ANTARCTIC SCIENCE

A resource book of ideas for teachers for National Science Week 2007

asta

Australian Science Teachers Association

MINISTER'S FOREWORD

On behalf of the Australian Government I am pleased to present to you the Australian Science Teachers Association's (ASTA) Resource Book for National Science Week 2007. Our science teachers are a valuable national asset, and I commend ASTA for supporting them in their teaching endeavours through the provision of this annual Resource Book.

The Resource Book is an integral part of National Science Week, which this year celebrates its 10th anniversary. The Australian Government is proud to support this annual celebration of science. Its success is, in no small part, due to the active participation of ASTA and its members across Australia.

It is to ASTA's credit that the Resource Book is such a useful educational asset that will assist teachers throughout the year. In 2006 the Resource Book was sent to all schools in Australia. This year, with an increase in funding, the Book will also be sent to all preschools and a number of Colleges of Technical and Further Education.

The theme of this year's Resource Book, Antarctic Science, celebrates the International Polar Year and provides information, online resources, classroom activities, experiments and photographs. Antarctica's unique ecosystems, landscapes, biodiversity and climate combine to make the study of this frozen continent both fascinating and informative. Data from Antarctica is also assisting us in understanding past and present climate processes, which is, of course, a subject of considerable interest to the community.

I trust this Resource Book will prove inspirational for the study of science by all young Australians.

The Hon Julie Bishop MP
Minister for Education, Science and Training
March 2007

CONTENTS AND ACKNOWLEDGEMENTS

Australian Science Teachers Association

An Australian Government Initiative

NATIONAL SCIENCE WEEK

In recognition of the International Polar Year and in celebration of National Science Week 2007 the Australian Science Teachers Association (ASTA) is pleased to present the 23rd edition of the ASTA National Science Week Teacher Resource Book, *Antarctic Science*.

Antarctic Science is packed with information, activities and experiments, photographs, diagrams and resource links that demonstrate the frontiers of scientific investigation in the Antarctic. In this edition, activities and experiments have been organised according to four broad schooling levels – lower primary, primary, middle school and senior secondary – for easier access by teachers. They may need to be adapted to suit your class/es or may act as a trigger for your own ideas.

ASTA is pleased to have funding received from the Australian Government through the Department of Education, Science and Training. On behalf of ASTA I would like to thank and congratulate the authors and designers of *Antarctic Science*, the education review team, scientific validators, the ASTA National Science Week Representatives in each state and territory and all the teachers and students who organise and participate in National Science Week in schools.

ASTA encourages teachers of science to organise a celebration of science during National Science Week 2007 and hopes that this book will provide useful ideas for this years theme: Antarctic Science. Your feedback is welcome.

Paul Carnemolla
President, Australian Science Teachers Association (ASTA)

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Scientific Authorisation:
Michael Grose and Moira Williams.

Authors: Louise McNeil and Christina Cleaver - Clue Communication.
Email: lou@cluecommunication.com

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Questionnaire

National Science Week 2007 Resource Book

Antarctic Science

TEACHER FEEDBACK



Antarctic Science is an ASTA resource book of ideas for teachers for National Science Week 2007. The information you provide will help ASTA make improvements to future publications.

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Please indicate your ratings

FEEDBACK CRITERIA

1. Overall response to the book	1	2	3	4	5	
A valuable resource ◀						▶ Of little value
Well presented ◀						▶ Poorly presented
Information sections were helpful ◀						▶ Not helpful
Supports an inquiry approach to student learning ◀						▶ Does not support an inquiry approach
Applicable beyond National Science Week 2007 ◀						▶ Not applicable

2. Resource Book Content	1	2	3	4	5	
Good balance of activities – primary to secondary ◀						▶ Too targeted
Includes activities relevant to the class level I teach ◀						▶ Irrelevant to my students
Created student interest ◀						▶ Little interest created
Provided a springboard to other ideas and activities ◀						▶ No scope for creativity
Additional resource links were useful ◀						▶ Not useful
Appropriate methodology ◀						▶ Inappropriate methodology

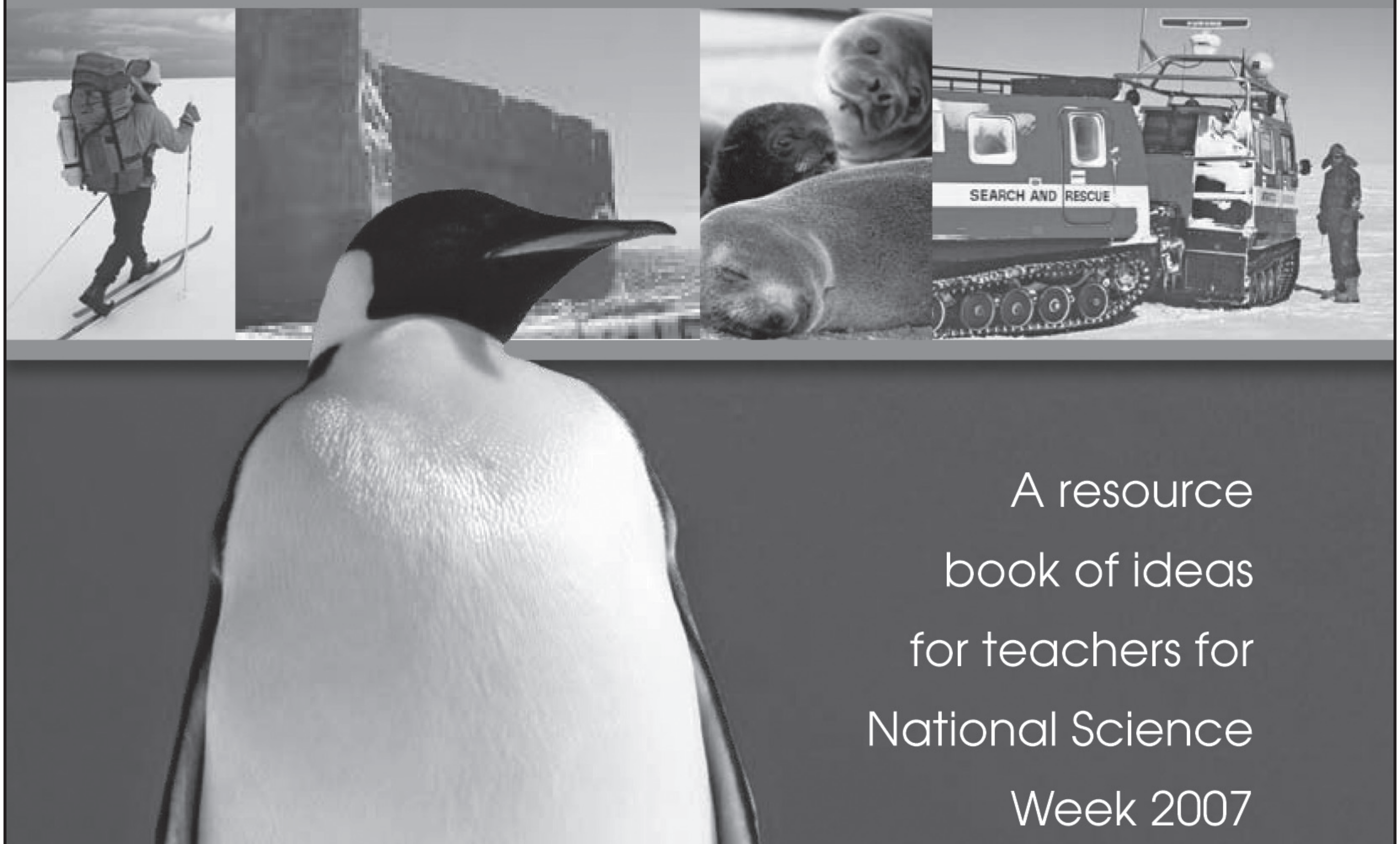
3. What did you find most valuable about the book? ______________________

Why? ______________________

4. What did you find least valuable about the book? ______________________

Why? ______________________

ANTARCTIC SCIENCE



2007 National Science Week Resource Book

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PO Box 334, Deakin West ACT 2600
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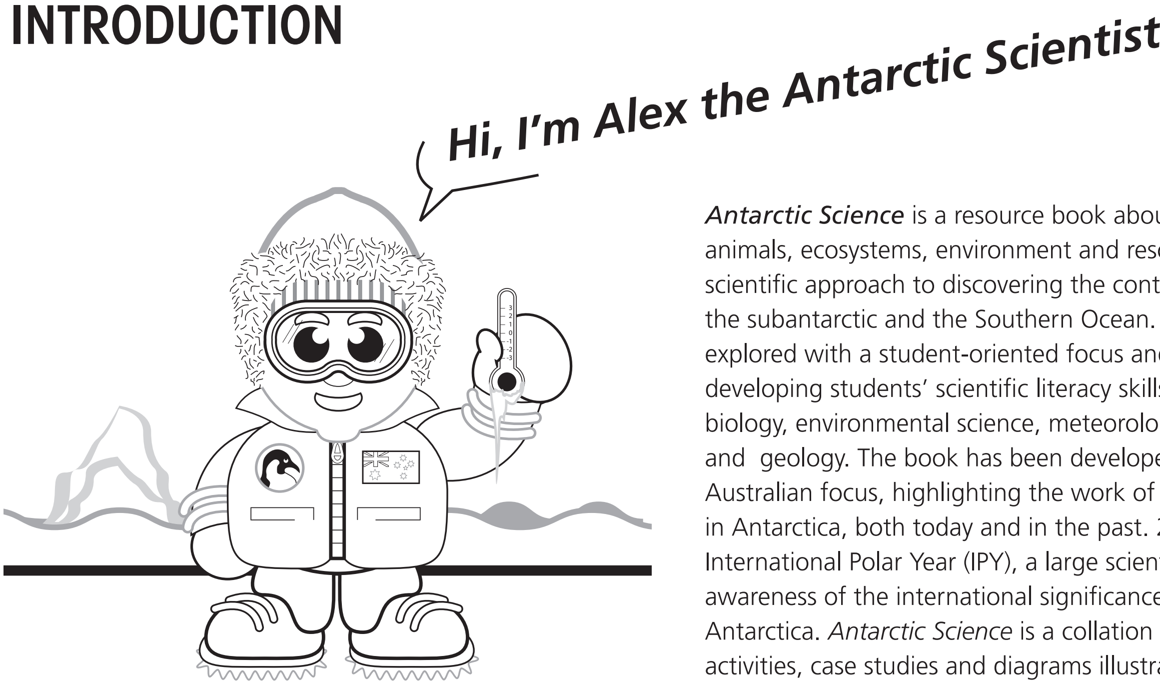
email: asta@asta.edu.au • www.asta.edu.auu

INTRODUCTION



Antarctic Science is a resource book about Antarctica: the animals, ecosystems, environment and resources. It applies a scientific approach to discovering the continent of Antarctica, the subantarctic and the Southern Ocean. All themes are explored with a student-oriented focus and are aimed at developing students' scientific literacy skills in the fields of biology, environmental science, meteorology, oceanography and geology. The book has been developed with an Australian focus, highlighting the work of Australian scientists in Antarctica, both today and in the past. 2007-2008 is the International Polar Year (IPY), a large scientific program raising awareness of the international significance of the Arctic and Antarctica. *Antarctic Science* is a collation of information, activities, case studies and diagrams illustrating the themes and issues being promoted during IPY.

HOW TO USE THIS BOOK

All information has an Australian focus and has been written using the most current sources available. All topics are self-contained, allowing teachers to select at random information and activities about specific topics. Each topic is structured to include scientific information about the topic, activities, experiments and case studies. Web links and other resources are included for each topic and in the Additional Resources section at the back of the book to enable teachers and students to conduct further research on any detail addressed in the chapter.

Activities/Experiments

Activities and experiments are included in every topic to engage students in the significant concepts introduced using a student-centred approach. Where relevant, all activities are linked to websites for further information.

All activities and experiments are categorised into appropriate stages. The four stages are:

LP – Lower Primary (preschool–Year 2)

Prim – Primary (Year 3-5)

MS – Middle School (Year 6-8)

SSec – Senior Secondary (Year 9-12)

These stages are not intended to be prescriptive but as a guide for teachers looking for appropriate activities for the year level/s they teach and what interests them and their students on science in the Antarctic. An overview of the activities/experiments included in this book is on p. 6.

Websites

Where appropriate websites have been suggested to enable readers to access further information and activities. All websites were deemed appropriate at the time of publication. It cannot be guaranteed that all websites will continue to be available after publication.

Did You Know?

Interesting snippets included as a light and easy way to retain students' interest!

Curriculum Guidelines

This resource book is intended to enhance all teaching programs within your school. Each activity and experiment has a teaching objective and a learning outcome to help assist teachers with their planning. The activities and experiments are not specifically curriculum linked, although they are designed to reflect a broad sweep of nationwide curriculum outcomes. Teachers will integrate the activities and experiments under the appropriate curriculum framework in their state or territory.

Questionnaire

Please complete and return to ASTA to ensure we continue to improve.

Glossary and Additional Resources

In the last two pages of the book teachers will find:

- A list of important words used in the book. These words are in bold type and can be identified throughout the book .
- Additional web, printed and audio-visual resources relevant to the theme to help promote further research.

Safety Awareness

All student experiments included in Antarctic Science have been designed to minimise hazards, however, there is no guarantee that a procedure will not cause injury. Teachers should test all activities/experiments before using them in class and consider the OH&S requirements within their state or territory. All necessary safety precautions should be outlined clearly to students. Students must be provided with all safety equipment necessary prior to the commencement of experiments/activities.

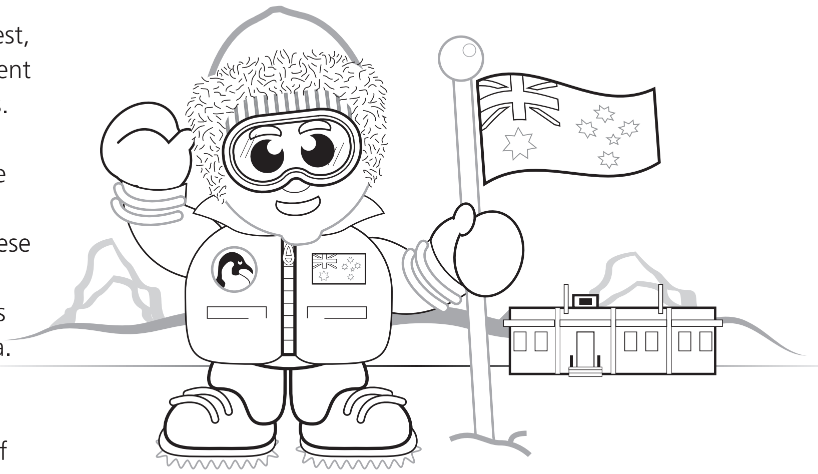
ACTIVITIES AND EXPERIMENTS AT A GLANCE

Name of Activity or Experiment	Activity or Experiment	Page	LP	Prim	MS	SSec
Discovering Antarctica						
The Antarctic climate	E	10			*	
Radiation and absorption	E	11		*	*	
Shades of blue	A	11	*	*		
The colours of Antarctica	A	11		*	*	
Why is it so cold in Antarctica?	A	12			*	
The Living Antarctic Environment						
The web of life game	A	14		*	*	
You and your food	A	14	*	*	*	
Who is eating whom?	A	14	*	*		
The ecological impact of humans	A	16				*
Whales in the Southern Ocean	A	16	*	*	*	
Library/Internet Research	A	17		*	*	*
The big question	A	17		*	*	
The race to save Vostok	A	18				*
The incredible Water Bears	A	19			*	
Counting organisms	E	19		*	*	
Antifreeze and the freezing point of water	E	20			*	*
Animal adaptations	E	21	*	*	*	*
Creating a huddle	A	22	*	*	*	
Creating a huddle II	A	22			*	
Design a penguin suit	A	23	*	*	*	
Studying penguins	A	23			*	
How much do you eat?	A	23		*	*	
The Physical Antarctic Environment						
Salinity and the freezing point of water	E	25	*	*	*	
Moving icebergs	E	25		*	*	
How do icebergs float?	E	27	*	*	*	
Affect of salinity on icebergs	E	27			*	*
Create a physical model of an icesheet	A	28				*
Measuring wind speed	E	29		*	*	
Wind chill	A	29	*	*	*	*
Ocean currents	A	30		*	*	*
Making an Antarctic cake	A	31	*	*	*	*
Continental drift	A	32		*	*	*
Antarctic fossils	A	32			*	
Make your own fossil	A	32	*	*		
Protecting the Antarctic environment	A	33		*	*	
The ocean carbon cycle	A	33				*
Detecting CO2 in water	E	34				*
Human Activity in Antarctica						
When a compass is useless	E	36		*	*	
Balloon compass	E	36		*		
The Antarctic Treaty	A	37			*	*
Travel in Antarctica	A	37		*	*	
The silence is striking	A	38	*	*		
What to wear	E	39		*		
Insulation	E	39		*	*	
Planning a trip to Antarctica	A	40		*		
Technology in Antarctica	A	41		*	*	*
What shape works best?	A	41		*	*	*
Environmental issues in Antarctica	A	42			*	*
Altering the natural state	A	42			*	*
Pollution and wildlife	A	43		*	*	
Debating the issues	A	44				*
Unseen pollution	A	44				*
You be the judge	A	45			*	*

DISCOVERING ANTARCTICA

The Continent

Antarctica is the southern-most continent. It is also the driest, coldest, windiest, highest continent on Earth, an environment so hostile and remote that it has no permanent inhabitants. Antarctica is made up of the continent and over twenty six surrounding island groups – coastal islands surrounding the continent, islands surrounding the Antarctic Peninsula and the subantarctic islands of the Southern Ocean. Most of these islands are uninhabited even by researchers. The Antarctic continent is so large it makes up nine percent of the Earth's continental surface and is almost twice the size of Australia. The Transantarctic Mountains split the continent into East and West Antarctica. The Antarctic Peninsula extends to the north from West Antarctica towards the southern tip of South America. The subantarctic islands are – Bouvet Island, South Sandwich Islands, South Georgia Island, Heard Island, Kerguelen Island, Prince Edward Islands, Macquarie Island and Crozet Islands. Macquarie and Heard Islands are World Heritage listed reserves.



Source: Wikipaedia

Size Comparison

Antarctica, Australia & United Kingdom

Source: Australian Antarctic Data Centre, Australian Antarctic Division, DEH, July 2000 © Commonwealth of Australia

Poles Apart

The name Antarctica means "opposite the Arctic". There are many similarities and differences between the two poles. The Arctic is an ocean surrounded by landmasses where polar bears, reindeer, and foxes live. Much of the Arctic is tundra and boreal forest (woodlands made up mostly of evergreen trees and shrubs that bear cones, such as pine cones). A wide variety of plant life can survive in the Arctic, including mosses, lichens, and hundreds of flowering plants. By contrast, Antarctica is a continent surrounded by oceans. Antarctica is colder than the Arctic with temperatures as low as -89.2°C having been recorded there. It is so cold in Antarctica that there are only two species of flowering plants that can survive although many animals such as penguins and many species of seals and whales, including the orca, or killer whale, live there.

