What is Antarctica?

Teaching Resource
Experiential Education

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Contents

- **What is Antarctica**
  - A close look at the Antarctic region
  - Students create a physical and biological Antarctic region
  - Possible scenarios to the fate of the Antarctic region

- **The Place of Science**
  - Students solve world problems by discovering scientific information within the Antarctic region
  - Positive and negative impacts are identified

- **We Need Each Other**
  a) **Inspection of the connection**
     - Interdependence of species within an ecosystem
  b) **Pyramid of Life**
     - Structure of a food chain
  c) **Keeping it in Balance**
     - Balance of an ecosystem

- **Why is the Antarctic Ecosystem so Fragile?**
  a) **Breeding Maturity**
     - Susceptibility of species to impacts due to the long length of time it takes Antarctic specie to reach breeding maturity
  b) **A Mixed up Bunch**
     - Susceptibility of species to impacts due to juvenile and adult specie living in the same area

- **Resource Management**
  - Natural and unnatural resource management strategies within the Antarctic region
Please Note

- In its present form this teaching resource is not complete.
- Physical Resources for "What is Antarctica?" are not included.
- All species cards need photos of species attached on the opposite side and laminated.
- All resource cards: information cards should be laminated.
- All discussion question sheets should be laminated.

⇒ The author feels that this resource should be proofread and critiqued before making the investment of the above resources.
What is Antarctica?

Learning Objectives

- Students will create an Antarctic continent containing many unique features
- Students will experience the impacts of four possible scenarios upon their Antarctic continent

By using the experiential method of teaching it is hoped that students will have a more realistic learning experience about Antarctica.

Through experiential learning, Antarctica is brought into their learning environment and lives by creating their own Antarctica. The time and energy spent creating their own continent and witnessing the destruction of this creation by the possible scenarios is more likely to produce an emotional (rather than just intellectual) learning outcome. These learning outcomes can then be more effectively transferred to the ‘real’ Antarctica.

Possible Scenarios

<table>
<thead>
<tr>
<th>GLOBAL</th>
<th>LOCAL</th>
</tr>
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<tbody>
<tr>
<td>Enhanced Greenhouse Effect</td>
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<tr>
<td>Ozone Depletion</td>
<td>Building a Scientific Base</td>
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Teaching Levels

There are two teaching levels contained within this resource:

**Level One**
- Up to Year Five
- All basic facts covered with simplistic descriptions

**Level Two**
- Year Six – Adult
- Some advanced technical terms
- Additional facts with background information
Resource List For ‘What is Antarctica?’

Round One: Physical Antarctica
- Physical Antarctica Information Cards
- Physical Antarctica Instruction Resources (as listed below)

The Antarctic Continent
- Rope
- Outline of Antarctica

Geology
- Information card
- Sheets of plastic, different colours of brown, black

Fossils
- Information card
- Laminated shapes off fossils

Mountains
- Information card
- Antarctica map of mountains only
- Plastic Cones
- Three plastic cones of a different colour (active volcanoes) (level two only)

Minerals
- Information card
- Antarctica map of minerals only
- Laminated cardboard of different colours to represent different types of minerals

The Antarctic Ice Cap
- Information card
- White Fabric (snow)
- Blue Fabric (ice)

Glaciers
- Information card
- Blue Fabric with stripes

Icebergs
- Information card
- Blue blocks of foam: square, chunky, rounded and patterned, of various sizes
The Southern Ocean
- Information card
- Piece of rope (Polar Front boundary)
- Dark Blue Fabric (cold water)
- Light Blue Fabric (warmer water)
- Cardboard arrows (yellow) (direction of currents)

Wind
- Information card
- Cardboard arrows, green (direction of wind flow)
- Cardboard arrows, orange (direction of energy transfer) (level two only)
- White rounded pieces of cardboard (storms)
- Yellow oval pieces of cardboard (sheltered areas)

Dry Valleys
- Information card
- Brown paper
- White laminated cardboard which can be drawn on
- Drawing markers
- Shapes of algae, bacteria and fungi

Lakes (level two only)
- Information card
- Mesh material – yellow (salt water lake)
  - White (freshwater lake)
- Mesh strips (streams)
- Shapes of plankton, algae and mosses

Round Two: Biological Antarctica
- Biological Antarctica Information Cards
- Specie Representation Resources

Round Three: Scenarios
- Scenario Sheets
- Discussion Questions
Method

Round One – Physical Antarctica
- With all participants complete the first resource card: Antarctica the continent
- Explain to students Antarctica is not just a flat white land at the bottom of the earth, instead it is made up of resources, history, unique features and wildlife. As a group we are going discover some of the features of Antarctica, bringing it into our learning area by filling in the present Antarctica we have here on the ground.
- Spread the physical information cards and appropriate resources equally around the participants (may work individually or in groups)
- Give the participants time to read through information and to become familiar with their resources
- Slowly participants jigsaw all of the resources together, building an Antarctic region. Each participant should report to the group the main features of their resource and explain their representation
- Encourage discussion identifying patterns, unique qualities, meanings and questions

Round Two – Biological Antarctica
- Having complete round one, equally distribute the biological information cards around the group (again may work individually or in groups). Participants now represent these species and have to find a home that best suits them for survival
- Students read their information cards and place representatives of their species in the appropriate place within the region
- Students report back to the group the main features of the species and why they placed their representatives where they did
- Encourage discussion identifying patterns, unique qualities, meanings and questions

Round Three – Scenarios
- Facilitator reads through one scenario at a time
- Speaks and acts out the consequences of the scenario, appropriately destroying the created Antarctic model
- Follow this process for all scenarios

Discussion
- What were the consequences?
- What caused these consequences?
- What do we need to do to minimise these consequences?
- How can you act in a way that would contribute to minimising the consequences of this scenario?
Round One: Physical Antarctica

Physical Antarctica Information Cards
Level One
The Antarctic Continent

Instructions
- Place the map of Antarctica in the centre of the room.
- Place the rope in a circle around the map of Antarctica.
- Using all the members in your group, spread yourselves evenly around the rope on the outside of the circle.
- As a team, move the rope to match the outline of the Antarctic continent.
Geology (Rocks)

- Beneath the frozen ice is a rocky base
- This rocky base is made up firstly of a platform of very old rocks (more than 570 million years old). These very old rocks are then over-lain with horizontal layers of younger rocks called sedimentary rocks. The layering of the sedimentary rocks form a pattern called ‘layer cake geology’
- Because the rocks in Antarctica have changed very little since their formation, secrets of the earth’s past can be found within the rocks of Antarctica and scientists are very interested in them
- Only 2% of the rocky base of Antarctica is not covered by ice and snow. This has made it very difficult for scientists to explore the rocks in Antarctica. As a result exciting geological discoveries are still being made

Instructions
Using the information given, create a ‘geological landscape’ of Antarctica with the resources provided
Fossils

- Fossils of ancient plants and animals are contained within the sedimentary rocks of Antarctica.
- These fossils provided scientists with information about what type of animals and plants once lived in Antarctica.
- Information gathered so far leads scientists to suggest that 200 million years ago Antarctica had a warm climate and was covered with forest

**Instructions**
Using the information given, place your fossils within the ‘geological landscape’ of Antarctica.
Mountains

- Antarctica has many mountains
- In many places the mountain ranges of Antarctica are almost completely hidden by ice and only isolated peaks show through the ice and snow
- The Transantarctic Mountains are one of the world's greatest mountain chains. They divide the Antarctic continent into east and west Antarctica. Made almost completely of sedimentary rock they contain a wealth of information that is very useful for geological history

**Instructions**
Using the map and resources provided, place your mountains within the Antarctic continent
Minerals

- There are mineral resources in Antarctica, some of which may be among the richest mineral sites in the world.
- Knowledge about these mineral resources is limited as very little of the land in Antarctica has been explored.
- Layers of coal four metres thick have been found in Antarctica. The coal formed from trees and other plants that grew millions of years ago.
- It is possible that gas and oil exist under the oceans surrounding Antarctica.
- Mineral exploitation of the Antarctic region is thought to be the most important issue facing Antarctica in the near future.

