight feathers.

The pintails normally form large flocks during winter months, but at the onset of spring they disperse and form pairs in the marshy ground beside streams and ponds. They are primarily fresh water birds. Unlike most other ducks, they have evolved to produce small clutches of only 3–6 eggs, which is to be expected since they live in an environment with relatively few predators. The nests are well hidden, and are constructed from grasses, tussock stems, feathers, etc.

The other duck which may be seen in small numbers in South Georgia is the speckled teal (or yellow-billed teal), which is common in southern South America and the Falkland Islands. It is extremely similar in appearance to the South Georgia pintail, but has a shorter neck and tail, and is less spotted on the belly. It is found only in the Cumberland Bay area, around Grytviken.

Snowy Sheathbills © G.Miller

Sheathbills

Sheathbills are plump and pigeon-sized, and indeed even look some-what like white pigeons. There are only rudimentary webs between the three front toes, and they have a well-developed hind toe. They are snow white (except when they have been scavenging in offal and mud), with pink, fleshy wattles, and are most often encountered as they walk deliberately among nesting penguins or along the shoreline. Sheathbills fly rather laboriously with short rounded wings. They can swim, and are occasionally seen at sea on ice floes. Their nests may be set within a rock crevice, or in a cavity, or perhaps under a ledge, and are constructed with pebbles, feathers, bones, etc. They are the most noticeable scavengers of the Antarctic. Sheathbills will eat almost anything of organic origin, including seal faeces, spilled (regurgitated) penguin food, seal placentas, dead seal pups, dead chicks, eggs or even live penguin chicks. There are only two species of sheathbill and both of them breed in the Antarctic and on subantarctic islands. The snowy, or greater, sheathbill is the one most likely to be seen. It breeds on South Georgia and other islands of the Scotia Arc, and on the Antarctic Peninsula. Part of the latter population flies north in winter to southern South America and the Falkland Islands. The lesser sheathbill is very similar, but has a black bill. It breeds on Heard Island and some subantarctic islands in the Indian Ocean.

Skuas

Large, predatory seabirds related to gulls and terns, skuas are much more pelagic, and aside from the breeding season spend most of their time at sea. The skuas can be distinguished from gulls by their white wing patches at the base of the primary flight feathers. They also have two elongated central tail feathers of varying lengths (though these are not always easily seen). Two species occur in Antarctica. These are both stocky, brownish birds which are rather hawk-like in their habits, and have strong hooked beaks and relatively strong talons on their webbed feet. The brown skua is the larger, and has a heavier bill; it is mottled gray-brown overall.

Brown skuas © R.Parker

The smaller south polar skua has a more slender bill, and is easily identified in its pale form, which features a tan body and head that contrasts with a dark back. The dark morph of the south polar skua is quite similar to the brown skua, apart from its less massive appearance, and relatively pale underparts. Hybrids between the two species sometimes occur.

Skuas are aggressive when it comes to protecting their eggs and offspring. If a visitor approaches too close to a nest, the adults will dive against the intruder to drive him away. The skuas of Antarctica are among the largest in their group, which makes them potentially dangerous to almost all the other birds and small animals. They are take eggs and eat chicks. Until penguin chicks are large enough to fend off skuas, they are at constant risk of attack. Skuas will chase and harass birds that have food in their beaks until they drop it out of desperation, and will also kill adult petrels and prions. They are active hunters and can kill quite large prey, such as wounded adult penguins, but they will also scavenge when necessary. Brown skuas have been observed taking milk from nursing elephant seals.

Skuas nest in loose colonies with 20-50 meters between neighbors. The Antarctic skuas usually nest near penguin colonies along the coast, but can be found at inland sites if there are petrels nesting there as well. They construct a perfunctory nest which is often a simple scrape. Both parents take turns incubating usually two eggs for about four weeks and both parents feed the chicks. Visitors should be wary of walking near skua nests, where intruders risk being dive-bombed with frightening speed and power.

As mentioned, skuas range widely outside the breeding season. Brown skuas may winter near the shores of South Africa, Australia, New Zealand, and South America, while the south polar skua ventures even farther, to the northern Pacific and Atlantic oceans. One banded sub-adult brown skua is known to have migrated from the Antarctic Peninsula to Greenland.

Gulls

Though primarily coastal seabirds, the gulls which breed in high latitudes, such as the kelp gull of Antarctica, often migrate long distances over open water during winter months.

These are general-purpose birds. They have long broad wings and are good fliers, but cannot fly as well as the albatrosses and petrels. They have webbed feet and are good swimmers, but cannot swim as well as the penguins and cormorants. They are predatory birds, but are not as successful or as fierce as the skuas.

Gulls take advantage of any situation they can. They will scavenge when necessary and will eat an impressive variety of foods. They often follow ships in the hope of receiving edible refuse, and many species have actually increased their numbers and ranges as a result of living off mankind's ever growing refuse. Gulls get their food either from the ground, or from the surface of the water. They rarely dive beneath the surface since they are very buoyant and float high in the water.

The kelp gull (sometimes called the southern black-backed or Dominican gull) is quite large and typically gull-like in appearance. The head, body, and short rounded tail are white, while the upper surface of the wings is black. The bill and legs are yellow. They are easily recognized, for they are the only gulls in Antarctica. Young birds, however, do not attain their adult plumage until their third winter and until then are a mottled brown.

The kelp gull has a very wide range, including South America, South Africa, and New Zealand as well as the Southern Ocean. It nests in rocks and on ledges, and often builds a nest with organic debris. Both parents incubate the 3–4 eggs, and both feed the chicks.

Terns

Terns are closely related to gulls, and some experts consider the two groups as one family. But whereas gulls often soar in updraughts and wind currents, terns have a straighter, more level flight. Most terns are coastal birds, but the two Antarctic species migrate varying distances over open water each year.

The Arctic tern is notable for having the longest annual migration route of any animal on earth, with some individuals flying 35,500 kms (22,000 miles) during a round trip flight from the Arctic (where they breed) to the Antarctic, and then back to the Arctic. The Antarctic tern, by contrast, travels much less, staying all year in ice-free waters in the Antarctic.

The Arctic and Antarctic terns are very similar, both in appearance and habits. They feed almost entirely on fish, which they catch by diving on them from above. Terns hover as they search for prey and can dive a short distance into the water if necessary. They breed at opposite ends of the Earth at opposite seasons.

Most terns nest in colonies, but the Antarctic tern often nests on its own, or at best in loose and widely segregated breeding areas. It may lay from 1–3 eggs, and incubation lasts about 3 weeks. Both parents share incubating and feeding. Unlike most other seabirds, terns bring freshly caught fish for their nestlings rather than feed them regurgitated food.

The nest usually consists of a simple scrape among loose pebbles. Fledging takes 4–5 weeks, but the parents continue to feed their offspring for some time after that. The eggs and young are well camouflage d against the gray pebbles, and a visitor can easily wander too close without realizing it. However, Antarctic terns will soon warn any potential trespasser, by diving and scolding. If this happens, the visitor should retreat, whereupon the terns will resume sitting on their eggs or brooding their chicks.

Pipit

The South Georgia pipit is the only songbird native to the Antarctic region. It is a sparrow-sized bird with a slender pointed bill and a long tail. The plumage is reddish brown, with buff underparts and characteristic streaking. It feeds on the ground and walks or runs (it does not hop like most small song birds), and continually flicks its tail like a wagtail.

The South Georgia pipit is most likely descended from the Falkland Islands or South American pipits, but is now considered a distinct species. Their ancestors were probably carried to South Georgia by the prevailing westerly winds.

These birds are remarkably difficult to spot among the tussock grass and other vegetation, but can easily be seen as they prowl along the beaches and streams or among kelp, looking for insects, copepods, and other small creatures. They breed on small rat-free islands off the coast of South Georgia, but do visit the main island to feed. The nests are made of woven grasses and are usually hidden among tussock grass roots. They remain on South Georgia throughout the year. The South Georgia Pipit has benefitted greatly from the recent rat eradication on South Georgia. Once the main island was declared rat-free, the pipits were seen the very next year singing and apparently breeding. The following season, breeding on the mainland was confirmed. We have high hopes that many more pipits will be able to live on a rat-free South Georgia.

Antarctic tern , Drygalski fjord © B.Holgate

Leopard seal © K.Bogos

Antarctic Seals

The Antarctic seals are all marine mammals that belong to the Order, Pinnipeds ('fin-footed'). This includes the Phocidae (true seals), Otariidae (fur seals and sea lions, or eared seals), and Odobenidae (walruses). In Antarctica, there is one eared seal – the Antarctic fur seal – and five true seals: southern elephant, Weddell, leopard, crabeater and Ross.

The Pinnipeds are well adapted to life in the sea. Their streamlined bodies, large fin-shaped front legs, and extensive webbing on their hind legs make them excellent swimmers. As diving animals, they also have a number of adaptations for holding their breath so they can stay underwater longer, and to withstand the pressure of diving deep in the ocean for feeding. They have more blood in relation to their body size (about twice the amount found in a comparably sized human) and their blood carries more haemoglobin in each cell that non-diving animals. Those two adaptations both allow them to carry more oxygen in their tissues than non-diving mammals.

In order to withstand the pressure, pinnipeds have no air spaces in their sinuses or inner ears. They can extend their dives by slowing their metabolism during longer dives. During a dive the heartbeat rate slows from perhaps 100 beats per minute to 4 or 5 beats per minute. They normally exhale before diving below the surface so there is no gas in their lungs that would continue to be absorbed during their dive. That strategy helps prevent the bends.

The females only give birth to one young. Because the seals disperse after the short breeding season, mating must take place soon after the females give birth. Although the gestation period is about nine months, implantation is delayed for about three months so that the next year's pup is born almost exactly one year later.

The mothers' milk contains about 45-60% fat and 10% protein (compared to about 4% and 2% respectively in cow's milk), so the seal pups grow very quickly. The males have little or nothing to do with the raising of their offspring.

How is a fur seal different from a true seal?

Fur seals have external ear flaps; their hip structure allows their hind feet to be rotated up under the body so they can walk/run on all four feet when on land; the fore flippers are long and broad and they swim through the water as if they were flying with their front flippers; the soles of their flippers are naked, and they have claws only on the middle three digits of each flipper. Fur seals also rely more on their fur and less on a blubber layer to maintain their body temperature in the cold waters of Antarctica. . Their fur consists of two different layers of hair, guard hairs and under-fur, which are arranged in bundles. Each long guard hair is surrounded by up to 70 short under-fur hairs, which gives the animal a highly efficient protective layer of insulation against low temperatures. It also gives it a pelt which was once highly valued by people. Finally, the females' reproductive strategy is to feed their

Elephant seal flippers, Elephant Island © G.Miller

pups for a few days then abandon it for a few days to a week so they can forage for themselves. Then they return to their pup to nurse it for a few days. The females continue with that pattern for many months compared to true seals.

By contrast, the true seals have no external ears (they have perfectly good ears, just no eternal flaps), their pelvis/hips do not allow their hind limbs to rotate under their body so they must inchworm or crawl along the ice or shore. Their fore limbs are short and broad and mostly used for steering when in the water. The hind limbs, however, have a huge webbing between the toes and swinging their hind flippers from side to side is the main driving force for swimming. Their flippers are completely covered with fur, and there are claws on all digits. When they have their pups, they stay with them continuously for a relatively short period (2-6 weeks) to nurse them and guard them. Once they leave, they do not return. The true seals, on the other hand, rely primarily on a thick layer of subcutaneous oil-rich fat, or blubber, to insulate their bodies from the intense cold. Their fur is not nearly so thick or luxurious. True seals do have both guard hairs and under-fur, but there are only a few under-fur hairs associated with each guard hair.

Antartic fur seal

Fur seals have a polygynous breeding system. The males compete with each other to claim a section of beach, then when the females arrive, they maintain a harem of multiple females through the season for them to breed with. Because of the fighting, males grow much larger than the females. Males are up to 180 kgs (400 pounds) and females just 50 kgs (110lbs). Males have heavier skulls and very thick skin and fur on their shoulders and neck. This hairs on the neck and shoulders form a thick mane, and the older bulls grow a crest on the top of the head. Fur seals favor rocky coastlines with sheltered beaches. The males start to arrive in September or October, and quickly set about establishing territories on the beaches by fighting all the neighboring males. The females begin to arrive at the beaches in late November, and usually give birth two to four days after arrival. Mating takes place about a week after the female gives birth.

Fur seal, South Georgia © J.Lancaster

By the middle of January the harems start to break up, and the exhausted bulls go to sea for short periods to feed. From the end of January to the beginning of March the animals molt. The cows and pups leave the beaches in April but some of the young males may stay around until the end of June.

Antarctic fur seals dive to about 50 meters (150 feet) and feed mainly on krill; they also consume fish, squid, and even penguins occasionally. During the winter they migrate northwards to warmer waters, and individuals have ranged as far north as the South Island of New Zealand.

Before their discovery, the Antarctic fur seal bred all around the South Shetland and South Orkney Islands as well as South Georgia. Within a few short years after discovery the breeding colonies on the South Shetland Islands they were wiped out and several ships went on voyages of discovery to look for more fur seals to hunt. Thus the South Orkney and South Sandwich Islands were found and charted. In South Georgia at the end of the 19th century there were 30 sealing vessels of American, British, and Russian origin taking hundreds of thousands of skins a year. They were also nearly wiped out.

By the end of the 19th century the South Georgia fur seals were thought to be gone. Fortunately, in 1933 a small surviving colony was discovered on Bird Island off the northwest tip of South Georgia. From this small beginning, and thanks to protective legislation, the population has expanded massively. There now may be more than 3,000,000 fur seals on South Georgia—perhaps more than before exploitation. As the South Georgia population has grown, fur seals are once again visiting and even starting to breed in several locations around the South Orkney, South Sandwich, and South Shetland Islands.

Southern elephant seal

The southern elephant seal has a large circumpolar range which includes not only the Antarctic mainland and islands, but most of the subantarctic islands as well. This is the largest species of seal in the world. The males can grow to 6 meters (20 feet) in length and can weigh as much as 3,600 kilograms (4 tons). Females, though large, are much smaller than the males, and grow to about 3.6 meters (12 feet) in length and 900 kilograms (1 ton) in weight.

The mature male elephant seal is distinguished by his immense size, large inflatable proboscis, and dark gray color. The females are brownish, and lack the enlarged nose of the male.

Elephant seal males maintain and defend breeding territories and harems (like the fur seals). They start coming ashore in August to establish their territories in anticipation of the arrival of the females a few weeks later. Each bull may guard a harem of up to 50 females, though he is often challenged by other males.

The precocious pups, which may be 1.5 meters (4 feet) long and weigh 36 kilograms (80 pounds), are born about a week after the females arrive. The mothers suckle their young for only about 3–4 weeks, and the pups put on weight very quickly – up to nine kilograms (20 pounds) per day.

Once the pups are weaned their mothers leave them behind and go to sea to recuperate and regain their energy reserves. Harem holding males also depart for a while, but they all return to shore somewhere to molt. A tightly-packed elephant seal wallow is an extraordinary sight.

Elephant seals do not truly migrate, because when they leave the breeding grounds and go to sea, they mainly move ahead of the advancing ice pack. They feed mostly on squid, supplemented by fish, which they catch in deep dives. Elephant seals are champion divers. Dives have been recorded to 1,500 m (5,000 ft) and lasting up to 2 hours. Most of their dives are much shallower than that and typical dives last less than 20 minutes. Twenty minutes is the aerobic dive limit for most elephant seals. That means if they only hold their breath for 20 minutes, they do not suffer oxygen debt and can take another breath and immediately dive for another 20 minutes. If they go beyond their aerobic dive limit, they must spend additional time on the surface to recover from the dive.

After the fur seals had been nearly exterminated by the 1820s, the sealers turned their attention to the elephant seals which were killed for their oily blubber. A large male yielded nearly 400 liters (100 gallons) of high quality oil. The pattern of over-exploitation was repeated, and by the mid-19th century so few elephant seals remained that the industry came to an end.

But numbers recovered and in 1910 elephant seals were again being killed on South Georgia. In due course, numbers declined once more and the species finally received total protection in the 1960s. Happily, populations have recovered very well, and the elephant seal is once again common in many parts of its original range.

Weddell seal

This is the most southerly of the seals – and indeed the most southerly of all mammals – breeding as far south as 78°S. It is almost always found within sight of land in both summer and winter. Although individuals do sometimes wander long distances (they have been found off South Australia and New Zealand, as well as South Georgia, Macquarie, Kerguelen, Heard, the South Orkneys, and even the Falkland Islands), the species was not discovered until 1823 when Captain James Weddell captured six specimens during his 'voyage to the South Pole.'

Weddell seal, Antarctic Peninsula © K.McLachlan

Female Weddell seals are slightly larger than males. During the breeding season, males establish underwater territories by controlling one or more breathing holes, where they will mate with females that enter. They do not form harems, per se, but since the females typically take up residence at a breathing hole, the males are effectively guarding a small group of females. Mating takes place in the water.

The Weddell seal is a rather tubby animal which weighs up to 400 kilograms (900 pounds), with a length of some 3 meters (10 feet). Weddell seals are dark gray above and light gray below, and the entire body is covered with distinctive light blotches and streaks. The face is small, but the eyes are extremely large to facilitate hunting in deep, dark waters under the ice. They primarily eat fish, although they also eat a fair amount of squid and krill. Their favored food is the large Antarctic cod, which can weigh 70 kilograms (154 pounds).

The breeding season starts when the cows haul out on the fast ice in early September and give birth within one or two days. It's at this time that males begin to claim breathing holes and fight with one another to maintain their spacing. Females protect their pups fiercely, but within a short period, they coax them into the water to prepare them for life ahead.

The pups are weaned in about 6 weeks, after they have more than quadrupled their weight to more than 120 kilograms (260 pounds). The cows will have lost about 136 kilograms (300 pounds) during the same period. The pups enter the water very soon after birth, though many are crushed to death by the ice breaking up. It has been estimated that the mortality rate of Weddell seal pups is as high as 50 percent during their first two months.

Weddell seals are unique in that they stay in the far southern reaches throughout the winter. They remain under the fast ice and maintaining breathing holes which allow them to breathe. The seal takes advantage of natural breaks and leads in the fast ice and keeps a hole open by both constant use and but scraping the edges of the hole with their teeth. The teeth of older individuals are usually badly worn, and this condition may be an important cause of death in mature animals.