Antarctica: The Polar Desert

Despite containing seventy percent of the world's fresh water, Antarctica is an arid environment. It is the world's largest desert due to the low **precipitation,** receiving only 146-192mm of water in the form of snow per year – about the same amount as the Sahara Desert. Snow and rain fall mainly on the coastal areas in Antarctica and up to two hundred kilometres inland. Fresh water is 'locked up' as snow and ice.

Did You Know?

Macquarie Island is part of the state of Tasmania. It is a subantarctic island located in the Southern Ocean at a latitude of 54° 30' south, 158° 57' east.

Did You Know?

Antarctica is the only continent that has never had an indigenous population due to its harsh climatic conditions.

Did You Know?

In Antarctica, winds can knock people to the ground or lift them off the ground and throw them many metres.

The Coldest Continent

Antarctica is the world's coldest continent with an average annual temperature in the interior of -50°C and -10 to -15°C at the coast. The lowest temperature ever recorded in Antarctica was -89.2°C in 1983. There are three basic climatic regions in Antarctica: the interior, the coastal areas, and the Antarctic Peninsula.

The Windiest Continent

Antarctica is swept by some of the strongest winds on Earth. The highest recorded wind velocity in Antarctica was 327 kilometres per hour in July 1972. In Antarctica's coastal regions winds combine with low temperatures to create dangerous wind chill conditions. The windiest spot on Earth is Cape Denison at Commonwealth Bay. It is swept by fierce **katabatic** winds.

The Highest Continent

With an average elevation of 2,500 metres, Antarctica is the highest continent on earth (Australia's average elevation is only 340 metres). The highest point on Antarctica is Vinson Massif at 4,897 metres. The high elevation is due to the enormous **ice sheet** that covers the continent – it is nearly five kilometres thick at its thickest point.

Mt Erebus. Source: Photo by Richard Waitt, 1972 (U.S. Geological Survey). Smithsonian Institute

Did You Know?

Mt Erebus is the highest and most active volcano in Antarctica, and the southern most active volcano on Earth. It is 3,794 metres high.

A EXPERIMENT – THE ANTARCTIC CLIMATE

MS

Teaching Objective: Students will carry out a detailed study of the weather in Antarctica compared to Australia and explain what causes different climates.

Learning Outcome: Students will use weather data to explain what factors affect climate.

Procedure Part 1:

1. Using the data from the Climate Chart linked to Unit 1.3 Weather on the Classroom Antarctica website www.classroom.antarctica.gov.au determine which Antarctic or subantarctic stations have the:
   - greatest average rainfall
   - lowest average rainfall
   - hottest average annual temperature
   - greatest range between average high and low temperatures
   - coldest average temperature
   - greatest average wind speed
   - largest wind
2. Then find this information for five cities in different parts of Australia.
3. Using this information, compare what these places do and do not have in common?
4. What does this information tell us about how location (latitude and proximity to the coast) and altitude help shape a region's climate?

Procedure Part 2:

1. Select six places in Australia and Antarctica.

   Draw a climate graph showing their monthly average temperatures (maximum and minimum), rainfall, wind speed and sunshine. Summarise the climate of each of these places, including the latitude, altitude and distance from the sea. You could then plot the data on a map showing Australia and Antarctica (one category of climate data per map). What do you notice about the sunlight hours at each place in June? How does this differ from December? Why?

Source:
Classroom Antarctica Unit 1.3, Weather
www.classroom.antarctica.gov.au

Did You Know?

Antarctica's ice is so heavy that it has forced most of the land surface of the continent to below sea level.

Did You Know?

Inuits, the indigenous people from the Artic region, use seventeen words for 'white' when describing different snow conditions.

EXPERIMENT – RADIATION AND ABSORPTION

Prim MS

Teaching Objective: Students will understand the concept of heat absorption.

Learning Outcome: Students will investigate the potential of different colours to absorb heat.

Materials: Two bulb thermometers or temperature sensors, 2cm square of white paper, 2cm square of black paper, a desk lamp.

Procedure:

1. Place the thermometers on a bench approximately 2cm apart.
2. Cover the bulb of the first thermometer with the white paper and the second with the black paper.
3. Place a lamp so it is 5cm from the thermometer bulbs and turn it on. Observe the temperature changes over ten minutes.
4. Switch the lamp off.
5. Record your results.
6. Write your conclusion.

Questions:

1. Which colour material heated up the fastest?
2. Which colour material heated up the slowest?
3. What material absorbed the least amount of heat?
4. What does this experiment show us about the effect of Antarctica's ice sheet on the sun's radiation?

Extension:

1. What is **albedo**?
2. Why has Antarctica got such a high **albedo**?

Source:

Sharwood, J and Khun, M, *Science Edge 1*, (2004), Thomson Learning. Australia. p. 142.

Did You Know?

When the wind really blows in Antarctica, pebbles the size of billiard balls can be blown along by the wind.

ACTIVITY – SHADES OF BLUE

LP Prim

Teaching Objective: Students will develop their understanding of the different shades of blue that exist within Antarctica.

Learning Outcome: Students will discover that Antarctica is not just white in colour.

Materials: Paint, food colouring, ice cube trays.

Procedure:

1. Students can attempt to create twenty different shades of blue either with paints or by using food colouring and water.
2. Have students freeze the examples in ice cube trays.
3. Ask students to come up with words to describe each of the 'blues' they have mixed. Use words that relate to Antarctica.

Source:

Classroom Antarctica Unit 1.11 Colours
www.classroom.antarctica.gov.au

ACTIVITY – THE COLOURS OF ANTARCTICA

Prim MS

Teaching Objective: Students will develop their understanding of the diversity of colour that makes up Antarctica.

Learning Outcomes: Students will develop a colour palette to demonstrate the colours of Antarctica.

Materials: Paint strips

Procedure:

1. Have students create their own Antarctic colour palette by collecting paint strips from a hardware shop, selecting those that seem to be 'Antarctic colours' and then naming each of them with an appropriate Antarctic name eg. glacial blue, midwinter pink.
2. Have students create a subantarctic colour palette (lots of greens and greys) after examining images of Macquarie Island.
3. Have students create an Australian Outback palette as a striking comparison.

Source:

Classroom Antarctica Unit 1.11, Colours
www.classroom.antarctica.gov.au

Antarctica: The Continent

Antarctica lies in the Southern Hemisphere, surrounding the South Pole. Including its **ice shelves**, Antarctica covers over thirteen million square kilometres, compared with 7.7 million square kilometres for Australia. South America is 1,000 kilometres away and New Zealand is 2,500 kilometres away.

Ninety-eight percent of Antarctica has a permanent blanket of snow and ice – about eighty seven percent consists of permanent ice sheet with about eleven percent made up of permanent floating ice shelves. At its thickest the ice is over four kilometres deep, covering a landscape of mountains, valleys, lakes and plains below it. The dome-shaped ice sheet has been formed by the accumulation of snow over hundreds of thousands of years. The ice generally flows from the centre of the continent towards the surrounding ocean, with thousands of **glaciers** extending into the sea. The ice cap makes Antarctica appear to be one landmass when under the ice. East Antarctica is a single landmass but West Antarctica is made up of a number of separate pieces of land. During the winter months it becomes so cold in Antarctica that the sea surrounding the continent freezes for hundreds of kilometres off-shore.

Australian Antarctic Territory (AAT) contains the world's largest **glacier,** the Lambert Glacier.

> **?** ***Did You Know?***
>
> *In Antarctica's Dry Valleys less than six centimetres of snow falls in a whole year.*

The Dry Valleys

The Dry Valleys of Antarctica is an area regarded as one of the most extreme deserts in the world where no rain has fallen for two million years. Dry Valleys are formed by the retreat of glaciers and are one of the worlds most delicate, yet simple ecosystems. The principal ice-free valleys in Antarctica include the Taylor, Wright, McKelvey, Balham, Victoria, and Barwick Valleys. Several lakes occupy parts of some valley floors, their surfaces frozen most of the year. Some lakes are over thirty metres deep and have perennial ice covers several metres thick. Lake Vanda is one such lake. Lake Vanda is a saline lake in a terminal valley (with no outlet). It is also permanently stratified and the water temperatures at the bottom are around 25°C (higher in some places) due to solar energy coming through the ice. To research Lake Vanda go to:
Antarctic Connection, www.antarcticconnection.com/antarctic/science/dryvalleys.shtml

Aurora Australis (Southern Lights)

Auroras occur in the polar regions in both hemispheres. They are caused by charged particles from the sun interacting with the earth's magnetic field. Some of the particles entering the upper **atmosphere** travel along the magnetic field lines and, as they strike atoms of the earth's thermosphere, emit energy as light which is seen from below as an aurora.

For more information about the significance of the colours of an aurora visit Classroom Antarctica Unit 1.10, Auroras www.classroom.antarctica.gov.au

A ACTIVITY – WHY IS IT SO COLD IN ANTARCTICA?

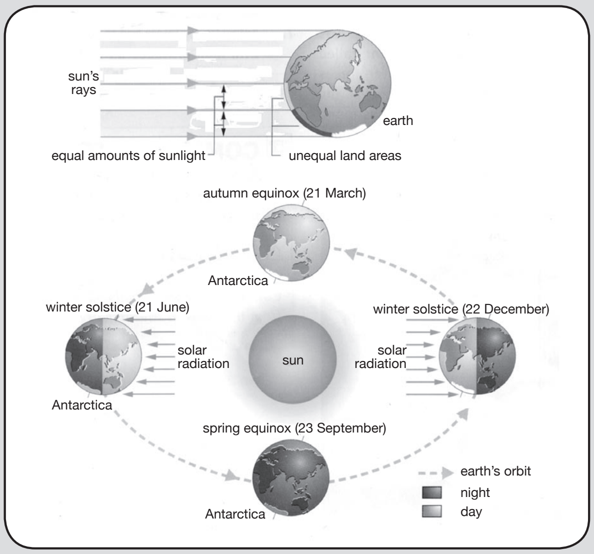
MS

Teaching Objective: Students will develop their understanding of the climate of Antarctica.

Learning Outcome: Students will investigate why it is so cold in Antarctica.

Procedure:

1. Put students in groups to discuss why they think it so cold in Antarctica.
2. Have students test the accuracy of their ideas by exploring the following factors:
   a. The angle of the sun's rays when they meet Antarctica and the impact this has on the climate. To demonstrate, shine a torch on the wall at 90° and then at a different angle. Have students explain how the amount of heat and light hitting the wall changes depending on this angle. How does this relate to Antarctica?
   b. The impact that white ice has on the amount of heat and light absorbed by the Antarctic continent.
   c. Ocean currents, in particular the Antarctic Circumpolar Current (ACC)
   d. The effect of the elevation of the continent.



THE LIVING ANTARCTIC ENVIRONMENT

Very few plants and animals can survive in Antarctica all year round. There are a couple of weeks in mid-winter (around 21 June), when the sun does not rise, and a couple of weeks in summer around Christmas when there is 24-hour sunlight.

In Antarctica, inland temperatures typically range from -20 to -70°C. Coastal temperatures range from 5 to -40°C. Wind gusts can reach up to 330km per hour.

Case study – Geoscience in Antarctica

Dr P.E. O'Brien, Geoscience Australia

Geoscience Australia's Marine and Coastal Environment Group is contributing expertise in sea floor mapping and sediment core collection to the Census of Antarctic Marine Life (CAML).

CAML is a five year International Program which will be undertaken as a major activity during the International Polar Year. This project will bring together all known data on Antarctic marine biodiversity and ocean change. The Antarctic Ocean is one of the most sensitive **ecosystems** in the world. Research undertaken via CAML will produce fascinating images of the Southern Ocean.

The Australian Antarctic Division is collecting oceanographic data, video footage and sediment cores through hot-water drill holes in the Amery Ice Shelf. The sediment cores are collected using a corer designed and built by Geoscience Australia, and are being analysed by scientists at Geoscience Australia to understand the environmental history beneath this ice shelf. This project has now produced four cores.

The only other core ever obtained from beneath an extant ice shelf – from under the Ross Ice Shelf in the early 1970s – showed no signs of life. However, several Amery cores contain **diatom**-rich sediments, and one contains a succession of **benthic** faunas that indicate progressive colonisation of the sub-ice sea floor as ice retreated and currents began to seep nutrients and plankton into the sub-ice shelf cavity.

For more information visit Geoscience Australia www.ga.gov.au

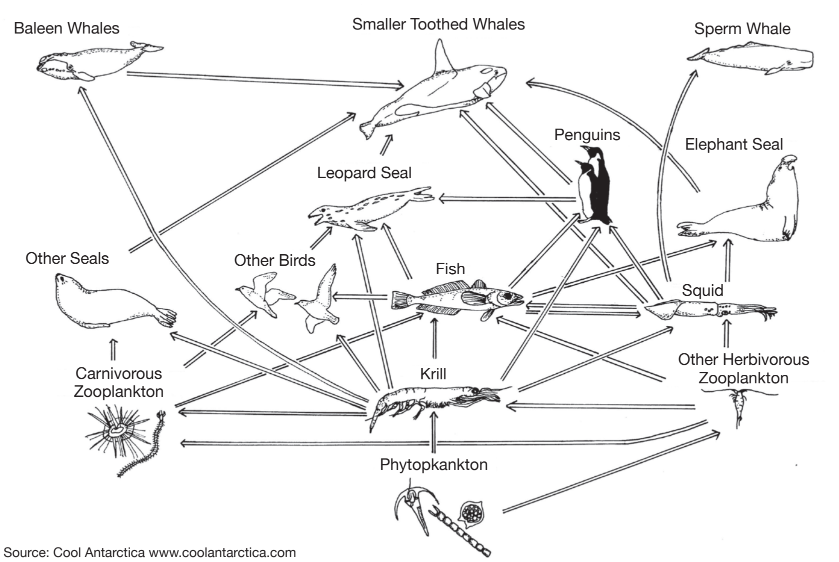
Biodiversity, Food Chains and Webs

Biodiversity is the variety of life: the different plants, animals and micro-organisms, their genes and the ecosystems that involve them. These ecosystems link the **marine** and **terrestrial** environments. Biodiversity is vital to the survival of all species in the environment. The more diverse an ecosystem the more chance organisms have of surviving if one part of the system is damaged.

Life exists because the Earth has organisms that can **photosynthesise**. Plants are able to use energy from the sun to make new chemical bonds between water molecules and $C0_2$. This matter is then cycled through other organisms when they are consumed. Energy is transferred when chemical bonds of the matter (or **nutrients**) are metabolised by the **consumers**.

Food chains and webs explain the relationship between organisms in an ecosystem. A food chain shows the flow of energy from the **producer** to the consumer. A food web combines a group of food chains. Food webs are complex and show how each organism fits into the ecosystem. If any of the links in a food web are damaged or removed, many organisms in the web may be affected. The following diagram is an example of an Antarctic food web.

Antarctic Ocean Food Web



Source: Cool Antarctica www.coolantarctica.com

ACTIVITY – THE WEB OF LIFE GAME

Teaching Objective: Students will develop their understanding and knowledge of the relationships between producers, predators and prey.

Prim

Learning Outcome: Students will play a game that demonstrates how a food chain works.

Materials: A piece of material to use as a tail.

Procedure: Divide class into three groups – dingoes, wallabies and grasses. Wallabies are identified by a tail (piece of cloth in their back pocket). Players stand in three concentric circles in the ratio of three grasses, four wallabies and three dingoes. Dingoes form a large circle with wallabies inside, grasses on the outside with grasses being unable to move. When the signal is given the wallabies must try to get to the grasses. The dingoes try to catch the wallabies by pulling out their tails. Wallabies cannot be caught when in a crouching position and can only move or get grasses when standing up. Wallabies must get food (by tipping a grass) each round or they die and become grasses. When a wallaby is caught by a dingo it turns into a dingo. If the dingo fails to catch a wallaby during the round it dies to become a grass. When the wallaby gets (tips) a grass the grass becomes a wallaby. Dingoes may only get one wallaby in each round, however wallabies may get more than one grass.

At the end of each round (15 to 20 seconds) record the results as follows:

Round	Number of wallabies	Number of dingoes	Number of grasses	Total

1. Discuss with the students why the populations change each round.
2. Adapt to an Antarctic food chain.

MS

Learning Outcome: Students understand the concept of the food chain and how energy moves through the chain.

Procedure: Carry out the procedure as for Primary. Graph the results. Ask students to answer:

1. What would happen if there was a drought resulting in a shortage of grasses for the wallabies? What effect would this have on the dingoes?
2. If human hunted dingoes to the point of extinction what would happen to the wallaby population. Would there be enough grasses?
3. Draw a food chain for this game. Where does each link in the chain get its energy from?

ACTIVITY – YOU AND YOUR FOOD!

Teaching Objective: Students will develop their understanding and knowledge of the interrelationships between prey and predators in a food chain or web.

LP

Learning Outcome: Students identify and construct a food chain based on the foods they eat.

Procedure: Introduce the students to the concept of a food chain. Ask them to think about some of the foods they eat and where it comes from. Draw a simple food chain based on this food.

Prim

Learning Outcome: Students will identify and construct a food web for an ecosystem.

Materials: Pen, paper.

Procedure: Take students outside and ask them to list all the organisms they can see and hear eg. ants, birds, lizards. Determine where the nutrients are coming from. In the classroom, have students place each organism into the correct column of the following table:

producer	consumer	decomposer	nutrients

NB. Definitions of these terms are on pg. 46 of this book.

MS

Learning Outcome: Students construct an Antarctic food web.

Procedure: Using the web resources listed at the end of the book ask the students to identify and make a list of organisms that inhabit the Antarctic. Construct a food web using the one on p. 14 as a guide. Analyse the impact of removing an organism from the food web. Brainstorm what environmental factors are impacting on this food web.

ACTIVITY – WHO IS EATING WHO?

Teaching Objective: Students will develop an understanding of how food webs and chains work.

LP
Prim

Learning Outcome: Students will study an Antarctic food web to investigate which organisms feed on each other.

Go to www.classroom.antarctica.gov.au and solve the Antarctic mystery of 'Who is Eating Who?'