**Instructions**
Using the map and information provided, place your minerals resources on and around the Antarctic Continent.
The Antarctic Ice Cap

- Antarctica is covered by a giant sheet of ice called the Antarctic ice cap. This ice cap is made of snow collected over 100,000 years and is compressed into ice.
- A small amount of snow remains on the surface of the ice cap and is blown about by the wind.
- The ice cap is huge, it covers 98% of Antarctica, leaving only a few rocky patches on the Antarctic Peninsula and on some coast lines. It swamps most of the Antarctic mountain chains, leaving only a few isolated peaks.
- The Antarctic ice cap is domed shaped, being highest in the centre at 4,500 metres thick and lowest at the sea edge.
- The Antarctic ice cap is so high it makes Antarctica the highest continent in the world.
- The Antarctic ice cap contains a wealth of information because climatic changes resulting in different snow crystals are preserved in its layers. To study the layers, scientists drill into the ice to obtain long tubes or ice cores. Some of these contain information about the climate that is as much as 500,000 years old. The layers of these ice cores are then analysed using physical and chemical techniques.
- The Antarctic Ice Cap plays an important role in locking up the world's water. If today's ice cap melted, sea levels globally would rise by 60 metres, drowning all major cities of the world.

Instructions
After reading the information carefully, use the resources provided to make an Antarctic Ice cap upon the rocky base of Antarctica.
Glaciers

- Glaciers are rivers of ice that flow very slowly
- In Antarctica, the glaciers flow from the highest parts of the Antarctic ice cap to the sea
- Antarctica has the world’s biggest glaciers, up to 402 kilometres long and 64 kilometres wide
- Crevasses are deep cracks in a glacier, they are caused by the movement of the ice

**Instructions**

After reading the information, use the resources provided and place ‘some of the largest glaciers in the world’ on the Antarctic Continent
Icebergs

- Floating lumps of ice that have broken off from glaciers and ice cliffs on the edge of Antarctica
- They begin their life square and chunky shaped. But as they get older they become smaller and more rounded. Often in this state they capsize out at sea, revealing beautiful patterns that have resulted from the ocean currents
- Icebergs generally travel from east to west around Antarctica, not too far from the coast. They eventually move north into the open ocean and melt.
- As a large berg drifts away from the ice sheet into warmer waters, it splits and breaks up into hundreds of smaller bergs.

**Instructions**
After reading the information provided, use your iceberg resources and place the different shaped icebergs where you would expect to find them.
The Southern Ocean

- The Southern Ocean is the coldest, stormiest and the most unpredictable ocean in the world. Due to these harsh conditions very little is known about this ocean.
- On first impression, the Southern Ocean appears to be full of life. But these scenes of plenty are misleading. Antarctic wildlife tends to occur in crowds and away from the 'hotspots' the ocean is almost empty of life.
- The Southern Ocean is 36 million kilometres squared.
- The point where the cold water from the Southern Ocean meets the warm water from the tropics is known as the Polar Front or the Convergence Zone. The exact position of the Polar Front changes from year to year, but is always found between 50 – 60 degrees south. It is characterised by lots of birds and marine life within this area.
- The area south of the Polar Front is known as the Southern Ocean. The area north of the Polar Front is known as the Sub-Antarctic.

Currents

- Ocean currents within the Southern Ocean circulate the Antarctic Continent in a westerly direction.
- Ocean currents within the Sub-Antarctic circulate the Polar Front in an easterly direction.

Instructions

Place your Southern Ocean resources around the Antarctic Continent so that the main points in the information provided is represented.
Wind

- Antarctica is the windiest continent in the world
- As the air in Antarctica cools it becomes dense and rolls down the slopes of the Antarctic ice cap from the high central plateau to the low coast lines. As a result, winds in Antarctica are strongest at the coast
- Upon reaching the coast the cold Antarctic winds interact with the warmer air from the ocean forming clouds and extremely severe blizzards that ring the Antarctic continent.
- Winds close to the continent flow in an easterly direction, while winds north of the Polar Front flow in a westerly direction. Where these two wind flows meet (at the Polar Front) another belt of storms is created producing lots of bad weather out in the Southern Ocean.

**Instructions**
After reading the material carefully, use your wind resources to represent the main features of the Antarctic wind flows.
Dry Valleys

- Within the Antarctic continent are three major dry valleys. They are called dry valleys because no rain has fallen there in the last two million years at least. They are really cold deserts.
- These valleys were formed by glaciers and have flat valley bottoms with steep sides.
- The dry valleys have very interesting species living in them. They grow in the rocks, and not the soil. Dark green organisms, a few millimetres deep, live in the air spaces of porous rocks. Algae, bacteria and fungi live in light-coloured semi-translucent rock, which the sunlight can shine into. Some are believed to have been in the rocks for 200,000 years.
- The dry valleys also have very interesting rocks called ventifacts. These ventifacts are very old, being polished smooth by sand blown by the wind on one side, while being soft and crumbly on the other side. They are useful for studying the forces of erosion.
- The dry valleys are considered the nearest equivalent on Earth to the landscape of Mars. As a result, NASA carried out a great deal of preparatory work here before launching it's Viking probe to the rainless deserts of Mars.

Instructions
Using your dry valley resources and the map provided:
- Create three dry valleys within the Antarctic continent.
- Place some ventifacts which you have drawn.
- Add some algae, bacteria and fungi where they would live within your dry valley.
The Southern Right Whale

- So named by whalers because it was the ‘right’ whale to catch, being slow swimming and floating when dead. At 13.5 – 17 metres long and 40 – 80 tonnes, it yielded large quantities of valuable oil.
- Unlike the larger baleen whales, the Right Whale does not have a streamlined torpedo shape. It’s massive head takes up a quarter of its body length and is covered with callosities. These crusty skin growths are homes for thriving colonies of barnacles, parasitic worms and whale lice.
- Has the finest baleen plate of all the baleen whales and traps the smallest prey, tiny copepods forms the major part of their diet.

Squid

- Some live at great depths and others in shallow water where daylight penetrates

Deep Squid
- Large species
- Covered in tiny organs that produce light, possibly for communication
- Predators are diving whales e.g. the Arnoux’s Beaked Whale and the Southern Bottlenose Whale

Shallow Squid
- Smaller species
- Luminous organs on their undersides. These may help them to avoid predators by carefully regulating the light they produce to match down-welling daylight
- Predators are seals, albatrosses and penguins

- Squid require protection from their predators because they are important sources of food for many of the Antarctic’s larger animals. Sperm whale eat virtually nothing except squid
- Human’s are also turning their attention to squid and large commercial squid fisheries are beginning to develop in the Southern Ocean
Seals

Seal adaptations
- Can move with surprising speed across the ice if there is danger
- Hearing is acute to hear even the faintest sounds of ice cracking
- In the water the adult’s whiskers sense the slightest movement of the fastest shrimp
- If wind stings its eyes, they fill with tears
- Milk and fish give them the best of coats and a layer of insulating fat
- The translucent white fur acts like a hothouse, conducting heat from the sun to the animal’s skin
- Milk is ten times richer than cow’s milk
- Can swim at a depths of nearly 600 metres for almost 40 minutes
- Torpedo shaped body
- Shortened or interior set-ears and nostrils that close when they dive
- Like bats, many seals use echo location to find prey by making high pitched noises which bounce off nearby objects
- Eyes on top of head to see dark images (prey) against the white sea ice while swimming
- As soon as the pup is born the mother sniffs the pup all over so that she becomes familiar with its particular smell. Even when the beach is crowded with pups, the mother recognises her own baby by its cry and smell. This is important because if a pup became separated from its mother it would soon starve to death