Weddell seals are excellent divers, and have been known to dive to over 600 meters (1,900 feet) and remain submerged for more than an hour. Perhaps because they meet few predators on or under the fast ice, they are not much concerned when they occasionally meet humans on land.

Crabeater seal

The most abundant seal in the world, estimates ranging from 12 to 70 million, the crabeater seal in one seal regularly swims in large groups. Its population has probably increased in recent decades probably because of the reduction of the number of whales in Antarctica means that much food is available. The crabeater seal lives almost entirely upon krill, not crabs.

Crabeater seal © T.Leach

The adults of both sexes are about the same size, growing to 2.7 meters (9 feet) in length with a weight of 227 kilograms (500 pounds). This medium-sized seal is long and slim, and is often called the white seal because of its cream-colored or silvery fur. It has a long blunt, rather dog-like snout and is often encountered resting on pack ice or ice floes. It is quite common to see adults with prominent scars on their flanks or bellies caused by encounters with leopard seals, and orcas. The remarkable number with heavy scars is testament that they are quite pugnacious themselves and often survive such attacks.

Their teeth are well adapted to an exclusive diet of krill. The specialized molars have numerous projecting cusps arranged in line with the jaws so as to act as strainers when the jaws are closed. This allows the animal to take in a mouthful of water and retain the krill while forcing the water out of the mouth with the tongue. It is an adaptation that works in a similar way to the baleen plates of the filter-feeding whales.

The females give birth on the drifting pack ice, with each family group separated from other crabeater seals by as much as a kilometer, or half a mile. The pups are born from the middle of September to early November and are weaned after about a month. They then have to take to the water, where they may be attacked by predatory leopard seals.

Crabeater seals stay mainly near the edge of the pack ice as it expands or retreats, but they need stretches of open water. They are commonly seen lying on the ice floes singly or in small groups. They live all around the continent, but in especially large numbers in the Ross Sea and around the Antarctic Peninsula.

Leopard seal

As its name suggests, this seal is a predator. It is the only Antarctic seal which regularly eats warm-blooded prey. A portion of its diet consists of penguins, but it also eats fish, krill, and even the young of other seals. The leopard seal has complex teeth with multiple cusps, like the crabeater seal, enabling it to filter krill from sea water in much the same way that the crabeater does.

Fenales are slightly larger than males, The males grow to 3 meters (10 feet), and the females reach about 3.6 meters (12 feet). The typical appearance is a dark gray back shading into a lighter belly marked with leopard-like spots. Leopard seals are long and sinuous and have a very large and powerful head and neck, said to look like very reptilian. From a distance, they are the only true seal that appears to have a well-defined neck.

The leopard seal has none of the cute appeal of the other seals, but despite its ferocious reputation there have been very few cases of attacks on humans. These are solitary animals, and it is rare to see more than one individual in a given area. They can be found throughout the pack ice during the summer, patrolling the places where penguins gather to dive into the sea. They chase and catch penguins with great speed, often vigorously shaking their prey to break it into smaller pieces before swallowing it.

They breed on the pack ice with pups born between November and December. Weaning takes about two months. Some animals spend their winters near subantarctic islands such as South Georgia and Macquarie, and a few individuals have roamed as far as southern Australia and New Zealand, South Africa, and South America.

The Ross seal is the least known of the Antarctic seals. It is a solitary animal and breed in the thick pack ice along the fringes of the Antarctic continent. The species was discovered by Captain James Clark Ross during the British Antarctic Expedition of 1839–43. Few sightings were reported during the following hundred years, until the big icebreakers started to penetrate the seal's remote habitat. Recent satellite tracking studies indicate that they also travel in wide open water during the summer when there is little ice in the Ross Sea.

Both sexes are similar in size and appearance. They grow to about 2.8 meters (9.5 feet), and are dark greenish gray on the back, fading to a light gray on the belly. The head is small and the snout short, and there are light stripes around the throat and flanks. The eyes are large and bulging, which helps it to find food and avoid obstacles in the dark waters beneath the ice.

Humpback whale, Antarctic Peninsula © S.Portelli

The Ross seal has very large and well developed flippers compared to other seals. The incisor and canine teeth are delicate, sharp, and recurved for catching squid, its main source of food (though it also eats fish and krill). It is very vocal, and one of its alternative names is 'singing seal.' Its varied calls can be heard over long distances. Very little is known of its breeding habits.

Antarctic Whales

Cetaceans – the group that includes all whales, dolphins, and porpoises – are air-breathing mammals, but have perfected the ability to live entirely in water. Unlike those other marine mammals, the seals, they never come ashore or onto ice at all. Their hind legs have completely degenerated and developed into a fluked tail for propulsion. The front limbs have been transformed into pectoral fins, the nostrils have moved to the top of the head, and they have lost their fur. To keep warm, they have opted for a thick layer of oil-rich blubber with which to insulate themselves from the cold waters.

The thick layer of blubber also aids buoyancy because fat is lighter than water. In addition, it is used as stored food during times of migration and fasting. Essentially weightless in water, whales have been free to grow to a great size.

Whales inhale before diving (seals do the opposite), but the tremendous pressure exerted by water causes the lungs to collapse there-by compressing the retained air into cartilaginous supply tubes in the bronchial system.

Whales have large lungs by comparison with most other mammals. And they are able to exchange up to 85 percent of the air in the lungs at each breath, compared with the 15–20 percent exchange which occurs during normal breathing in humans. Most of the larger species produce a visible vaporous 'blow' when they exhale at the surface. This is caused mainly by condensation when the air in the lungs is suddenly depressurized on exhalation.

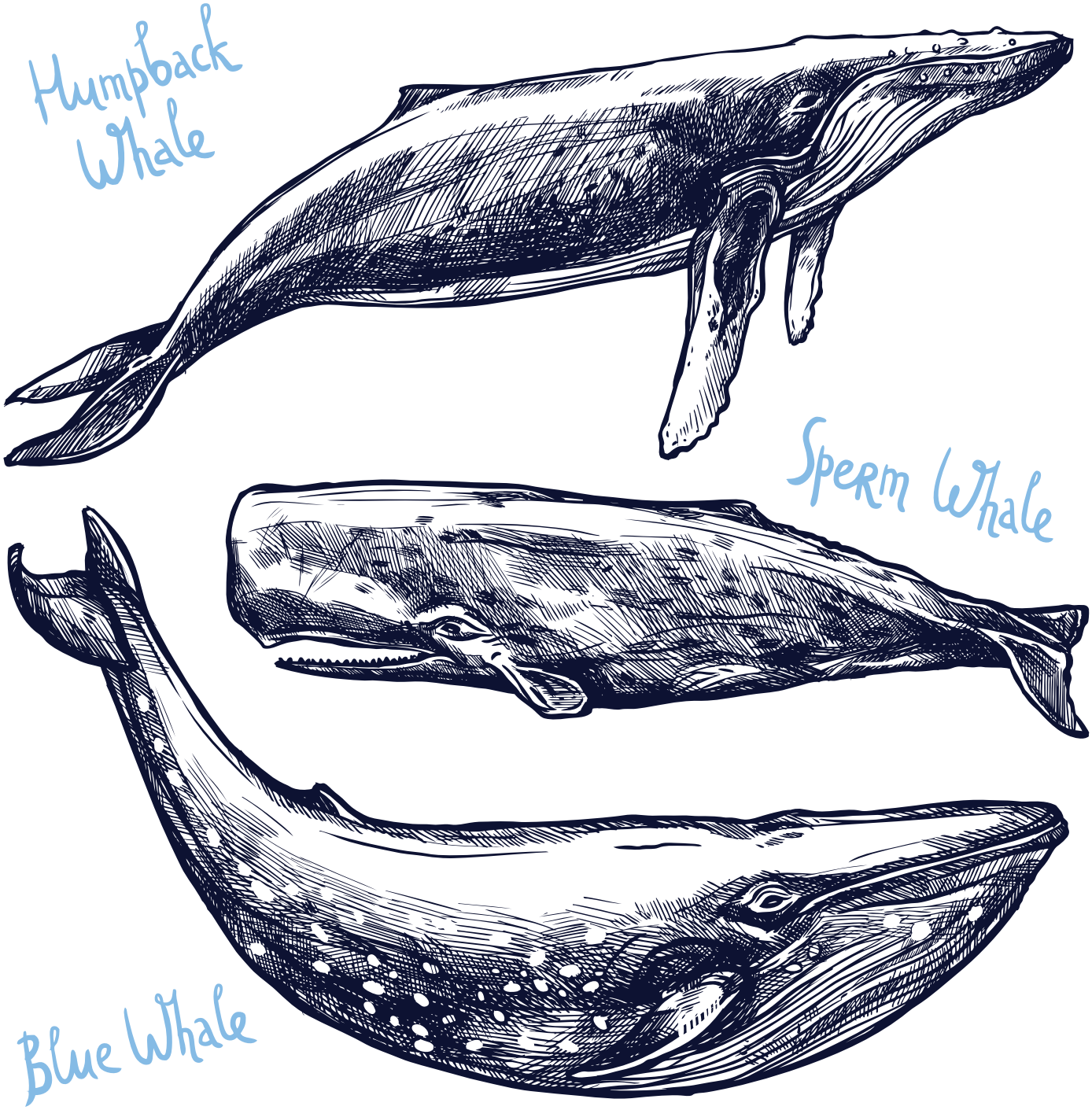
Teeth versus baleen

Cetaceans are divided into two different groups, those with teeth and those with-out teeth. The toothed whales include the dolphins, orcas and sperm whale. The whales without teeth are known as the whalebone or baleen whales, and feed by filtering plankton through a series of baleen plates suspended from the position normally occupied by upper teeth.

Toothed whales actively pursue relatively large prey such as squid, fish, birds, seals, and other whales. The toothed whales have developed very useful sonar or echolocation systems with which they can locate and capture prey in even the dark water found at great depths.

The baleen whales feed in quite a different way from those with teeth. As mentioned, they possess plates of horny baleen which hang down vertically from the roof of the mouth. The inside edge of each plate is frayed so there are many loose fibers, and the plates over-lap one another so the frayed edges form a very effective sieve. As the whale moves through the water it opens its huge jaws (most species also have expandable throats which increase the efficiency of this method of feeding) and takes in a large quantity of water that is filled with krill or small shoaling fish. The water is squeezed out between the plates, trapping any small pre, such as krill or small fish inside the mouth.

This process enables the baleen whales to take advantage of the huge quantities of available krill as well as other small organisms. Different species of baleen whales have different sizes of filter plates which allow them to coexist while feeding on different prey.


Humpback Whale
Sperm Whale
Blue Whale

Baleen whales typically feed in relatively shallow water because the zooplankton which makes up most of their diet is dependent upon phytoplankton which in turn is dependent upon sunlight. Therefore they are not normally deep divers like some of the toothed whales, and seldom dive to more than 90 meters (300 feet) below the surface.

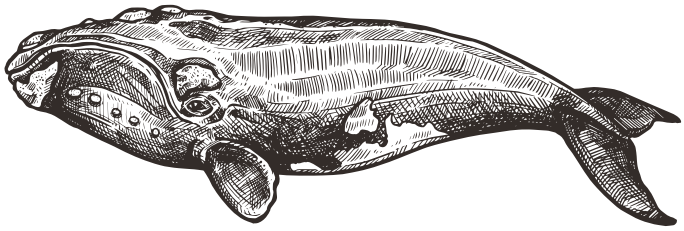
The Antarctic baleen whales have a pronounced annual cycle of breeding in the warm waters at low latitudes in the winter, and feeding in the cold Antarctic waters in the summer. Baby baleen whales, especially those of the larger species, must undergo an accelerated rate of growth in order to be weaned by the time they reach the feeding grounds in summer.

Massive growth rate

Cetacean milk has a high fat content and a thick consistency, which prevents it from mixing readily with sea water. The females mammaries are also muscular and essentially shoot a stream of milk under pressure when the young whale nurses. This helps the baby whale to avoid swallowing too much water when it nurses. The rich, highly nutritious milk produces rapid growth. The extreme example of this is seen in the blue whale, whose offspring may gain weight at the rate of 4.5 kilograms (10 pounds) per hour!

Southern right whale

This large whale is a slow moving animal, and its body is so rich in oil that it floats, even after death. It was therefore the 'right' species to hunt in the days of whaling. Both males and females average about 15 meters (50 feet) in length, with a maximum of 18 meters (60 feet), and average about 55,000 kilograms (60 tons) in weight, with a maximum of 96,000 kilograms (106 tons).



Southern right whale

The coloring is pure black with some mottling of brown, as well as white callosities above the eyes, near the tip of the snout, and on the chin, and sometimes a white marking on the belly. Its body is extremely broad and smooth. There is no dorsal fin, so it should not be mistaken for any other large whale in Antarctic waters. The right whale has two widely separated blowholes which produce a high and distinctive V-shaped double spout when viewed fro the front or rear. The tail of this species, which is broad with very pointed tips and a deep notch, is usually raised above the surface when the animal dives. They sometimes also hold their tail in the are to 'sail' with it.

The head is very large, about 35 percent of the total body length, and there are no throat grooves. Therefore the animal cannot expand its throat significantly when feeding, like most baleen whales. Instead, it has a narrow and highly arched upper jaw which carries the longest baleen plates, more than 2 meters (7 feet) long, of all the Cetaceans. The baleen fibers are very fine as well. The right whale simply swims along slowly with its mouth open and filters very small food items through its very long baleen plates as it moves through the water. With their fine baleen, right whales can feed on some of the smallest zooplankton such as copepods and small amphipods.

Because it was so easy to hunt and had such a great return of oil, the southern right whale was greatly over-exploited by the whalers and had almost disappeared by the end of the 19th century. Now totally protected, it is making a gradual recovery. The whales are most likely to be seen around South Georgia, and at one of their strongholds, the Valdez Peninsula in southern Argentina. A few individuals are spotted in the South Shetland Islands as well.

Rorquals

The group of baleen whales known as rorquals share the characteristic of having many throat grooves, which allows he throat to be expanded when feeding. Unlike the right whales, they engulf a single huge mouthful of water and then close their jaws and squeeze the water out through the short baleen plates. The advantage of this method is that with the throat constricted, they assume a surprisingly long and streamlined shape which allows them to swim at speeds as high as 30 kms per hour (16 knots). There are five species of rorqual whales in Antarctic waters. Four of them, belonging to the genus Balaenoptera, are closely related and differ mainly in size and coloration. They are difficult to identify.

Blue whale

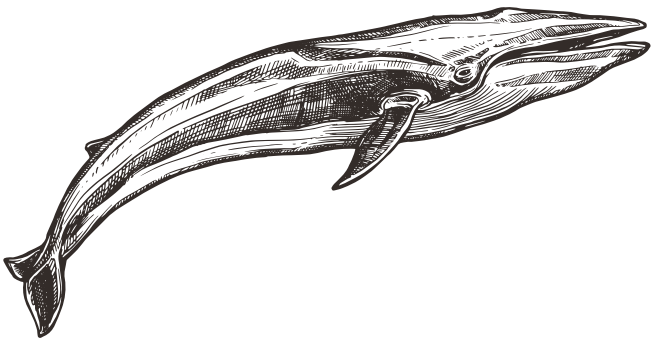
The blue whale is the largest of the rorquals, the largest of all the cetaceans, and the largest animal ever to have appeared on our planet. It can exceed 30 meters (100 feet) in length, and weigh between 80,000 and 130,000 kilograms (90–144 tons). The maximum recorded weight was 178,000 kilograms (196 tons). The color is hard to evaluate unless one is fairly close, but is a bluish gray, mottled with small white or light gray spots. It has a tiny triangular dorsal fin that sits very far down the back so it only shows long after the blow, and often the flukes are exposed as the animal dives. Blue whales do not often raise their tails into a vertical position when they dive, but they do pick them p low to the water fairly often.

In Antarctic waters blue whales feed almost entirely upon krill, and a large whale may consume 8,000 kilograms (over 8 tons) of these tiny animals in a day. At the end of the Antarctic summer, the whales move northward where they live off their blubber and gather in small groups for courtship and mating. The females breed about once every three years.

There are separate populations of blue whales in the North Pacific, North Atlantic, and Southern Oceans. The species was seriously over-hunted by the whalers, to the point where it has not yet managed to make much of a recovery. They are usually seen either on their own or in small groups of three or four. It would be rare to spot one around the Antarctic Peninsula, but they are regularly sighted northwest of South Georgia around Shag Rocks.

Fin whale

The fin whale is the next largest cetacean, with a length of up to 27 meters (89 feet). The weight ranges from 35,000 to 45,000 kilograms (40–50 tons) with a maximum of 80,000 kilograms (90 tons). It has a relatively larger falcate dorsal fin that is not so far down the back as a blue whale's. The dorsal fin lays down so that the angle from the back to the fin is very low. They also normally present a high thin spinal column so they appear to have a thin back.



FIn whale

The fin whale has a unique asymmetrical coloration. Like most whales the belly is lighter than the back. Fin whales are usually very dark to black with a light chevron of light lines on its shoulders. The white of the belly extends under the chin, but on the right side, it comes all the way up to the line of the mouth opening. On the left side, the lower lip iis dark like the rest of the back. Asymmetry is unusual in animals, and in this case may be connected with its method of catching krill. It rolls sideways to the right and swims in a tight circle, so that its paler right side is underneath, and therefore camouflaged.

The fin whale is probably the fastest swimmer of the great whales, with a top speed of about 18 knots. It not only eats krill, but also feeds on fishes such as sardines, anchovies and pollack, and squid. The fin whale's blow is a tall, vertical spout. Its relatively fast speed saved it, initially, from the whalers but with the introduction of the fast, steam-powered catcher boats, its turn came for over-exploitation. Like other species it is now protected, but there is little information about its population status.

Sei whale

Sei whales generally avoid the coldest waters closest to the ice, so they are rarely seen near the continent, thought they are regularly sighted just north of the South Shetland Island over the continental shelf. This species is quite large, averaging about 15 meters (50 feet) in length, and 12,000 to 15,000 kg (14–17 tons) in weight. The coloration is much like the fin whale, mostly dark steely gray but with a lighter throat and belly, without the asymmetrical jaw coloration. There is usually some light mottling on the flanks and belly. It's dorsal fin is similar in size to that of the fin whale, but it stands up nearly vertically from the back.

The sei whale also specializes on krill in the Antarctic, but will also eat small schooling fish.