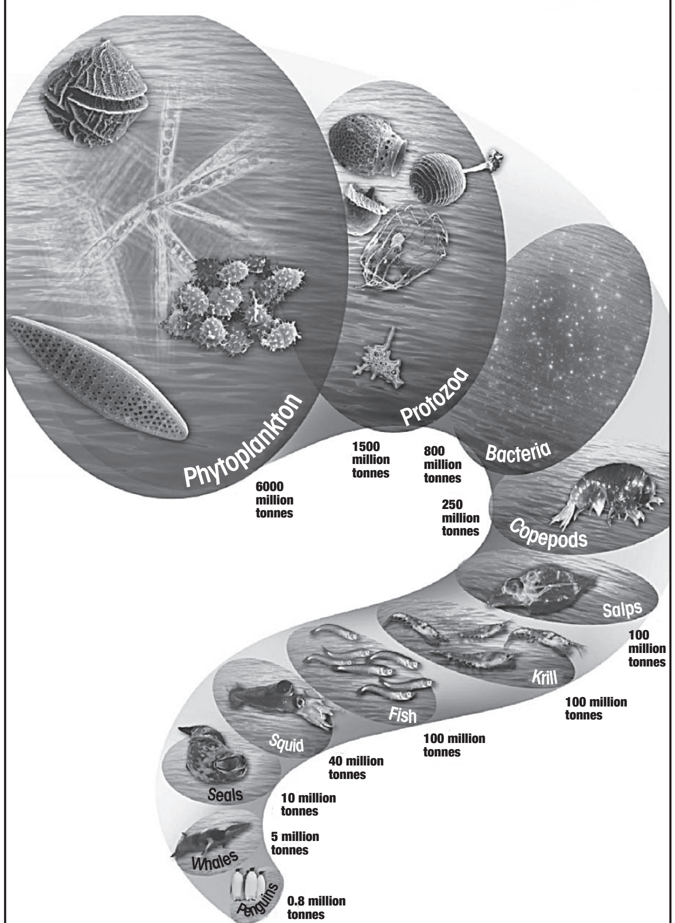
Did You Know?

There are over 200 species of sea spiders or pycnogonids in Antarctica, many of which are endemic. Sea spiders grow much larger in Antarctica than elsewhere.
Some grow to about 20cm in diameter, more than ten times the size of sea spiders from other regions.
NB. Sea spiders are in different phyla to land spiders.

Sea spider (pycnogonids) from the Southern Ocean near Heard Island

Photograph: Kirrily Moore, Australian Government Antarctic Division © Commonwealth of Australia 07

Relative Abundance of Life in the Southern Ocean



Source: Illustration by Pingala Walsh, Tasmanian Museum and Art Gallery Islands to Ice Gallery

The Antarctic Marine Ecosystem

The marine system in Antarctica is centred around the Southern Ocean (waters south of the Antarctic Convergence or polar front – see the diagram in the ***Southern Ocean*** section of the book.) Extensive areas of the Southern Ocean are covered by ice on a seasonal basis. The marine animals are:

- *Whales* – Blue, Fin, Humpback, Minke, Orca, Southern Right, Sei, Sperm
- *Penguins* – Emperor, Adelie, Chinstrap, Gentoo
- *Seals* - Weddell, Crabeater, Ross, Leopard, Elephant and Fur
- *Seabirds* – Skuas, Petrels, Albatross, Terns, Cormorants, Fulmars, Gulls, Sheathbills (numerous species of each)
- *Fish* – two hundred species of fish. Most well known are the Antarctic Cod, Ice Fish and the Patagonian Toothfish.
- *Squid* – numerous species
- *Zooplankton* (including krill) – numerous species of copepod, krill and others

NB. Penguins are considered marine animals as they spend most of their time in water, only spending time on land to breed.

The Antarctic marine environment also contains plants known as phytoplankton. Phytoplankton are generally microscopic but some can exceed one millimetre. It is difficult for plants to survive in the oceans around Antarctica as the ice acts as a curtain preventing sunlight from coming through to aid photosynthesis, however some of these plants also rely on sea ice for winter survivial. Phytoplankton are incorporated into sea ice and grow as thick bands of 'sea ice algae' in the ice. Strips at the bottom or middle of sea ice can appear brown with algae.

Phytoplankton are produced in enormous numbers in surface water during the late spring and summer months.

Phytoplankton are at the base of the Antarctic marine food web. Changes in the global environment and in particular the hole in the ozone layer can impact on the phytoplankton populations. The increase in the hole in the ozone layer allows damaging Ultraviolet-B rays to penetrate deep into the ocean. Ultraviolet-B radiation affects the orientation and motility of the phytoplankton and makes it difficult for them to photosynthesise.

Krill is a general term used to describe about 85 species of open-ocean crustaceans. Krill have an important role in Antarctic food webs – they are the major food source for whales, penguins, seals and many birds.

Did You Know?

It has been estimated that during the feeding season in Antarctica, a fully grown blue whale eats about four million krill per day - that's 3,600kg every day for six months.

ACTIVITY – THE ECOLOGICAL IMPACT OF HUMANS

Teaching Objective: Students will develop their knowledge and understanding of the ecological impact of humans competing with animals.

SSec

Learning Outcome: Students will discuss the issues associated with fishing and the competition for resources.

Background: A blue whale eats 3,600kg of krill each day. Assume that 90% of the biomass is lost going up the food pyramid. 3,600kg of krill equates to approximately 360kg of sardines or 36kg of tuna - therefore, the whale consumes 36 times 182.5 (they eat for 6 months of the year) which equals 6,570kg of fish per annum that would be otherwise available for human consumption (Australia harvests about 200,000,000kg of fish per annum, enough to support 30,000 whales!)

Questions:

1. Think about the information outlined above. Does this mean that current whale populations are unsustainable in the face of competition by humans for food?
2. What is the solution for the co-existence of marine populations with a growing human population?

Humpback whale breaching Source: Lt Scott Simpson RN, The HMS Endurance Tracking Project

ACTIVITY – WHALES IN THE SOUTHERN OCEAN

Teaching Objective: Students will develop their knowledge and understanding of the whales of the Southern Ocean.

Type	Length	Weight
Southern Right Whale	to 17m	to 100 tonnes
Blue Whale	to 30m	to 150 tonnes
Fin Whale	to 27m	to 90 tonnes
Minke Whale	to 10m	to 10 tonnes
Humpback Whale	to 16m	to 48 tonnes
Sperm Whale	to 15m	to 40 tonnes
Arnoux's beaked Whale	to 9m	to 8 tonnes
Southern Bottlenose Whale	to 9m	to 4.5 tonnes
Killer Whale (Orca)	to 9m	to 7 tonnes

LP

Learning Outcome: Students will demonstrate the relative size of certain whales.

Materials: Ruler, 30 x 1 metre strips of cardboard/ paper.

Procedure: Take students out into an open space such as an oval or playground. Get each student to cut a strip of cardboard/paper 1m in length. Place the 30 strips end to end. Explain that is the length of the largest whale in the Southern Ocean. Measure out nine metres for the smallest whale. Ask students to calculate how many times longer than them the whale is.

Prim MS

Learning Outcome: Students will understand scale and the vast size of some marine animals.

Procedure: Carry out the Procedure as for LP. Back in the classroom help students to come up with a scale which would allow them to draw pictures of the whales on a sheet of paper. Draw each whale to scale. Ask the students to include a scale drawing of themselves on the paper as well.

Case Study – How do scientists know so much about marine animals?

Satellite Trackers
Satellite trackers tell scientists where marine life eg. penguins, travel when they are out at sea looking for food. The trackers transmit signals that can be detected by overhead satellites. Each time a satellite receives a tracker signal, the exact location of the bird can be calculated. These locations are plotted on a map, and the positions linked together to show the entire foraging trip of the penguin whilst at sea.

Depth Recorders
Dive depth recorders record how deep the penguins and seals dive when they are at sea. These are used in conjunction with satellite trackers to get a three dimensional look at the penguins foraging behaviour.

The Australian Antarctic Division have a number of programs to track penguins. Visit their website to find out more about them: www.aad.gov.au/default.asp?casid=2939

Biopsy Sampling
The Australian Government is studying whales using small pieces of skin and blubber. These samples can be used to provide information about whale DNA and genetic stocks.

Faeces sampling
Collecting and analysing whale, seal and penguin faeces to study diet can inform scientists where these animals feed and how they fit into the complex food web.

Reference: *New Scientist 23/30 2006* "Deep Doo Doo" p. 54-57 Training of sniffer sogs to help locate the faeces of various whale species.

For more information about whale research visit the Department of Environment and Heritage website www.deh.gov.au

A ACTIVITY – LIBRARY/INTERNET RESEARCH

Teaching Objective: Students will develop an understanding of the habits of marine animals.

Prim

Learning Outcome: Students will identify what a marine animal eats.
Procedure: Students will choose one of the marine animals found in Antarctica and use the library or internet to find out what the animal eats. Collate the information from all of the students. In groups ask the students to design a card game to teach young students what Antarctic animals eat.

Prim MS

Learning Outcome: Students will identify what, when and how much some marine animals eat.
Procedure:
Choose ten Antarctic marine animals. Allocate students into groups. In groups students will use the internet and library to find out what each of the Antarctic marine animals eat. They will also need to determine if they eat seasonally and how much they eat. Record each groups findings in the table:

Animal	Food source	Amount of food consumed per day	Time of year the animal needs to eat	Env. Factors effecting food availability

Ask students to research what environmental factors determine the availability of the food available to each animal? Ask each group of students to design a card game to show what Antarctic animals eat. Introduce concepts to the game such as seasonal availability of food and the amount of food consumed per day.

SSec

Learning Outcome: Students will analyse the human impact on the lifecycles of marine animals in the Antarctic region.
Procedure: Students should choose one Antarctic animal and determine what are the features of their life strategy that make them vulnerable to human impacts e.g. seals coming ashore to breed, whales having regular predictable breeding grounds OR study the different adaptations of birds to foraging – some birds fly a long way to find good feeding grounds but can not dive deeply e.g. albatross, whereas others can fly only relatively short distances but can dive deeper to get the fish e.g. cormorants.

A ACTIVITY – THE BIG QUESTION

Teaching Objective: Students will develop their knowledge and understanding of the differences between the Arctic and Antarctica.

Prim MS

Learning Outcome: Solve the riddle, "Why don't polar bears eat penguins?"

Procedure: Have students use the internet or library to answer this question.
Hint: determine where polar bears live and where penguins live.

The Antarctic Fresh Water Ecosystem

There are hundreds of Antarctic lakes, both fresh water and saline. Summer meltwater runoff from the Antarctic ice sheet has resulted in the formation of freshwater lakes. The water in some of these lakes is amongst the purest naturally-occurring water in the world and has particularly low levels of nutrients and therefore productivity. The lakes vary in the degree of ice cover – some are perennially covered whilst others are covered seasonally.

Fresh water organisms are invertebrates all less than two centimetres long:

- Copepods (tiny crustaceans)
- Rotifers
- Tardigrades
- Nematodes (round worms)
- Cladocerans
- Turbellarians
- Fairy shrimp

Scientists in Antarctica have found diverse colonies of microbes below Vostok Station. This is significant because this fresh water lake has been isolated from the usual sources of atmospheric-derived energy, such as photosynthesis, for millions of years. The ice has been the perfect environment for these bacteria as it has slowed down their metabolism so they require less food.

For more information visit NASA http://science.nasa.gov/newhome/headlines/ast10dec99_2.htm

Case Study – The race to discover what is under Lake Vostok

Lake Vostok, located under Russia's Vostock Station, is the largest sub-glacial lake in Antarctica. Its waters have been hermetically sealed from air and light for perhaps 35 million years. Scientists think Lake Vostok may be used as a model for the ecosystems that might exist on Jupiter's frozen moons. The lake is predicted to contain unique life forms and will give scientists an understanding of past life on earth.

In the late 1990s Russian scientists drilled into the ice covering the lake and stopped about 130 metres above the lake surface. Many countries have raised environmental concerns over drilling into the lake any further. The Russian Antarctic Research Institute aims to start drilling again this year and will attempt to reach the lake in 2008. The area where drilling will resume is located in the Australian Antarctic Territory.

Australia has concerns over the drilling for the following reasons:

- Drilling may contaminate the lake with biological material
- Potential damage could spread to other linked subglacial lakes
- Lubricating fluid from the machinery may enter the lake
- The lake may erupt into a massive geyser like explosion due to high gas concentrations (particularly oxygen) in the lake
- The drilling equipment should be tested in one of the other lakes first

A ACTIVITY – THE RACE TO SAVE VOSTOK

Teaching Objective: Students will be able to analyse a scientific issue and form opinions.

Learning Outcome: Students will identify the issues involved in a scientific problem

SSec

Procedure: Ask students to read the case study above and the following articles and ask them to make up their own mind about drilling in Lake Vostok. Have students outline the plot for a science fiction story that exposes some of the potential issues.

The Independent 10 Jan 2007
http://environment.independent.co.uk/nature/article2141640.ece

The Age 13 July 2006
www.theage.com.au/news/world/russia-ignores-plea-on-drilling-antarctic-lake/2006/07/12/1152637740824.html

BBC 25 May 2005
news.bbc.co.uk/1/hi/sci/tech/4577627.stm

ABC 20 Aug 2003
www.abc.net.au/science/news/stories/2003/928391.htm

Flash animation of Lake Vostok
www.earth.columbia.edu/news/story03_21_02.php

Ekho Lake. Photo: Ross Scott Source: The Wildernes Society.

The Antarctic Terrestrial Ecosystem

The land in Antarctica is some of the most inhospitable in the world. A massive ice sheet up to 4000 metres thick covers most of the Antarctic continent. Terrestrial flora in the area south of 60° south is confined to:

- mosses
- lichens
- liverworts
- two species of flowering plant.

Some animals breed and live on the continent but no land-based **vertebrates** in Antarctica get their food from land.

Terrestrial animals:

- protozoa (single-celled creatures),
- rotifers
- tardigrades
- nematodes
- arthropods (mainly mites and springtails)
- The largest invertebrate in Antarctica is the wingless midge, *Belgica antarctica*, an insect about 12 mm long.

Case Study – *Belgica antarctica*

Only sixty-seven species of insects have been recorded in Antarctica, most of which are less than two millimetres long. Many of the insects are parasites, like lice, which live in the feathers and fur of birds and seals, where they are protected from the harsh climate for much of the time. *Belgica antarctica* is a wingless midge present only on the Antarctic peninsula.

How does Belgica antarctica survive?

- They feed on algae and fungi.
- They remain dormant in winter.
- They tolerate a wide variety of. harsh conditions, including freezing, dehydration, lack of oxygen and wide fluctuations in pH and salinity.
- They spend two years as a larva, and less than two weeks as an adult, mating, laying eggs and dying after

A ACTIVITY – THE INCREDIBLE WATER BEARS

MS

Teaching Objective: Students will develop their knowledge and understanding of water bears, also known as **tardigrades**.

Learning Outcome: Students will gain an understanding of the extreme conditions some organisms can survive under and learn to use microscopy skills to locate an organism.

Materials: Shallow dish such as a Petri dish, microscope.

Procedure: Visit the following websites to look at images of this strange creature and learn about how it survives in Antarctica. Once students have familiarised themselves with the tardigrade they can look for their own using the following procedure:
Collect some moss and place them in a shallow dish. Wet the moss with rainwater so there is a centimetre of water in the dish. Leave the dish to stand overnight. Tip out the water, squeeze out the moss, collecting only the water that squeezes out. Observe the water under a microscope at 40-100x. There will be many organisms to see and the students may be lucky enough to locate a tardigrade.

Websites:
www.tardigrades.com
www.microscopy-uk.org.uk/mag/indexmag.html
www.microscopyuk.org.uk/mag/artjun00/mmbearp.html

A ACTIVITY – COUNTING ORGANISMS

Teaching Objective: Students will be able to understand the procedures scientists use to estimate population sizes of living things.

Prim

Learning Outcome: Students will estimate populations of non-moving organisms ie. plants.

Materials: One metre ruler, calculator

Procedure: Find a location at school which contains a number of weeds as well as grass. Measure out an area one metre by one metre. Get students to cut out a template which is ten centimetres by ten centimetres. Count the number of weeds in the ten centimetre by ten centimetre area. Extrapolate that to work out how many weeds there are in a ten metre by ten metre area. Hint: The number of weeds they find in their area should be multiplied by 1000 to give the answer.

MS

Learning Outcome: Students will estimate population size and extend their knowledge to determine how to estimate animal populations.

Procedure: Carry out the population estimate as for Prim. Discuss what changes would have to be made to this procedure if it was used to measure numbers of animals rather than plants ie. taking into consideration that animals move around. Work out the population density of the area measured by using the formula:
density of weed = estimated population number divided by total area investigated.
Use this information to determine how students estimate the population of a container of worms. Consider counting the worms and/or weighing the worms and extrapolating this to a larger area such as a garden bed.

Animal and Plant Adaptations

Antarctica is an ideal environment for studying evolution and adaptation. The harsh environment has led to biological adaptations of plants and animals. Organisms ranging from bacteria to mammals have developed ingenious ways to survive the frigid, dry climate and relentless winds.

Did You Know?

Antarctic micro-organisms have adapted to their surroundings by slowing down their lifecycles.

Case Study – Extremophiles

Extremophiles are microbes which live in extreme conditions where organisms would not be expected to live. Researchers have discovered two extremophiles that live at the bottom of Ace Lake in Antarctica, where there is no oxygen and the average temperature is 0.5 degrees Celsius. The two bacteria, called *Methanogenium frigidum* and *Methanococcoides burtonii*, are known as **methanogens**. Methanogens produce methane and are able to survive in a wide range of temperatures.

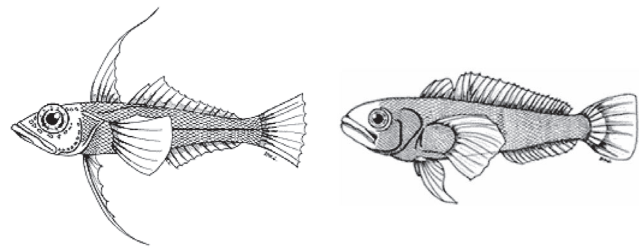
Through unveiling the genome sequence of these organisms it was discovered that both microbes have flexible proteins, which allow their cells to survive cold temperatures and carry out basic cell functions under extreme conditions. The genome sequence of *M. frigidum* was sequenced by the Australian Genome Research Facility at the University of Queensland in Australia.

Case Study – Fish in the ice

Notothenoids

Antarctica has a peculiar group of fish called **Notothenoids.** Most marine fish would freeze to death as the temperature of the water is below the freezing point of their body fluids and tissues, however Notothenoids synthesise **antifreeze glycoproteins** in their livers that prevent them from freezing. The glycoproteins bind to tiny ice crystals in the fish and prevent the ice from growing. Scientists believe that the Notothenoids developed this mechanism five to fourteen million years ago when living in the waters near the Antarctic continent and adapted gradually to the cooling conditions. At the time the fish did not need this adaptation, however as the water has got colder other species have died off and the adaptation has allowed the Notothenoids to survive.