Weddell Seal

- The most southerly naturally occurring mammal in the world
- Lives on or under the fast-ice near the Antarctic Coast all year round
- During the winter darkness they live permanently under the ice, continually gnawing and scraping away at the ice with their teeth to keep open their breathing holes. Their teeth become worn down as a result, and their gums often develop abscesses. Very few Weddell seals live longer than about 18 years for this reason
- Eats mainly fish and squid and some crustaceans
- Uses sonar to locate their food and to find their way back to holes in the ice
- Champion diver : 600 metres for 40 minutes
Leopard Seal

- Named for their spotted skin
- Live mainly on the northern edge of the pack-ice but are often found in the sea near penguin rockeries and at some Sub-Antarctic Islands
- Ferocious hunters with powerful jaws
- Eat mainly krill, but also birds, penguins, and young crabeater seals

Crabeater Seals

- The most common Antarctic Seal making up almost half the world’s seal population
- Creatures of the drifting pack-ice, great wanderers throughout the Antarctic region but rarely seen ashore
- Eat mainly squid and some fish
- Live for 39 years
- Preyed upon by Orca Whales

Ross Seal

- Least well known as they are the least abundant Antarctic seal
- Live in the thickest areas of the pack-ice
- More abundant near Cape Adare
- Live singularly or in small groups
- Main food is squid
Scenario One: Enhanced Greenhouse Effect

Continued emission of carbon dioxide, by the burning of fossil fuels enhances the Greenhouse effect of the earth’s atmosphere. As a result, global temperatures increase.

Consequences:

Increased Temperature

- Penguins and seals are too hot due to their insulating qualities and die of over heating
- Tropical animals are able to live in the Antarctic region, competition for food, interbreeding between animals, loss of species
- Things can now decay, not enough food for Skuas, bacteria can grows wildly, disease and sickness to species
- Historic huts and science bases deteriorate

Melting of Ice

Raised Sea Level
- Loss of rocky coastal areas, loss of breeding areas

Flattening of the Antarctic Ice Cap
- Loss of katabatic winds, loss of ocean currents, loss of nutrient stirring, not enough energy for food chain – phytoplankton, krill and resultant consequence of loss of these species
- Loss of katabatic winds, not enough wind for Albatross to take off, die

No Ice Shelves and Glaciers
- Land nutrients not scraped and carried out into the ocean, not enough energy for benthos, phytoplankton, krill and the consequent loss of these species

Smaller Pack Ice
- More energy in the sea, too hot for cold adapted fish
- Tropical fish can enter, competition for food
- Adelie and Emperor penguin breeding grounds can be reached by other species, not enough room
- Too thin for seals to lie on and so move to the land, Orcas cannot reach them on the land and starve to death
- Soft sea ice, Weddell seal do not have to use their teeth to make holes for access to and from the ocean. Survive longer, over population, eat out fish and squid, other species starve through lack of food resource
Scenario Two: Ozone Depletion

Level One
Continued and past use of CFC’s in refrigerators, air conditioning and the making of foam are rapidly destroying a layer in the atmosphere called the ozone layer. Ozone acts like a filter, filtering out harmful ultra violet rays from the sun. Ultra violet rays cause rapid deterioration of materials and biological matter and is strongly related to skin cancer. Depletion of the ozone hole means increased ultra violet rays reaching the earth’s surface.

Level Two
Ozone is concentrated into a 50 kilometre thick layer that begins 16 kilometres above the ground at the lower edge of the stratosphere. It shields life on Earth from the damaging effects of ultra violet radiation. The natural rate at which ozone is destroyed is being increased mainly by the presence of free chlorine atoms, which are released by the decomposition of chlorofluorocarbons (CFC’s) above the ozone layer. CFC’s are used as a coolant in refrigerators, propellant in aerosols, air conditioners, and as a blowing agent in the manufacture of foam.

The international effort towards ozone research reflects the growing concern among many scientists, environmentalists and politicians that what we are seeing in Antarctica may be the beginning of a much wider breakdown in the ozone layer.

Consequences

- Destruction to phytoplankton and the resultant consequences of this (beginning of the food chain)
- Skin cancer to animals, slow cruel death, pollution, extra food for bacteria and skuas, over population, disease, and sickness to animals. Prey to Skua over populate, competition for food, starvation and over feeding (destruction) of specie
- Skin cancer to humans, cannot visit, loss of adventure, beauty, scientific activity, world problems not solved (cyclic effect here – further ozone depletion and green house effect)
- Breakdown of building and materials, scientific experiments and survival clothes, costly, less effective science
Increased melt water
- Too much free water for lichens, drown, as a consequence there is no shelter for moss, no soil for plants, no shelter for invertebrates, less nutrients washed out to sea for sea bed, population becomes diminished and vulnerable to prey
- Fresh and salt water lakes become rivers, ancient structure destroyed, species washed out to sea

Easier for human access
- Easier for mineral, gas and oil exploitation, pollution, destruction to the environment
- More appealing to tourists, infrastructure, destruction, pollution, but now less unique because of migration of tropical animals into the area, less beautiful due to destruction

Icebergs Melt
- Loss of beauty
- Loss of habitat for crabeater seals and petrels
- Nutrients not carried out to sea for sea bed and phytoplankton
- Shipping less hazardous, increased human access, environmental impacts

Foundations to buildings melt, collapse of building, and need to use concrete, increased expense and increased foreign material to Antarctica

Warming of the Sea
- Holds less oxygen, oxygen adapted fish die from too much oxygen
- Cold adapted fish die from over heating
- Less temperature gradients between cold and warm areas, diminish of polar front and its productivity
Scenario Three: Building of a Scientific Base

Increasing world problems and the need to solve these problems has lead to an increased demand for scientific research within the Antarctic region. A new scientific base is proposed for the northern Antarctic Peninsula, as this is the most accessible and least costly area. It is the area of most interest as it contains the most abundant wildlife and icefree areas, allowing access to the underlying rocky base.

Consequences

Ground modification, construction of buildings and transport facilities
- Rocks overturned, destruction to plants and invertebrates
- Change of moisture and wind currents, destruction to plants, penguin breeding colonies, loss of food to seals and toothed whales
- Increased dust, melting of snow, loss of algae habitat, impurification of surrounding snow for research

Use of Fossil Fuels, power generation, and transport
- Emission of carbon dioxide, contributing to the green house effect, polluting local snow for scientific research
- Accidental spills, do not break down due to cold conditions, pollution of water, de-water proofing of birds (including penguins), drowning, seals, hypothermia, loss of prey, contamination of nutrients in water general destruction of wildlife

- Sewage outfall, microbacteria introduced into the ecosystem, disease and sickness to some animals, extra food and nutrients to others, over population, competition for food, depletion of prey

- Increased rubbish waiting to be transported back to the country of origin, extra food for skuas, over population of skuas and their natural prey, in balance of food chain. Blown by the wind into the sea, seals and birds play and eat plastic, falls suffocation and poisoning

- Increased science activity, alter the natural state of things, destruction to environment, destruction of resource material for research, increased need for humans, enhanced disruption
Scenario Four: Mineral Exploitation

As the demand for minerals increases, and world mineral resources are depleted, Antarctica may contain some of the richest mineral deposits on the globe. Interest is increasing into the possibility of mineral, gas and oil exploitation within the region.