Minke whale

The smallest rorqual is the minke, or piked whale is the smallest of the baleen whales we normally see I Antarctica. It averages about 8 meters (26 feet) in length with a maximum of 10 meters (33 feet). Its average weight is 5,800–7,250 kilograms (6–8 tons), with a maximum of 9,000 kilograms (10 tons). The rostrum, or snout, is distinctive in that it is narrow and pointed. It's latin name is acutorostrus' which means narrow-nosed. The coloration is dark bluish gray above and light gray underneath, with two palish bracket marks above the flipper extending across the back. Its relatively large, pointed dorsal fin is located almost midway along the body.

The minke whale does not usually produce a very noticeable spout, because it often begins to exhale before it breaks surface. It often leaps clear of the water, usually two or three times in succession, and has the peculiar habit, for a baleen whale anyway, of approaching ships, which it may dive under, from side to side. It is commonly seen close inshore, and in among the pack ice.

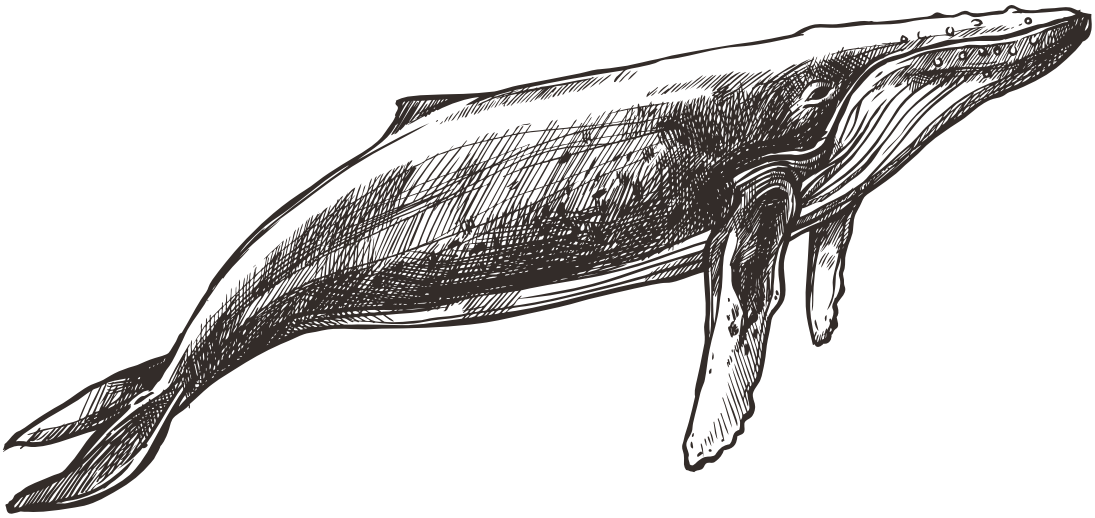
This species is a fast swimmer, and in places where krill are not readily available it often eats small schooling fish and squid. It tends to be a vigorous feeder, with a lot of leaping and splashing accompanying what may almost be described as a feeding frenzy. Minke whales seem to have flourished following the decimation of the larger baleen whales, because they have taken advantage of the increased food resource. As with most whale species and populations, there are conflicting opinions on numbers, but there may be half a million of them altogether, with nearly half that total being found in the Antarctic. The Japanese still catch this species, using pelagic factory ships, despite international pressure.

Humpback Whale

The humpback belongs to a different genus from the other rorquals. It shares the same general life style as the others, but does not have the same long, sleek body shape. Comparatively broader and more massive, it averages about 15 meters (50 feet) in length with a maximum of 19 meters (62 feet), and weighs about 30,000 to 40,000 kilograms (34–35 tons) with a maximum of 48,000 kilograms (53 tons).

The body characteristics and its behavior make this the easiest great whale to identify. Its coloration is basically black or dark grey with a white throat area. The ventral surface of the tail is also white, as well as most of the flippers (which are nearly one third as long as the body). The humpback whale's broad bushy blow is distinctive, as is its dorsal fin which is small low triangle mounted on a fleshy hump. Its head and jaws are covered with fleshy 'tuberosities,' and barnacles are often attached to the body.

Humpbacks are well known and well-like. They often show themselves with very active behaviours at the surface, and often feed in areas very close inshore so it is easy to spot them from shore or from small boats. They often breach—leap completely



Humpback whale

out of the water to land on their backs with a tremendous splash. Besides breaching, the hump-back whale waves and slaps its enormous flippers on the surface of the water (flipper slapping) to make a loud sound rather like a gun shot, and almost always exposes its great tail flukes when it dives deep. This species is amazingly acrobatic and energetic and never fails to create excitement among visitors lucky enough to encounter one.

In Antarctic waters they usually 'lunge feed' by surging forward near the surface to gulp a huge mouthful of water and prey, or come up on their prey from below. Humpback whales are famous for communicating with each other by means of long, plaintive, and varied songs. Like other baleen whales, their numbers were greatly depleted, but they have recovered well compared to other species.

Arnoux's beaked whale

The beaked whales (a sub group of toothed whales) are not well-known. They are deep divers and are very shy of ships so they are difficult to approach and study. We do see small groups of beaked whales on occasion around the South Shetland Islands. This toothed whale averages about 9 meters (30 feet) in length and weighs 6,400 kilograms (7 tons). It is blue gray This toothed whale averages about 9 meters (30 feet) in length and weighs 6,400 kilograms (7 tons). It is blue gray in color and has a bulbous forehead, or 'melon', and a pronounced beak. The lower jaw extends beyond the upper, revealing the foremost pair of teeth. This species has only two pairs of teeth, and they are all in the lower jaw. The flippers are broad and rounded, the dorsal fin is small and triangular and set far back, and the flukes are large and pointed with little or no notch between them.

Both males and females usually bear pale scars on their backs and flanks, presumably caused by the teeth of others of their kind during mating conflicts. This whale is very uncommon, and little is known of its life history. Squid beaks have been recovered from the stomachs of stranded specimens. It has been recorded around South Georgia and the Antarctic Peninsula.

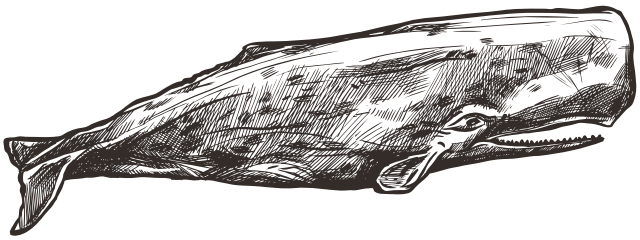
Southern bottlenose whale

This smallish species is another beaked whale. It is 6–8 meters (20–26 feet) long and weighs 3,600 kilograms (3 tons). The body is rather cylindrical in the fore section but tapers off towards an elongated tail. It has an enormous melon. The tail is very broad with pointed tips. It is usually a deep metallic gray in color, shading to bluish on the flanks, but may also be brown. The dorsal fin is sickle-shaped and located far back on the body.

The southern bottlenose whale has only one pair of small teeth located at the tip of the lower jaw. Stomach analysis of dead animals suggests that this species feeds mostly on squid and pelagic fish. It is rarely seen, and most studies have been restricted to dead specimens which have been washed up on beaches.

Sperm whale

This is by far the largest of the toothed whales. Males average 15 meters (50 feet) in length and 36,000 kilograms (40 tons) in weight, and the much smaller females average 11 meters (36 feet) in length and 20,000 kilograms (22 tons) in weight. In profile, this whale is unmistakable, with an enormous square head that makes up one third of the total body length. The lower jaw is long and narrow, and seems rather puny compared to the overall size of the head.



Sperm whale

There is no true dorsal fin, but most animals have a series of knobs or lumps on their back with the front one being the largest. Much of the body surface is covered with crenulations, making it look as if the body has shrunk within its skin. The normal coloration is dark gray or brownish (pure white specimens like the mythical Moby Dick have actually been seen, but rarely).

Unlike all other cetaceans, the blow hole of the sperm whale is at the foremost upper point of the snout, on the left side. The blow is very characteristic because it shoots out in a forward direction and to the left. One can easily identify the sperm whale from its blow, and also tell in which direction the animal is swimming. The flippers are short and stubby, and the tail is very strong and somewhat square in shape (this species usually makes steep dives and exposes its tail as it goes under).

Sperm whales feed primarily on squid, including giant deep-sea species, but also prey on skates, sharks, and a variety of fish. They often bear the distinctive sucker marks from the tentacles of giant squid. They are champion divers, and are known to have dived to at least 3,000 meters (10,000 feet). While most dives are only about 10 minutes long, they can stay underwater for an hour or more.

Solitary males migrate long distances, ranging from equatorial waters in the winter right to the edge of the Antarctic ice in the summer, in the case of non-breeding males. The females and young generally stay closer to tropical waters throughout the year, and are not seen in Antarctica.

In the heyday of whaling, sperm whales were caught largely by American vessels based at New England ports and later at San Francisco. At one time, sperm whales comprised 40 percent, by weight, of the total catch of all species of whales. They were valued mainly for their oil and also for spermaceti, a liquid wax obtained from the whale's forehead; this was used for cosmetics, ointment, and candles. Sperm whales are still hunted from shore stations in the northern hemisphere.

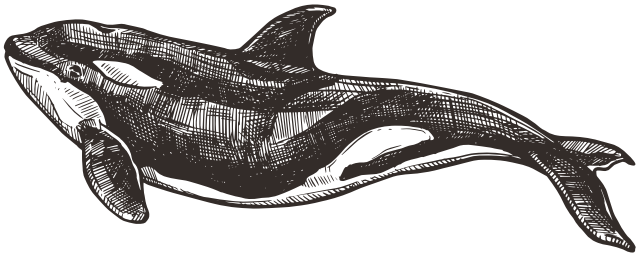
Killer whale

The killer whale or orca is the largest of the dolphins, and probably the most easily recognized of all cetaceans. It is of medium size, reaching 9.5 meters (31 feet) in length for males and 7 meters (23 feet) for females. Killer whales are heavy bodied with a blunt head. Their coloration is striking with most of the body a glossy black, except for a highly contrasted bright white belly extending onto the flanks, and a patch just behind the eye. There is also a gray saddle mark behind the dorsal fin.

The most obvious feature is the enormous dorsal fin, which is the tallest and most pointed of any cetacean. In adult males it has a straight vertical shape of a very long triangle and may stand 2 meters (6 feet) high, while in females and immature males it is falcate like a minke whale's dorsal fin.

Killer whale © G.Miller

Killer whales normally travel in pods of 5–20 individuals, usually an extended family. These groups are very cohesive and exhibit a high degree of cooperation in hunting prey and caring for one another. The animals are top predators and feed on a large variety of prey including squid, sharks, rays, fish, seabirds, seals, and even other cetaceans. There are accounts of large whales being attacked by a pod of killer whales acting together – rather like a moose being attacked by wolves.



Killer whale

They are seen quite often from ships in the Antarctic, and sometimes change course to get a closer look. They can also be seen 'spy-hopping', when they rise vertically in the water to look around for prey.

In Antarctic the orcas can be divided into 4 different identifiable groups. The position, shape and size of the white auricular patch (the white patches on the side of its head behind the eyes). One variety feeds primarily on fish, another mainly on penguins another a mixture of seals and other cetaceans. The different groups are under study to decide if we should call them different subspecies.

Dolphins

There are several dolphins species we sometimes encountered in the southern ocean. In close to the coast of South America we often spot Peale's dolphins. They have a large dorsal fin and a typical dolphin shape They often race over to the ship to ride the bow wave as we come along the Cape Horn area.

The other common inshore dolphin is the Commerson's dolphin, a thick bodied little animal that is more porpoise-shaped than dolphin-shaped. It has a broad flat head, small rounded flippers, and a low rounded dorsal fin. It is usually found in shallow areas near land, including isolated islands. We often see them when we visit the Falkland Islands. Two-thirds of the dolphin is white so they are easily recognised. It sometimes jumps clear of the water, but most often just rolls at the surface. It feeds on krill, squid, and small fish.

Offshore in the southern ocean—and occasionally south of the convergence, our most common sighting of dolphins are hourglass dolphins. Named for the distinctive white hourglass shape on their flanks, they are fast and acrobatic dolphins. They do come to play at the ship some times, but rarely stay for long. Little is known about the life history of this species, but it seems to be fairly common in cold southern waters, feeding mainly on fish and squid.

Finally, the southern right-whale dolphins are not often spotted, but are distinctive. They have no dorsal fin (hence they are named after the right whales). They are mostly black on the top and white on the bottom and have a very thin appearance. They too are fast swimmers so you need to be quick to spot them. They do not come to play around the ship. The ones we have seen are a short-lived treat as they often overtake the ship and swim off into the distance.

Commerson's dolphins

Shackleton's crew on the ice after the Endurance was abandoned © NSW State Library

V. EXPLORERS AND SCIENTISTS

The Exploration of Antarctica

The name Antarctica comes from early Greek geographers and philosophers. They named the Arctic after 'Arktos,' the bear constellation in the northern sky. They also knew of the extent of the continents in the northern hemisphere and reasoned—because of their philosophy of symmetry and balance Aristotle posited -- that there should be an equally extensive mass in the southern hemisphere so 'Antarktos' was the opposite of the 'Arktos'. Antarctica is the Latinised version that came into use. Hence Antarctica existed as a philosophical concept long before any real evidence existed.

The term Terra Australis Incognita was adopted by medieval map makers to designate the location of the still unknown land. Many maps of the day picture continents of various shapes and sizes. As exploration expanded, the explorers consistently failed to find this southern land. Each exploration pushed the imagined coastline farther south, from the tropics to the temperate regions to the pack ice and beyond.

The Beginnings (1492–1800)

The end of the 15th Century was the beginning of the Golden Age of Exploration. Christopher Columbus, in trying to reach the Spice Islands of the East Indies, discovered the New World in 1492. First with Bartholomeu Dias (Portugal) in 1488 who sailed around the southern tip of Africa, then Vasco De Gama (Portugal) sailed from Europe all the way to India around Africa in 1497 the Portuguese pushed the idea of Terra Australis Incognita to be well south of Africa.

Twenty three years later, in 1520, another Portuguese navigator, Ferdinand Magellan, explored the coastline of South America and discovered a long, winding channel at the foot of the continent which led from the Atlantic Ocean to the Pacific Ocean—the Straits of Magellan. The land they saw to the south was thought to be the coastline of Terra Australis for a time, but in 1578 Sir Francis Drake (England) proved that it only separated an island, Tierra del Fuego, from the mainland of South America. Drake sailed completely around the tip of South America. (Note: It wasn't until 1616 when William Shouten, a Dutch captain, first sighted Cape Horn that it received its name—after Shouten's home town 'Hoorn' in the Netherlands). t

It was the tempestuous weather of the southern ocean that can be credited with many of the early discoveries regarding Antarctica. The first sighting of Antarctica is clouded in doubt. In 1599, a Dutchman, Dirk Gerritsz, was blown off course by a storm after passing through the Straits of Magellan. He reported seeing snow-covered mountains some 500 kilometers (300 miles) from South America, in latitude 64° South, which may very well have been the South Shetland Islands. But other accounts of the voyage do not mention the sighting. Perhaps it was large icebergs.

James Cook was one of the most important early explorers with regard to Terra Australis, because he essentially proved where it was not. During his first voyage of discovery (1768–1772) he proved New Zealand to be a pair of islands, and finally pushed the supposed boundary of Terra Australis out of tropical and temperate latitudes. Then, during his second voyage (1772–1775), Cook circumnavigated the globe in high southern latitudes, without seeing land, casting doubt on the existence of the still unknown Antarctic continent. He became the first person to cross the Antarctic Circle (south of Kerguelen) and went on to explore the south-western Pacific Ocean at a high latitude, crossing the Circle again near Thurston Island (off Lesser Antarctica). Here he entered pack ice and continued south to latitude 71°10'S in what is now the Bellingshausen Sea. Cook was unlucky, for this was the only region where he could have sailed so far south and yet remain too far away from the continent to discover it. Cook wrote that no one would probably ever go farther south than he had just been, but he also felt the world would never derive any benefit from a continent that far south. During this voyage Cook discovered the South Sandwich Islands and landed on South Georgia Island. South Georgia was originally sighted a century before that by an English merchant, Anthony de la Roché. Blown off course in 1675 he discovered and took shelter in South Georgia but did not go ashore. In Cook's voyage, one of his most important reports was of the wealth of fur seals in the Southern Hemisphere. His reports of huge populations of these valuable fur-bearing animals led directly to the next era of exploration in the Antarctic.

The Age of Discovery (1800–1900)

Within a few years, American, European, and Russian sealers had become the new explorers of the far south. By 1802, only 27 years after Cook's second voyage, the sealers had seriously depleted the fur seals of South Georgia, Kerguelen, and Heard Islands. Searching ever farther south from their bases in New Zealand, sealers discovered and started exploiting the fur seals of the Antipodes Islands in 1800, the Auckland Islands in 1806, and Campbell and Macquarie Islands in 1810.

The South Shetland Islands, may have been discovered in 1819, when the 644 crew of Spanish frigate San Telmo wrecked on the shores of a small islet near Livingstone Island. The San Telmo set sail from Cadiz in 1819 for Callao, Peru but were blown off course. She vanished without a trace of her 644 crew, but remains discovered on Telmo Island suggest they spent time on shore before dying without reporting the new discovery to the world. The first confirmed discovery of the South Shetland Islands was by William Smith (who was blown off course by a storm) in 1819. At first he had difficulty convincing the British Admiralty in Santiago that he had found new land, but the news of his discovery brought more than 40 ships to harvest fur seal skins and oil from those islands during the next season of 1820–21. In the following season, 1821–22, more than 90 ships were working the islands. By the end of the third year after the islands' discovery, more than 320,000 fur seal skins and 940 tons of oil had been taken in the South Shetland Islands, and for all practical purposes the resource had been destroyed.

The Antarctic Continent was finally discovered in 1820. The honor of who first sighted the continent, however, is still disputed. Ironically, none of the three men involved in the controversy realized at the time that he may have actually sighted the continent. In that momentous year, Thaddeus von Bellingshausen, during a Russian expedition, records sighting the coast of Queen Maud Land on 27 January 1820. If correct, this is clearly the first sighting. Bellingshausen greatly admired Cook and he was driven to equal Cook's accomplishments in the Antarctic. Over the course of two summers he became the second man to circumnavigate Antarctica, and did so considerably farther south than Cook's route.