The Notothenoids have also developed different subpopulations which survive in differing environments. The Threadfin pithead lives in a deep sea habitat while the Bald notothen lives along the underside of the surface ice layer.



Threadfin pithead (Aethotaxis mitopteryx) *Bald notothen (Pagothenia borchgrevinki)*

Source: British Antarctic Survey

Channichyidae or Ice Fish

Ice Fish have a number of adaptations to help them survive:

- Accumulation of ions and urea to lower their freezing point.
- The production of anti-freeze glycoproteins.
- Production of enzymes that are efficient at low temperatures.
- Eyes adapted to low light.
- No red pigment (haemoglobin) in their blood to carry oxygen around. Because the temperature is so low and oxygen dissolves better in cold temperatures, they get by perfectly well without it. The thinner blood allows a slower metabolism and conserves energy.

A

EXPERIMENT – ANTIFREEZE AND THE FREEZING POINT OF WATER

MS SSec

Teaching Objective: Students will develop an understanding of the effects of antifreeze on water in relation to the adaptation of fish to the harsh conditions in Antarctica.

Learning Outcome: Students will demonstrate how antifreeze works.

Materials: Polystyrene cups, ice, salt, glass vials or test tubes, antifreeze (propylene glycol), gloves, safety glasses.

Procedure: Fill two polystyrene cups with crushed ice, water and salt. Place a glass vial in each cup. Fill one vial with water and the other with half water and half car antifreeze (propylene glycol). The students should then periodically measure the temperature in each vial. The water-only vial will begin to form ice crystals within ten to fifteen minutes. Ask the students to observe what temperature the water with antifreeze can go down to without forming ice crystals. Repeat the experiment using different ratios of water and antifreeze.

SAFETY – wear gloves and safety glasses while handling antifreeze. You may decide to use urea or honey instead of the antifreeze for safety reasons.

Did You Know?

Despite their need to photosynthesise in order to survive, several species of marine and fresh water algae have developed the ability to survive several months of total darkness every year.

A EXPERIMENT – ANIMAL ADAPTATIONS

Teaching Objective: Students will develop an understanding of the harsh conditions in Antarctica and how animals adapt.

LP Prim

Learning Outcome: Students will experience the conditions of Antarctica.

Materials: Salt, access to freezer, thermometer, ice cubes, woollen socks, cotton socks, nylon stocking, plastic bag.

Procedure:

1. Make your own sea water by dissolving 50 grams of salt in a litre of warm water. Put the water in the freezer. Check the temperature every half an hour until it reaches one degree Celsius. Get the students to put their hand in the water. Explain that this is the temperature of the Southern Ocean. Discuss what adaptations animals may have to cope with this.
2. Obtain a tray of ice cubes. Encourage students to stand on the ice with bare feet. What adaptations would animals have to be able to walk around on ice?

Learning Outcome: Students will experience the simulated conditions of Antarctica and explore how to adapt to them.

Procedure: Carry out activity as for 2. above. Obtain items such as a pair of woollen socks, a pair of cotton socks, nylon stockings, a plastic bag. Get the students to put each of these on their hands and place them on the ice. Which of the items provide the best insulation? Talk about what animals have on their feet to protect them against the cold.

MS

Learning Outcome: Students will design an Antarctic animal to demonstrate how biological adaptations work.

Procedure:
Design the 'perfect' Antarctic animal. Include the adaptations it would need to survive. What does it eat? Where does it fit into the Antarctic food chain/web? Give it a scientific name.

SSec

Learning Outcome: Students will investigate heat exchange systems in Antarctic animals.

Procedure: Visit the Cool Antarctica site: www.coolantarctica.com

Look at how penguins in Antarctica use heat exchange to keep warm.

Did You Know?

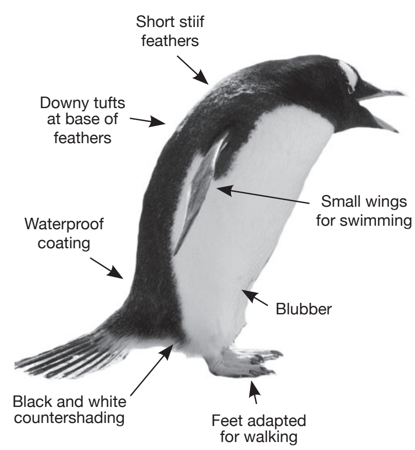
There are five species of penguins adapted to living in the Antarctic - adélie, emperor, gentoo, chinstrap and maccaroni penguins.

Case Study – Penguin Adaptations

Penguins have four main ways of insulating themselves against the cold:

1. Feathers – the feathers are small, stiff and densley packed. They overlap to seal out wind and water. The feathers can only be ruffled by winds over 110kph (60 knots).
2. Downy tufts – are located at the base of each feather and trap warm air.
3. Blubber - a layer of fat cells under the shin and around the organs keeps the body warm and also acts as an energy reserve.
4. Counter current heat exchangers - blood from the legs and flippers gets warmed before it enters the body core. This saves a lot of energy.

Penguin Adaptions



Breeding
Some penguins build nests to keep their eggs warm during the breeding season. The Emperor penguins cannot build nests on the fast ice, instead they cradle their eggs on their feet and cover them with a fold of skin – the brood pouch. The male penguin incubates the egg whilst the female searches for food. The female returns after two months to feed the newly hatched chick and relieve their mate. Emperor penguins are the only penguins to breed in winter.

They are able to do this as the males can fast for a long period if they have enough body reserves at the start of the breeding season. This is an advantage as the young go to sea when resources are abundant.

Camouflage

The colouring of penguins, the black and white countershading, makes them nearly invisible to their predators from above and below.

Body Shape

Birds that rely on flight have a large wingspan to keep them in the air and hollow bones to make them lighter. Penguins have developed small wings making it easier to swim through the water and solid heavy bones to help them float low in the water making it easier for them to dive down to hunt for fish. Emperor penguins can swim at speeds of up to 19km/h.

Penguin feet have thick leathery skin with fat pads on the bottom so they can walk across ice and snow without getting frozen. They also have crampon like toes to help them walk on slippery surfaces. Pengiuns use their flippers to swim and their webbed feet to steer.

Emperor penguins often huddle together during severe storms and at night. This is to conserve heat as well as to protect chicks from predators. As many as ten adult birds can squeeze into one square metre. Outside a huddle it can be minus thirty-five degrees Celsius while inside it can be over twenty degrees Celsius. Penguins will swap from the inside to the outside of the huddle so they all have a chance to stay warm.

Leucistic (reduced pigment) Gentoo penguin Roughly I in 20,000 Gentoos are leucistic.

Source: LA(Phot) Kelly Whybrow, HMS Endurance Tracking Project

A ACTIVITY – CREATING A HUDDLE

Teaching Objective: Students will be introduced to the practicalities of huddling to keep warm.

LP

Learning Outcome: Students will discover how squashed penguins get when they are in a huddle.

Materials: One metre ruler.

Procedure: Measure out an area which is one metre square. See how many students can squeeze in to this area. Explain how this would keep them warm in Antarctica.

Prim

Learning Outcome: Students will discover how huddling can keep penguins warm.

Procedure: Repeat the procedure as for LP. The student in the middle of the huddle should hold the thermometer (not by the bulb) and note the temperature after two minutes and five minutes. Do the same for a student on the outside of the huddle and the ambient temperature. Compare the temperatures and have students discuss the effect of huddling.

MS

Learning Outcome: Students will determine how the number of people change the temperature of a 'huddle'.

Procedure: Carry out the procedure as for Prim. Change the number of students in the huddle and re-record all the temperatures. Determine how the number of students affects the temperature in the huddle.

EXPERIMENT – CREATING A HUDDLE II

Teaching Objective: Students will develop an understanding of how penguins would experience different temperatures depending on their position in the huddle.

MS

Learning Outcome: Students will simulate a penguin huddle to understand the different temperatures at different points of the huddle.

Materials: Ten test tubes per student or group of students, rubber band, thermometer.

Procedure: Students each need ten test tubes, a rubber band and a thermometer. Half fill each of the test tubes with warm water. Ensure the tubes each contain the same amount of water at the same temperature. Bundle the tubes together tightly with the elastic band. Take the temperature of each tube at the beginning and then every 15 minutes for two hours. Record the results. Determine which tubes cool the quickest and which the slowest. How does this relate to their position in the huddle?

Websites:

For a range of activities relating to penguins visit Gulf of Maine Research Institute www.gma.org/surfing/antarctica/penguin.html

? *Did You Know?*

The Emperor Penguin weighs from twenty three to forty kilograms and is 115 centimetres tall.

Did You Know?

Emperor penguins can stay under water for up to twenty minutes and dive to depths of over 500 metres.

ACTIVITY– DESIGN A PENGUIN

Teaching Objective: Students will develop their understanding of the concept of insulation and how it relates to penguins in Antarctica.

LP

Learning Outcome: Students will create the ideal level of insulation using black materials.

Materials: Soft plastic drink bottle, squares of different fabrics, elastic bands.

Procedure: Give each student a soft plastic drink bottle, some squares of different fabric and some elastic bands. Encourage the students to cover the bottle with the fabric to provide the best level of insulation. Discuss the fact that penguins are covered in feathers. Raise the issue of clothing worn in summer in contrast to clothing worn in winter by people.

Prim MS

Learning Outcome: Students will determine how to create the ideal insulation for their penguin.

Procedure: Carry out the activity as for LP. Fill each of the bottles with water of a standard temperature. Record that temperature. Measure the temperature in each bottle every fifteen minutes for two hours. Which penguin loses heat more rapidly? Discuss how the level of insulation of the penguin changes the rate of heat loss. The penguin that loses the least heat wins a prize.

ACTIVITY – STUDYING PENGUINS

Teaching Objective: Students will develop an understanding of the range of penguin species in Antarctica.

MS

Learning Outcome: Students will compare and contrast the different species of penguins in Antarctica.

Procedure: Use the internet or library to complete the table for the five species of penguins in Antarctica (find five interesting facts about each species):

Penguin	Height	Weight	Life expectancy	Breeding season	Prey	Predator

Visit the site:
Antarctica Connection www.antarcticconnection.com
or the Australian Antarctic Division www.aad.gov.au/casid=1654

Extension: Watch the movie *Happy Feet* and determine what the three species of penguins shown in the movie are, or watch the DVD *Planet Earth Part II* – all about penguins.

ACTIVITY – HOW MUCH DO YOU EAT?

Teaching Objective: Students will be able to identify the food requirements of penguins.

Prim

Learning Outcome: Students will determine how much penguin chicks eat in comparison to themselves.

Background: Emperor penguin chicks eat up to ten percent of their body weight in one meal.

Materials: Scales, calculator.

Procedure: Students weigh themselves and record their weight. They then weigh their lunch and compare that to their body weight. How much food would they have to eat for lunch to be eating ten percent of their body weight in a meal?

MS

Learning Outcome: Students will research why penguin chicks eat so much.

Procedure: Carry out the activity outlined for Prim. Carry out internet or library research to find out why penguin chicks have such a high food requirement.

Extension: Assume that penguins eat 80% protein and 20% fat. Determine the amount of kJ this would represent.

THE PHYSICAL ANTARCTIC ENVIRONMENT

All about ice

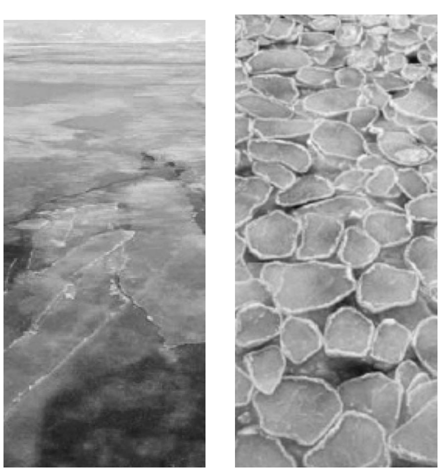
The Antarctic continent is covered by a dome of ice that has accumulated from snowfall over many millions of years. The average thickness of the ice is around 2,500 metres but is thinner near the coast where **glaciers** flow out into the ocean. Sometimes parts of the floating ice tongues break off to form icebergs which drift northward into the Southern Ocean where they eventually melt. This is a natural part of the cycle by which snowfall that accumulates over Antarctica is eventually returned to the ocean. Up to 10,000 icebergs may calve off each year.

The ocean around Antarctica is also covered by a different kind of ice, called **sea ice**, which forms when sea water freezes. Unlike the freshwater ice over Antarctica, sea ice is salty and most of it melts during the summer. In winter, the sea ice around Antarctica grows at a rapid rate, more than doubling the size of the continent to approximately nineteen million square kilometres (four million square kilometres in summer).

Visit the NASA site to see an animation of how sea ice changes over time.
http://polynya.gsfc.nasa.gov/seaice_amsr_south.html

How Ice Forms

Fresh water freezes at 0°Celsius, whereas normal seawater freezes at about -1.9°C. In Antarctica, when seawater reaches freezing point and freezes to form sea ice, some salty water is rejected and forms salty channels in the ice, called **frazil ice**. The frazil ice forms greasy looking slicks, called "grease ice" which eventually aggregates into small ice chunks which turn into pancake-shaped ice (see picture below). Eventually the pancakes freeze together and form a solid ice cover. Pancakes form in disturbed conditions. In very calm conditions, a thin continuous sheet of **Nilas ice** forms (see picture below) that then thickens to form a solid cover.



Far left: Nilas is an early stage of sea ice that forms under calm conditions.
Source: ACE CRC Sea Ice Group

Left: Pancake ice forms under turbulent conditions.
Source: ACE CRC Sea Ice Group

? Did You Know?

Antarctica contains about seventy percent of the world's fresh water.

Glaciers and Icebergs

Glaciers are formed entirely of fresh water. Most icebergs are pieces of glaciers, which have broken off and floated away when the glaciers reached the sea. They are jagged chunks of ice that can take many shapes. Most of an iceberg is below the surface of the sea

For pictures and information about the different types of ice visit: Antarctic Sea Ice Processes and Climate
www.aspect.aq/slushice.html

? Did You Know?

Fifteen percent of an iceberg is visible above the water surface; the larger portion is underwater.

? Did You Know?

Antarctica produces 1,250 cubic kilometres a year of ice in the form of icebergs of various sizes.

A EXPERIMENT – SALINITY AND THE FREEZING POINT OF WATER

Teaching Objective: Students will develop and undertstanding of the effect the salinity of water has on its freezing point and/or the time taken to freeze.

LP **Learning Outcome:** Students will observe whether salty water or fresh water freezes more quickly.

Materials: Two small jars filled with water - one labelled "fresh water" and the other labelled "salty water", salt, teaspoon measure, ice cube trays.

Procedure: Fill two small jars with water from the tap. Label one jar 'fresh water' and one jar 'salty water'. In the salty water jar dissolve five-six teaspoons of salt. Label ice cube trays the same as the jars. Fill each ice cube tray with the corresponding water. Place the trays in a freezer. Observe the trays after one hour, three hours, twenty four hours and forty eight hours. Which one froze first?

Prim **Learning Outcome**: Students will observe the different freezing temperatures of salty water and fresh water.

Procedure: Set up the ice cube trays as for LP experiment. Place the ice cube trays in the freezer. Take the following measurements after one hour, twenty four hours and forty eight hours:

1. An estimate of the temperature of the ice cube by inserting a thermometer into the centre of one of the ice cubes.
2. An estimate of the percentage of the water has frozen in each ice cube ie. the degree of solidification.

Questions:

1. Which water freezes first?
2. At what temperature did the ice crystals appear to start forming in each of the water samples? Record the results in a table.

MS **Learning Outcome:** Students will observe the different freezing temperatures of water of differing salinity.

Procedure:

Label 4 jars A,B,C and D. Put one cup of water in each jar and then the following:-

A – 2 teaspoons of salt

B – 4 teaspoons of salt

C – 6 teaspoons of salt

D – no salt

Label corresponding ice trays and fill with the salt solutions. Place in the freezer and record observations as for the Prim activity. Graph the results. Did all the solutions freeze? Which froze first and how did the freezing points differ? Do the ice cubes look different? Observe what happens when you float each of the ice cubes in fresh water.

? Did You Know?

The ice on the Antarctic continent is an average of about 2,500 metres thick.

A EXPERIMENT – MOVING ICEBERGS

Teaching Objective: Students will understand whether it is possible to control the rate at which an iceberg melts.

Background: Australia is prone to suffering extended droughts. If seventy percent of the world's fresh water is frozen in Antarctica, why can't we tow icebergs to Australia to provide a new supply of fresh water? How would you get an iceberg to the Middle East? Consider ocean swells breaking up icebergs and the continental shelf around most countries being too shallow to ground the icebergs well offshore.

Prim MS **Learning Outcome:** Students will determine if it would be possible to transport icebergs to solve the water crisis in Australia.

Materials: Ice cubes, bucket of room temperature water.

Procedure:

1. Give students ice cubes to float in a tub of room-temperature water. How fast do they melt?
2. Students work in pairs to figure out a way to protect the ice cube from melting.
3. See which pair can prevent an ice cube from melting for the longest period of time. Write up the results. What did the students do to prevent their iceberg from melting? How can their discovery assist in the transportation of icebergs on a grand scale?

Webquest: Examining the economic feasibility of transporting icebergs.

www.pbl.cqu.edu.au/web_quest/content/transport_economist.htm

Did You Know?

If one tenth of the ice in Antarctica slid into the sea, sea levels would rise by 6m globally.

Case Study – The Importance of Sea Ice

Antarctic sea ice is highly seasonal, covering about nineteen million square kilometres around Antarctica each winter. Approximately eighty percent of this ice melts in the summer.

Sea ice plays a critical role in both global climate and Southern Ocean ecosystems for the following reasons:

1. The Earth's global average surface temperature is regulated through the amount of radiation received from the sun, the amount reflected back to space (**albedo**) and the ability of atmospheric gases such as water vapour and carbon dioxide to absorb heat (the greenhouse effect). Sea ice increases the Earth's surface reflectivity and reduces the amount of solar radiation absorbed by the ocean.
2. Sea ice is an insulator that greatly reduces the exchange of heat between the ocean and the atmosphere.
3. The formation and melting of sea ice plays a major role in the global overturning ocean circulation that helps distribute heat around the Earth.
4. Changes in the amount of sea ice may slow the overturning circulation, decreasing the ocean's ability to absorb atmospheric carbon dioxide and affecting the distribution of heat around the globe.
5. Algae that grow in brine trapped in sea ice are a critical food source for krill larvae in winter. Sea ice algae grow throughout the ice – the under surface, in bands in the middle of ice, in slush on top of ice and in brine channels. The algae on the bottom is often the most abundant and is also the most important for krill as it's the most accessible. Changes in sea ice extent or thickness may affect the abundance and distribution of krill impacting on the Antarctic food web.