Owing to the harsh conditions, the thick ice cap and the environmental sensitivity of the region, exploitation of on-shore minerals seems unlikely. It has been suggested however, that with only a few advances in technology, which is perhaps presently being developed and tried by present scientific ice and geological drilling projects within the Antarctic region, commencement of exploitation of on-shore minerals is possibly only a matter of time.

Present technology is already available for exploitation for off shore gas and oil deposits such as those in the Ross Sea region.

Consequences

The hazardous nature of the stormy Antarctic waters, with its sea ice, and icebergs, raises the possibility of oil pollution either from offshore wells, or more likely, from tankers. Such leaks, which would be hard to plug in the extremely harsh conditions, would have a devastating and long lasting impact on all levels of the fragile ecosystem, particularly on the ice-free coastal areas, where many birds, seals, fish and an abundance of smaller marine life are concentrated.

Off-shore oil exploitation would also require substantial on-shore facilities thus creating direct competition with wildlife for the limited amount of easily accessible, snow free areas available and producing additional environmental disturbance to the region.

The effect of seismic surveying on the oceanic wildlife is another area for concern. The high powered shock waves used in such surveys may disrupt whale feeding and reproductive behaviour and may also affect the behaviour of seals, fish and other marine organisms.
Scenario Discussion Questions for ‘What is Antarctica?’

1. What were the consequences?

2. What caused these consequences?

3. What do we need to do to minimise these consequences?

4. How can you act in a way that would contribute to minimising the consequences of this scenario?
The Place of Science

During the ‘What is Antarctica?’ activity, environmental impacts resulting from the practice of science within the Antarctic region was highlighted. It is important, however that students become aware of both the positive and negative impacts of science. The following activity is suggested, to highlight the positive and essential qualities of science within the Antarctic region.

**Learning Objectives**
- Students will experientially solve some present world problems by investigating and finding information in the Antarctic region
- Students will learn that information within the Antarctic region is an important contributor to solving some of the world’s problems
- Students will demonstrate that science has both positive and negative impacts
- Students will suggest strategies to minimise the negative impacts of science

**Resources**
- Antarctic information resource cards
- World Problem resource cards
- A piece of rope
- A flat learning
- Scientists (2 approx)
- Discovery people (10 approx)
- World problem people (10 approx)

**Method**

**Round One**
- Place the rope down the middle of the learning area so there are two equal halves
- Designate one half: the Antarctic region, the other half: world problems
- Discovery people pin Antarctic information resource cards upon themselves
- World Problem people pin world problem resource cards upon themselves
- Discovery people and scientists enter the Antarctic region
- World problem people enter the world problem area and spread themselves out on the furthestmost boundary

- Upon go:
  - World problem people creep (lie down on the ground, extend yourself, stand up and move to edge of extension) towards the rope. The aim is to reach the rope before being solved by the scientists. The closer to the rope, the bigger the problem, upon reaching the rope: destruction to human kind / the planet
  - Scientists make discoveries by tagging discovery people. They investigate the discovery person’s information card and take their new knowledge (discovery person and resource card) out of the Antarctic region and solve the appropriate problem (tag the corresponding problem to the information discovered)
  - Upon the problem being solved, the problem person goes back to the furthestmost boundary to start the creeping process again, the scientist and discovery person re-enter the Antarctic region (scientist is not allowed to re-tag the same discovery person within the first 10 seconds of re-entering the Antarctic region)
Discussion
- What did we do?
- Why was science important?
- What did the scientist need to solve the problems?
- Could this information have been collected from places other than the Antarctic region?
- What are the unique qualities within the Antarctic region that are important for science?

Round Two
But science comes at a cost. As we have learnt previously, there are negative impacts of science; we need to add this to our equation

Additional Resources
- Negative impact cards

Method
- Discuss what the negative impacts of science might be and the consequent effects of this. Lead this discussion to highlight that the very resources science require for their problem solving information is being negatively impacted upon by the practice of science itself.
  - Disturbance to wildlife
  - Ground modification, bases, air strips, science projects
  - Pollution, sewage, oil spills, waste management, noise, aesthetics
  - Introduction of foreign species, micro organisms
  - Increased human presence, humans to support / monitor present humans, more humans to support / monitor more humans
- Scientists are given negative impact cards
- Run the activity as in round one adding: when a scientist discovers a discovery person, they are given a negative impact card from the scientist. Upon collecting three negative impact card you cannot share your information resource card with the scientist (it has become too damaged by the negative impacts to extract information from)

Round Three and Four
- Alter the number of impact cards required to destroy Antarctic information. E.g. one negative impact, five negative impacts

Discussion
- What did we do?
- What impact did this have on solving our world problems?
- To be the most effective at solving world problems, what do scientists need to do?
- Could this scenario be transferred to other parts of the world where scientific activity is taking place?
- Where are the other parts of the world where scientific activity is taking place?
- What is something you could do to minimise your impacts upon the world’s resources?
World Problem Resource Cards

Problem
Increased ultra violet radiation at the earth’s surface causing skin cancer and decline of fragile species

Problem
Increased global temperature from increased carbon dioxide in the earth’s atmosphere. Raising of sea levels, death of cold adapted species and extreme weather patterns results

Problem
Unexplained weather patterns causing disruption to human activity

Problem
Unable to store human organs for medical transplants for long periods of time
Problem

Collapse of fisheries in fishing areas

Problem

Decline of penguins, whales and seals at tourist destinations

Problem

What's on Mars? How will our technology, behaviour and resources react in the Mars environment?

Problem

Is there life in outer space?
Problem

We’re running out of minerals

Problem

Problems we don’t know about yet
Antarctic Information Resource Cards

**Discovery**

Measurement of Ozone depletion in atmosphere above Antarctica

**Discovery**

Measurement of carbon dioxide in the Antarctic atmosphere and within the Antarctic ice cap

**Discovery**

History of global weather and associated atmosphere conditions preserved and analysed in Antarctica’s ice cap

**Discovery**

Discovery of animals that can survive being frozen during the winter months in Antarctica
Discovery

Understanding species relationships and behaviour within the Southern Ocean

Discovery

Researching human impacts upon local ecologies

Discovery

Experimentation and practice of Mars activities in Antarctica, the most similar environment on Earth to Mars

Discovery

Study of meteorites found in Antarctica containing amino acids, a suggestion there is life in outer space
Discovery

Antarctica has very stable geology, trapping 'geological stories' of the earth's past and likely sources of minerals

Discovery

Science for Science sake
Discussion Questions for ‘The Place of Science’

1) What did we do?

2) Why was science important?

3) What did the scientist need to solve the problems?

4) Could this information have been collected from places other than the Antarctic region?

5) What are the unique qualities within the Antarctic region that are important for science?
Negative Impact

Negative Impact

Negative Impact

Negative Impact

Negative Impact

Negative Impact
Further Discussion Questions for ‘The Place of Science’

1. What did we do?

2. What impact did this have on solving our world problems?

3. To be the most effective at solving world problems, what do scientists need to do?

4. Could this scenario be transferred to other parts of the world where scientific activity is taking place?

5. Where are the other parts of the world where scientific activity is taking place?

6. What is something you could do to minimise your impacts upon the world’s resources?
We Need Each Other

The following is a series of experiential activities, which demonstrate the interdependence and balance required between species within the Antarctic ecosystem.
Inspection of the Connection

The Antarctic ecosystem (like all ecosystems) is made up of connections of
dependence between the species within that ecosystem. No species can survive
without the presence of other species. An impact upon one species not only impacts all
those species that are connected and dependent, this in turn has an impact on further species which are also connected and dependent.
This activity experientially demonstrates these connections and effects.