In response to William Smith's report, Edward Bransfield, of Britain's Royal Navy, was sent to examine the South Shetland Islands in 1819, and he sighted land (most probably the Danco coast of the Antarctic Peninsula) on 30 January 1820. Later in the same year, Nathaniel Palmer, a young sealing captain from Stonington, Connecticut, sailed from the South Shetlands aboard the 47-foot sloop Hero, and on 16 November sighted what was probably the coast of the Antarctic Peninsula, from a distance of about three miles.

At this time there may have been numerous sealing boats exploring the region of the South Shetlands and the Antarctic Peninsula, but it was common for captains to keep their finds secret in order to protect their commercial interests. Many discoveries must have been made during these years that were never publicized.

On 7 February 1821, the American sealer John Davis became the first person to set foot upon the Antarctic continent when he landed at Hughes Bay on the Antarctic Peninsula. At the time of his achievement he said he believed the southern shore he landed on was a continent. But it was not until the following decade that geographers and scientists concluded that the long-sought Southern Continent had indeed been found.

NORTH POLE, SOUTH POLE, JOURNEYS TO THE ENDS OF THE EARTH.

Imbert, Bertrand. 1992. New York: Abrams, paper, 191 pp. This slim volume is a suprisingly good introduction to polar exploration.

British Antarctic Expedition 1907-09 © NSW State Library

British sealer James Weddell had completed a few successful seasons sealing around the South Shetland Islands and the South Orkney Islands, but in 1823 their results were disappointing. With unusually little ice and calm conditions they decided to sail south. They reached 74°15'S in the Weddell Sea, the farthest south that any man had ever been. Weddell found no new sealing grounds, but he did discover a new species of seal which was later named after him and no one reached so far south by ship for some time.

The last major search for new sealing grounds was made in 1838 by John Balleny. Although he discovered the islands that bear his name, and the Sabrina Coast of Antarctica, he returned from the expedition with only 178 seal skins. The sealing bonanza was over. But by then the collection of oil had become very profitable, and the ships' crews rendered elephant seals, several species of whales, and even penguins into valuable oil. This new industry continued until well into the twentieth century.

Scientific Expeditions

During the sealing era, in the mid-nineteenth century, expeditions for scientific discovery became important. Expeditions and surveys were organized, primarily by the British, Americans, and French. There were two such expeditions in 1840. Jules Dumont d'Urville discovered a bare, rocky shore directly south from Australia and named it Adélie Land after his wife. He also made important measurements of the Earth's magnetic field in these southern waters, and he remapped the South Shetland Islands and some sections of the Antarctic Peninsula.

U.S. Navy Lieutenant Charles Wilkes led the first American scientific expedition to the Antarctic, and was the first important investigator to insist that Antarctica was a continent rather than endless ice packs and scattered islands. His initial exploration of the Weddell Sea in 1839 had to be cancelled because of leaking ships. Returning in 1840, he sailed deep into the pack ice in a search for the South Magnetic Pole. He did not reach it, but he did discover a very long coastline south of India and Australia which he followed for 2,400 kilometers (1,500 miles). This proved the existence, beyond any doubt, of the Antarctic continent.

Wilkes originally set off with six ships, most of questionable sea-worthiness, and returned with only two. He also had continuing disputes and personal conflicts with some of his officers. He was court martialled, but was eventually cleared of any wrong-doing and spent the next 12 years writing official reports of the expedition. The information and collections made during this voyage were some of the earliest collections held by the recently founded Smithsonian Institution in Washington, D.C.

In 1841 James Clark Ross was appointed to lead an official British expedition to Antarctica. Already famous for his exploits in the Arctic, having located the North Magnetic Pole in 1831, he set out to find the South Magnetic Pole. At the time, the South Magnetic Pole was well inland so he was unable to record its position, but Ross did discover the Ross Ice Shelf and Mount Erebus, the most active volcano in Antarctica. His expedition made many scientific discoveries, and he was knighted on his return to England. He also reported on the vast numbers of whales encountered during his voyage, which created great interest in certain quarters.

After a 50 year hiatus, the next important voyage to Antarctica was the Belgian expedition of 1897–1899 to chart new lands along the western side of the Antarctic Peninsula. Led by Baron Adrian de Gerlache, with first mate, Roald Amundsen and ship's

doctor, Frederick Cook, it was the first fully scientific expedition as well as the first to spend a full winter in Antarctica when their ship, the Belgica, was trapped in the ice in the Bellingshausen Sea. They would have failed completely, as they were all suffering from scurvy by late in the winter, except that Amundsen and Cook had considerable experience with native people in the Arctic and were able to stem the disease by having them eat fresh seal meat.

In 1898, Carsten Borchgrevink and his small party became the first men to winter over on the Antarctic continent itself. They built a hut at Cape Adare for their base, and made the first sledge journey on the Ross Ice Shelf. These two important expeditions led to the next period of exploration by having shown that it was possible to winter through the Antarctic night.

The Heroic Age (1901–1916)

This period was characterized by great triumphs and tragedies, and was the beginning of the privately funded scientific investigations in Antarctica. In 1895 the Sixth International Geographical Congress identified Antarctica as the last major geographical research to be undertaken. The Seventh Congress met in Berlin and essentially divided up the continent for different expeditions to visit. Britain, Germany and Sweden all embarked on voyages of exploration in 1901. The French sent their own expedition in 1904 and many more followed in the first two decades of the twentieth century. These expeditions had research as their stated goal, but there was implicit competition among the countries involved. In 1901 Robert Falcon Scott, an officer in the Royal Navy, led the Discovery expedition to Victoria Land in the Ross Sea. They built a hut at the southern tip of Ross Island in McMurdo Sound, and spent the winter doing scientific research. The following summer, Scott, with two companions, Edward Wilson and Ernest Shackleton, made a trek towards the South Pole using dogs to pull their sledges. They reached 82°S before having to turn back.

In the same year, Otto von Nordenskjold led a Swedish expedition to the Weddell Sea. They constructed a hut on Snow Hill Island and conducted a successful expedition despite, considerable and remarkable hardship. After their first winter, Nordenskjold and his men spent a productive summer conducting research around the northern Weddell Sea. Unknown to them, their ship, the Antarctic, had trouble reaching them to retrieve the scientific team. First they unloaded a team of three men at Hope Bay to try to reach Nordenskjold over the land and sea ice, then the ship headed for another route to find their way south to Snow Hill. The three men were unable to travel to Snow Hill so they returned to Hope Bay to await pickup by the ship. Meanwhile the ship, under Captain Carl Anton Larsen, was crushed in the ice and sank—foreshadowing Shackleton's expedition in another ten years. Larsen and his men escaped to Paulet Island and built a hut there to spend the winter. After a series of adventures and extraordinary hardship involving small groups of men stranded at different places, the whole party was rescued in November 1903 by the Argentine corvette, Uruguay led by Commander, Julian Irizar. The scientific results of this expedition proved to be very important, including the first fossil penguins from Antarctica. Meanwhile, Erich von Drygalski, led the German expedition to Kerguelen Islands, Heard Island, and East Antarctica and successfully discovered and charted large areas of previously unknown coasts.

Slightly later, Jean-Baptiste Charcot organized a French national expedition in 1903 on the *Française* which charted large parts of the Antarctic Peninsula region. This work was to be of great importance to navigators in the years to come. Charcot returned in 1908 in the most modern polar ship to date, the Pourquoi Pas?. Besides exploring and charting further coasts and islands, he tested a lot of new equipment such as electric lamps, anti-snow blindness goggles, a petrol-engine motor boat, and different clothing. Charcot was a, known as 'the polar gentleman,' and was one of the first to point out the dangers of over-harvesting the whales. He conducted considerable research in hydrography, geology, botany, and zoology.

The two great quests of Antarctica, to reach the South Pole and the South Magnetic Pole, had still not been achieved. Ernest Shackleton returned in 1907, this time in command of his own expedition aboard the Nimrod. He hoped to take both prizes. He decided to use Siberian ponies, instead of dogs, to haul sledges across the Ross Ice Shelf and up to the polar plateau. But the ponies did not last long and Shackleton's polar party was reduced to man-hauling the sledges.

Despite appalling conditions, they reached a point within 180 kilometers (97 miles) of the pole before Shackleton decided to turn back. Meanwhile, the other aim of the expedition had been achieved by Shackleton's second-in-command, the Australian Edgeworth David, who led a successful trek to the South Magnetic Pole with Douglas Mawson and Alistair Mackay.

THE BIRTHDAY BOYS. NEW YORK: CARROLL & GRAF, 189 PP.

Bainbridge, Beryl. 1994. This mesmerizing novel tells the story of Scott's last expedition – with fictionalized chapters by Evans, Wilson, Scott, Bowers and Oates.

Mawsons Hut © S.Giovanoli

Roald Amundsen , from the Belgica expedition and the lately first man to sail the northwest passage (1903-1906), had long dreamed of being the first man to the North Pole. But some months before he was due to set out in 1910 news came that both Robert Peary and his good friend Frederick Cook claimed to have already reached it. Undaunted, Amundsen changed his plans and decided to go to the South Pole instead. This put him in direct competition with Captain Robert Scott, who had already announced that he was making another attempt to reach the South Pole.

Amundsen established his Antarctic camp on the Ross Ice Shelf at the Bay of Whales, which put his starting point a vital 96 kilometers (60 miles) nearer the pole than Scott's base at McMurdo Sound. He used dog teams, which had proved themselves time and again on his journeys in the Arctic. The trip to the pole was carefully and methodically planned to the last detail. He reached the pole on 14 December 1911, and to his relief, there was no sign of Scott. The entire round trip to the South Pole and back went like clockwork, and took 99 days.

Meanwhile, Captain Robert Scott returned to Antarctica early in 1911, and constructed a base at Cape Evans on Ross Island. He then spent the next nine months conducting scientific research and preparing for his forthcoming trek to the pole. On 23 October, one week before his planned departure, Scott received word that Amundsen had left his base camp for his attempt to reach the pole.

The main details of Scott's heroic, but doomed, expedition are well known, but he and four companions reached the South Pole on 17 January 1912, 33 days after Amundsen. It was a bitter disappointment that their Norwegian rival had got there first. On their return journey, the five men were plagued by ferociously bad weather. Evans and Oates died first, and finally Scott, Wilson, and Henry 'Birdie' Bowers died in their tent in a blizzard on 29 March 1912, only 18 kilometers (11 miles) from a supply depot. Their bodies were found eight months later and were buried where they lay on the Ross Ice Shelf.

Ironically, it was Scott's tragic journey that captured the world's attention, while Amundsen's achievement of being the first man to reach the South Pole brought him relatively little glory outside his native Norway. Another, but perhaps understandable irony is that the tragic end of Scott's polar journey overshadowed the many valuable scientific discoveries of his expedition.

Douglas Mawson, an intrepid Australian who had accompanied Edgeworth David to the South Magnetic Pole and achieved the first ascent of Mount erebus on Shackleton's 1907 expedition, landed his own party at Cape Denison in Commonwealth Bay at about the same time that Scott reached the South Pole in January 1912. His expedition turned into another tale of hardship and courage. Dubbed the windiest place on earth, Cape Denison created special conditions for their stay. The nearly constant gale-force winds caused considerable problems with almost every project Mawson's team attempted, but in November (10 months after

Australian stamp depicting Sir Douglas Mawson

they had arrived) the weather relented enough to allow some geographical and scientific work. Mawson's team divided into several sledging journeys to explore the surrounding territory. Mawson led a trek which was to become one of the great survival stories of Antarctica. Ultimately, his two companions, Belgrave Ninnis and Xaviar Mertz, died on the journey leaving Mawson alone and 160 kilometers from base with almost no food. It is a harrowing tale worth following up on. Mawson did manage to return to base, but he arrived a couple weeks after he had ordered the ship to leave. The ship waited as long as they thought possible then remarkably everyone had such faith in their companions eventual return, that six men stayed behind for a second winter to await Mawson. Mawson did arrive in dreadful condition, and without Ninnis and Mertz. The men nursed Mawson back to health over the winter months and they returned to Australia the following year. Mawson went on to have an illustrious career and to champion Australia's role in Antarctic.

Ernest Shackleton had failed in his own attempt to be the first man to reach the South Pole, but still craving Antarctic achievements and fame, he conceived another, audacious goal in trying to be the first man to lead an expedition across the continent. The plan was that two parties in two ships would land on opposite sides of the continent. Shackleton would land in the Weddell Sea and lead six men on a walk 2,900 kilometers (1,800 miles) across the continent, via the South Pole. The other group would land in the Ross Sea and lay food depots all the way to the top of the Beardmore Glacier to resupply Shackleton's team for their final distance to the Ross Sea base.

Things did not go well, almost from the start. Against the advice from whalers on South Georgia, Shackleton took the Endurance into the Weddell Sea in early December 1914 and found ice conditions especially difficult. By 19 January 1915 they were hopelessly trapped in pack ice. As the ship began to be crushed, they abandoned the Endurance and set up a camp on the ice nearby on 27 October 1915. The Weddell Sea ice was so rough that they abandoned their attempt to drag their lifeboats toward open water and they waited on the ice for months. By early April 1916 they had ridden the moving sea ice platform to the north edge of the Weddell Sea and the ice finally released them. In their three lifeboats, they reached Elephant Island, after 6 days of difficult sailing and rowing.

There were no good campsites, but they did find shelter at Point Wild where they found seals and penguins which provided them with plenty of food. Shackleton decided to set off in the largest boat with five companions to seek help from a Norwegian whaling station on South Georgia. Departing on 24 April, the six men crossed 1,280 kilometers (794 miles) of rough seas in 16 days in the open boat to reach South Georgia.

Unfortunately, they landed on the wrong side of the island and were forced to climb over an unknown mountain range with very little equipment in order to reach the whaling station. After their near-miraculous trek over South Georgia, Shackleton set about rescuing the rest of his men who stayed behind on Elephant Island. On 30 August 1916, after four months and three unsuccessful rescue attempts, Shackleton returned on board the Chilean vessel Yelcho to rescue the men left behind at Elephant Island. All of them had survived their ordeal. He then set out to retrieve the men from the Ross Sea. Their's was another dramatic tale of deprivation and heroic efforts. They did manage to set out the depots, but in the end lost 3 men in the ordeal.

Science and whaling

Whaling did not start in earnest in Antarctica until the early years of the twentieth century. As long as there were whales to hunt in other parts of the world, Antarctica was still a difficult proposition. It was Carl Anton Larsen, from the Nordenskjold expedition, who really started whaling in Antarctica. After the remarkable rescue of the men from Snow Hill and Paulet Islands, there was a huge celebration in Buenos Aires to honor the men of the expedition and the men who saved them. At a large dinner, Larsen thanked everyone involved but also mentioned the tremendous number of whales they encountered on their voyages. From that time he joined with Argentinian investors to start the first whaling station in South Georgia.

In November of 1904, Larsen and his Norwegian team arrived at Grytviken to create a whaling station. After a few months of setting up the tools of the trade, they had their first season whaling in South Georgia. They took 195 whales in the first season and from there the station, and their harvest, grew for many years. Additional stations were constructed around South Georgia and the heyday of Antarctic whaling began.

South Georgia was claimed by Britain and soon they set up a magistrate near Grytviken at King Edward Point. They recorded and authorised all the whaling in South Georgia and imposed some regulations on the industry. Eventually, a marine biological station was set up by the British at King Edward Point 1925 primarily to collect information from the whalers about Antarctic whale populations. The purpose was to make recommendations for a conservation policy, because it had become obvious that the whales were in danger of being hunted to extinction. Between 1925 and 1939 there were 13 scientific voyages; the first five of which used Scott's old ship Discovery.

Information was needed on breeding seasons, gestation periods, growth rates, etc. Some whale conservation measures soon began to take shape. For example, in 1929 the Norwegian Government enacted legislation which prohibited its whaling fleet

(the biggest in the world at the time) from taking calves and nursing mothers. Minimum size limits were imposed in 1930, and in the following year 26 countries agreed to form an international commission to regulate the industry. Six years later nine member nations agreed to new minimum size limits and to the placement of inspectors on each factory ship.

None of these regulations really had much effect on preventing the decline of whale populations. In response, the International Whaling Commission was set up in Washington, D.C., immediately after World War II in 1946 and more serious efforts to achieve sustainable utilization as whaling resumed after the hiatus imposed by the war. The IWC was formed to enact regulations that would ensure that the member nations would be able to sustain a whale harvest 'in perpetuity'. On May 26, 1994 the IWC declared 11 million square miles surrounding Antarctica a whale sanctuary, where commercial whaling is prohibited indefinitely. Contiguous with the previously declared Indian Ocean whale sanctuary, whaling is now prohibited in one-third of the world's oceans.

Abandoned whalers' ship, Grytviken, South Georgia © Chris van Hove

The Aviation Age

Many people had talked of using aircraft to explore Antarctica, including Mawson in 1912, but the first to do so was an Australian adventurer, Sir Hubert Wilkins, who was backed by William Randolph Hearst. He organized two expeditions to Deception Island in the South Shetland Islands in 1928 and 1929. After initial difficulties, Wilkins succeeded with the first flight in Antarctica on 16 November 1928. That season he explored nearly 2,100 kilometers (1,300 miles) of the Antarctic Peninsula by air. Much of this terrain had never been seen before, and Wilkins obtained many photographs and a wealth of information. Much of his information was incorrectly interpreted. t

Even after Wilkins' success, few people believed aircraft could be flown to the South Pole. The American Richard Evelyn Byrd was already an accomplished polar pilot, he made the first attempt at the North Pole in 1926 (that flight is tainted with controversy as to whether or not Byrd achieved the pole). He was determined to do the same at the South Pole, and discussed the project with Roald Amundsen, who had plenty of advice to give.

Byrd arrived in Antarctica at the Bay of Whales on Christmas Day in 1928 with three aircraft (a Ford Trimotor, a Fokker Universal, and a Fairchild monoplane with folding wings), 95 dogs, and more than 50 men. His base was built at the Bay of Whales on the Ross Ice Shelf 14 kilometers (9 miles) from the edge of the ice (near where Framheim was sited for Amundsen's South Pole expedition), and was named Little America.

Several test flights were made in the ensuing months resulting in numerous discoveries. Other groups undertook geological studies and charting missions. In November 1929 a geological party made the startling discovery that the interior mountains consisted of sandstone with coal deposits, and were therefore part of the Earth's buckled crust rather than volcanic extrusions.