Sea ice extent in the Arctic has been declining rapidly over the past few decades. Although there are currently no clear trends in the extent of Antarctic sea ice, numerous climate models agree that Antarctic sea ice will decline in the future.

Source: This case study was provided by the ACE CRC.

Iceberg. Photo: Robert Reeves Source: Australian Antarctic Division

Scientific Programs in Antarctica

Australia's scientific research program is one of the largest in Antarctica. Approximately 250 scientists from Australian and overseas universities participate in research projects focusing on four key areas:

- Ice, Ocean, Atmosphere and Climate
- Southern Ocean Ecosystems
- Adaptation to Environmental Change
- Impacts of Human Activities in Antarctica

Case Study - Australian Scientists in Antarctica

"*We needed two helicopters for safety - it's too far to quickly send help from Davis if something went wrong - but my equipment could easily fit into one, so there were a few extra seats. That meant we could take some passengers - three 'tradies' who've been working at Davis station all summer, and deserved a chance to see some more Antarctic scenery*". This is an excerpt from a diary entry from a scientist in Antarctica. For the rest of his story and many others like it or for more information about scientists in Antarctica go to: Classroom Antarctica www.classroomantarctica.aad.gov.au and www.questacon.typepad.com/polarpassport/200702landing_bluff.html

Glaciology

Glaciologists study the history and dynamics of all naturally occurring forms of snow and ice, including floating ice, seasonal snow, glaciers, and continental and marine ice sheets. Sea ice research can be very difficult as the ice can only be accessed from the Antarctic research stations or by ice breaker ships. Sea ice is studied by taking core samples to study the physical properties of sea ice formation, growth and characteristics e.g. crystal structure or the biology in the ice, algae communities and krill grazing. Specially designed corers are driven into the ice by hand or motor. Extracted cores are packed into plastic tubes and returned to the ship where they are deep frozen for further analysis in the home laboratory, or processed on the ice.

Sea ice is not only investigated directly by scientists from ships. Other procedures for sea ice research include remote sensing, radar, upward looking sonar deployed under the ice on moorings and aerial surveys from helicopters or aeroplanes. Many scientists use currently available meteorological, oceanographic as well as biological data to model sea ice dynamics and productivity in order to understand the role of sea ice in the global climate system as well as for the polar ecosystems.

Case Study - Autosub Under Ice

This is a program to explore the marine environment beneath floating ice shelves using an Autonomous Underwater Vehicle. The program investigates the role of sub-ice shelf processes in the climate system. For more information visit www.soc.ac.uk/aui/

EXPERIMENT – HOW DO ICEBERGS FLOAT?

Teaching Objective: Students will understand that icebergs weighing thousands of tonnes can float.

LP

Learning Outcome: Students will record what happens to ice in water and how ice floats.

Materials: Ice cubes, food colouring, ice trays, bowl of warm water.

Procedure: Give students ice cubes made using food colouring in water. Ask the students to place the ice cubes in a bowl of warm water. Do they float or sink? Observe the ice melting and record the results.

Prim MS

Learning Outcome: Students will observe how warm water and cold water interact and explain the impact of this on icebergs.

Materials: A large bowl of cold water, a small plastic bottle full of warm water, food colouring.

Procedure: Fill a large bowl with cold water. Fill a small plastic bottle such as a drink bottle with warm water (the bottle must be small enough to sink below the surface in the bowl of water). Add some food colouring to the bottle. Place the bottle in the bowl allowing it to sit on the bottom of the bowl. Observe what happens to the warm water. Add some coloured ice cubes as for LP and observe what the ice does. Describe why the ice and the warm water appear to float.

EXPERIMENT – AFFECT OF SALINITY ON ICEBERGS

Teaching Objective: Students will develop an understanding of the affect of salinity on floating icebergs.

MS SSec

Learning Outcome: Students will design and conduct an experiment to demonstrate the affect of salinity on floating icebergs.

Materials: You will need access to a freezer. The following materials will be required for each group of students – 4 paper cups (2 large and 2 small), tap water, salt, a measuring cup, a large plastic container, a ruler.

Procedure:

1. Explain to the class that they are going to design and conduct an experiment to demonstrate the effect of salinity, or amount of salt, on floating icebergs. Their experiments will answer the questions:
   - Does the presence of salt in an iceberg make the iceberg more or less buoyant?
   - Does the size of an iceberg affect its buoyancy?
2. Divide the class into groups of four. Instruct each group to form a hypothesis. Students should use any prior experience or knowledge of buoyancy and the properties of water to help them make informed guesses.
3. Have students discuss a plan for testing their hypotheses.
4. Instruct each group to create four model icebergs by freezing the contents of the four paper cups as follows: one small cup filled with plain tap water, one large cup filled with tap water, one small cup filled with salt water (by dissolving 50 grams of salt into half a litre of tap water), one large cup filled with salt water.
5. Tell the class that when their icebergs are frozen, they will remove them from the cups and float them, one by one, in a clear plastic container filled with tap water. Ask students how they will accurately test their hypotheses (their answers should involve measuring the heights of the parts of the icebergs both above and below the surface of the water).
6. Have students measure the height of each iceberg with a ruler then have them separately measure the part of each that is above and below the surface of the water. Have students calculate the percentage of each iceberg that is below the surface of the water.
7. Have groups discuss their findings and determine whether the findings confirm their hypotheses.

Extension: Older students could add to the experiment two more icebergs, one large and one small, that are made with salt of lower salinity (25 grams of salt to half a litre of water).

Did You Know?

As fresh water gets colder it becomes heavier down to a temperature of -4 °Celcius - colder than that it begins to get lighter again and rises to the surface. When it cools to 0 °C ice forms which can float.

A

ACTIVITY – CREATE A PHYSICAL MODEL OF AN ICE SHEET FROM MULTI-BEAM SONAR DATA

Teaching Objective: Students will develop their understanding of ice sheet formation and how sonar data can be used to create a physical model of the floating margin of an ice sheet.

SSec

Learning Outcome: Students will transform sonar data into graph form and make a physical model of an ice sheet from Antarctica.

The sonar data for this activity can be found at www.asta.edu.au plus a podcast demonstrating the building of the model.

Materials: 111 sheets of 1cm x 1m x 0.5m polystyrene foam, multi-beam sonar data, data projector, felt-tipped pen, hot wire (Nichrome resistance wire connected to a power source), two wooden boards, 1m long threaded rod and bolts.

Procedure:

1. Plot each spreadsheet column as a bar chart in Excel.
2. Use a data projector to project one beam of the sonar onto each of the polystyrene sheets. Trace the line of data onto the sheet with a felt-tipped pen.
3. Cut the sheet along the traced line.
4. Repeat for each beam and stack them all to produce the model. Clamp together with two wooden boards and 1m long threaded rod and bolts.
5. Suspend model from the ceiling to see the underside of an ice sheet.

This experiment was kindly provided by Dr Ken Collins, National Oceanography Centre Southampton, UK.

?

Did You Know?

A white-out occurs when it is overcast and the sky and snow merge without a horizon. Everything looks the same – flat and white. A white-out is very dangerous.

Antarctic Weather

Average Annual Temperature

The average annual temperature is about -10˚C on the Antarctic coast to -50°C at the highest parts of the interior. Near the coast the temperature can exceed 10°C at times in summer and fall to below -40°C in winter. Over the elevated inland, it can rise to about -30°C in summer but fall below -80°C in winter.

Pressure Systems

Normally there is a belt of low pressure surrounding Antarctica (the Antarctic Circumpolar Trough), whilst the continent is dominated by high pressure.

Radiative cooling over the Antarctic ice sheet produces very cold, dense air that flows away from elevated areas and is replaced by subsiding air from above. This causes **katabatic** winds which accelerate downhill. Katabatic winds blow with great consistency over large areas. Low-pressure systems near the Antarctic coast can interact with katabatic winds to increase their strength, however at the coast they lose their driving force and soon dissipate offshore.

Precipitation

Though rain is observed at times near the coast, most precipitation over Antarctica is in the form of snow or ice crystals. It is difficult to accurately measure snowfall under windy conditions, but the average accumulation of snow over the continent as a whole is estimated to be equivalent to about 150 millimetres of water per year. Over the elevated plateau the annual value is less than fifty millimetres. Generally near the coast it exceeds 200 millimetres, the heaviest being over 1000 millimetres for an area near the Bellingshausen Sea. Australia's highest average annual rainfall is 8,312 millimetres at Bellenden Ker, Queensland.

Blizzards

Blizzards occur in Antarctica when drift snow is picked up and blown along the surface by the gale force winds. The result is often blinding conditions where objects are not visible even a metre away. A severe blizzard spurred by strong winds can last for a week . Winds greater than 18km/hr can whip up snow and grit, and in a full scale blizzard, winds reach speeds of up to and in excess of 150 kilometres per hour.

Expedition member Captain Reginald Ford explained that, "To be out in a blizzard is a really trying experience….The snow doesn't fall in flakes….but is driven by the wind into hard, fine particles like sand, and the icy sand attacks you everywhere. The particles force their way into your nostrils and your eyes fasten to your eyelashes and then freeze, so that before you can open your eyes you must first rub off the ice". (Trewby, M, p. 37)

A EXPERIMENT – MEASURING WIND SPEED

Teaching Objective: Students will understand the importance of being able to accurately measure the speed of wind.

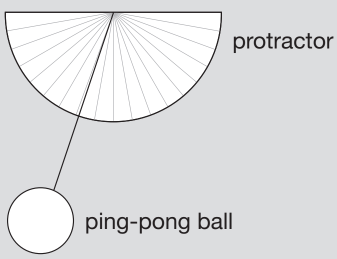
Prim MS

Learning Outcome: Students will build an instrument to measure wind speed.

Materials: About fifty centimetres of strong thread or thin fishing line, a ping-pong ball, a large protractor, glue and tape, thick cardboard (for mounting protractor).

Procedure:

1. Use tape to mount the protractor to the cardboard with the curved side pointing down.
2. Tape or glue the thread to the ping-pong ball.
3. Tie or glue the other end of the thread to the centre of the protractor, 40cm from the ball.
4. When the wind blows the thread off centre, read the angle on the protractor.
5. Convert this angle to the wind velocity in this table.
6. Use the students' instruments outside and away from buildings to measure wind speed.



String Angle (degrees)	90°	80°	70°	60°	50°	50°	30°	20°
Wind Speed (km/h)	0	13	19	24	29	34	41	52

Questions:

1. What is wind?
2. Can wind be useful to us?
3. What damage can wind do?

A ACTIVITY – WIND CHILL

Teaching Objective: Students will be introduced to the concept of wind chill and loss of body heat.

Background: Wind chill factor is a measure of the cooling effect of wind. Wind causes a person to lose heat more quickly so the person feels colder than the thermometer actually indicates.

LP

Learning Outcome: Students will demonstrate how wind can cause loss of body heat.
Materials: A desk fan, a bowl, water, ice cubes.

Procedure: Set up a fan to blow cold air, and a bowl containing water with ice cubes in it. Students should put their finger in front of the fan when it is dry. Compare this to how much colder their finger feels in front of the fan after they have wet it in the cold water.

Prim MS

Learning Outcome: Students will demonstrate the effect of wind on temperature.

Materials: Two bowls, water, thermometer, two desk fans.

Procedure: Set up two shallow bowls of water. Take the temperature of each bowl and record. Set up a fan to blow across one of the bowls and keep the other one away from any wind. Record the temperature of each bowl every minute until the temperature appears to be stable. Which bowl cools down the fastest? Why is this? Graph the results to show what effect wind has on the temperature of the bowls of water.

SSec

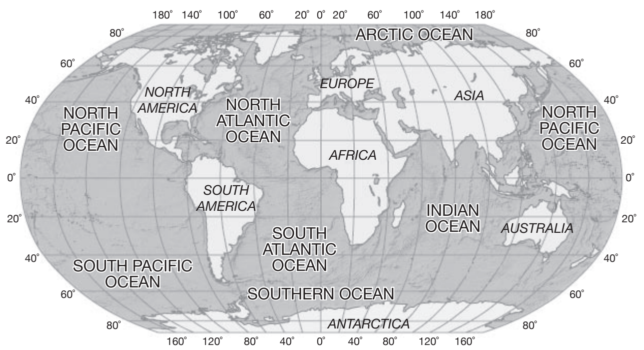
Learning Outcome: Learn to calculate wind chill factor.

Procedure: Carry out the procedure as for Prim/MS. Use an anemometer to measure the wind speed of the fan. Visit the website:
www.pbs.org/teachers/mathline/concepts/weather/activity2.shtm
and calculate the wind chill factor of the fan. Compare this to the wind chill factor in Antarctica – this can be calculated using data from the Bureau of Meteorology website:
www.bom.gov.au/climate/dwo/IDCJDW0920.shtml
Think about what precautions people visiting Antarctica should take to prevent exposure to the cold winds.

Oceanography

Oceans are large connecting bodies of salt water taking up three quarters of the earth's surface. The largest ocean is the Pacific followed by the Atlantic, Indian, Southern and Arctic. The Southern Ocean, wasn't officially named until 2000. Scientists classified the Southern Ocean as being separate to the Pacific and Atlantic Oceans as the plant and animal life and ocean floor features were so different.

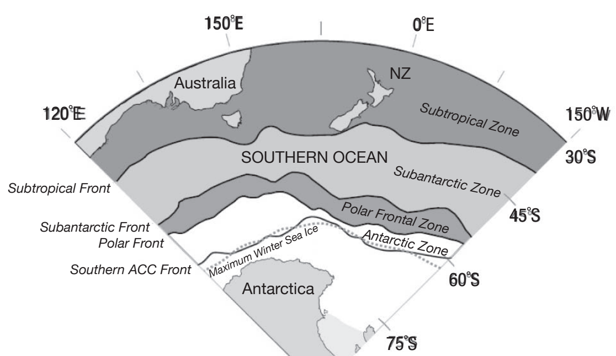
Map of World Oceans



The Southern Ocean

The Southern Ocean is located south of the subtropical front. Subtropical Front is a term used in Oceanography to describe a boundary (front) between water systems based on temperature and salinity. The Southern Ocean is about 20,000,000 square kilometers in area and is one of the deepest oceans, being 5,000 metres deep in some places. The Southern Ocean is actually warmer than the land with a temperature -1.8˚C to 3.5˚C

Zones of the Southern Ocean



Source: ACE CRC

Did You Know?

The Southern Ocean is the only ocean that circles the globe without being blocked by land.

The Antarctic Circumpolar Current

The Circumpolar Current circles around Antarctica. It flows eastward or clockwise (looking from above the south pole) and it carries 150 times more water than all of the world's rivers combined.

The Circumpolar Current is not a single mass of water; it is a series of linked flows which follow the uneven shape of the sea bed. It moves at different speeds according to the depth of the ocean at each point.

The Circumpolar Current flows around the bottom of the Atlantic, Pacific and Indian oceans and mixes the water. It has a major effect on the way the world's oceans behave.

Where the Antarctic Circumpolar Current meets the warmer waters to the north the area is referred to as the Antarctic Convergence.

A ACTIVITY – OCEAN CURRENTS

Teaching Objective: Students will be able to understand how wind can cause ocean currents.

Prim MS

Learning Outcome: Students will create a model ocean to look at how currents work.

Materials: Baking dish, water, red food colouring, small plastic bowl.

Procedure: Fill a clear tray such as a baking dish with water. When the water has settled put a drop of red food colouring at one end of the tray. Blow across the tray. What happens to the drop of food dye? Where do the currents move the fastest? Next, place a small plastic bowl (island) upside down in the centre of the tray so that it sticks out of the water. Add a drop of food colouring on one side of the island and repeat the above activity. What effect does the island have on the current?

SSec

Learning Outcome: Students will graphically represent ocean currents.

Procedure: Carry out the activity as for Prim/MS. Sketch the currents for each activity. Describe the effect the island has on the currents.

Extension: Students will demonstrate the effect of temperature on ocean currents.

Materials: Two rocks, two plastic bags filled with hot water, baking tray filled with water, ice cubes.

Procedure: Place a heavy object such as a rock in a plastic bag filled with hot water. Place the bag in one corner of the tray. Fill another bag with ice cubes and a rock and place in the opposite corner. Place drops of food colouring near each of the bags. Describe the currents – where did the food colouring sink and where did it rise? In what direction did the water flow along the bottom?

Southern Ocean and Climate

Oceans operate as a giant thermostat regulating global temperature and driving weather systems. The world's climatic zones are determined by the ocean's climatic zones. This is due to the latent heat stored and transferred in the upper few hundred metres of the sea.

There is a strong link between the Southern Ocean and global climate. The Southern Ocean buffers the rest of the world from the frigid conditions of the Antarctic continent.

The Southern Ocean affects climate in three ways:

1. The flow of the Circumpolar Current from west to east around Antarctica connects the Pacific, Indian and Atlantic Ocean basins and their currents. This resulting global circulation redistributes heat and other properties, influencing patterns of temperature and rainfall.
2. The Southern Ocean is a source of intermediate and deep water for the world oceans. The cooling of the ocean and the formation of sea ice during winter causes an increase of denser water. This dense water, produced between 60°S and the Antarctic Shelf, controls the distribution of the physical and chemical properties of the world's deep oceans.
3. The ocean is the largest reservoir of carbon. Large quantities of carbon are cycled between the atmosphere, biosphere and the ocean. The Southern Ocean (as do all oceans) exchanges carbon dioxide and oxygen at the surface. This is in conjunction with cooling so the water sinks transferring gases into the deep ocean. The Southern Ocean is one of the few areas of the world's oceans where surface waters are dense enough to sink into the deep sea. These waters absorb carbon dioxide from the atmosphere, and by sinking into the deep they effectively pump it out of the atmosphere.

To read more about this go to CSIRO Marine Research www.marine.csiro.au/LeafletsFolder/10ocean/10html

LP - SSec

? Did You Know?

Of the six to seven billion tonnes of carbon released into the atmosphere by the burning of fossil fuels and deforestation, three billion remain in the atmosphere, one to three billion are absorbed by the ocean and up to two appear to be absorbed by the terrestrial biosphere.

Geology

A ACTIVITY – MAKING AN ANTARCTIC CAKE

Teaching Objective: Students will develop a knowledge of the rock stratificaton of Antarctica.

Learning Outcome: Students will engage in drilling "core samples" from cakes representing the geology of Antarctica.