Learning Objective

- Students will create a web of connections for an Antarctic ecosystem
- Students will identify and discuss the interconnectedness and dependence of all
  species within their Antarctic ecosystem
- Students will transfer the knowledge learnt from the Antarctic ecosystem to other
  ecosystems
- Students will understand the meaning of these patterns and suggest management
  systems that need to be considered when humans choose to interact with an
  ecosystem

Resources

- Balls of wool (different colours preferred)
- Species cards
- Facilitator

Method

- Each participant picks up a ball of wool and a species card
- All participants stand in a circle
- One by one each participant passes their ball of wool to all the species they
  depend on for food or shelter, that is, all the species they have a connection with
- The facilitator reads through the scenario cards. Each scenario card impacts upon
  a species (A); this species crouches, representing their diminish in population or
  death.
- All species whose pieces of wool are attached to A (X, Y, Z) crouch down as a
  consequence of A’s diminished population or death.
- All species whose pieces of wool are attached to X, Y, Z crouch down as a
  consequence of X’s, Y’s and Z’s diminished populations or death.
- And so on until there are no more chain reactions
- Go through discussion questions
- Read further scenario and repeat process until all students understand the pattern
  of interconnection and dependence of all species within this ecosystem
- Go through further discussion questions

Discussion during game

- What is happening?
- Why is this happening?
- What does this mean?
- What do we need to do to prevent this from happening?
Further Discussion

- What were the patterns throughout the activity?
- Was the effect the same for all species?
- What does this mean?
- Do you think this applies to other ecosystems?
- What do we need to be thinking of when humans choose to interact with ecosystems, for example: pollution, fishing, and science exploration?
- What are some ways that you impact upon an ecosystem with your present actions?
- How can you modify these actions to minimise your impacts?
Inspection of the Connection

- Krill
- Petrel
- Skua
- Albatross
- Lichens
- Moss
- Antarctic Hair Grass
- Fish
- Humpback Whale
- Seaweed, Corals, Barnacles
- Fungi
- Bacteria
- Sun
- Phytoplankton
Inspection of the Connection Species Cards

Level One

Lichens

- Able to live totally without soil, but requires nutrients
- Obtains nutrients from bare rocks and bird droppings
- Some species can survive for at least 2,000 years

Mosses

- Require moisture and a little sandy soil which is trapped by lichens
- Moss grows especially well next to bird nests where it can gather nutrients from their droppings
- Very old moss forms peat (rich soil) up to several metres

Antarctic Hair Grass

- One of the two flowering plants found on Antarctica
- Requires moisture, sunlight, shelter and nutrients
- Finds moisture and nutrients from moss, fungi, bacteria, and bird droppings

Fungi

- Requires soil made by moss and dead flowering plants
- Working with bacteria, fungi is responsible for breaking down dead plants to form peat and releasing nutrients into the ecosystem

Bacteria

- Responsible, with moss, for breaking down dead plants to form peat and releasing nutrients into the ecosystem
Skua

- Mainly fish feeding, but finds food at bird colonies (Penguin, Albatross and Petrel) by stealing eggs and chicks
- Scavenges at rubbish dumps

Albatross

- The largest bird in the world, adapted to spend endless flight at sea
- Feed on small fish and krill
- Life span of 80 – 85 years

Petrel

- The Wilson’s Storm Petrel found in Antarctica is the smallest bird in the world
- Feed upon krill and small fish
- Often they are seen following humpback whales who drive clumps of krill to the surface of the ocean, within the petrels reach

Fish

- Of the 20,000 kinds of fish known in the world, only about 120 live in the Antarctic region.
- Many of the fish found here are unique to Antarctica and live nowhere else
- Require Seaweed, Corals and Sponges for protection from prey and sources of food
- Also eat krill

Antarctic Seaweed, Corals, Sponges and Barnacles

- Because the Southern Ocean is very cold and for half the year there is no sunlight, seaweed, corals, sponges and barnacles need lots of nutrients. These nutrients come from dead fish, krill, plants and peat made from moss, bacteria and fungi.
- Barnacles also grow within crusty skin growths on Southern Right and Humpback whales
Krill

- The total number of krill in the Southern Ocean is estimated at 600 million million, making krill the most numerous creature on Earth
- Krill eat Phytoplankton during the summer months

Humpback Whale

- Humpback whales feed in the summer on krill
- It's population is only 3% of it's original size due to intensive whaling in the Southern Ocean
- It's massive head is often covered with crusty skin growths which provide homes for barnacles, parasitic worms and whale lice

Phytoplankton

- Tiny plants which grow on the surface of the Southern Ocean during the months of sunshine
- Requires sunshine and nutrients supplied from rocks, dead plants, moss, fungi, bacteria peat, dead fish, krill, whales, seaweed, corals and barnacles
Level Two

Lichens

- Can photosynthesise at a lower temperature than all other plants and with very little light and/or moisture
- Able to live totally without soil, but requires nutrients
- Extracts nutrients from bare rocks
- Flourish next to nesting birds whose guano provides the basic nutrients essential for plant life
- Only increase in size by about 15 millimetres every 100 years
- Some species can survive for at least 2,000 years

Mosses

- Require moisture and a little sandy soil
- Once established, Lichens provide enough shelter to trap the small amount of sandy soil required for moss to grow
- Flourish next to nesting birds whose guano provides the basic nutrients essential for plant life
- The deep moss shoots can slowly accumulate and form peat banks, which may be up to several metres thick, and 5,000 years old

Antarctic Hair Grass

- One of the two flowering plants found on Antarctica
- Restricted to the Antarctic peninsula where it grows in small clumps
- Requires moisture, sunlight, shelter and nutrients
- Finds moisture and nutrients from moss and fungi/bacteria peat
- Flourishes next to nesting birds whose guano provides the basic nutrients essential for plant life

Fungi

- Microscopic filaments of fungi occur in the soil created by mosses and dead plants
- Working with bacteria, fungi is responsible for breaking down dead plants to form peat and releasing nutrients into the ecosystem
Bacteria

- Responsible, with moss, for breaking down dead plants to form peat and releasing nutrients into the ecosystem
- Found to colonise within light-coloured semi-translucent rock, which the sunlight penetrates, in the dry valleys. Some are believed to have been in the rocks for 2000,000 years

Skua

- Highly adapted yet ancient group of birds. Separated from modern gulls for probably 100,000's of years
- Mainly fish feeding, but finds food at bird colonies (Penguin, Albatross and Petrel) by stealing eggs and chicks
- Follows ice breakers, picking up food churned up by the propellers
- Scavenges at rubbish dumps

Albatross

- The largest bird in the world, perfectly adapted to spend endless flight at sea
- Incubation is unusually long (80 days). As a result, parents and chicks stay on land long enough to support populations of avian scavengers such as Skuas
- Feed on small fish and krill
- Life span of 80 – 85 years

Petrel

- Are among the most primitive birds alive today
- The Wilson’s Storm Petrel found in Antarctica is the smallest bird in the world
- Scoop the water for krill and small fish upon which they feed
- If the krill are too deep to scoop, they follow humpback whales who drive clumps of krill up within the petrels reach
Fish

- Of the 20,000 kinds of fish known in the world, only about 120 live in the waters of the Southern Ocean south of the Polar Front. This is less than 1% of the total in an ocean that makes up 10% of the world’s total area of ocean.
- 85% of the species living in the shallow coastal waters are endemic to the Southern Ocean.
- Require Seaweed, Corals and Sponges for protection from prey and sources of food.
- Also eat krill.