On 29 November four men, with Byrd navigating, took off from Little America in the Ford Trimotor, the Floyd Bennet, and flew non-stop to a position over the South Pole, and then returned via a fuel dump. The total time for the round trip was 18 hours 41 minutes, of which the flight time was 15 hours 51 minutes. The same trip had taken Amundsen three months to complete 18 years earlier.

Byrd returned in 1934 with sledges, tracked vehicles, and aircraft to continue his work in Antarctica, making sledge trips and aerial surveys from Little America. This expedition added a great deal to man's scientific knowledge of the Antarctic. Scientists measured the depth of the continental ice cap, discovered and mapped vast new land areas, made in-depth weather studies, found and catalogued new life forms, and much more.

Byrd himself spent the winter alone, 200 kilometers (124 miles) away from Little America in a small hut sunk in the ice, making meteorological observations. He stayed there for four months, but nearly died when from carbon monoxide fumes from the radio generator and faulty stove. His judgement was seriously affected and could have proved fatal, but his peculiar radio messages alerted the men at the main base who came and rescued him.

Byrd returned again in 1939 with the U.S. Antarctic Service Expedition, the largest Antarctic expedition to date, which accomplished further extensive exploration and important mapping work. He brought with him this time an experimental vehicle called the Snow Cruiser. It was 17 meters (55 feet) long, and the wheels were 3 meters (10 feet) in diameter.

It was diesel powered, with living quarters, a laboratory, machine shop, and a darkroom, and had a small aircraft perched on top. Unfortunately, the tires provided too little traction and the motors were too weak to move the vehicle in snow. The farthest it travelled was 5 kilometers (3 miles) from the landing site to Little America.

Another noteworthy milestone in the history of Antarctic exploration was the first flight across the continent made in 1935 by Lincoln Ellsworth, an American millionaire. He had already flown over the North Pole in 1926 in an airship with Roald Amundsen, after Byrd's flight, and had been beaten again by Byrd in flying to the South Pole. This new project, like so many other Antarctic expeditions before it, faced bad weather and numerous setbacks.

Ellsworth, a rather shy man who habitually carried for good luck an ammunition belt that belonged to his hero, Wyatt Earp, arrived at the Bay of Whales in January 1934 and set up camp on the ice. He planned to fly from the Ross Sea to the Weddell Sea, and back – a distance of nearly 5,500 kilometers (3,400 miles). Just before he took off, severe ice movements destroyed the camp and nearly destroyed the aircraft, which fell between two ice floes. He was forced to postpone his epic flight.

Returning later the same year, Ellsworth planned to fly the route in the opposite direction. But bad weather conditions and a contrary pilot prevented the flight on this occasion as well. His ship became trapped by ice and he had to remain at Snow Hill Island in the Weddell Sea for several months before the ship could get free.

Ellsworth returned to Antarctica for a third time in November 1935 and set up camp at Dundee Island off the tip of the Antarctic Peninsula. On 23 November, he and his new pilot, Herbert Hollick-Kenyon, finally took off on what was to be an eventful flight in a single-engined Northrop monoplane to Little America in the Ross Sea. The total flying time was 14 hours, but they had to make four stops along the way, and on one occasion were trapped in their tent for eight days by a blizzard. They ran out of fuel just short of their goal and were forced to walk the final 26 kilometers (16 miles) to Little America. Nevertheless, their 3,200-kilometer (2,000-mile) journey was a great achievement and showed supreme courage

In 1946 the United States Navy mounted Operation Highjump, the largest Antarctic expedition ever attempted, using 13 ships (including an aircraft carrier and a submarine), 23 aircraft, and more than 4,700 men. Admiral Byrd was placed in charge of the operations. The main group set up a base on the Ross Ice Shelf in the Bay of Whales. Icebreakers and helicopters were used for the first time in Antarctica, and nearly four million square kilometers (1.6 million square miles) of the continent were charted. Some 70,000 aerial photographs were taken, covering 60 percent of the coastline.

Byrd himself was on board one of two aircraft which together made a flight to the pole on 15 February 1947. A follow-up expedition named Operation Windmill used shipborne helicopters to place survey markers to accurately fix the position of landmarks shown on the photographs taken during Operation Highjump. This enabled accurate maps to be drawn.

In 1947–48, Finn Ronne led a privately financed expedition to Marguerite Bay, reoccupying Admiral Byrd's 1939 East Base. During this expedition, Ronne showed that the Antarctic Peninsula was connected to the rest of Antarctica, solving one of the last great mysteries of the continent.

The International Era

The first International Polar Year was held in 1882–83, when 12 nations established 14 bases in the Arctic to observe and study the earth's climate and magnetism. Such international cooperation was not common, but in 1895 and again in 19899 the 6th and 7th International Geographical Congresses were models of scientific cooperation. In those early congresses, the cooperation was to decide where in the polar regions each country should focus, and what kinds of information was the most valuable to the international scientific community.

The first polar year in 1882-1883 was such a success that it was decided to repeat the exercise every 50 years. The second International Polar Year was held in 1932–33, for the first time focused on Antarctica. But scientific techniques were advancing so rapidly that many felt 50-year intervals were too long.

In 1950, Dr. Lloyd Berkner, an American scientist, suggested that the next collaboration should be an International Geophysical Year. The idea was enthusiastically received, and some 50 countries offered to take part. This would be the first time the primary emphasis would be on the Antarctic. The original idea was for various countries to set up scientific stations for one year so that a broad range of scientific information could be collected over the entire continent. Twelve countries (Argentina, Australia, Belgium, Chile, France, Great Britain, Japan, New Zealand, Norway, South Africa, the United States, and the Soviet Union) agreed to set up stations in Antarctica.

The period June 1957–December 1958 was chosen for IGY because solar activity would be at a maximum. Forty scientific stations were established on the continent and another twenty were set up on various Antarctic islands. The United States

established the Amundsen–Scott Base at the Geographic South Pole (as part of Operation Deep-Freeze), and the Soviet Union established Vostok base at the Geomagnetic Pole. The year was considered an unqualified success. Most of the countries involved, decided to make Antarctic research a permanent feature of their government programs so much of the research that was undertaken became long-term in nature, and continues today.

It was not until 1958 that the first overland trans-continental expedition was made. The Commonwealth Trans-Antarctic Expedition, led by Vivian Fuchs and Sir Edmund Hillary (the New Zealander of Mount Everest fame), was designed along the same lines as Shackleton's unsuccessful expedition of 1914. Hillary's team was to leave from Scott Base on Ross Island with four Massey-Ferguson tractors with track fitted to them and four sledges to lay fuel and food depots up onto the polar plateau.

Meanwhile, Fuchs's group left the Ronne Ice Shelf in the Weddell Sea with eight vehicles and two dog sledges. They had many problems with glacial crevasses and bad weather, and had to abandon three of the vehicles. Contrary to his orders, Hillary's team decided at their farthest south depot to carry on to the pole so they became the next people after Scott to travel overland to the South Pole. Fuchs' expedition team arrived shortly after 19 January 1958, and proceeded to Scott Base via Hillary's route.

Scott Base Antarctica

The Antarctic Treaty

Many countries have made territorial claims to Antarctica over the years, based upon discovery, occupation, and geographical contiguity. Today, seven countries still maintain official claims upon parts of Antarctica: Argentina (claim dated 1943), Australia (1933), Chile (1940), France (1924), New Zealand (1923), Norway (1939), and the United Kingdom (1908). The claims are in accordance with the sector principle established in the Arctic which delineates wedge-shaped pieces extending to the Pole (though Norway's claim does not reach the South Pole).

The British, Argentine, and Chilean claims overlap, and have been the cause of some disputes over the years. The United States and Russia do not make any claims of their own in Antarctica (though they reserve the right to do so in the future), and do not recognize the claims of any other nation.

In 1948 the USA proposed to the seven claimant nations that Antarctica be made an international trust territory, though nothing came of that early initiative. But during the International Geophysical Year of 1957– 58 the USSR established a presence in Australian Antarctica, and the USA built stations in New Zealand's territory and Marie Byrd Land. The fact that both the USSR and the USA intended to stay in Antarctica after the finish of the IGY helped convince the nations involved to continue their cooperation. The IGY was therefore followed by the Year of International Geophysical Cooperation, from January to December 1959.

In April 1958 U.S. President Eisenhower convened a conference to discuss the future of Antarctica. It was proposed that the continent should be open to all nations for the pursuit of scientific and other peaceful activities. On 1 December 1959 the Antarctic Treaty was signed by the 12 nations which had operated scientific stations in the area during IGY. The treaty was ratified on 23 June 1961, and has grown to more than 40 signatory states.

One of the most important aspects of the Treaty is that the claimant nations have, in effect, frozen or shelved their claims indefinitely. They do, however, maintain the underlying existence of these territorial claims by issuing national legislation for such entities as the British Antarctic Territory, the Ross Dependency (New Zealand), and the Provincia de Tierra del Fuego, Antartida e Islas del Atlantico Sur (Argentina). The latter includes the Falklands, South Georgia, and the South Sandwich Islands.

In fact, there are two categories of 'membership' of the Antarctic Treaty. While any country can sign the treaty and thus adhere to its principles ('Acceding State'), only those that conduct significant scientific research in the region may participate in consultative meetings, and thus take part in the decision-making process ('Consultative Party').

The Antarctic Treaty System includes the Scientific Committee on Antarctic Research (SCAR); the 1972 Convention for the Conservation of Antarctic Seals (CCAS); the 1980 Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); and the 1991 Protocol on Environmental Protection to the Antarctic Treaty (often called the Madrid Protocols).

The Protocol followed two years of intense negotiations which finally resulted in a 50-year ban on all mineral exploitation. This is reflected in the briefest of all the Articles in the Protocol, comprising just 13 words: 'Any activity relating to mineral resources, other than scientific research, shall be prohibited.' But the Protocol contains a number of other important measures. All human activities must now be planned on the basis of prior environmental impact assessments, and regulations on waste disposal and marine pollution have been introduced.

Currently, the 53 signatories of the Antarctic Treaty are (Consultative members are designated with a 'C':

Argentina	C
Australia	C
Austria	
Belarus	
Belgium	C
Brazil	C
Bulgaria	C
Canada	
Chile	C
China	C
Colombia	
Cuba	
Czech Republic	C
Denmark	
Ecuador	C
Estonia	
Finland	C
France	C
Germany	C
Greece	
Guatemala	
Hungary	
Iceland	
India	

Italy	C
Japan	C
Kazakhstan	
Malaysia	
Monaco	
Mongolia	
Netherlands	C
New Zealand	C
North Korea	
Norway	C
Pakistan	
Papua New Guinea	
Peru	C
Poland	C
Portugal	
Romania	
Russia	C
Slovakia	
South Africa	C
South Korea	C
Spain	C
Sweden	C
Switzerland	
Turkey	

Ukraine	C
United Kingdom	C
United States	C
Uruguay	C
Venezuela	

The Treaty consists of 14 Articles:

1. Antarctica shall be used for peaceful purposes only (no military bases, fortifications, maneuvers, or weapons testing are permitted), but military equipment and personnel may be used to assist in scientific and other peaceful projects.
2. There is to be a freedom of scientific investigation, and any international cooperation which may be needed toward that end.
3. Information regarding Antarctic scientific programs, as well as scientific personnel and the results of scientific work, will be exchanged to permit maximum cooperation, efficiency, and economy of operations.
4. This treaty is not to be interpreted as a renunciation by any signatory nation of previously asserted rights or territorial claims, and no new such claims may be made while the treaty is in force.
5. Nuclear explosions and the disposal of nuclear wastes are prohibited in Antarctica.
6. The provisions of this treaty apply to the area south of 60°S Latitude (except where precluded by the international law of the sea).
7. Any signatory may designate observers to inspect the activities, stations, equipment, vessels, etc., of any other signatory state at any time or place.
8. Designated observers and scientific personnel in exchange programs come under the jurisdiction of their respective governments.
9. Representatives of all signatories shall meet at suitable intervals and places to exchange information, consult upon matters of common interest regarding Antarctica, and make recommendations concerning those matters to their respective governments.
10. Appropriate efforts will be made to ensure no one engages in activities contrary to the principles or purposes of this treaty.
11. It is the responsibility of any signatories involved in a dispute regarding this treaty to consult among themselves peacefully in an attempt to resolve said dispute, and if this is not possible the matter is to be referred to the International Court of Justice for arbitration.
12. This treaty may be modified or amended at any time by unanimous agreement of the signatories.
13. This treaty is subject to ratification by all signatories, and is open for accession by any state which is a member of the United Nations, or any other state only by consent of all signatories.
14. This treaty is written in English, French, Russian, and Spanish, and these equally authentic versions are to be deposited in the Archives of the Government of the United States of America (each signatory is to be given a duly certified copy of the treaty).

Point Wild, Elephant Island © D.McClean

VI. PLACES YOU MAY VISIT

South Shetland Islands

Typically when ships travel to the Antarctic Peninsula, the first sighting is of an iceberg somewhere in the Drake passage. If the weather is good, the next highly anticipated sighting is of land—at the South Shetland Islands. Lying north and roughly parallel to the Antarctic Peninsula, the 20 or so islands about 500 kms (280 miles) from the north-east to the southwest. They are separated from the peninsula by the deep waters of the 150-kilometer wide (100 miles) Bransfield Strait. The South Shetlands were first sighted in February 1819 by William Smith, who was blown off course while rounding Cape Horn. He returned in October of the same year to claim them for Britain as 'New South Shetland.' Edward Bransfield was sent with William Smith there to carry out mapping and survey work in 1820. Being the nearest Antarctic land to South America with high numbers of fur seals, the South Shetlands were instrumental in opening up Antarctica. The early sealers explored the islands extensively to find fur seals to hunt and it only took them a few years to reduce the population so much that they were no longer profitable to hunt.

The South Shetlands are of continental origin and form their own microplate between the Shetland trough to the north and the Bransfield trough to the south (forming Bransfield Strait). The islands formed by the upwelling of magma and not by volcanism. The islands do, however, include some active and recently active volcanoes, such as Deception and Penguin Islands.

At the north-east end of the South Shetland Islands, and somewhat separated from the rest, are Elephant Island and its neighbor, Clarence Island. Elephant Island is important historically as the site where Shackleton's men stayed for 5 months Shackleton set off for South Georgia to seek help. No sign of their presence remains, though if you are lucky enough to come land or even cruise close to Point Wild there is a bust commemorating Captain Luis Pardo of the Yelcho, the small Chilean tug that eventually came to their rescue.

One feature of the South Shetlands today is the large number of scientific stations occupying the islands starting with the International Geophysical Year in 1957–58. The South Shetlands, and especially King George Island, were popular because of their proximity to the South American mainland and their relatively mild climactic conditions. King George Island has extensive ice-free areas around the coast, and being on the northern boundary of Antarctica the area has the longest period of accessibility from sea ice.

Among the stations on King George Island is the large Presidente Frei and Teniente Marsh stations (both from Chile) and the adjacent Bellingshausen station (Russia). The Chilean station is most important because of the airstrip from the Chilean Air Force. Flights to and from Antarctica are regular occurrences now so if you will fly in or out of Antarctica you are most likely to visit the Chilean Station. The neighboring Russian station is used much less now, but includes a beautiful wooden Russian Orthodox Church that overlooks the bay. Also in the vicinity are Chinese, South Korean, Argentine, and Uruguayan stations. In the nearby

Admiralty Bay are the Ferraz (Brazil) and Arctowski (Poland) stations, and the United States operates the Pieter J. Lenie summer station at a site called Copacabana near Arctowski.

Several sites in the South Shetlands have unique wildlife or plant material so they have been declared specially protected areas. Those sites are effectively off limits for tourist visits but many exciting opportunities remain. The chinstrap penguin colony at Half Moon Island (which also has a small Argentine scientific station) and the extensive gentoo penguin colony at Yankee Harbor on Greenwich Island are popular. Hannah Point on Livingston Island has a wealth of wildlife, including many elephant seals, penguins of several species, and nesting giant petrels.

Both the volcanic islands already mentioned are well worth visiting. Penguin Island offers chinstrap penguin colonies and abundant Southenr Giant Petrels, as well as a hike up the volcanic cone for a spectacular view. At Deception Island, there is a very large chinstrap penguin colony at Baily Head, on the outside of the island. This is a wonderful place, though sometimes difficult to land at in certain weather conditions. Entering the vast collapsed caldera through Neptune's Bellows, one can visit the remains of a large whaling station in Whaler's Bay, and also the remains of Chilean and British stations which were destroyed during eruptions in 1969.

Antarctic Peninsula

The northeast tip fo the Antarctic Peninsula has a small set of islands standing off to the east that collectively form the Antarctic Sound. Named after the ship the Antarctic that was used by the Nordenskjold expedition of 1901-1903, the Antarctic Sound is also the gateway to the Weddell Sea. As such it has a well-deserved reputation as being an iceberg alley. Many large tabular bergs escape the Weddell Sea through the Antarctic Sound and they present fantastic scenery for our expeditions. At the northeast tip of the Peninsula the beautiful sites, Hope Bay and Brown Bluff which both boast large Adélie penguin colonies. Hope Bay was first used by three of Nordenskjold's men when they were forced to winter over in a small stone hut in 1902. The hut remains are still visible and are an important historic site for the area. In 1945, as part of the Operation Tabarin, the British erected Base D (later called Trinity House), and carried out a regular program of research until it closed in 1964. The adjacent Argentine station, Esperanza was established in 1952. It is a large station manned by Argentine military personnel and their families. Here, in 1978, Emilio de Palma was the first child to be born in Antarctica. Argentina no longer sends families to Antarctica but the area remains important historically.

Lamaire Channel, Antarctic Peninsula

Not far away, and just outside the Antarctic Sound in the northern Weddell Sea is Paulet Island, a another small volcanic island with a central cone rising to 400 meters (1,300 feet). A large colony of Adélie penguins breed on its rocky slopes, and there is a big colony of Antarctic blue-eyed shags as well as the nest sites of Wilson's storm petrels. It is of historical interest, too, as an over-wintering site for some members of the Nordenskjold Expedition. Their hut is still standing. Also nearby are the Danger Islands. They are not often visited by expedition ships, but recently satellite and aerial surveys discovered that nearly 1.5 million Adélie penguins breed there. They are now considered an important center of penguin activity for the region.