Procedure: Students bake two cakes - a chocolate/cherry cake and a banana/choc-chip cake representing the metamorphic "platform" and sedimentary layers of Antarctica. Once the cakes are baked they are sculpted into a map of Antarctica and students cut core samplers out of the cake. For details of this activity go to: www.antarcticanz.govt.nz/article/6873.html#10263

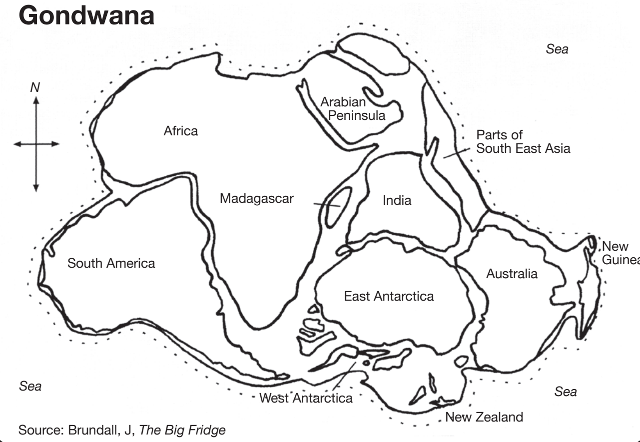
Fossils and Continental Drift

The theory of continental drift has its origins in the early 1900's with a German meteorologist, Alfred Wegener, who noticed that the contours of South America fitted with those of West Africa (an earlier idea, however, had been around since the 1620's). Since then fossils and geological discoveries have been found in Antarctica to provide evidence for this theory.

Current scientific belief is that, for much of the past 600 million years, Antarctica was part of the supercontinent of Gondwana, which included present-day Africa, South America, peninsular India, Australia and New Zealand. About 250 million years ago, Gondwana became part of the larger supercontinent Pangea (meaning 'all land'), which incuded all of the major continents.

Pangea began to break apart about 150 million years ago and Gondwana drifted south. Gondwana then broke apart between 120 and 50 million years ago, leaving Antarctica isolated at the pole. The development of a circumpolar ocean surrounding Antarctica is one mechanism that has allowed the cooling and growth of glacial ice.

Gondwana



Source: Brundall, J, *The Big Fridge*

ACTIVITY – CONTINENTAL DRIFT

Prim SSec

Look up the following website and books to make a list of some animals and rocks fossils that have been found in Antarctica and which support the theory of continental drift.

1. Origins Antarctica www.exploratorium.edu/origins/antarctica/ideas/index.html
2. Brundall, J, *Antarctica: The People and the Place*, User Friendly Resources, New Zealand, 2004.
3. Brundall, J, *The Big Fridge*, User Friendly Resource Enterprises, New Zealand. 1999

ACTIVITY – ANTARCTIC FOSSILS

MS

Teaching Objective: Students will be introduced to a webquest about Antarctic fossils.

www.glencoe.com/sec/science/webquest/content/fossils.shtml

Learning Outcome: Students will carry out a web research project or webquest.

Procedure: Have students complete this webquest to investigate what fossils have been found in Antarctica, and to identify how these fossils either support or disprove the theory of continental drift.

Questions:

1. What were the first fossils found in Antarctica? Where and when were they found?
2. What was the first dinosaur fossil found in Antarctica? Where and when was it found?
3. Why have so few dinosaur fossils been found in Antarctica?
4. How do plant fossils and beds of coal support the idea that Antarctica once was warmer than it is today?

Extension: Have students make a list of alternative websites that also provide the information they are researching.

Mineral Resources in Antarctica

Speculation about the existence of oil in Antarctica has come from oil being discovered in the other southern continents. Gaseous hydrocarbons, which often occur with petroleum, have also been found off-shore under the Ross Sea. Much of what scientists have discovered about the geology of Antarctica and the minerals present is based on what is already known about the geology of Australia, South America and South Africa. The most recent geological studies in Antarctica have also confirmed that significant mineral deposits exist in Antarctica – coal is to be found in the Transantarctic Mountains, gold, titanium, copper, uranium, tin and cobalt have all been found in small amounts in the Antarctic Peninsula and some other areas.

Did You Know?

In 1991 forty nations signed the Protocol on Environmental Protection to the Antarctic Treaty. Part of the agreement is a fifty year ban on mining activities on the continent.

ACTIVITY – MAKE YOUR OWN FOSSIL

LP Prim

Teaching Objective: Students will develop and understanding of how fossils are made.

Learning Outcome: Students will make their own simulated fossil.

Materials: Plasticine, shells, Plaster of Paris, bowl

Procedure:

1. Using the plasticine, make a mould of the inside and outside of a shell.
2. Mix up the Plaster of Paris and fill the moulds with plaster.
3. Let them dry.
4. Peel off the plasticine.
5. Have students explain how this represents a fossil.

Extension: Have students research what a fossil is and how they are made.

ACTIVITY – PROTECTING THE ANTARCTIC ENVIRONMENT

Prim MS

Teaching Objective: Students will be able to express and give reasons for their feelings toward protecting wilderness regions.

Learning Outcome: Students will list reasons for and against the preservation of Antarctica and justify these reasons.

Questions:

1. What are the issues with exploiting the mineral resources of Antarctica?
2. What are the risks associated with mining in Antarctica and the surrounding oceans?
3. Why would some countries be interested in mining in Antarctica?
4. Have students list their reasons for and against mining in Antarctica.
5. Discuss the reasons students have listed.
6. Divide the class into two groups – one group is for mineral exploitation and the other is against. Have students compile a list of reasons for or against mining.
7. Have students debate the topic: Global resources are there for the taking.

Antarctica and Climate Change

Antarctic studies have clarified many key issues in the science of climate change. Antarctic ice cores show that climate has always changed and revealed a clear link between the levels of greenhouse gases in the atmosphere and surface temperatures. They show how human activity has now elevated the levels of atmospheric greenhouse gases into uncharted territory and at an unprecedented speed.

Many scientists believe that the Antarctic region provides early indications of climate change.

Case Study – Oceans, Carbon and Acidification

Key points

- As a result of human activities, atmospheric carbon dioxide (CO_2) is now higher than it has been in the last 650,000 years and, most likely, the last 23 million years.
- CO_2 levels in the atmosphere continue to increase and are expected to be double preindustrial levels by the middle of this century.
- The ocean is a major sink for CO_2 emissions and has absorbed about 48% of the CO_2 emitted by human activities since preindustrial times.
- Adding CO_2 to the ocean alters the carbonate chemistry and lowers pH, making surface waters more acidic and decreasing carbonate ion concentrations.
- Increased acidity and decreased carbonate ion concentrations are likely to interfere with the shell-making ability of a variety of organisms including some species of phytoplankton, zooplankton, molluscs and reef-building corals. These organisms make their shells out of calcium carbonate.
- Resultant changes in the abundance or distribution of these organisms could disrupt ocean food webs and ecosystems, with possible feedback to the climate system. However, we are not yet able to predict the ecological consequences with any certainty.

Source: provided by ACE CRC

ACTIVITY – THE OCEAN CARBON CYCLE

Teaching Objective: Students will be able to understand the concept of increasing CO_2 and the ocean carbon cycle.

Background: When CO_2 enters the ocean it reacts with water to form bicarbonate (HCO_3-) and carbonate (CO_3- -) ions. These reactions release hydrogen ions (H+) into the water, increasing the acidity of the water. The net effect of increased CO_2 is to increase the acidity of the water and to increase the carbonate ion concentration. Normal ocean water is slightly basic, having a pH of about 8.2. The global average pH of the ocean has already declined by about 0.1 unit (representing a 30% increase in H+ ions) since the preindustrial era and will decline further as atmospheric CO_2 levels continue to rise and some of this added CO_2 enters the ocean.

SSec

Learning Outcome: Students will describe the ocean carbon cycle and the chemical reactions occurring as CO_2 levels in the atmosphere increase.

Procedure:

1. Write the chemical equations for the bicarbonate and carbonate reactions.
2. Use the library or internet to find a diagram of the carbon cycle. Describe the changes on the cycle caused by the increasing CO_2 in the environment.

   Visit the NASA Oceanography site

   www.science.hq.nasa.gov/oceans/

3. Carry out the experiments at: http://mattson.creighton.edu/CO2/ looking at the acidity changes of water when CO_2 is added.

A EXPERIMENT – DETECTING CO_2 IN WATER *This experiment was provided by the ACE CRC*

SSec

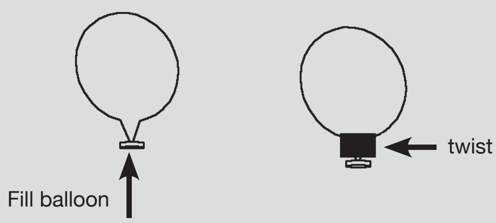
Teaching Objective: Students will be able to understand the procedures used to detect CO_2.

Learning Outcome: Students will use an indicator to test air samples for CO_2.

Materials: 4 vials or test tubes, test tube rack, measuring cup (marked in millilitres), measuring spoons, 4 plastic straws, 3 round balloons (all same size), 6 twist ties,1 plastic soft drink bottle (1.25 – 2 litre), 150 ml vinegar, 10 ml bicarbonate of soda, bromothymol blue or other indicator solution, dropper bottle ammonia (1 part ammonia per 25 parts water), safety goggles (for all students), instruction/data sheet

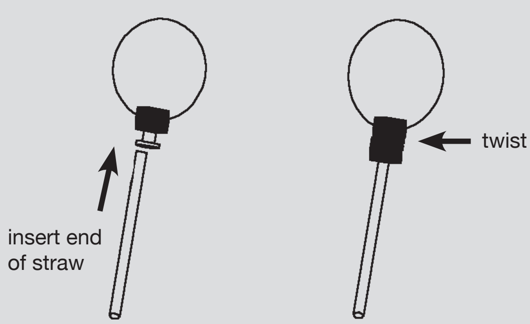
Procedure: Measure fifteen millilitres of distilled water into each of the four test tubes and label them A, B, C, and D. Test tube D will be your control.
Add ten drops of bromothymol blue to each test tube.

Put 100 millilitres of vinegar in the soft drink bottle. Using the funnel, add five millilitres of bicarbonate of soda to the vinegar. Stretch the neck of the balloon over the bottle so that it will inflate. When the balloon is inflated, take it off the bottle and seal it with a twist tie. Make sure the twist tie is at least two centimetres from the end of the balloon.



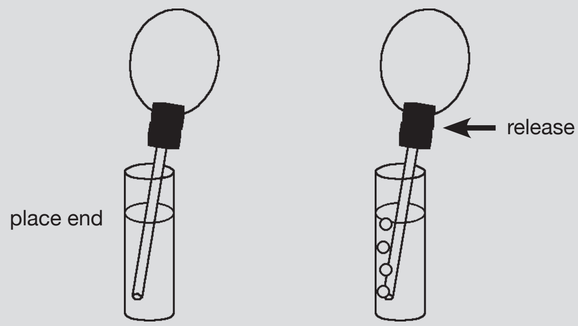
Measure the diameter of the inflated balloon. Inflate two other balloons to the same diameter and seal them. Blow one up by mouth and inflate the other using the air pump. Label the balloons so that you know which is which.

Place one end of a straw in the neck of each of the balloons. Hold the straw in place with another twist tie. This tie should be tight enough to keep air out, but not tight enough to crush the straw.



Predict what will happen when you bubble the gas through the bromothymol solution. Give a reason for your prediction:

Working with a partner, hold one of the balloons over test tube A. Place the end of the straw in the liquid, then partially release the first twist tie. Release it just enough to allow the air in the balloon to bubble slowly through the solution. Compare the solution with the liquid in your control test tube, and record your observations.



Repeat the process with the other two balloons.

Add ammonia one drop at a time to each of the samples. Gently shake the test tube after each drop. Count and record the number of drops needed to return the sample to its original colour.

	Air sample		
	Balloon 1 Vinegar/bicarb	Balloon 2 Exhaled air	Balloon 3 Ambient air
Colour change			
# drops ammonia			

Questions

1. What happened when you bubbled the air through the solutions? Why?

2 Which air sample had the most carbon dioxide?

3. How do you know?

Extension: The solubility of carbon dioxide in water decreases with increasing temperature. When you add carbon dioxide the amount of carbonic acid increases and the pH level drops. When carbon dioxide is removed the pH level rises. Would you get different results in the previous experiment if you were to change the water temperature? How might this relate to possible changes in global sea surface temperatures?

Normal rain is slightly acidic (pH 5.6-6) due to the carbon dioxide picked up from the earth's atmosphere. Pure freshwater is neutral (pH 7). Ocean water is slightly basic (pH 8) because of its salinity. Would your experimental results be different if you used salt water instead of fresh?

Heat Traps and Melting Ice

The burning of fossil fuels causes large amounts of heat to remain trapped in the atmosphere. This leads to an increase in temperatures around the globe.

The melting of ice is a natural part of the water cycle. Problems arise if the ice is melting faster than the snow is falling. Sea levels are appearing to rise. The rise is caused by many processes including thermal expansion of the oceans, an overall contribution of water from melted glaciers, and human changes in storage of water on and under the land. The contribution to sea level rise of ice sheets in Antarctica and Greenland over this period is not well established and is subject of conflicting assessments, but it could account for around one third of the present rate of sea level rise which is two millimetres per annum. (British Antarctic Survey)

If global warming occurs and the ice in Antarctica melts there will be more land and water exposed to the sun. This will lead to increased absorption of solar energy from the atmosphere as open water reflects a lot less radiation than ice. In turn this will lead to the melting of even more ice and an increase in the temperature in Antarctica – a positive feedback loop. A wide variety of Antarctic life forms depend on the sea ice for survival so this would have a great impact on the Antarctic food web.

? *Did You Know?*

On the Antarctic Peninsula, temperatures have been recorded as increasing two to three times more quickly than the rest of the Earth.

Implications of Ice Melting and Sea Level Rise

Rising sea level is a major consequence of climate change that is already being felt in Australia and the South Pacific.

Sea level rise depends on a complex interplay of global, regional and local factors. These include the expansion of ocean water as it warms, the melting of ice on land (e.g. mountain glaciers and ice sheets in Antarctica and Greenland), changes in snowfall and water storage, and vertical land movement caused by geological processes.

The implications of sea level rise:

- Increase in the impact of natural extreme events such as storm surges.
- Winds and waves may increase and change the frequency and intensity of extreme events
- Increased coastal erosion.

Case Study – Research Scientists Involved in Studying Climate Change in Antarctica

Meteorologists collect weather data and analyse the changes in Antarctic weather over time. The Australian Bureau of Meteorology has four locations in Antarctica for which daily weather observations are routinely prepared.

Glaciologists study the stability of the ice sheet and take ice core samples to look at the effect of climate change on the ice.

Oceanographers study the Southern Ocean and the changes occurring seasonally and over time.

Biologists study the impact of climate change on marine life and the effect of increased ultraviolet radiation from the hole in the ozone layer on plants and animals.

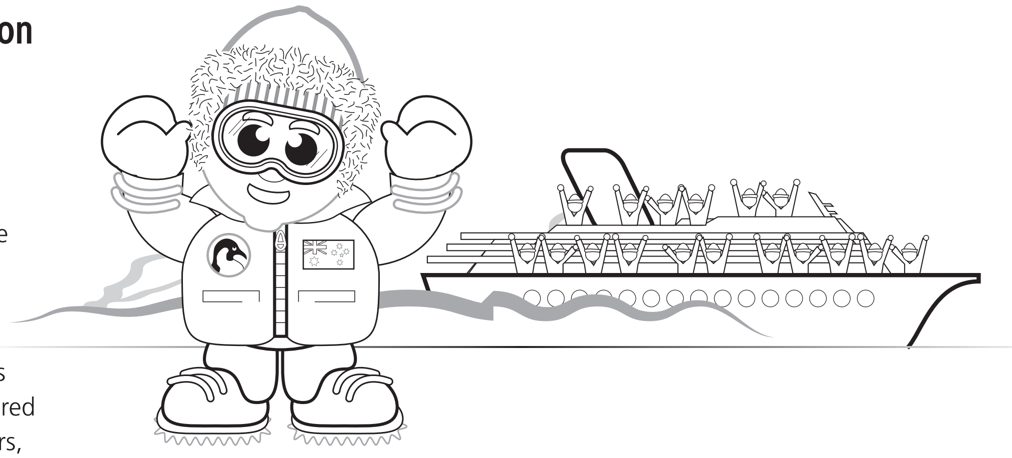
Geologists look at the sediment on the sea floor to study the change in glacial ice, ocean temperatures and ocean chemistry over time.

Quad bikes transporting equipment in the field.
Photo by Mike Whittle. Source: Australian Antarctic Division

Macquarie Island station. Photo by Christo Baars. Source: Australian Antarctic Division

HUMAN ACTIVITY IN ANTARCTICA

History of Australian Interaction with Antarctica



Terra Australia Incognita (the unknown southern land) was the name given to the southern continent that scientists in many countries believed existed but none had actually seen. Captain James Cook is credited as the first person to circumnavigate the Antarctic continent during his 1772–1775 expedition. Cook's reports of the rich sea life of the unexplored Southern Ocean attracted sealers, whalers, explorers and scientists over the next 200 years. James Clark Ross' expedition of 1839–43, sailed further south amongst the icebergs than any previous explorers. Ross was a scientist with a keen interest in the Earth's magnetic field, as well as a naval officer. He sailed from Tasmania with his ships, Erebus and Terror, and got within 130km of the Antarctic coast, before being stopped by a giant ice shelf. He discovered the Ross Sea, Victoria Land and Mount Erebus.

A EXPERIMENT – WHEN A COMPASS IS USELESS

Prim MS

Teaching Objective: Students will be able to understand the effect that the poles have on a compass.

Learning Outcome: Students will discover why using a magnetic compass around the poles is difficult.

Materials: A strong bar magnet, a cardboard circle (slightly larger than the bar magnet), sticky tape, a small magnetic compass.

Procedure:

1. The circle is the world. Draw the main continents of the world onto the circle and mark the north and south poles.
2. Sticky tape the bar magnet onto the middle of the card, pointing north and south. This has an invisible magnetic field around it, like the actual Earth.
3. Hold the compass horizontal and the flat Earth below it.
4. Position the flat Earth so the compass is over the Equator – it should line up with the magnets field, pointing north-south.
5. Rotate the flat Earth so the compass is directly over the North Pole. Its needle will probably spin around and settle in a different location each time. This is because the lines of magnetic force at the Pole are going straight into Earth – the compass needle cannot align with them.

A EXPERIMENT – BALLOON COMPASS

Prim

Teaching Objective: Students will develop their knowledge and understanding of using a magnetic compass.

Learning Outcome: Students will discover what happens to a compass at the Earth's poles.

Materials: Bar magnet, water balloon inflated with air, waterproof marker pen, bucket of water, sticky tape, compass (optional)

Procedure:

1. Using the waterproof marker pen, draw a straight line across the round end of the inflated balloon.
2. Hold the bar magnet against the side of the balloon so the north pole of the magnet lines up with the line you have drawn
3. Use the sticky tape to attach the bar magnet securely to the balloon.
4. Float the balloon in the middle of the bucket of water and watch how it moves.
5. (Optional) Check whether the balloon compass is pointing north using a compass.