Antarctic Seaweed, Corals, Sponges and Barnacles

- The boundary of the benthos, where seaweed, corals and sponges and barnacles flourish, is at the northern limit of the pack ice. Sediments and nutrients from the land (minerals in rocks, dead plants, moss and fungi/bacteria peats) are transported by icebergs and are deposited when they melt, thus determining the boundary of a nutrient rich medium in which benthos life forms.
- Cold, stable temperatures, scarcity of food and sunlight, for significant amounts of the year, lowers metabolic rates of benthos species. As a result they grow larger, more slowly and in many cases for longer than their counterparts in warmer waters. Seaweed and coral beds are extensive and luxuriant. Sponges can live for centuries.
- Barnacles also thrive within callosities (crusty skin growths) on Southern Right and Humpback whales.

Krill

- A shrimp like crustacean that is a major food supply for 5 species of whale, 3 species of seal, 20 species of fish, 3 species of squid and numerous bird species.
- Dependence of so many predators on one prey group is extremely unusual.
- The total number of krill in the Southern Ocean is estimated to be a staggering 600 million million, making krill easily the most numerous creature on Earth.
- Phytoplankton support rapidly increasing numbers of krill during the summer months.
Humpback Whale

- Migrating south from tropical oceans the Humpback whales feed in the summer on swarms of krill
- Population now stands at less than 3% of its original population due to 60 years of intensive whaling in the Southern Ocean
- Its massive head is often covered with callosities, crusty skin growths which provide thriving homes for barnacles, parasitic worms and whale lice

Phytoplankton

- Tiny plants which flourish on the Southern Ocean surface during the months of sunshine
- Low temperatures of the Southern Ocean waters might be expected to slow down phytoplankton growth. But the Southern Ocean makes up for the cold by being rich in nutrients transported from the land, such as minerals from rocks, dead plants, moss and fungi/bacteria peat, by glaciers and pack-ice; and from the sea floor, such as dead fish, krill, whales, seaweed, corals and barnacles by vertical ocean currents at the Polar Front
Scenarios for Inspection of the Connection

1. Due to the destruction of the Ozone in the earth’s atmosphere, increased levels of ultra violet radiation reaches the earth’s surface. Fragile, tiny species such as:
   a) Phytoplanckton
   b) Bacteria are unable to survive

2. As a result of increased health awareness amongst humans, there is an increased demand for fish as they are marketed as the clean, green, low fat, high protein meal. Fish stocks in the northern hemisphere are already depleted, so fishing companies turn to fishing the Southern Ocean in a gold rush manner
   a) fish are depleted
   b) Petrel numbers diminish as they mistake the long line hooks for small fish

3. Continued Carbon Dioxide emissions from the burning of fossil fuels raises the earth’s temperature by enhancing the ‘Green House Effect’ of the earth’s atmosphere. The ice cap melts, and pack ice no longer transports land nutrients out to the sea.
   a) Seaweed and corals away from the coast do not receive enough nutrients to survive
   b) Phytoplanckton blooms are small due to the lack of nutrients in the ocean

4. Science chemicals for measuring the acidity of soils are accidentally placed in the wrong rubbish tin, where recycling and separation of toxic waste usually occurs. Skuas who have learnt that rubbish dumps are a good supply of food, feed upon rubbish that is contaminated by the toxic chemicals and die

5. The sun goes down for the winter months
Discussion Questions for Inspection of the Connection

1) What were the patterns throughout the activity?

2) Was the effect the same for all species?

3) What does this mean?

4) Do you think this applies to other ecosystems?

5) What are some ways that you impact upon an ecosystem with your present actions?

6) How can you modify these actions to minimise your impacts?
The Pyramid of Life

Not only do species within an ecosystem have a connection and interdependence between each other, but also these factors occur in an ordered structure. The following activity highlights this structure and its importance for the survival of an ecosystem.

**Learning Objectives**
- Students will experientially construct a structure that maintains an Antarctic ecosystem
- Students will identify the important characteristics of this structure and why it is required for the survival of an ecosystem
- Students will identify human activities that are presently destroying the structure of the Antarctic ecosystem and the consequences of this
- Students will suggest alternative human activities that would be more effective in maintaining the Antarctic ecosystem
- Students will transfer the knowledge learnt about the Antarctic ecosystem to other systems

**Resources**
- Specie cards
- A flat learning area (preferably on grass or a crash mat)

**Method**
- Each participant takes a specie card of their own choice
- Participants build a specie pyramid in trophic levels

![Pyramid Diagram]

- Did the pyramid work? Why not? What needs to change?
- Participants reselect their specie cards in order to make the pyramid to work
- Participants effectively build the structure of the ecosystem (a pyramid)

**Discussion**
- What did we do?
- What was important about our second pyramid?
- If our pyramid reflects an ecosystem, what is important for the survival of an Antarctic ecosystem?
- What present human activities could be destroying the structure of our Antarctic ecosystem?
- What are the consequences of this?
- If you were managing human activities within this ecosystem, what would you suggest?
- Does this apply to other ecosystems? Why? Why not?
- What is something that you could now do to help preserve ecosystems?
Pyramid of Life Cards

Level One

Phytoplankton

- Tiny plants that live in the Southern Ocean
- Start the food chain by feeding off the sun’s energy

Krill

- A small sea animal that lives in the Southern Ocean
- Feeds upon tiny plants called Phytoplankton

Penguin

- A bird that flies under the water in the Southern Ocean
- Eggs have red yolks, coloured by the pink krill upon which they eat

Blue Whale

- The largest animal in the world (24 – 28 metres in length)
- Its tongue alone weighs as much as an elephant
- The Blue whale eats 6 million individual krill a day by using a very large sieve in it’s mouth. This large sieve is called a baleen

Orca

- Large black and white whales, weighing up to 8 tonnes
- Hunt cooperatively to feed on seals, penguins and small whales
Level Two

Phytoplankton

- Tiny plants that live in the Southern Ocean. They are too small to see without a microscope, but big enough to be food for tiny animals
- Responsible for starting the food chains in the Southern Ocean. Phytoplankton do this by trapping the sun’s energy through photosynthesis

Krill

- A shrimp like crustacean belonging to the zooplankton family
- Live in huge swarms feeding on phytoplankton
- The most numerous creature on Earth

Penguin

- Birds which fly in the water
- The Emperor Penguin is perhaps the only species of bird that never sets foot on land, choosing to live in the sea and on the fast ice of the Antarctic Continent
- Eggs have red yokes. This is caused by the red pigment in the krill upon which they eat

Blue Whale

- The largest animal that has ever existed on land or sea. 150 tonnes, 24 – 28 metres in length
- Eats 6 tonnes of krill (or 6 million individual krill) a day, using a big sieve in its mouth called a baleen plate
- Population now stands at 1% of its original population due to whaling throughout the last century

Orca

- Widely spread throughout the Southern Ocean. Orca whales spend their lives in small family groups called pods
- They weigh up to 8 tonnes
- They are fierce hunters and hunt co-operatively to trap seals, penguins and small whales
- The Orca is the only whale to eat warm blooded mammals
Discussion Questions for 'The Pyramid of Life'

1) What did we do?

2) What was important about our second pyramid?

3) If our pyramid reflects an ecosystem, what is important for the survival of an Antarctic ecosystem?

4) What present human activities could be destroying the structure of our Antarctic ecosystem?

5) What are the consequences of this?

6) If you were managing human activities within this ecosystem, what would you suggest?

7) Does this apply to other ecosystems? Why? Why not?

8) What is something that you could now do to help preserve ecosystems?
Keeping It In Balance

All species within the Antarctic region are in a state of balance. Each species supports and is dependent upon another. Characteristics of a species population, such as an increase or decrease in population numbers, are reflected throughout the Antarctic ecosystem. Due to natural variation within an ecosystem, balance within the ecosystem is not static. Instead it sways, moving with the natural changes, to maintain equilibrium within the ecosystem.