Traveling south along the Peninsula in the southern Bransfield Strait, you may visit, Gourdin Island with Adélie, chinstrap and gentoo penguins on one small island, Astrolabe Islands, or Mickelson Harbor. Once south of Gourdin Island there are no more Adélie penguins until you get well south in the Gerlache Strait. But humpback whales are common throughout the Bransfield and Gerlache Straits—especially during the second half of summer. Indeed, as you travel south there are good opportunities to see humpback, minke and orcas. There are several potentially rewarding visitor sites in this area. Cuverville Island, named after a French admiral by Adrian de Gerlache, leader of the Belgica expedition, is a small island dominated by a large, lichen-covered rocky hill. It supports a compact colony of gentoo penguins as well as breeding south polar and brown skuas, and nesting Wilson's storm petrels.

Farther south, is aptly named Paradise Harbour, where the Chilean station, Gonzalez Videla stands by the entrance at Waterboat Point. This is set in the midst of a bustling colony of gentoo penguins. The site is known as Waterboat Point, after two British scientists who chose to over-winter here in 1921, using a ship's waterboat for shelter (its remains can still be seen). Farther into Paradise Bay lies Brown Station (Argentina), partially destroyed by fire 1984 by the station doctor who couldn't bear the idea of spending the winter there. Now rebuilt and manned by the Argentine Antarctic Institute in some summers, it offers a high viewpoint to look over Paradise Harbor. Around the corner is Skontorp Cove with several short steep glaciers diving into the sea.

Not far distant Wiencke Island lies across the Gerlache from Paradise Harbor. Nestled into a sheltered cove is Port Lockroy (usually approached via the magnificent Neumayer Channel). Port Lockroy was established as Base A by the British Government in 1944, as the first base of a secret wartime initiative to monitor German shipping movements. This expedition was code-named Operation Tabarin, after the Bal Tabarin, a well-known Paris night club, because team members would be staying there during the darkness of the Antarctic winter. After World

War II, the station continued as a research station until 1964, when it ceased operations. Port Lockroy lay unused for many years and deteriorated considerably over the next 30 years. IN 1995 the British Antarctic Survey decided to restore the site as a living museum as it looked in the 1960s. It is now fully restored so that visiting is just like walking into a 1964 research station. It is occupied each year by a team to look after the sit and run the very successful shop.

Port Lockroy Antarctic Peninsula © A.Halsall

The only U.S. station north of the Antarctic Circle is at Arthur Harbor on the shore of Anvers Island. Palmer Station was established in 1965 and named after Nathaniel B. Palmer, a Connecticut sealer who may have been the first person to sight the Antarctic continent in 1820. Palmer supports up to 40 people in summer, with about 10 staying for the winter. It is well situated for studies of birds, seals, and the marine ecosystem, as well as other research projects. Two islands near Palmer are inhabited by Adélie penguins. Litchfield Island is protected, and cannot be visited, but visitors are welcome to explore Torgersen Island. Site of a long term ecological research, the number of penguins at Litchfield has declined compared with those at heavily-visited Torgersen, which is probably because Litchfield now has deeper snow cover than it used to.

Sailing south, one reaches the famous Lemaire Channel, a deep, narrow cleft between Booth Island and the mainland of the Antarctic Peninsula. With 1000 m peaks on either side of a narrow channel, the Lemaire is often cited as one of the most beautiful areas in the peninsula.

South of the Lemaire Channel, Pléneau, Hovgaard, Petermann and the Yalour Islands offer a mix of gentoo and Adélie penguins as well as elephant seals, especially young males, often hauled out onto the flat rocks to enjoy communal wallows in the summer sunshine. The area between Pléneau and Booth Islands usually offers a remarkable maze of stranded icebergs that offer a favorite place to cruise to see the ice—as well as leopard and crabeater seals and the occasional minke whale.

Jean-Baptiste Charcot first overwintered in Antarctica at Booth Island in 1904 and next at Circumcision Bay on Petermann Island. Just to the south are the Argentine Islands, a small archipelago of igneous rocks, most with permanent snow cover. The British have had a presence here since 1934, when a geological party under John Rymill wintered over, and Faraday station was established on Galindez Island in 1947. This former British Antarctic Survey station is the oldest operational station in the Antarctic Peninsula area. The British transferred the station to the Ukraine in 1995–96 and it is now known as Vernadsky. In 2006 gentoo penguins colonized Galindez Island for the first time as they are expanding their range as a response to global climate change. The peninsula climate is now milder and there is less sea ice during the winter months.

South of the Antarctic Circle, Adelaide Island is the site of Rothera Station, the largest of Britain's Antarctic stations. Built in 1990 to replace Adelaide Station, the scientific studies here concentrate on geophysical and atmospheric physics. A 915 meter (3,000 feet) airstrip of crushed rock was built in 1991/92 to take aircraft as big as a Lockheed C130 transport. Britain has a long history in the area with Base E on Stonington Island, Horseshoe Island and Adelaide Station as former stations.

The earliest station in the area was East Base, established during Admiral Richard E. Byrd's third expedition, the U.S. Antarctic Service Expedition of 1939–41. The base was reoccupied after World War II by the Ronne Antarctic Research Expedition of 1947–48. Finn Ronne (who had also been a member of the earlier expedition) gathered a crew of volunteers and experienced pilots, borrowed a ship and three planes from the U.S. Army, and raised over $50,000 to finance the last of the privately funded, major exploration efforts in Antarctica. One of its achievements was to prove that the Antarctic Peninsula was connected to the rest of the continent. The team included the first two women to winter in Antarctica: Ronne's wife Edith, and Jennie Darlington, the wife of Harry Darlington III, the expedition's chief pilot. A few hundred meters away is the abandoned British Base E, which operated from 1945–75.

In 1989, the Antarctic Treaty declared East Base a Historic Monument, and representatives of the U.S. National Parks Service and the National Science Foundation, plus two BAS team members, went there in 1992 to effect a clean-up and remove hazardous wastes. Visitors can still see many fascinating artifacts around the camp, including a World War I vintage army tank and tractor, a spare air-craft engine still in its packing crate, canned goods, piles of coal, and bales of hay. Unfortunately, despite its interest, Stonington is quite far south, and the approach is often blocked by ice, a difficult place to reach by ship.

Weddell Sea

Tabular icebeg, Weddell Sea © M.Baynes

A deep indentation in the Antarctic continent between the Antarctic Peninsula and Coats land, the Weddell Sea was first visited by the British sealer and explorer James Weddell in 1822. Meeting unusually favorable pack ice conditions, he succeeded in sailing as far south as 74° 15'S. Navigation in the Weddell Sea is normally quite difficult because of the great amount of sea ice and also large icebergs generated by the Larsen, Ronne, and Filchner ice shelves. Even icebreakers have difficulty getting around in the Weddell Sea.

But a visit can be very rewarding, not least for its historical associations. It played a part in the saga of the Swedish Nordenskjold expedition. The main expedition hut was built on Snow Hill Island, and still stands. On the shores one can find fossil reminders of a more temperate era – gastropods, large clams, and spiral-shaped ammonites, all turned to stone.

The area is also central to the Shackleton story, too, for it was here in 1915 that the men had to abandon their ship, the Endurance, after it became trapped in the ice. Wrote Shackleton: 'It was a sickening sensation to feel the decks breaking up under one's feet, the great beams bending and then snapping with a noise like gunfire.'

Today, one of the main reasons to visit the Weddell Sea, apart from ice-watching, is in the hope of seeing the most famous of Antarctic birds, the emperor penguin. Previously known mostly from the area around the Ross Sea, these big birds start to breed during the winter months on fast ice near the continent. Several colonies were discovered in 1986 on the eastern side of the Weddell Sea. One is at the Riiser–Larsen Ice Shelf at 72° 09'S, 15°07'W, while another is not far away at Atka Bay, near the German station Neumayer but It is rarely possible to get near those colonies. In the mid 1990s another colony was discovered on the south end of Snow Hill Island. It's still difficult to find and see emperor penguins in the Weddell Sea, but with luck and good ice conditions the possibility is there.

South Orkney Islands

Chinstrap penguins, Orkney Islands

A group of rather barren, uninhabited islands 1,360 kilometers (850 miles) north-east of the Antarctic Peninsula, the South Orkneys were discovered in 1821 by the sealers, George Powell and Nathanial Palmer, who also described the South Shetland Islands in great detail. The islands are heavily glaciated, and because of their position north of the Weddell Sea, are surrounded by ice during the annual winter freeze-up of the Antarctic Ocean.

The climate is rather harsh, with strong winds, frequent rain and snow – snow falls on about 280 days each year. Like the Antarctic Peninsula and other maritime islands, this is also a very cloudy region; the average amount of sunshine is just 520 hours per year.

Despite these unwelcoming weather conditions, the islands have two scientific stations. There is an Argentine station, Orcadas, on Laurie Island at the site of a former Scottish base established in 1903. It is the oldest continuously operating station in Antarctica. The British Antarctic Survey operates a research station on Signy Island. Established in 1947, it was, until recently, operated as a year-round station with accommodations for 24 people. Here, BAS scientists conducted long-term studies of terrestrial and freshwater biology. Research was also undertaken on the seabird populations, and it was a center for studies of Antarctic marine life. Much of its biology program was recently transferred to Rothera Station.

The bird life of the South Orkneys is plentiful, and Coronation Island is an important breeding site for the beautiful, but rather elusive pure white snow petrel. There are some large penguin rookeries, and a host of other seabirds also breed here. For scientists, one of the main attractions of the South Orkneys are the extensive areas of moss and grass which are exposed in summer. Signy Island is famous for its peat moss banks. The deepest of these is over two meters (6.6 feet), and the peat at the bottom is about 4,500 years old.

South Georgia

King penguins, Gold Harbour South Georgia © M.Baynes

A slightly crescent-shaped, mountainous island some 1,300 kilometers (800 miles) east-south-east of the Falkland Islands, South Georgia was first sighted in 1675 by the English merchant, Anthony de la Roché. He was blown off course from Staaten Island and took shelter in one of the bays of South Georgia. Captain James Cook, in 1775, was the first to go ashore where he claimed sovereignty for Britain. He named the place where he landed Possession Bay. South Georgia was once more ice-bound then than it is today, and Cook described it and the South Sandwich Islands as 'Lands doomed by Nature to perpetual frigidness: never to feel the warmth of the sun's rays; whose horrible and savage aspects I have not words to describe.'

South Georgia lies north of 60˚ latitude so is not covered by the Antarctic treaty. Britain formally restated her claim to South Georgia and the South Sandwich Islands in 1908. After the Falklands war with Argentina, Britain separated the Government of South Georgia and south Sandwich Islands (GSGSSI). Today, the islands together form a single UK Dependent Territory; the British government's representative is the Commissioner, who is normally the Governor of the Falkland Islands, ex officio.

South Georgia measures about 160 kilometers (100 miles) long and 30 kilometers (19 miles) wide, and covers an area of 3,755 square kilometers (1450 square miles). The island has a spine of mountains along its entire length, with 12 of the peaks rising above 1800 meters (6000 feet). The highest point is Mount Paget, at 2934 meters (9626 feet). There are more than 160 glaciers, many of which come down to the sea.

The south coast faces the prevailing westerly winds and tends to be cold, stormy, and generally Antarctic in conditions. There are no safe harbors. The northern coast, by contrast, is in the lee of the central mountains and thus relatively mild in comparison. Many of the fjords offer safe anchorages, and this is where the whaling stations were eventually established.

The sealers came first, starting soon after Cook's reports of abundant fur seals in the Southern Ocean. The sealing industry was well under way by 1786, and continued until the 1950s. But long before then, fur seal numbers were so reduced that latterly the only species taken was the southern elephant seal, for its valuable oil.

Norwegian whalers

Grytviken, South Georgia © Chris van Hove

The whalers came to South Georgia in 1904 and established a number of shore-based stations for processing the animals, mainly for their oil but later for other products as well. The law came soon afterwards, in 1906, in the form of a British magistrate based at Grytviken. His staff included customs officers, sealing inspectors, radio opera-tors, mechanics, cooks, etc. His main duty was to control the whaling industry, by ensuring that the terms of the whalers' leases and licenses were observed (conservation only came as a set of rules that required the complete use of the whale carcass once it was killed).

Grytviken was the administrative center for the British, but each of the whaling stations formed its own little town with sports clubs and activities outside of the toil of whaling. A church was built in Gryviken in 1913 and was used for services as well as necessary celbrations and funerals etc. The first pastor – a Norwegian, since the whalers were virtually all from Norway—remarked, a trifle sadly, that 'religious life among the whalers left much to be desired.' In the heyday of whaling in the 1920s there were five stations in operation on the island. It is estimated that between 1904 and 1965, a total of 175,000 whales were caught around South Georgia. In the Antarctic region as a whole, the total for the same period was 1,500,000. The whaling stations all closed down by 1965 for the simple reason that the whales had been 'fished out.' Whaling did not stop, they just had move to factory ships so they could hunt whales farther offshore.

With the end of whaling, the 14-strong Grytviken administration had nothing to administer but itself, so it was replaced by British Antarctic Survey personnel. Meanwhile, Argentina, which had made its own claim to South Georgia and the South Sandwich Islands in 1925, occupied South Georgia for a few weeks in April 1982 before being evicted by the British.

Following the British–Argentine conflict that began with the occupation of South Georgia, but with most of the action being fought in the Falkland Islands, the British presence at Grytviken was upgraded to a small military garrison. More recently, the BAS station at King Edward Point has been rebuilt and there is no longer a garrison.

Visitor sites

Shackleton's grave South Georgia © Chris van Hove

Visitors to South Georgia are required to visit Grytviken to pass customs. Normally visitors spend time exploring the extensive remains of the former whaling station. There is much to see, including the restored church and the former manager's house, which now houses an excellent whaling museum. There are also many elephant seals in the area, and a highlight is the small cemetery where Sir Ernest Shackleton is buried. His name will always be associated with South Georgia following his legendary exploits in 1914 (see the chapter on Antarctic Exploration elsewhere in this book). After World War I, Shackleton set out on another expedition to Antarctica. His vessel, the Quest, reached South Georgia on January 4, 1922. He died of a heart attack the next day and was buried in the Grytviken cemetery, according to his wishes.

Elsewhere, most ships visit the Bay of Isles, where there is a massive king penguin colony on the shore and hillside at Salisbury Plain. Nearby is Prion Island and several small islets where wandering albatrosses and giant petrels nest.

The government regulates visits by designating a list of allowable visitor sites. Most of the sites include large king penguin colonies or other historically interesting sites. Many South Georgia beaches are heavily populated by fur seals—especially through December at the peak of breeding. I can be difficult to land at some places but very rewarding to wander a beach with thousands of fur seals, hundreds of elephant seals and a hundred thousand king penguins.

South Georgia has a history of exploitation its whales and seals, but introduced animals also caused tremendous damage. The Norwegians introduced reindeer, for sport and meat, before World War I. They increased considerably, and damaged large areas of tussock grass. Furthermore, rats and mice were accidentally introduced by various ships over the past 200 years. Fortunately, after a huge program to eradicate such non-native species, South Georgia is free from rats, mice and reindeer since 2015. It's remarkable to witness how quickly some of the affected species have recovered. The endemic South Georgia Pipit which could only survive on rat-free offshore islands only took 2 years before they were breeding on the mainland again. Estimates indicate that without rats, the mainland may support an additional 20,000,000 seabirds!

The Falkland Islands

Falkland Islands © A.Fayan

This British outpost in the South Atlantic was first discovered in August 1592 by John Davis, captain of the English sloop Desire, who had been blown off course by the westerly winds. But the first known landing was not made until 1690, when John Strong arrived aboard another English sloop, the Welfare. Strong was actually engaged on a pirate cruise targeted at the French, with whom England was at war at the time.

The islands received an early version of their present name in 1708, when the pirate Woodes Rogers dubbed them 'Falkland's Land' in honor of England's First Lord of the Admiralty. Not until 1764 was the archipelago settled. In that year the French explorer de Bougainville established a small colony at Port Louis in East Falkland. Soon afterwards, in 1765, a British expedition came to claim the islands and establish their own settlement at Port Egmont on Saunders Island in the north-west. Neither the British nor the French were at first aware of each other's presence.

The French named the islands the 'Iles Malouines,' after the port of St. Malo, where most of the sailors came from. This name is echoed in the present-day name used by Argentina – Las Islas Malvinas.

The islands changed hands several times in the following 70 years, with Spanish, British, and then some Spanish from South America living there for short periods. For about 20 years the Falklands were a base for sealers and whalers, many of them American. In 1832, the U.S. warship Lexington sacked a small Argentine settlement in response to the seizure of three American sealing vessels. The Falkland Islands' permanent settlement by the British dates from 1833, when a governor was installed. The new capital was named Stanley in 1845, after Britain's Secretary of State for the Colonies.

The next major event of historical significance happened on April 2, 1982, when Argentine armed forces invaded and occupied the islands. A task force was soon on its way from the U.K. and eleven weeks later some 12,000 Argentine soldiers (many of them poorly trained and ill-equipped conscripts) surrendered and British sovereignty was restored.

Over the years, ship repairing, as well as the sealing, whaling, and penguin oil industries have provided the islanders with a livelihood. Then sheep farming – mainly for wool – came to dominate the Falklands economy. Today, however, with the prevailing low level of wool prices on the world market, the Falklands' main source of income comes from licenses to exploit the substantial stocks of squid in the surrounding waters. Most of the fishing boats come from Europe and Asia, many with Argentine registry. On the horizon is the future possibility of very large revenues from offshore oil.

The population of the Falklands is about 4,000 (1916), just over half of whom live in or near the capital, Stanley. This pleasant, quiet town has a distinctly old-world Victorian charm. It boasts the southernmost Anglican cathedral in the world (which recently celebrated its centenary), several stores selling items of tourist interest, including locally made woolen goods, a small but excellent museum, and a well-stocked philatelic bureau that sells colorful first-day covers. Stanley is the seat of government, which is conducted by an elected Legislative Council. The Falklands are a British Colony, and so the Governor is the effective 'head of state,' but in practice his role in domestic affairs is more advisory than executive.

In Falklands parlance, anywhere outside Stanley is referred to as 'camp,' a word derived from the Spanish campo, or field. There are some 420 islands in the archipelago. The two large islands – East and West Falkland – occupy most of the land area. Of the rest, only about 20 are of any size. The islands lie some 280 miles northeast of Tierra del Fuego, the nearest point in South America. The land area is roughly 12,000 square kilometers (4,700 square miles), occupying about 255 by 135 kilometers (160 by 85 miles).