The Antarctic Treaty

No single nation controls Antarctica. It has no government and no indigenous inhabitants. Explorers have for hundreds of years, tried their luck at reaching the great south land. Technological advancement and improved knowledge about the climate and environment of the Southern Ocean and Antarctica has allowed greater access to the continent. The gradual occupation of Antarctica by scientific stations has occurred as a result. By the mid-1950s, permanent stations were being established and planning was underway for the International Geophysical Year (IGY) in 1957-58, the first substantial multi-nation research program in Antarctica. By mid-century, territorial positions had also been asserted, but not agreed, creating a tension that threatened future scientific cooperation. In 1958 twelve nations set up over sixty scientific stations. When IGY finished they decided to continue their research. Representatives of the nations met in Washington in 1959 to draft and sign The Antarctic Treaty which dedicated the whole continent to peace and science. Since then, many other nations have signed the treaty. Australia claims as territory nearly half of Antarctica's 13.5 million square kilometres, a patch roughly the size of Australia without Queensland, and the largest Antarctic claim of any nation.

? ***Did You Know?***

Antarctica is the only continent with no nations.

? ***Did You Know?***

Mawson Station named after explorer Douglas Mawson, is the oldest continuously operating research station south of the Antarctic circle.

A RESEARCH - THE ANTARCTIC TREATY

MS SSec

Teaching Objective: Students will discover the significance of The Antarctic Treaty to preserving the environment and ecology of Antarctica.

Learning Outcome: Students will investigate the principles of The Antarctic Treaty.

Procedure:

Research the Antarctic Treaty including the following information:

1. What are the six key principles of The Antarctic Treaty?
2. What are the fourteen articles of The Antarctic Treaty?
3. What countries are signatories to The Antarctic Treaty?
4. Explain why the signing of this treaty is so significant ecologically?
5. Why is it so important that scientific investigation is carried out in Antarctica?
6. What is so unique about The Antarctic Treaty in terms of governing Antarctica?
7. Can you see any future problems with so many scientists visiting and investigating Antarctica – environmentally, economically, politically?
8. What are the impacts of so many scientists living and working on Antarctica?
9. What has been the environmental impact of scientific research in Antarctica?
10. What will happen to Antarctica if tourism becomes a major activity?
11. An international treaty depends on the agreement of all the countries signing it. Do you think countries will break the Antarctic treaty and start mining there when reserves run out elsewhere in the world?

Travelling to Antarctica

A ACTIVITY – TRAVEL IN ANTARCTICA

Prim MS

Teaching Objective: Students will have an understanding of the preparation needed to travel to Antarctica and in Antarctica.

Learning Outcome: Students will research the hazards of travelling south to Antarctica and travelling within Antarctica.

Questions:

1. What form of transport most commonly travels to Antarctica? Why?
2. What is the alternative? What are the hazards associated with the alternative?

Research: Research the type of vehicles that people get around on in Antarctica. What are the special features that these vehicles must possess to make them suitable for use on ice?

Source: http://www.classroom.antarctica.gov.au/4-on-thin-ice/4-3-vehicles-getting-around/

Case Study: The *Aurora Australis*

The *Aurora Australis* is Australia's Antarctic flagship, designed as a multi-purpose research and supply vessel (RSV). It is ninety-four metres long and 3900 tonnes in weight, accommodating 116 passengers. The *Aurora Australis* is well equipped with a trawl deck, a CTD (a water sampling device that is lowered into the deep ocean) and laboratories purpose designed for marine science and oceanographic work.

The ship is also fitted with a helipad and hangar facilities for three helicopters.

Photo by Fred Olivier. Source: Australian Antarctic Division

Living and Working in Antarctica

The Silence

One thing that is immediately obvious to all expeditioners that visit Antarctica is the silence. To read accounts of how striking the silence is in Antarctica go to
Classroom Antarctica Unit 3, Living - expeditioner profiles.
www.classroom.antarctica.gov.au

Clothing

The key quality for clothing in Antarctica is the capacity to provide good insulation and protection from the elements while allowing the wearer mobility, the ability to work and comfort. Several lightweight layers of clothes are better than one thick heavy layer as they allow greater flexibility of movement and allow the wearer to strip off or add layers to remain comfortable and not get too cold or hot. The outer layer must be windproof and possibly waterproof while the inner layers must be insulating and warm. All extremities must be covered – head, fingers and toes, ankles, wrists and neck.

Modern Antarctic clothing.
Source: Australian Antarctic Division

A ACTIVITY – THE SILENCE IS STRIKING

LP Prim

Teaching Objective: Students will be able to understand the contrast between the community in which they live and Antarctica in terms of noise.

Learning Outcome: Students will appreciate how silent Antarctica is.

Procedure:

1. Put students in groups of five.
2. Place groups of students at different locations in the school environment for ten minutes.
3. Have students sit in silence and record all the sounds they hear during this time.

   Note. It is more effective to have students close their eyes in order to heighten the sense of hearing.
4. Have students consider what it would be like to sit quietly in Antarctica for the same length of time.
5. Discuss what the contrast would be between the noise level of Antarctica and their school.

Source: Classroom Antarctica, Unit 1.11, Sound. www.classroom.antarctica.gov.au

Insulation

Thermal insulation slows the heat transfer between objects and keeps homes warm and fridges cold. One of the most important examples of thermal insulation is clothing. The principal non-aesthetic purpose of clothing is to control the rate at which heat flows into and out of our bodies. Clothing helps maintain a proper body temperature.

Did You Know?

Fingers and toes lose heat quickly and generate and retain heat poorly because they have a high surface area compared to their volume.

EXPERIMENT – WHAT TO WEAR

Teaching Objective: Students will develop a knowledge and understanding of the insulating properties of different clothing materials.

Prim

Learning Outcome: Students will investigate the different materials used to make clothes.

Procedure: Have students discuss the materials that their clothes and shoes are normally made from e.g. cotton, wool, fleece, polyester, leather. Have them read the labels on their clothing and write a list of the materials used.

Questions:

1. Which materials make them the warmest and which keep them cool?
2. What do students use to keep themselves dry? What sort of materials are these usually made from?
3. Do some materials allow more air movement than others? How can they tell this eg. what sort of clothes are their gym/sports clothes made from?
4. What role do hats play in regulating body temperature in the cold weather?
5. What happens when you take your hat off when it is cold? What happens when you put it back on.

Did You Know?

The head can lose up to fifty percent of the body's heat in cold weather. "When your feet are cold, cover your head." - Inuit saying.

EXPERIMENT – INSULATION

Teaching Objective: Students will develop a knowledge and understanding of the thermal and insulating properties of materials.

Prim MS

Learning Outcome: Students will investigate the thermal properties of materials and discover which materials make the best insulators.

Materials: Ten identical jars, newspaper, plastic sheet, cotton wool, metal foil, wool, fur, polar fleece, cotton, nylon.

Procedure:

1. Put students into ten groups.
2. Put the same amount of hot water into each identical jar.
3. Label the jars and record the temperature of each.
4. Wrap each jar in a different material, one layer of each material.
5. Place jars in the freezer for ten minutes, then remove jars and record the temperatures again.
6. Try this experiment several times to compare the results.

Conclusion: What materials were the best insulators based on temperature results?

EXTENSION ACTIVITY – INSULATION

MS

Learning Outcome: Students will make predictions about the insulating properties of different materials when applied in varying thicknesses.

Procedure:

1. Students should record their predictions about which material will be the best insulator.
2. Students should make predictions about what effect thickness of insulation material will have ie. if you double the thickness of the newspaper does it affect the result? Repeat the experiment increasing the thickness of each material. Record the results. Compare results. Were student predictions correct?
3. Students should discuss their results.
4. Students should then discuss the implications for clothing, and for insulation in buildings.

Extension:

1. Investigate the properties of synthetic materials such as polypropylene fleece or pile fibre. Why are they commonly used as the outer layer for polar clothing? What advantages do they have over natural fibres?
2. What types of material are used for the insulating inner layers?
3. Why are zips, collars and draw cords used in Antarctic clothing?

Source: Tasmanian Museum and Art Gallery www.tmag.tas.gov.au

ACTIVITY – PLANNING A TRIP TO ANTARCTICA

Prim

Teaching Objective: Students will understand the importance of preparedness when travelling to Antarctica.

Learning Outcome: Students will conduct research on preparing to travel to Antarctica.

Procedure: Students plan a trip to Antarctica including their mode of transport, food, clothing, shelter, waste removal, communication and safety equipment. Students should research the websites listed throughout this book to put together a list of essential items they would need to take to Antarctica.

Special Note: Clothing and Safety Requirements in Antarctica
The Australian National Antarctic Research Expeditions (ANARE) Field and First Aid manuals list the following equipment as the minimum to be carried on any day trip away from the station limits—irrespective of the length of the journey, mode of travel and weather conditions. For a look at these requirements go to: www.classroomantarctica.aad.gov.au Classroom Antarctica, Unit 4, Working

Case Study - Captain Robert Scott

Captain Robert Scott's expedition to the South Pole in 1911 – 1912 taught us a lot about polar clothing. The men on that expedition were adequately insulated (most of the time) and could move about easily. Their clothing, however lacked the ability to dissipate sweat and the possibility of easily adding or removing insulating layers without exposing the wearer to the elements (i.e. taking layers off to add or remove other layers underneath) or without removing gloves and mittens to make adjustments. The result was that on Scott's fateful journey to the pole and back, the men's clothing became very wet with sweat during the day from the exertion of trekking through the ice and the sweat made them colder when they started to cool down. A lack of fuel meant that they were unable to dry their clothes out properly overnight in the tent. Damp clothes lose much of their insulating properties. This inadequacy in clothing wasn't the cause of their deaths on returning from the pole, but it was certainly a contributory factor.

Scott's party at the South Pole with Amundsen's tent in the background.
Mawson's Antarctic Collection, courtesy of McGraw Hill Australia

RESEARCH – TECHNOLOGY IN ANTARCTICA

Prim - SSEc

Teaching Objective: Students will develop and understanding of the significance of scientific development in Antarctica.

Learning Objective: Students will examine the different types of technology used in Antarctica over the past one hundred years.

Research: Research one expedition to Antarctica from the following list:

1. Roald Amundsen – 1911
2. Robert Scott – 1911
3. Douglas Mawson – 1910-1912
4. Sir Ernest Shackleton – 1914

Questions:

1. What form of transport did they use? Compare the success of this form of transport to what is used today.
2. What sort of shelter did they build in Antarctica?
3. Describe their food rations.
4. What type of technology did they use on their expeditions?
5. Research technology used in Antarctica today for heating, communication, transport, food, clothing. How does technology today compare with what expeditioners had to use in the early 1900s?
6. Debate: Should we encourage or discourage tourist expeditions in Antarctica?

Shelter

It was not until after World War Two that the first permanent scientific stations were set up in east Antarctica. In 1954 Australia's Mawson Station was the first permanent station to be established on Australian territory. It was established on ice-free land in east Antarctica, next to a natural harbour. Since the signing of The Antarctic Treaty in 1959, many countries have set up bases on the continent. Because less than two percent of Antarctica is ice-free and the climate is so hostile, it is difficult to find a suitable site for a station: ice can move and melt, stations can be buried in snow, and animals, many of whom nest and breed on ice-free land, and humans compete for limited suitable space. Most stations are near the coast but there is also South Pole and Vostok stations – built up on the Antarctic plateau on the ice sheet.

A ACTIVITY – WHAT SHAPE WORKS BEST?

Prim MS

Teaching Objective: Students will develop an understanding of the best shape for buildings in Antarctica.

Learning Outcome: Students will investigate the reasons behind the design and structure of buildings in Antarctica.

Background: There are many different types of accommodation used in Antarctica. Go to the Australian Antarctic Division website www.aad.gov.au to investigate the range of accommodation in Antarctica and compare the advantages and disadvantages of each type.

Questions:

1. What shapes are the tents used in Antarctica?
2. What are the advantages and disadvantages of each shape?
3. Many of the buildings in Antarctica look fairly weird and wonderful, but all have a serious practical reason for their design. What features do they all have and what environmental condition are they responding to?

SSec

Teaching Objective: Students will develop an understanding of the design features of buildings in Antarctica.

Learning Outcome: Students will design a building suited to the Antarctic environment.

1. Draw your ideal design for a building on the ice cap.
2. What do you think are the most important features?
3. Start by making a list of environmental conditions and your design responses to them. Remember that design is not just about external conditions but also has to address how people live together in close proximity, how they deal with waste disposal and how air quality impacts on them.

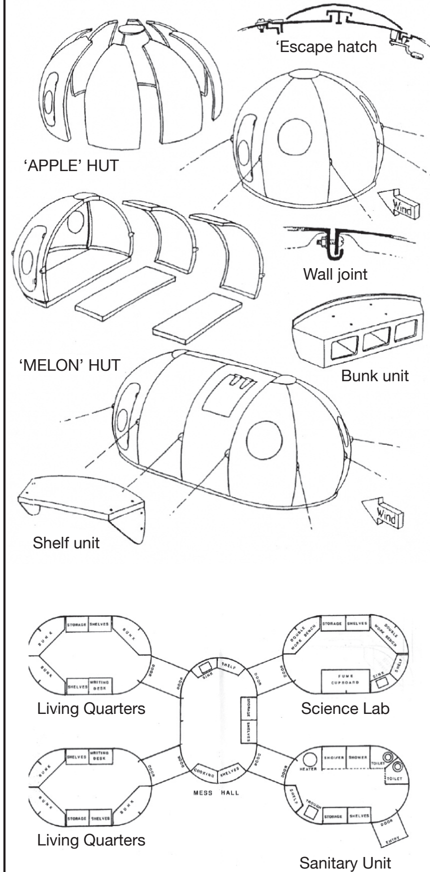
Hint: Examine the "Apple" below. Research the Apple at The Tasmanian Museum and Art Gallery: www.tmag.tas.gov.au

Source: This activity is taken from the Tasmanian Museum and Art Gallery web resource Islands to Ice: Apples in Antarctica. www.tmag.tas.gov.au

Apple – Igloo Satellite cabin

The Igloo Satellite cabin has been used in Antarctica and on the sub-Antarctic islands as semi permanent bases and movable field huts. Dubbed an Apple because of its red colouring and Tasmanian origin.

Igloo Satellite Cabin



Source: www.tmag.tas.gov.au

Case Study – Recording Energy Consumption

Go to the Australian Antarctic Division weblink below to investigate the innovations developed to maintain up-to-date records on energy consumption in Antarctic stations.

www.aad.gov.au/defaultasp?casid=24416

Environmental Protection and Management

For just over one hundred years humans have been travelling to Antarctica. Human impact has caused the destruction and extinction of some animal species, soil and water contamination through waste and sewage disposal. The Antarctic environment, the clean air, water and ice, are vital to global scientific research into the earth's changing environment.

A ACTIVITY - ENVIRONMENTAL ISSUES IN ANTARCTICA

Teaching Objective: Students will develop a knowledge and understanding of environmental problems that affect Antarctica.

MS SSec

Learning Outcome: Students will research environmental issues that affect Antarctica.

Procedure:

1. Ask students to list some of the environmental problems they have heard about either locally or in other parts of the world.
2. Have them place a tick next to the ones they think might affect Antarctica. Ask them to place two ticks next to any environmental problem they think may impact Antarctica more severely than any other parts of the world.
3. Discuss the list as a class. Have students hypothesise the reasons as to why certain environmental problems might have a particularly severe impact on Antarctica.
4. Have students use web and print resources to find out about environmental issues that affect Antarctica. As they conduct their research they should ask the following questions:
   a. What is the ozone hole and what are its effects?
   b. How has global warming affected Antarctica and what complications might this have for the rest of the world?
   c. What types of pollution threaten Antarctica and why is this region more sensitive to pollution than other parts of the world?

Extension:

1. Have students create "environmental fact sheets" that could be given to politicians, members of environmental organisations or the general public to educate them about Antarctic environmental issues.
2. Have students compare Antarctica and the Arctic.
3. Have students create magazine ads that will raise public awareness of the the human impact on Antarctica.

A ACTIVITY - ALTERING THE NATURAL STATE

Teaching Objective: Students will develop an understanding of the environmental impact of human interaction with Antarctica.

MS SSec

Learning Outcome: Students will list the environmental impacts caused by humans living and working on Antarctica.

Questions:

1. Make a list of the environmental impacts caused by permanent stations being set up on Antarctica. Consider:
   - Ecological impact
   - Waste removal and disposal
   - Powering and heating scientific stations
   - The impact of vehicles and aircraft.
2. In pairs, consider the impacts you have listed. For each listed impact, devise rules that can protect Antarctica. Find out the Australian Antarctic Division's rules for protecting the environment of Antarctica at www.aad.gov.au

Case Study – Innovation in Waste Removal

Australia is committed to cleaning up waste in Antarctica, including the waste produced both by current and past expeditioners. Containers of contaminated waste are shipped back to a waste collection terminal at Macquarie Wharf in Hobart. This is an initiative implemented by scientists from the Australian Antarctic Division and the University of Tasmania.

Source: www.aad.gov.au/default.asp?casid=13855

There are now over thirty five permanent Antarctic stations with four stations on subantarctic islands. These camps are mostly nationally funded scientific camps, although private expeditions have also set up small stations. More camps operate each year during summer with the population of Antarctica quadrupling over summer.

The Australian Antarctic Division maintains four permanent research stations. Mawson, Davis and Casey are on the Antarctic continent, and Macquarie Island is in the subantarctic. All four stations are occupied by scientists and support staff all year.


Marine debris is collected . Source: Australian Antarctic Division

A ACTIVITY – POLLUTION AND WILDLIFE

Prim MS

Teaching Objective: Students will develop an understanding of the impact of human pollution on wildlife.

Learning Outcome: Students will watch a film that illustrates the effect rubbish disposal can have on penguins in Antarctica.

Procedure:

1. Discuss the problem of pollution in Antarctica and how it could affect animals.
2. Watch the movie *Happy Feet*. Explain what happened to Lovelace. Ask students to explain how they think the pollution arrived in Antarctica.

Antarctic Airlink

A new aircraft link has been established between Hobart and an ice runway at Casey station, Antarctica. The plane is capable of flying from Hobart to Antarctica and back without refuelling and has the capacity to fly different configurations of people and cargo to Antarctica. This new airlink will operate during the summer months beginning in 2007–2008 greatly increasing the logistical flexibility of scientific programs in Antarctica. It will also provide a rapid medical evacuation facility.

Human Impact on the Southern Ocean and Antarctica

Hunting for whales and seals has traditionally been one of the major impacts on the environment of the Southern Ocean.