Balance is an ecosystem’s state of equilibrium, it is constantly variable and reflects the interdependence, co-operation and wholeness of an ecosystem.

This activity aims to highlight the ecosystem balance. Participants will create and live in a functioning Antarctic ecosystem. Throughout the activity, ecosystem variation will naturally occur and as a result species (participant) behaviour will change. Participants are asked to note the patterns of variation and change within their ecosystem to acquire an understanding of ecosystem balance.

Learning Objectives
- Students will create and live in an Antarctic ecosystem
- Students will note natural and unnatural variability and change while living in the Antarctic ecosystem
- Students will identify the consequences upon an ecosystem as a result of these changes
- Students will discuss the features and importance of balance within an ecosystem

Resources
- Ecosystem (a flat learning area)
- Specie cards
- Energy disks
- Pegs

Method

Round One – natural change
- Participants choose a species card and peg it onto their front, they now represent this species.
- All participants are given three energy disks
- Participants identify their prey and aims to catch (tag) that species
- Upon being eaten (tagged by predator) an energy disk is passed to the predator
- If a participant runs out of energy they exit the ecosystem
- As whales have no natural predators, die upon collecting ten energy disks. The energy disks are given to the phytoplankton species, as their decaying bodies provide extra nutrients. Upon dying, whales are immediately reborn again and continue participating in the ecosystem
Discussion Questions
- What did we do?
- What happened?
- What were some of the patterns, variables that you identified during this activity?
- Was our ecosystem in balance?
  Yes – how did we achieve this?
  No – what does our ecosystem need to do to become in balance?
- What is the consequence for an ecosystem if it is in balance?
- What is the consequence for an ecosystem if it is not in balance?

Successive Rounds – unnatural change
- Add a fisher-person: vary the specie—the fisher-person targets [highlighting change in ecosystem balance with the diminish of a specie]. Are the consequences the same for all specie?
- Add ozone: kills, removes energy from phytoplankton [highlighting change in ecosystem balance with the diminish of the producers]
- Add rubbish: if eaten (tagged by a skua) provides extra energy and rubbish is breed into a skua [highlights the change in ecosystem balance when a specie population is on the increase]

Discussion Questions
- What did we do?
- What happened?
- What were some of the patterns, variables that you identified during this activity?
- Was our ecosystem in balance?
  Yes – how did we achieve this?
  No – what does our ecosystem need to do to become in balance?
- What is the consequence for an ecosystem if it is in balance?
- What is the consequence for an ecosystem if it is not in balance?
Krill

Preys on Phytoplankton
Krill

Preys on Phytoplankton
Krill

Preys on Phytoplankton
Krill

Preys on Phytoplankton
Emperor Penguin
Preys on Krill

Adelie Penguin
Preys on Krill, Fish and Squid
Chinstrap Penguin
Preys on Krill

Snow Petrel
Preys on Krill, Fish and shallow water Squid
Albatross

Preys on Krill and Small Fish

Skua

Preys on Albatross, Petrel and Penguin chicks, Seal pups, Fish, and scavenges from rubbish dumps
Spider
Preys on Corals, Seaweed and Phytoplankton

Star Fish
Preys on Coral, Seaweed and Phytoplankton
Seaweed

Preys on nutrients in water and Phytoplankton

Coral

Preys on water nutrients and phytoplankton
Fish

Prey on Coral, Spiders, Starfish and Krill

Blue Whale

Preys on Krill
Sperm Whale

Preys on Squid

Orca Whale

Preys on baby Whales, Seals and Penguins
Squid
Preys on Spiders, Starfish, and Fish

Weddell Seal
Preys of Fish, Squid and some Krill
Leopard Seal

Prey on Krill, Birds, and young Crabeater seals

Crabeater Seal

Prey mainly on Squid and some Krill
Phytoplankton

Preys on nutrients and sunshine
Phytoplankton

Preys on nutrients and sunshine
Phytoplankton

Preys on nutrients and sunshine
Phytoplankton
Preys on nutrients and sunshine
Energy Disks for ‘Keeping it in Balance’
Discussion Questions for 'Keeping it in Balance'

1. What did we do?

2. What happened?

3. What were some of the patterns, variables that you identified during this activity?

4. Was our ecosystem in balance?
   Yes – how did we achieve this?
   No – what does our ecosystem need to do to become in balance?

5. What is the consequence for an ecosystem if it is in balance?

6. What is the consequence for an ecosystem if it is not in balance?
Why is the Antarctic Ecosystem so Fragile?

The following is a series of experiential learning activities highlighting the special qualities of the Antarctic ecosystem and its response to human interaction.
Breeding Maturity Age:

Antarctic species are especially vulnerable to human impacts because they take a long time to mature. The following activity highlights species vulnerability rates to human impacts as a consequence of the length of time it takes them to mature to their breeding age.

**Learning Objectives**
- Students will become aware of the vulnerability of Antarctic species to human impacts due to their tendency to take a long time to reach breeding maturity
- Students will discuss future options in managing human interaction and Antarctic species

**Resources**
- The Antarctic (perimeter of activity)
- A breeding ground (area set aside from activity)
- Time keeper
- Animals (e.g. Krill, one year to breeding maturity)
- Human that impacts upon the animals (e.g. a fisher-person)

**Method**
- Two mature breeding krill and one fisher-person enter the Antarctic. The fisher-person aims to catch the breeding krill.
- If a krill is caught by the fisher-person (tagged) they die and return to the breeding ground
- After one minute (representing one year to reach breeding maturity) the surviving breeding krill may enter the breeding ground and release another krill
- Continue this process and watch the impact of the fisher-person upon the krill

For successive experiential rounds:
- Alter the length of time that it takes for the animal to reach breeding maturity and is able to enter the breeding ground – what is the effect upon the populations?
Suggestions for species:

<table>
<thead>
<tr>
<th>Specie</th>
<th>Breeding Maturity Age (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krill</td>
<td>1</td>
</tr>
<tr>
<td>Adelie penguin</td>
<td>4-6</td>
</tr>
<tr>
<td>Blue Whale</td>
<td>5</td>
</tr>
<tr>
<td>Skua</td>
<td>5-6</td>
</tr>
<tr>
<td>Wandering Albatross</td>
<td>10-14</td>
</tr>
<tr>
<td>Springtails:</td>
<td>no set breeding season, reproduce</td>
</tr>
<tr>
<td></td>
<td>whenever the temperature</td>
</tr>
<tr>
<td></td>
<td>Rises above freezing point</td>
</tr>
</tbody>
</table>

Discussion Questions:
- What species' population was least impacted upon by human interference?
- What species' population was the most impacted upon by human interference?
- What happens when the breeding maturity age increases?
- How does this apply to Antarctic species?
- What human activities are presently affecting Antarctic specie populations?
- What do we need to consider when managing human interactions and Antarctic species?
- Can this be applied to managing human interactions and New Zealand species? If not, what needs to be changed?
- What can you do?
Breeding Maturity Age Discussion Questions:

1) What species’ population was least impacted upon by human interference?

2) What species’ population was the most impacted upon by human interference?

3) What happens when the breeding maturity age increases? How does this apply to Antarctic species?

4) What human activities are presently affecting Antarctic species populations?

5) What do we need to consider when managing human interactions and Antarctic species?

6) Can this be applied to managing human interactions and New Zealand species? If not, what needs to be changed?

7) What can you do to minimise your impact upon a) Antarctic species b) New Zealand species?
A Mixed up Bunch

Antarctic fish are especially vulnerable to over fishing because juvenile fish and adults are found in the same fishing grounds. Many undersized fish are caught in fisheries where there are no mesh-size regulations.