The typical Falkland countryside is rolling moorland, with low-growing shrubs. There are no native trees, but some trees and bushes, such as gorse, have been introduced for shelter. There is a surprising variety of flowering plants, though many of the flowers themselves are small. One of the most interesting and important plant species is the native tussock grass. This is a tall (2.5 meters or 8 feet), sturdy plant that grows in clumps, generally near the coast. It provides an important habitat for many birds, and shelter for some seals, but has been much reduced by grazing sheep.

The Falklands are of great interest for birdwatchers. There are 63 breeding species and 23 annual migrants, plus a long list of others that occasionally show up. Thanks to the rich surrounding seas, the Falklands boast no less than six breeding species of penguins: king, gentoo, rockhopper, macaroni, royal, and Magellanic. And another five species have been recorded as migrants. The black-browed albatross breeds here in often very large colonies, and another six species have been seen offshore. The land birds cover most groups, and include birds of prey, ducks, geese, herons, owls, finches, and thrushes, and a fair number of sea and shore birds.

There are no native land mammals, but plenty of marine mammals, many of them the same as those that frequent Antarctic waters. Among the dolphins found in the Falklands, look for Peale's dolphin, a relatively large, coastal species that is regularly seen in small groups. There are two eared seals in the Falklands – the Falklands fur seal (a different species from the one in Antarctica), and the southern sea lion.

Visitors should avoid disturbing the wildlife, and keep a sensible distance from breeding birds and from seals and sea lions. Since all the land is owned by somebody, visitors should also respect the countryside as they would at home, such as by leaving no litter and closing all gates behind them. In particular, it is important to guard against the risk of fire in areas of tussock grass, which are often very dry in the summer. Some landowners request that visitors do not smoke on shore, when out of doors.

South Sandwich Islands

The South Sandwich Islands were discovered by Captain Cook in 1775, on the same voyage that he landed on South Georgia. He named them for Lord Sandwich, First Lord of the Admiralty. They are considered together with South Georgia, as a UK Dependent Territory (see above), and are uninhabited. Although Cook sighted a number of the islands, several more were not discovered until Bellingshausen visited in 1819.

Located about 460 miles south-east of South Georgia, the islands form a chain some 350 kilometers (220 miles) long, comprising 11 large and several smaller islands with a total area of about 600 square kilometers (230 square miles). Most are ice-capped, and the tallest peak, on

Montagu Island, reaches 1,370 meters (4,500 feet). The climate is cold, with frequent snow and strong winds.

King penguins, South Sandwich Islands

The islands are volcanic in origin and some remain active. The island of Zavodovski, for instance, appears in constant eruption and reeks of rotten eggs (the volcano itself is named Mt. Asphyxia), while the islands of Visokoi, Candlemas, Saunders, and Bellingshausen all show definite signs of activity. Bristol, Cook, and Thule islands are heavily glaciated and show no signs of warmth or activity. All the islands are steep-sided above the water, and fall away rapidly into deep water (more than 1,500 meters or 5,000 feet).

The area of shallow sea around each island is small and there are almost no anchorages. In fact, only Thule Island has an anchorage and is therefore the only likely site for any kind of habitation.

Little is known about these islands, although the British Antarctic Survey has undertaken some limited biological and geological work there, mainly in the 1960s. Vegetation is very sparse. But there's at least one extraordinary wildlife spectacle: Zavodovski Island supports a chinstrap penguin colony that numbers around one million penguins on its steep volcanic slopes. Those who have seen this massive penguin colony speak of it with awe.

The Historic Ross Sea Sector

This part of Antarctica is of extraordinary historic interest as the staging area for some of the most famous expeditions of the 'heroic age' of Antarctic exploration. It is also a region of extreme beauty.

The Ross Sea was discovered by Captain (later Sir) James Clark Ross during his remarkable voyage of 1839–43 with two ships, HMS Erebus and HMS Terror. They succeeded in penetrating the pack ice that normally blocks the entrance for most of the summer. Once he pushed through that pack ice he discovered the open waters now called the Ross Sea. They sailed along the coast and found a range of snow-covered peaks, two huge volcanoes – one of them spectacularly active – hundreds and thousands of whales and penguins, and something completely new: a level barrier of ice 60 meters (200 feet) high stretching for hundreds of miles across their path south. This is now known as the Ross Ice Shelf. Wrote Ross: 'We gazed with feelings of indescribable delight upon a scene of grandeur and magnificence far beyond anything we had before seen or could have conceived.'

Emperor penguin, Ross Ice Shelf

Ross Ice Shelf

Virtually filling what would otherwise be a gigantic bay or inlet in the coast of the continent, and straddling longitude 180°, the Ross Ice Shelf is approximately the size of France. The ice increases in thickness from about 400 meters (1,300 feet) in the north to more than 750 meters (2,460 feet) in the south. It moves outward at about one kilometer (over half a mile) each year. Huge icebergs regularly calve off the front, including the extraordinary B-15.

Iceberg B-15 calved from the Ross Ice Shelf in March of 2000. It was the world's largest recorded iceberg. It measured around 295 kilometres (183 mi) long and 37 kilometres (23 mi) wide, with a surface area of 11,000 square kilometres (4,200 sq mi)—larger than the whole island of Jamaica. Such massive icebergs can cause terrible trouble for local wildlife by changing the dynamics of the sea ice around them. In 2003, B-15A drifted away from Ross Island into the Ross Sea and headed north, eventually breaking up into several smaller icebergs. Several remnants of B-15 are still slowly moving out of the Antarctica. Now, over 18 years later, some o the last pieces are quickly disappearing.

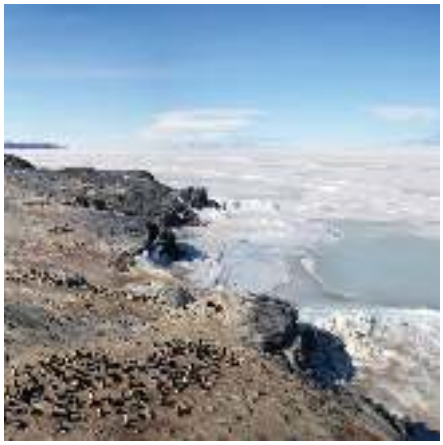
Ross Island, on the west side of the Ross Sea and separated from the mainland by McMurdo Sound, is dominated by Mount Erebus (3,795 meters or 12,450 feet) and the slightly lower Mount Terror. In November 1979, a New Zealand airliner crashed into the side of Mount Erebus, killing all 257 people on board, tragically ending sightseeing flights to the continent for many years. Ross Island was the starting point for three major expeditions, and played a significant role in a fourth. It is now the site of the massive U.S. McMurdo Station and New Zealand's Scott Base.

Hut Point

Located on a promontory called Hut Point near the southern tip of Ross Island, the 'Discovery Hut' was transported from Australia for Scott's 1901–04 expedition. Expedition members lived on board the ship Discovery, and the hut was mainly used as a store room and laboratory. Expedition members sometimes performed plays here, and on such occasions the hut became the 'Royal Terror Theatre'.

Four years later it was used as an advance base for sledging operations during Shackleton's 1907–09 expedition (which was based at Cape Royds). Later still, it was used in 1911–13 by sledging parties during Scott's second expedition (which was based at Cape Evans). The large memorial cross to Scott and his four companions was made in this hut; the cross now stands at the top

of Observation Hill. Finally, the hut was used a fourth time in 1915 by sledging parties of the Ross Sea party supporting Shackleton's transantarctic expedition of 1914–17.



McMurdo Sound, Cape Royds

Cape Royds

Cape Royds on the west side of Ross Island was the base for Shackleton's 1907–09 Nimrod expedition. From the Cape Royds hut, Shackleton and three others got to within 97 nautical miles of the South Pole before turning back. The first motor transport in Antarctica – an Arrol-Johnson car – was put ashore here, and in 1908 the book Aurora Australis was written, printed, and published at this hut. The hut was also visited by members of Scott's 1910–13 expedition, and again by members of Shackleton's Ross Sea support party, between 1914–16. In front of the hut is the most southerly recorded Adélie penguin rookery, a specially protected area and not to be visited without a permit.

Cape Evans

Also on the west side of Ross Island, between Cape Royds and Hut Point, is Cape Evans – site of the most famous, and largest, of all the historic huts. This is the hut used by Captain Scott and his team during the 1910–13 expedition. In that expedition, Scott, Wilson, Bowers, Oates, and Evans reached the pole, but died on their return journey. When the surviving members departed in 1913 they left behind a large quantity of provisions, equipment, and some clothing. This was later to be of vital importance to ten members of Shackleton's Ross Sea support party (1914–17). They were stranded here when their ship, Aurora, was blown out to sea by a blizzard in May 1915. Three of them died, but the remaining seven were eventually picked up in 1917 by Shackleton himself, after he had rescued the Elephant Island party and then travelled to New Zealand to board the Aurora.

Two anchors from the Aurora are still embedded in the beach near the Cape Evans hut and the remains of Weddell seals killed for food and fuel can be seen nearby. Within the hut are improvised boots, and other garments and artifacts. A visit to this hut, with all its poignant memories, is an unforgettable experience.

Cape Adare

Cape Adare is a volcanic headland at the western entrance to the Ross Sea. The beach below was home for the 1898–1900 Southern Cross expedition led by a Norwegian, Carsten Borchgrevink, and sponsored by a British newspaper owner, George Newnes. The expedition was the first to winter over on the Antarctic continent. One of the group, a Norwegian biologist named Nikolai Hanson, died here on 14 October 1899. He is buried on top of the Cape, the first known grave in Antarctica.

Cape Adare was later visited by the 'Northern Party' of Scott's 1910–13 expedition, but they built a separate hut of their own. The two Borchgrevink huts still stand, but that of the Northern Party has been demolished by the strong, gusty winds. Completely surrounding the huts is the largest known Adélie penguin rookery in Antarctica, with an estimated 280,000 breeding pairs.

McMurdo Station

The largest scientific station in Antarctica, McMurdo is the logistics hub of the U.S. Antarctic Program. It is located on McMurdo Sound, which was named after Lieutenant Archibald McMurdo of James Clark Ross's 1841 expedition. McMurdo was established in 1955 near the southern extremity of Ross Island and is adjacent to Scott's Discovery Hut. It houses up to 1,200 people in summer, with the winter population reduced to about 200. Something of a cross between a frontier town and a high-tech, modern city, the complex of 100 structures includes a state-of-the-art laboratory facility, repair shops, dormitories, offices, a firehouse, power plant, water desalinization plant, stores, clubs, and a coffee shop.

The buildings are constructed on stilts, to avoid disturbing the permafrost, and are linked to above-ground water, sewer, telephone, and power lines. Giant jets of Military Airlift Command, using air strips on the sea ice of McMurdo Sound or the nearby blue-ice runway, Pegasus, transport people and urgent cargo between Christchurch, New Zealand, and McMurdo from August through February. A few ships visit McMurdo in January to deliver a year's supply of fuel, food, building materials, and other supplies and equipment. McMurdo also provides logistic support for New Zealand, Italian, and Russian Antarctic programs. Research in the area includes marine and terrestrial biology, biomedical work, glaciology, meteorology, and upper atmosphere physics.

Amundsen–Scott South Pole Station

The Amundsen–Scott Station is supplied entirely by air from McMurdo, some 840 miles (1345 Kilometers) away. It has been located at the geographical South Pole since 1956. The main station was recently rebuilt (opened 2003) to replace the previous structure of a huge geodesic dome with modular buildings underneath. There are some 200 people at Amundsen–Scott in summer, dropping to about 20 in winter. The station is served by frequent flights in summer, but is isolated from mid-February to early November. Research at Amundsen–Scott includes glaciology, geophysics, meteorology, upper atmosphere physics, astronomy and biomedical studies.

McMurdo Station, Ross Island

Scott Base

Scott Base on Ross Island, six kilometers from McMurdo Station, is the focus of New Zealand Antarctic Programme (NZAP) activity. It was built in 1957, and comprises accommodation, workshops, and a laboratory. It is run by 35 people, who also assist field parties in summer; this number drops to ten during the winter months. NZAP cooperates closely with the U.S. Antarctic Program, and Royal New Zealand Air Force planes as well as USAF aircraft are used for the long flights to and from Christchurch and McMurdo.

Each year, NZAP supports about 30 projects, involving nearly 250 people. Recent projects include research into the geological history of Gondwanaland, the nature of sea ice, and biological studies of fishes, penguins, skuas, and Antarctic lakes. Current research focuses on the impact of human activities; biodiversity and ecosystems; climate processes; and terrestrial evolution.

Between Scott Base and McMurdo Station is Observation Hill, which can be climbed with some effort. At the top is a large memorial cross, made of jarrah wood, which was erected by comrades of Scott and his companions in 1913. It is inscribed with these words from Tennyson's Ulysses: 'To strive, to seek, to find – and not to yield.'

The Dry Valleys

A prime example of one of the most extreme ecosystems in the world can be found at the 1,100-square-mile Dry Valleys of south Victoria Land, within helicopter range of McMurdo and Scott Base. Discovered by Scott and two companions on a sledging trip in 1903, these valleys are virtually free of ice and snow year-round. They are also almost – but not completely – lifeless. Here, in Scott's words, are 'all the indications of colossal ice action and considerable water action, and yet neither of these agents is now at work.' Erosion is at work, however, creating strange and beautiful wind-sculpted boulders.

There are some lakes in the Dry Valleys, but of peculiar kinds. Don Juan Pond, for example, is a nearly saturated solution of calcium chloride that never freezes, even at temperatures as low as -51°C (-60°F). Japanese scientists discovered in it a mineral new to science: crystals called 'antarcticite' which turn to liquid unless refrigerated. Another water body called Lake Vanda has no outflow, and is permanently ice-covered. Beneath the ice is a layer of cold, fresh water, but beneath that is highly salty water with a temperature of 25°C (77°F). Here live algae, bacteria, and protozoa – but being sealed off from the outside world, apart from incoming solar energy, they live by recycling nutrients between them.

Other remarkable life forms found in the Dry Valleys are cryptoendolithic communities of lichens, fungi, and algae that actually live inside solid rock. In fact, they live in minute cracks in the rock or even between the crystals of more porous sandstones and granites. But higher animals and plants cannot survive in the arid conditions of the Dry Valleys, where evaporation exceeds precipitation. Curiously, some seals and penguins have wandered here, some 80 kilometers (50 miles) from the sea, and their mummified remains are preserved for thousands of years. Scott found the skeleton of a Weddell seal, but 'how it came there is beyond guessing. It is certainly a valley of the dead.'

The hanging glaciers, dramatic mountains and unique nature of the Dry Valleys make this one of the most intriguing areas to visit. The whole area has an unearthly beauty. Lucky passengers on ships making Ross Sea trips may get a chance to visit the Taylor Valley next to the Canada Glacier with the help of on-board helicopters.

Commonwealth Bay

The Cape Denison Historic Site is located in Commonwealth Bay in the Australian sector of Antarctica, at about 142°40'E longitude. It commemorates the Australasian Antarctic Expedition of 1911–14, led by Douglas Mawson, who was knighted in 1914. The expedition received financial support from the Australian and British governments, and also private organizations and individuals. It is named after one of the latter, Hugh Denison of Sydney. Britons will be amused by the names given to opposite ends of the site, Land's End and John O'Groats (the tip of Cornwall and the northernmost point of Scotland respectively). The site is near the South Magnetic Pole, and Mawson's scientific program was mainly concerned with the earth's magnetic field.

Cape Denison has the reputation of being the windiest place on earth that people have lived for any length of time. Gravity-driven katabatic winds are common, flowing down the ice slope towards the coast. The average summer wind speed is 24 knots (35 miles per hour); gusts of 130 knots (150 miles per hour) have been recorded. For this reason, landings by Zodiac are sometimes impossible. Blue ice on the plateau indicates strong winds, and snow plumes are often seen blowing off the glacier snouts nearby, even when the hut area is calm. Among notable sights are the offshore McKeller Islets, which are covered with snow 'mushrooms' up to 18 meters (60 feet) high on the landward side caused by sea spray whipped up by the winds.

At Commonwealth Bay stands a substantial main hut and work-shop, and several smaller huts connected with the scientific studies. Visitors should not enter these huts, and should not take or disturb any artifacts in the area, including animal remains (there are several piles of penguin and seal remains dating from the Mawson expedition). A number of Adélie penguin rookeries are scattered around the Cape, and Wilson's storm-petrels, skuas, and Weddell seals are commonly seen. The whole site, and especially the huts and artifacts, are the esponsibility of the Australian government's Antarctic Division, and the Australian Heritage Commission.

Adélie penguin, Commonwealth Bay, Antarctica

South Georgia © C.Goldrick

VII. FURTHER READING

Essential

David Campbell. The Crystal Desert: Summers in Antarctica
1992, HARD COVER, 307 PAGES

Written by a working scientist, Crystal Desert is a splendid, prize-winning portrait of Antarctica, the land and its history –and especially its marine life. Campbell could have been a poet.

Louise Crossley. Explore Antarctica
1995, PAPER, 112 PAGES

A concise, illustrated primer on the White Continent. The book provides an overview of the geology, history and wildlife of Antarctica in seven chapters. With hundreds of maps, charts and color photographs, it is an up-to-date survey of modern life in Antarctica, current research and scientific challenges.

Bertrand Imbert. North Pole, South Pole, Journeys to the Ends of the Earth.
1992, PAPER, 192 PAGES

An overview of polar exploration, complete with hundreds of maps, historic photographs and journal excerpts. It's a mystery how Imbert managed to pack so much useful information into this slim, 5' x 7' volume.

Alfred Lansing. Endurance, Shackleton's Incredible Voyage
1986, PAPER, 280 PAGES

An extraordinary tale of survival that reads like a good novel. Here's the day-by-day story of Shackleton's legendary perseverance: losing his ship in the ice; drifting helplessly across the Weddell Sea; and finally reaching Elephant Island, from where he sailed 800 miles to South Georgia to get help for his stranded men.

Jeff Rubin. Antarctica, Lonely Planet Travel Survival Kit
1996, PAPER, 362 PAGES

Environmental writer and Antarctic enthusiast Jeff Rubin compiled this volume – which is not so much a practical guide but an overview of Antarctica. The book includes sections on Antarctic science and environmental issues. It features a 32- page full color guide to the wildlife, excellent chapters on preparing for a voyage and details on gateway cities.

Tony Soper. Antarctica: A Guide to the Wildlife
1994, PAPER, 144 PAGES

Here's a compact, illustrated handbook featuring all the species of birds, seals and whales that the Antarctic traveller is likely to encounter. The book is enhanced by range maps and masterful color drawings (by the granddaughter of Captain Scott).