Southern Ocean Seals

The seal populations of Macquarie Island have been protected by the island's status as a wildlife sanctuary since 1933. The seals of Australia's sub-antarctic islands were further protected in 1997 when both Macquarie and the Heard and McDonald Islands were added to the World Heritage list. The exploited seal populations have been protected since 1970 when the Antarctic Treaty Consultative Parties adopted the Convention for the Conservation of Antarctic Seals. In recent years some species (eg. *Arctocephalus* – fur seals) have recovered substantially and are no longer endangered.

Southern Ocean Whales

TIMELINE FOR THE WHALES

1904	Whaling in the Southern Ocean began.
1910	Southern Ocean provides fifty percent of the world's catch.
1946	The International Convention for the Regulation of Whaling and the International Whaling Commission (IWC) were established in response to certain species of whales being hunted to the point of commercial extinction and in an attempt to regulate harvesting and thereby the price of whale oil.
1960	The IWC protects Blue and humpback whales.
1970	Protection extended to Fin and Sei whales.
1982	IWC suspends all commercial whaling from 1985–86. This has resulted in indications that whale populations are beginning to recover but some long-lived species with low reproductive rates are incapable of rebuilding their numbers in just a few years.
1994	The Southern Ocean is declared a Whale Sanctuary under the International Convention for the Regulation of Whaling.

Fishing

Fishing is the only large-scale commercial resource harvest currently undertaken in the Antarctic Treaty area since the hunting of whales and seals ended. Fishing in the Southern Ocean has the potential to eliminate certain species, change the food web by altering predator populations, harm other sea animals and birds and destroy habitat.

The Australian Fisheries Management Authority limits the fishery around Heard and Macquarie Islands to trawling to minimise the impacts on seabirds. The Australian Antarctic Division has recently established the Antarctic Marine Living Resources program to provide the scientific basis for ecologically sustainable management of Southern Ocean fisheries. However, illegal fishermen, primarily on the hunt for the prized Patagonian toothfish *(Dissostichus eleginoides),* are jeopardising the survival of both fish stocks and bird species that live in the ocean.

Pollution

The Southern Ocean is the most remote body of water in the world but already floating debris and pollution has been found there. On the shores of the sub-Antarctic islands, tonnes of waste, mainly plastics, are washed up every year. Fishing gear such as bait straps, ropes, nets, floats, buoys and domestic rubbish, such as bottles, bags, shoes, bottle tops are commonly found. Many of these are often mistaken for food by wildlife.

Most of the pollution appears to come from the commercial fishing operations which have also been known to spill oil and chemicals which take years to break down.

ACTIVITY – DEBATING THE ISSUES

SSec

Teaching Objective: Students will develop skills in research and debating.

Learning Outcome: Students will debate issues around human interaction with Antarctic wildlife.

Procedure:
Students research and then discuss the following statements or questions:-

1. Why are fishermen hunting the Patagonian toothfish? Why is it illegal?
2. What is Australia doing to protect the toothfish?
3. The Patagonian toothfish has only recently been discovered, if that is the case, why would it matter if it was fished to extinction?
4. Is it possible that there are undiscovered Antarctic species which are disappearing as well? Should Australia worry about this?

Fur seals. Source: Geoscience Australia

ACTIVITY – UNSEEN POLLUTION

SSec

Teaching Objective: Students will understand the impact of 'unseen' pollution such as greenhouse gases

Learning Outcome: Students will investigate the impact of humans on wildlife.

Procedure:
Some of the scariest pollution is what you can't see. CO_2 and other Greenhouse gases being contributed to the atmosphere are invisible. Artificial oestrogen-like compounds humans use in perfumes have been found in Antarctic ice which gives an indication of how prevalent their use is. No one knows exactly what impact these have (but it is thought to be a reason for intersex fish, amphibians and reptiles that are found in some parts of the world).

Use this information to run a hypothetical style discussion, or have students develop answers in pairs or teams:

1. What evidence would convince you these oestrogen-like perfume components affect/are harmless to Antarctic life?
2. What would be required to collect this evidence? Who should pay for this research? In whose interests is this research? Whose responsibility is it, ultimately, to pay for it?
3. Do you personally use cosmetics – deodorants, perfumes particularly those with a slightly musky smell?
4. Imagine you found out the perfumes you used harmed animals in Antarctica, however, these same fragrances are wildly successful for you – they help attract a romantic interest, and you also think they smell good. Would you stop using them?
5. Many people choose to keep using these perfumes despite them being harmful to the environment (just as we keep driving cars even though we are aware that they produce harmful greenhouse gases). What do you think it would take to make people think about the environment before themselves?

Tourism

It is not only science that draws people to Antarctica. Since the 1960s tourist expeditions have been travelling to Antarctica, sparking controversy over the potential environmental damage tourism causes to this fragile continent. Whilst commercial Antarctic tourism dates back to the late 1960s, there has been a rapid growth since the late 1980s. As with tourism to all remote wilderness areas, the debate rages over the potential environmental hazards caused to this region by tourism. There are very strict regulations in place governing the activities of tour operators and tourists to the continent and surrounding islands. The Antarctic Treaty specifies these activities and maintains strict guidelines for tourism to Antarctica. Tourism usually occurs in summer, from mid-November to March as the temperatures are milder, there is less ice and the wildlife is more visible. Tourists generally sail to Antarctica from South America, although many companies also offer the opportunity to fly.

MS SSec

A ACTIVITY – YOU BE THE JUDGE

Teaching Objective: Students will develop an awareness of the issues concerning tourism to environmentally fragile regions.

Learning Outcome: Students will evaluate the environmental impact of tourism on Antarctica.

Debate: "Is tourism a threat to the Antarctic wilderness?"

Procedure:

1. Separate the class into two groups.
2. Have all students on one side of the room as the "affirmative team" and all students on the opposite side of the room as the "negative team".
3. Ask students to compile a list of points for or against the topic, "Is tourism a threat to the Antarctic wilderness?"
4. Write these on the board.

Research: Have students research the topic to discover examples for their arguments.

Debate: Have students choose three speakers from each group to represent them in a debate. Hold a class debate.

Case Study (Advertorial) – Cruising in the white wilderness *By Kerry Lorimer*

A soft fog hung over the bay, amplifying and isolating the pops and groans of the glaciers as they calved icebergs into water that had the smoothness and sheen of mercury.

Standing alone on the bow of the ship, I was startled by a sound like a bursting car tyre. I leaned over the cap-rail and looked straight into the blowhole of a humpback whale.

Minutes later we were in the inflatable Zodiac boats, nudging through the brash ice as whales surfaced all around us. A huge male breached, heaving his 40-tonne bulk clear of the water and crashing down with a thunderous splash. For the next hour he 'performed' for us: breaching, tail slapping and occasionally approaching so close to the Zodiacs we could smell his fishy breath.

Such wondrous wildlife interactions are a daily – even hourly – occurrence in Antarctica. Hundreds of thousands of penguins stretch like 3-D wallpaper as far as you can see. If you sit at the edge of a rookery, you'll soon find yourself surrounded: the birds haven't read the rules on minimum approach distances. Albatrosses wheel effortlessly about the ship on the passage through the Southern Ocean; elephant seals, lying in scrofulous heaps like monstrous mouldy cigars, belch and fart with casual disinterest.

Antarctica is, arguably, the most beautiful place on Earth – a pristine wilderness where ice takes on every rainbow hue, where the wildlife is astonishingly prolific and without fear of man, and where you are utterly at the mercy of the elements. It's nature at her most raw and powerful. I was awed and humbled by my first visit – and I've looked at the world differently ever since.

Source: This is an extract from Code Green: Experiences of a Lifetime published by Lonely Planet © 2006. Reproduced with permission.

Responsible Travel Credentials

- There are now more than 30 cruise-ship operators working in Antarctica, with vessels ranging from 400 passenger ocean liners to 50-100 passenger ice-strengthened 'expedition-style' ships, most of which were built for the Russian scientific programme before the USSR collapsed. All are required to abide by the strictest minimum environmental impact guidelines, as stipulated by the Independent Association of Antarctic Tour Operators (IAATO) and in accordance with the Protocol on Environmental Protection to the Antarctic Treaty (1991).
- One of the larger operators, Peregrine, claims to lead the way in environmental responsibility. Among other measures, all its Zodiacs run four-stroke outboards (cleaner than two-stroke), and it maintains a high guide-to-client ratio and a comprehensive client educational programme. The company also supports a range of scientific projects and has raised over A$300,000 for albatross conservation, establishing a hands-on partnership with World Wildlife Fund (WWF) Australia.

Getting there

- The Antarctic Peninsula is the most popular and accessible part of Antarctica – it's two days' sailing from Ushuaia, at the southern tip of South America, across the infamous Drake Passage, and has the highest concentration of wildlife on the continent. There are also voyages from Tasmania, New Zealand and South Africa, travelling to the Ross Sea and remote Emporor Penguin rookeries.

When to go

Voyages depart between November and March.

Further information:

www.iaato.org and www.peregrineadventures.com

Glossary

Albedo - (Latin for white) is commonly used to apply to the overall average reflection coefficient of an object

Atmosphere - system of gases and particles that surround the Earth

Benthic - relating to the ocean floor

Cladocerans - small, mostly freshwater crustaceans including water fleas

Consumer - organisms that can't make their own food, they must eat other organisms to get energy

Continental drift - is the movement of the Earth's continents relative to each other

Decomposer - an organism that breaks down dead plants and animals

Diatom - group of phytoplankton having cells enclosed in shells made of silicon

Ecosystem - a relatively self-contained ecological system defined by the types of organisms found in it and their interactions.

Extremophile - an organism that survives in extreme conditions

Frazil Ice - formed from sea ice crystals that are disturbed by ocean turbulence.

Glacier - glaciers are frozen "rivers"

Glycoprotein antifreeze - a protein that circulates in the blood of Antarctic fish to prevent ice crystals forming.

Gondwanaland - The southern supercontinent Gondwana (originally Gondwanaland) included most of the landmasses in today's southern hemisphere, including Antarctica, South America, Africa, Madagascar, Australia, New Guinea, and New Zealand, as well as Arabia and the Indian subcontinent, which are in the Northern Hemisphere.

Ice sheet - a mass of glacier ice that covers surrounding terrain.

Ice shelf - occurs when glaciers meet the sea and the ice floats on the water.

Invertebrate - animal without a backbone

Katabatic wind - occurs when cold, heavy air flows down the slopes of the inland mountains and ice plateau

Marine - relating to the ocean

Motility - the ability of an organism to move

Nilas ice - is a thin elastic crust of ice that bends easily on waves and under pressure. It is the early stage of forming sea ice.

Notothenioid - the dominant suborder of fish in Antarctica, exclusively confined to the Southern Ocean.

Nutrient - any substance used or required by an organism as food.

Photosynthesis – the process of converting light energy to chemical energy and storing it in the bonds of sugars. Plants and some algae carry out photosynthesis.

Phytoplankton - microscopic floating plants eg. algae

Precipitation – any form of water such as rain, snow, sleet or hail, that falls to the Earth's surface

Producer - an organism that synthesises organic materials from inorganic materials usually by photosynthesis

Rotifer - rotifers are microscopic animals having less than 100 cells. They can measure up to 2mm in length and live in lakes or ponds.

Sea ice - forms on the ocean surface. It is saline and forms by the growth of crystals, rather than compressed snow,. It can take many forms including frazil ice and pancake ice.

Tardigrade - a microscopic, multicellular animal living in oceans or ponds. Tardigrades can survive the process of freezing or thawing, as well as changes in salinity, extreme vacuum pressure conditions, and a lack of oxygen

Terrestrial - living on land

Turbellarians - commonly known as flatworms

Vertebrate - animal with a backbone

www.

Websites

ABC
Up to date news stories on issues in Antarctica
www.abc.net.au/science/news/stories/2003/928391.htm

Antarctic Climate and Ecosystems CRC
Information about climate change, sea level rise and other environmental issues.
www.acecrc.org.au

Antarctica Connection
A comprehensive website providing information on Antarctica including up to date weather and extensive information about the Antarctic Treaty
www.antarcticconnection.com/antarctic/science/meteorology.shtml

Antarctica 90 Degrees South
Activities and lesson plans
www.pbs4549.org/antarcti/index.htm

Antarctica Online
Education resources
www.antarcticaonline.com

Antarctic Sea Ice Processes and Climate
All about sea ice and sea ice research
www.aspect.aq

Australian Antarctic Division
Information relating to all aspects of Antarctic research and science. Up-to-date weather data and Antarctic and subantarctic maps for free download
www.aad.gov.au/

Bears On Ice!
Follow the adventures of Berkley and OzGold the bears in Antarctica (K-6). Also Antarctica maps and images, information and lesson plane K-12
http://ku-prism.org/resources/BearsOnIce/index.html

Board Games – downloads
www.aad.gov.au/MediaLibrary/asset/MediaItems/ml_376635100231481_environment_a4.doc

www.aad.gov.au/MediaLibrary/asset/MediaItems/ml_376635454861111_journey.doc

www.aad.gov.au/MediaLibrary/asset/MediaItems/ml_376635466435185_krill.doc

and some physics for older classes, http://www.aad.gov.au/default.asp?casid=19533

British Antarctic Survey
Information about current scientific research
www.antarctica.ac.uk

Classroom Antarctica
A comprehensive teacher resource. It is an internet resource providing a huge range of activities, weblinks and information. A "must visit"
www.classroom.antarctica.aad.gov.au

Commission for the Conservation of Antarctic Marine Living Resources (CAMLR)
Information about the conservation of Antarctic's biodiversity and safe fishing practices to maintain biodiversity
www.ccamlr.org/default.htm

Committee for Environmental Protection
The Antarctic Treaty
http://cep.ats.aq/cep/

Cool Antarctica
Fascinating facts, great images and examples of food chains and webs
www.coolantarctica.com

CSIRO Marine Research
Understanding the Circumpolar Current
www.marine.csiro.au/LeafletsFolder/10ocean/10.html

Department of the Environment and Heritage
Information about whale research and conservation
www.deh.gov.au/whales

Discovering Antarctica
An interactive site packed with audio and video clips, fact sheets, interactive activities, images, links, glossary. Extremely informative and fun
www.discoveringantarctica.org.uk/

Education Network Austalia (Edna)
Antarctica theme page to assist teachers with their planning. Learning quests, lesson plans, images, related sites.
http://www.edna.edu.au/edna/go/schooled/school_theme_pages/pid/1079

Friends of the Earth, Australia
Antarctica and the Southern Ocean. Focus on climate change and environmental issues
www.foe.org.au

Genome News Network
Information about extremophiles
www.genomenewsnetwork.org/categories/index/environment/ext.php

Geoscience Australia
An article outlining Geoscience Australia's involvement in CAML
www.ga.gov.au/ausgeonews/ausgeonews200612/antarctic.jsp

Gulf of Maine Research Institute
Activities relating to penguins and other marine animals
www.gma.org/surfing/antarctica/penguin.html

Interactive Schooling
Information and images to do with ice and ice formation
www.skwirk.com/p-c_s-1_u-21_t-190_c-610/global-warming/nsw/hsie/current-issues-antarctica/environmental-conditions

International Polar Year 2006-2008
Information about International Polar Year 2006-2008
www.ipy.org

Laboratory for the Ecophysiological Cryobiology
Images and information about Antarctic organisms.
www.units.muohio.edu/cryolab/

Linking for learning
This website provides an internet webquest about Antarctica. It provides a self-contained unit of work including investigative questions for students and appropriate weblinks.
www.linkingforlearning.com/webquests/Antarctica%20Webquest/index.htm

NASA Oceanography site
The ocean and the carbon cycle
www.science.hq.nasa.gov/oceans/

Nova Online /PBS Teacher Source
A website hosting a range of teacher activities and information – deriving from public television programs.
Extensive information about ice and ice formation
www.pbs.org/wgbh/nova/warnings/almanac.html
www.pbs.org/teachersource/mathline/concepts/weather/activity2.shtm

Origins Antarctica
The latest scientific research from Antarctica
www.exploratorium.edu/origins/antarctica/ideas/index.html

Problem Based Learning
Information about transporting icebergs
www.pbl.cqu.edu.au/web_quest/content/transport_economist.htm

Royal Statistical Society- Centre for Statistical Education
Site looking at methods of counting and analysing of animal and plant populations
http://www.rsscse.org.uk/

Services Environment Development
Information about using icebergs for drinking water.
www.smec.com.au/development/quantum/icebergs.htm

Tasmanian Museum and Art Gallery Islands to Ice Education Kit
This is a great web-resource for exploring Antarctica. The chapter, Apples in Antarctica, covers people working and living in Antarctica. NB. An 'Apple' in Antarctica is a reference to a transportable prefabricated Igloo hut.
www.tmag.tas.gov.au

The Age
News stories on Antarctica
www.theage.com.au/news/world/russia-ignores-plea-on-drilling-antarctic-lake/2006/07/12/1152637740824.html

The Alfred Wegener Institute
Sea ice research
www.awi-bremerhaven.de/Eistour/eisbildung-e.html

The JASON Project
A range of interactive multimedia educational resources offering an inquiry-based approach to learning about frozen worlds. They are designed for students in Years 4-9. The resources may be purchased from this site.
www.jasonproject.org/jason13/expedition.html

Visit and Learn – The HMS Endurance Tracking Project
Current information about science and research in Antarctica
www.visitandlearn.co.uk/

World Oceans
Facts about the Southern Ocean
http://library.thinkquest.org/TQ0311165/ocean.htm

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Sharwood, J and Khun, M. 2004. *Science Edge 1,* Thomson Learning, Australia.

Stow, D. 2004. *Encyclopaedia of the Oceans,* Oxford University Press, London.

Trewby, M. 2002. *Antarctica: An Encyclopaedia from Abbott Ice Shelf to Zooplankton,* Firefly Books Ltd, New Zealand.

Kits

Travelling South – Journeys into Antarctica.
A multi-media education kit by the Wilderness Society Education Unit, written by Tracey Diggins. The kit includes a teachers guide, student activity sheets, colour transparencies, audio commentary, slide notes, colour prints, map of Antarctica, stimulus material for debates and discussions.

The Ice Box (for Tasmanian schools only)
Packaged set of learning materials for primary, middle and high school including books, maps, CD's, teacher resources and guides, and Antarctic clothing. Contact Gordon Bain, 32 Derwent Ave, MARGATE. TAS. 7054 or hausbain@bigpond.net.au

Visual

Planet Earth Part 2, Ice Worlds - DVD
Planet Earth Part 2 is a BBC/Discovery Channel/NHK co-production, in association with the CBC narrated by Sir David Attenborough. This series brings viewers unprecedented footage of some of nature's greatest spectacles. The DVD or book may be purchased at the ABC or online at shop.abc.net.au

March of the Penguins - DVD
A documentary narrated by Morgan Freeman taking viewers on an amazing journey with the Emperor Penguin from ocean to ice as they bring new life into their colony. May be purchased online at shop.abc.net.au

Happy Feet - DVD
Directed by George Miller
Available online at www.dstore.com.au