Since 1969 three of the four most important fin fish species: marbled notothenia, scaled notothenia and the Patagonian toothfish, have been heavily over fished in the area and few controls have been introduced

Learning Objectives
- Students will become aware of the vulnerability of Antarctic animals to human impacts due to their tendency to live in the same areas, despite their maturity.
- Students will discuss future options in managing human interaction and Antarctic species

Resources
- A fisher-person
- Participants equally divided into adult icefish, juvenile icefish and icefish eggs
- Time keeper
- A habitat area

Method

Round One : A Separate bunch
- Divide the learning area into three habitats (adult, juvenile, eggs)
- Participants go and live in their habitats
  - Adults walk (swim)
  - Juvenile crawl
  - Eggs crouch and stay put
- Fisher-person only fishes in the adult habitat
- If an adult icefish is caught by the fisher-person (by tagging), they exit the adult icefish habitat
- After one minute:
  - eggs move to juvenile habitat
  - juveniles move to adult habitat
  - caught adults move to egg habitat
- Play the game for sufficient length of time to be able to observe the level of impact upon the specie from the fisher-person
Round Two: A mixed up bunch

- The entire learning area is a habitat for all icefish regardless of their designated maturity
  - Adults walk (swim)
  - Juvenile crawl
  - Eggs crouch and stay put
- Fisher-person may fish any icefish or egg within the breeding habitat, if caught the participant exits the habitat area until the next minute
- After one minute:
  - eggs move to juvenile stage and movement
  - juveniles move to adult stage and movement
  - caught participants move to egg stage and movement
- Play the game for sufficient length of time to be able to observe the level of impact upon the specie from the fisher-person

Discussion:

- What happened in round one?
- What happened in round two?
- What was the difference? How does living in one habitat area affect the icefish’s vulnerability to fishing?
- There are few fishing regulations in the Southern Ocean, what do you think the consequences of this could be?
- How can we manage the fisheries in the Southern Ocean?
- Could this plan be used to manage New Zealand’s fishing in local oceans, lakes, rivers, and estuaries?
- What can you do?
Discussion Questions for ‘A Mixed up Bunch’

1) What happened in round one?

2) What happened in round two?

3) What was the difference? How does living in one habitat area affect the icefish’s vulnerability to fishing?

4) There are few fishing regulations in the Southern Ocean, what do you think the consequences of this could be?

5) How can we manage the fisheries in the Southern Ocean?

6) Could this plan be used to manage New Zealand’s fishing in local oceans, lakes, rivers, and estuaries?

7) What can you do?
Adding a Financial Component (continuation of ‘A Mixed up Bunch’)

OK, OK, so you might not care about the survival of the icefish. But you want to make money out of it instead! Well let’s see if the icefish market is vulnerable to overfishing by catching as much as you can (just like in round two). Let’s look at the long-term value of catching both adult and juvenile icefish.

**Learning Objective:**
- Students will become aware that regulated and managed fishing has a long term monetary benefit rather than ‘gold rush’ fishing.

**Additional Resources**
- Money

**Method**
- Run round one and two of the ‘Mixed up Bunch’ activity again. But this time each fish has a value and they hand this to the fisher-person before dying:
  - Adult icefish $5
  - Juvenile icefish $3
  - Eggs $1
- At the end of a set time for both rounds the fisher-person counts up the money s/he has made from fishing

**Discussion**
- What is the monetary difference between the two rounds?
- Does this apply to fishing in the Southern Ocean?
- If you were managing the fishing in the Southern Ocean, what would you suggest?
- Can your suggestions be used for managing New Zealand’s oceans, rivers, lakes, and estuaries? If not, what needs to be changed?
- What can you do now?
Discussion Questions for Adding a Financial Component
(continuation of ‘A Mixed up Bunch’)

1) What is the monetary difference between the two rounds?

2) Does this apply to fishing in the Southern Ocean?

3) If you were managing the fishing in the Southern Ocean, what would you suggest?

4) Can your suggestions be used for managing New Zealand’s oceans, rivers, lakes, and estuaries? If not, what needs to be changed?

5) What can you do now?
Resource Management

Within one year Antarctica has a finite quantity of resources. This resource is at its largest during the short summer. The sun provides energy for phytoplankton blooms, which as a result, initiates a chain of feeding and breeding throughout the food web. Fresh water is unlocked from frozen ice providing sustenance for algae, lichens and other plants creating a further chain reaction of feeding and breeding of species throughout the Antarctic ecosystem.

A successful flourishing and ultimate survival of all species within the Antarctic ecosystem requires effective resource management. All species need to efficiently use and share the finite resources that are available within the system.

This activity aims to demonstrate the ‘natural resource management’ that is present within the Antarctic ecosystem. It provides a model, which can subsequently be considered when aiming to integrate human resource use within Antarctic ecological system.

Learning Objectives
- Students will experientially form a resource management system that is efficient for a number of Antarctic species.
- Students will use their resource management system as a model for managing additional resource use within the same area, e.g. Fishing in the Southern Ocean.
- Students will design an overall resource management plan which includes both natural and additional users.

Resources
- A learning area
- Resource and species playing cards

Method
- Divide the participants into groups
- Provide each group with a set of resource and species playing cards
- Each participant picks up a species card – they now represent this species throughout the entire activity. Read the species card and identify the types of food you can catch and eat (what resource you can use).
- Each participant is given a resource card. If they cannot eat the resource on their card they place it turned down and without speaking, give it to the species they think may eat this resource.
- Resource cards are silently passed onto further species until all species have a resource card which they can eat.
- No species may take a resource card off another species, it has to be given.
- No species may talk or communicate to another species unless to give a resource card to that species.
Discussion

- What did your group do?
- How did you maximise your resource use?
- What management strategies have species evolved to develop efficient resource management?
- What could humans do to maximise their resource use?
- If you were in the position of managing human resource use within the Antarctic region, what would you suggest?
- Can your resource management plan be used here in New Zealand? If not what needs to be changed?
- What can you do now to improve your energy resource use?
Specie Cards for Resource Management

Blue Whale
- Feeds on krill
- You have a coarse Baleen plate and therefore can trap only large krill

Southern Right Whale
- Feeds on krill
- You have a very fine Baleen plate and can feed on all sizes of krill

Humpback Whale
- Feeds on krill
- Preferring to stay close to the coast, you only catch krill near the shore

Sperm Whale
- Feeds on krill and squid
- Having unique ballast qualities, you are able to dive deeper than any other whale

Bottle-nosed Whale
- Eats krill and squid
- You dive for your food to moderate depths only

Arnoux’s Beaked Whale
- Feeds on krill and squid
- Preferring to live along way south you catch krill close to the coastline and squid at moderate depths under the ocean

Orca
- Feeds on Penguins, Seals and Small Whales
- You are able to penetrate deep into the pack ice, smashing your way through the ice to get your prey
Small krill
close to the coastline

Krill
out in the middle of the
Southern Ocean

Large krill
Close to the
Coastline

Seal

Squid
living on the Southern Ocean
floor in a very deep valley

Squid
living in shallow waters near
Antarctica’s coast
Moderately deep squid out in the middle of the Southern Ocean
Discussion Questions For Resource Management

1) What did your group do?

2) How did you maximise your resource use?

3) What management strategies have species evolved to develop efficient resource management?

4) What could humans do to maximise their resource use?

5) If you were in the position of managing human resource use within the Antarctic region, what would you suggest?

6) Can your resource management plan be used here in New Zealand? If not what needs to be changed?

7) What can you do now to improve your energy resource use?