International Antarctic Centre. Antarctica Info Map
This uncluttered map shows the ice shelves, topography and oceans with essays covering geology, weather, wildlife and conservation.

Highly Recommended

Ackerman, Diane. The Moon by Whale Light.
1991. New York: Vintage Press, paper, 249 pp

In a series of essays, Ackerman evokes the wonder of nature. Includes chapters on penguins and whales.

Bainbridge, Beryl. The Birthday Boys.
1994. New York: Carroll & Graf, 189 pp

This mesmerizing novel tells the story of Scott's last expedition – with fictionalized chapters by Evans, Wilson, Scott, Bowers and Oates.

Cherry-Garrard, Apsley. Worst Journey in the World.
1997, paper, 704 pp

The classic tale of adventure, originally published in 1922. Cherry-Garrard's epic midwinter journey to the emperor penguin rookery is just a warm-up for the main event: a vivid account of Scott's doomed last expedition. George Bernard Shaw hailed it as 'absolutely and convincingly credible.' This huge book is worth the effort.

Chester, Jonathan. The World of the Penguin.
1996, Hard Cover

The latest volume of a series of authoritative, wonderfully illustrated books on wildlife. Expedition leader, author and photographer Chester presents 58 full color penguin photographs with short essays on these much-loved birds.

Gurney, Alan. Below the Convergence, Voyages Toward Antarctica 1699–1839.
1996, Hard Cover, 315 pp

Alan Gurney has written the first of what we hope will be a series of engaging volumes on the history of Antarctic exploration. A master storyteller, Gurney weaves remarkable tales in this book on the early days of exploration.

Moss, Sanford. Natural History of the Antarctic Peninsula.
1988. New York: Columbia University Press, 208 pp

Marvelous introduction to the environment and wildlife of the Peninsula. Excellent bibliography, line drawings.

Naveen, Ron, Colin Monteath, Tui de Roy and Mark Jones. Wild Ice: Antarctic Journeys.
1990. Smithsonian Press, 224 pp

Spectacular photographs illustrate this emotional journey, written and photographed by Antarctic naturalists.

Parmelee, David. Antarctic Birds: Ecological and Behavioral Approaches.
1992. Minneapolis: U of Minnesota Press

This book features Dr. Parmelee's illustrations, photographs and well-wrought prose: a comprehensive treatment of the birds of the Antarctic Peninsula.

Readers Digest. Antarctica: Great Stories From the Frozen Continent.
1985. Readers Digest Services (Dist. by Random House), 319 pp

This profusely illustrated popular encyclopedia contains short chapters on the natural history of Antarctica, discovery, history and exploration of the continent; an excellent and comprehensive introduction.

Galen Rowell. Poles Apart.
1997, Paper

Noted landscape photographer Rowell turns his attention to the ends of the earth: a gorgeous collection of 188 color photographs with insightful commentary on the story behind each picture – including the technical data for the photographers among us.

Stonehouse, Bernard. 1990. North Pole, South Pole, A Guide to the Ecology and Resources of the Arctic and Antarctic. London: Prion Press, 215 pp

This is a wonderfully illustrated overview of the climate, geology, history and wildlife of polar regions.

Watson, George E. Birds of the Antarctic and Sub-Antarctic.
1988. Washington: American Geophysical Union, 350 pp

Excellent field guide and detailed introduction to Antarctic environments. Includes geographic account and range maps. A volume in the AGU Antarctic Research Series.

General

Adams, Richard and Ronald Lockley. Voyage Through the Antarctic.
1985. Penguin Books, paper, 160 pp, illustrated.

Amusing and well-written account of a cruise from Tierra del Fuego to New Zealand by the author of Watership Down and naturalist Ronald Lockley.

Fothergill, Alastair. Life in the Freezer: A Natural History of the Antarctic.
1993.BBC Books, UK.and Sterling Publishing Group, New York (1995, 224 pp)

Companion book to the superb new series.

Fuchs, Sir Vivian. A Time to Speak: An Autobiography.
1991. Nelson, London.

By the British geologist, explorer, who also wrote: Of Ice and Men, a history of the British Antarctic Survey.

Gould, L. McK. Cold.
1931.Carleton College, 213 pp

Gould was a geologist during the early days of exploration in Antarctica; he relates his pioneering experiences.

Halle, Louis J. The Sea and the Ice, a Naturalist in Antarctica. Ithaca, New York:
1989.Cornell University Press, paper, $12.95 (Originally published by Houghton Mifflin, 1973)

Published in cooperation with the National Audubon Society with new foreword by Frank Rhodes.

Headland, R. K. The Island of South Georgia.
1992. Cambridge University Press, U.K., 293 pp

Based on this popular lecturer's studies at South Georgia. A historian, he also compiled a Chronological List of Antarctic Expeditions and related Historical Events (1990).

May, John. The Greenpeace Book of Antarctica: A New View of the Seventh Continent.
1989. New York: Doubleday, Inc., 192 pp

Opinionated, readable and profusely illustrated overview of the wildlife and politics of the Seventh Continent.

Nieder, Charles. Beyond Cape Horn.
1980. San Francisco: Sierra Club Books, 387 pp

Good account of an Antarctic voyage, including a history of the United States scientific stations.

Parfit, Michael. South Light.
1987. New York: Macmillan Publishing Company (Collier Books), paper, 306 pp

Well-written, personal account of a season spent in Antarctica that includes excellent portraits of those involved in modern research.

Porter, Eliot. Antarctica.
1988. Arch Cape Press (New York: Crown Publishers), 168 pp (reprint of 1978 Dutton)

Handsome book of essays and magnificent photographs by one of the great wildlife and landscape photographers. Record of a trip to Antarctica at the invitation of the National Science Foundation. Superb.

Pyne, Stephen. The Ice: A Journey to Antarctica.
1988. New York: Ballantine Books, paper, 434 pp

Dense, philosophical meditation that integrates information on the history of exploration, geophysics of the ice, and the symbolic meaning of this white continent in art and literature.

Wilson, Edward. Birds of the Antarctic.
1987. Dorset: New Orchard Edited by Brian Roberts

From the original illustrations in the Scott Polar Research Institute with numerous fine reproductions of watercolors and drawings by this expedition member who died with Scott.

Antarctic Science

Ainley, David, Robert LeResche and William Sladen. 1983. Breeding Biology of the Adélie Penguin. Berkeley: U of California Press, 240 pp
Detailed, scientific report based on 15 years of field work.

Bonner, W.N. and D.W.H. Walton, eds. 1985. Key Environments: Antarctica.
New York: Pergamon Press, 381 pp

Excellent collection of review articles by Antarctic scientists from six countries. Comprehensive and readable. Bibliography

Laws, Richard. 1989. Antarctica, The Last Frontier.
London: Boxtree Ltd., 208 pp

Written by a former director of the British Antarctic Survey, this introduction to the Seventh continent is strong on research and human activity.

Muller-Schwartze, Dietland. 1984. The Behavior of Penguins, Adapted to Ice and Tropics.
Albany: SUNY Press, paper, 193 pp

Based on the author's field work and suitable for a course in animal behavior, this readable book is a thorough treatment of penguin biology.

Walton,David ed.1987. Antarctic Science.
Cambridge University Press, 280 pp

Review of scientific developments in the Antarctic from its early beginnings, written by members of the British Antarctic Survey.

Field Guides

Evans, Phyllis. 1986. The Sea World Book of Seals and Sea Lions.
Sea World Press

Intended for young readers, but a good introduction with nice photographs.

Harrison, Peter. 1987. A Field Guide to Sea Birds of the World.
Lexington, Massachusetts: The Stephen Greene Press

A portable version of Harrison's Seabirds, An Identification Guide, with color photographs instead of drawings

Leatherwood, Stephen and Randall Reeves. 1983. The Sierra Club Handbook of Whales and Dolphins. Sierra Club Books, paper
Well-illustrated, convenient guide to the cetaceans.

Reeves, Randall, Brent Stewart and Stephen Leatherwood. 1992. The Sierra Club Handbook of Seals and Sirenians. Sierra Club Books, 359 pp, Paper
A convenient and compact guide to the world's seals.

Wildlife

Bonner, Nigel. 1990. The Natural History of Seals.
New York: Facts on File, 196 pp

Comprehensive guide to the ecology and evolution of seals.

Gorman, James. 1990. The Total Penguin.
New York: Prentice Hall

History, lore, social habits, and biology of the world's best-dressed bird with superb photographs, by Frans Lanting.

Murphy, R.C. 1936. Oceanic Birds of South America

This is a classic, beautifully-illustrated text. He also wrote Logbook for Grace, a delightful journey for Murphy's new bride of a trip to South Georgia aboard a whaling brig.

Parmelee, David. 1980. Bird Island in Antarctic Waters.
Minneapolis: University of Minnesota Press, 140 pp

Delightful account of field work on Bird Island, a small island in the South Georgia group of islands, by an ornithologist and artist.

Peterson, Roger Tory. 1975. Penguins.
New York: Houghton Mifflin.

Warm, profusely illustrated account of the world's penguins by the grand old man of birdwatching.

Ray, G. Carleton and M.G. McCormick-Ray. 1981. Wildlife of the Polar Regions.
New York: Harry N. Abrams (Chanticleer Press Edition), 232 pp

Magnificently illustrated introduction to the wildlife of Polar regions, particularly birds and marine mammals.

Simpson, George Gaylord. Penguins: Past and Present, Here and There.
New Haven: Yale University Press. Paper, 150 pp

Written with scholarship, wit and great affection, this great paleontologist tells the history of our fascination with these animals, their evolutionary history and behavior.

Strange, Ian. 1992. A Field Guide to the Wildlife of the Falkland Islands and South Georgia.
Harper Collins.

Todd, Frank. 1981. The Sea World Book of Penguins.
Sea World Press, 1981.

Excellent photographs and concise text provide a good introduction to penguins.

Exploration

Bertrand, Kenneth. 1971. Americans in Antarctica, 1774–1948.
New York: American Geographical Society, 654 pp

Masterfully researched and well-written history with detailed chapters on Nathaniel Palmer, Wilkes and Byrd.

Bickel, Lennard. 1988. Mawson's Will: The Greatest Survival Story Ever Written.
Dorset Press (originally published 1977), 237 pp

Dramatic tale of what Sir Edmund Hillary (who wrote the foreword) calls, 'The most outstanding solo journey ever recorded in Antarctic history.'

Boorstin, Daniel. 1985. The Discoverers.
New York: Vintage Books, paper

This wide-ranging and readable account of exploration includes a chapter on some of the great sea voyages, including Magellan's voyage to Tierra del Fuego and Cook's extraordinary journey into the Southern Ocean.

Byrd, Richard E. 1986. Alone.
Los Angeles: Jeremy P. Tarcher (dist. by St. Martin's Press, New York), (originally published 1938)

Classic tale of Byrd's winter alone on the continent.

Byrd, Richard E. 1935. Discovery.
G.P. Putnam's & Sons

Byrd's account of his 1928–1930 and 1933–1935 expeditions. It gives insight into the character of this polar explorer and the problems of large expeditions.

Cook, Frederick. 1900. Through the First Antarctic Night.
Montreal: McGill-Queens University Press (1980 reprint)

An outstanding narrative of the first expedition to explore and map the Gerlache Strait and Palmer Archipelago, a voyage that commanded by Adrian Gerlache with Amundsen and Cook.

Fiennes, Ranulph. 1993. Mind over Matter.
New York: Delacorte Press, 322 pages

The tale of the first unsupported crossing of Antarctica – by two men each hauling a 500-pound sled.

Fogg, G.E. and D. Smith. 1990. The Explorations of Antarctica: The Last Unspoiled Continent.
Cassell, London

Dedicated to the British Antarctic Survey, this is a good history of the Peninsula, Falklands and South Georgia with numerous archival photographs.

Goetzman, William. 1987. New Lands, New Men.
New York: Penguin Books,

Masterful history of America and exploration with excellent chapters on the discovery of Antarctica and the Wilkes expedition.

Huntford, Roland. 1985. Shackleton.
New York: Fawcett Columbine (Ballantine books), paper, 774 pp

Excellent biography that reads like a good novel.

Huntford, Roland. 1987. The Amundsen Photographs.
New York: Atlantic Monthly Press, 199 pp

Reproduced from Amundsen's original lantern slides, long thought lost.

Huxley, Elspeth. 1977. Scott of the Antarctic. Atheneum

Maxtone-Graham, John. 1988. Safe Return Doubtful, The Heroic Age of Polar Exploration.
New York: Charles Scribner's Sons, 363 pp

Well-written collection of historic adventures at both poles. Takes Huntford to task for his negative views on Scott's expedition.

Mawson, Douglas. 1915. The Home of the Blizzard.
London: William Heinemann, two Volumes.

Account of the search for the South Magnetic Pole under extreme conditions at Commonwealth Bay.

Mawson, D. 1991. Antarctic Diaries.
Allen & Unwin, Adelaide

Tale of Mawson's outstanding solo journey in Antarctica.

Mickleburgh, Edwin. 1987. Beyond the Frozen Sea: Visions of Antarctica.
New York: St. Martin's Press, paper, 256 pp

Superb review of the history of Antarctic exploration and discussion of the Antarctic Treaty.

Shackleton, Ernest. 1983. South.
London: Century. paper, 375 pp (also published in new edition with Hurley's photographs)

Shackleton's account of this famous tale of survival.

Worsley, F.A. 1987. Shackleton's Boat Journey.
New York: W.W. Norton & Company, paper, 220 pp

Worsley's version of the great survival story of Shackleton and his men was written by an expedition member and captain of Endurance.

Wandering albatross, Prion Island © B.Holgate

VIII. WILDLIFE CHECKLISTS

Antarctic Birds

(South of the Convergence)

Penguins

- ☐ King penguin (*Aptenodytes patagonica*)
- ☐ Emperor penguin (*Aptenodytes forsteri*)
- ☐ Adélie penguin (*Pygoscelis adeliae*)
- ☐ Chinstrap penguin (*Pygoscelis antarctica*)
- ☐ Gentoo penguin *(Pygoscelis papua*)
- ☐ Macaroni penguin (*Eudyptes chrysolophus*)
- ☐ Rockhopper penguin (*Eudyptes chrysocome*)

Albatrosses

- ☐ Wandering albatross (*Diomedea exulans*)
- ☐ Royal albatross (*Diomedea epomophora*)
- ☐ Black-browed albatross (*Diomedea melanophris*)
- ☐ Gray-headed albatross (*Diomedea chrysostoma*)
- ☐ Light-mantled sooty albatross (*Phoebetria palpebrata*)

Petrels

- ☐ Southern giant petrel (*Macronectes giganteus*)
- ☐ Northern giant petrel (*Macronectes halli*)
- ☐ Southern fulmar (*Fulmarus glacialoides*)

- ☐ Cape petrel, or pintado or Cape pigeon (*Daption capense*)
- ☐ Antarctic petrel (*Thalassoica antarctica*)
- ☐ Snow petrel (*Pagodroma nivea*)
- ☐ Kerguelen petrel (*Pterodroma brevirostris*)
- ☐ White-headed petrel (*Pterodroma lessoni*)
- ☐ Gray petrel (*Procellaria cinerea*)
- ☐ White-chinned petrel (*Procellaria aequinoctialis*)
- ☐ Blue petrel (*Halobaena caerulea*)
- ☐ Broad-billed prion, Antarctic prion (*Pachyptila vittata*)
- ☐ Thin-billed prion (*Pachyptila belcheri*)
- ☐ Fairy prion (*Pachyptila turtur*)
- ☐ Sooty shearwater (*Puffinus griseus*)

Storm petrels

- ☐ Wilson's storm-petrel (*Oceanites oceanicus*)
- ☐ Black-bellied storm-petrel (*Fregetta tropica*)
- ☐ Gray-backed storm-petrel (*Garrodia nereis*)

Diving petrels

- ☐ South Georgia pintail (*Anas georgica*)
- ☐ Speckled teal (*Anas flavirostris*)

Sheathbills

- ☐ Snowy sheathbill (*Chionis alba*)
- ☐ Lesser sheathbill (*Chionis minor*)

Gulls and terns

- ☐ Brown skua (*Catharacta lonnbergi)*
- ☐ South polar skua (*Catharacta maccormicki*)
- ☐ Kelp, or southern black-backed gull (*Larus dominicanus*)
- ☐ Antarctic tern (*Sterna vittata*)
- ☐ Arctic tern (*Sterna paradisaea*)

Perching birds

- ☐ South Georgia pipit (*Anthus antarcticus*)

Marine Mammals of Antarctica

(and Surrounding Waters)

Seals

- ☐ Antarctic fur seal (*Arctocephalus gazella*)
- ☐ Kerguelan fur seal (*Arctocephalus tropicalis*)
- ☐ New Zealand fur seal (*Arctocephalus forsteri*)
- ☐ South American sea lion (*Otaria lavescens*)
- ☐ Hooker's sea lion (*Phocarctos hookeri*)
- ☐ South American fur seal (*Arctocephalus. australis*)
- ☐ Southern Elephant Seal (*Mirounga leonina*)
- ☐ Weddell Seal (*Leptonychotes weddelli*)
- ☐ Crabeater seal (*Lobodon carcinophagus*)
- ☐ Leopard Seal (*Hydrurga leptonyx*)
- ☐ Ross Seal (*Ommatophoca rossi*)

Whales

Baleen whales

- ☐ Southern right whale (*Eubalaena australis*)
- ☐ Blue whale (*Balaenoptera musculus*)
- ☐ Fin whale (*Balaenoptera physalis*)
- ☐ Sei whale (*Balaenoptera borealis*)
- ☐ Minke whale (*Balaenoptera acutorostrata*)
- ☐ Humpback whale (*Megaptera novaeangliae*)

Toothed whales

- ☐ Arnoux's beaked whale (*Berardius arnuxii*)
- ☐ Southern bottlenose whale (*Hyperodon planifrons*)
- ☐ Sperm whale (*Physeter macrocephalus*)
- ☐ Killer whale (*Orcinus orca*)
- ☐ Hourglass dolphin (*Lagenorhynchus cruciger*)
- ☐ Peale's Dolphin (*Lagenorhynchus australis*)
- ☐ Southern rightwhale dolphin (*Lissodelphis peronii*)
- ☐ Commerson's dolphin (*Cephalorhynchus commersonii*)

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