# Environmental Issues

## Teachers

This unit of work has been designed to support your class visit for the 'Environmental Issues' programme at the National Aquarium of New Zealand. Students will participate in a range of level-specific interactive activities.

The primary focus of this programme is the Living World Strand of the Science Curriculum, however when planning your unit of work, links can be made to other essential learning areas. Similarly, different essential skills can be emphasised depending on the needs of your students.

## **Programme Overview**

The Environmental Issues programme teaches students about the different types of issues that affect both aquatic and terrestrial environments, with a special emphasis on environmental issues that affect New Zealand.

Students will examine the positive and negative impacts humans have on the environment. They will discover the importance of independence, biodiversity and sustainability as well as what they can do to help the environment.

## Essential Learning Area: Science

Strand: Living World

Achievement Aims 1 and 4: Gain an understanding of order and pattern in the diversity of living organisms, including the special characteristics of New Zealand plants and animals. Investigate local ecosystems and understand the interdependence of living organisms, including humans, and their relationship with their physical environment.

Strand: Planet Earth and Beyond

**Achievement Aim 4:** Investigate how people's decisions and activities change planet Earth's physical environment, and develop a responsibility for the guardianship of planet Earth and its resources.

Level	Essential Learning Area	Strand	Achievement Aim	Achievement Objective
1	Science	Living World	Understanding order and pattern.	Observe and identify parts of animals and plants.
2	Science	Living World	Understanding the interdependence of living organisms and their relationship to the environment.	Investigate the responses of plants and animals, including people, to environmental changes in their habitats.
3	Science	Living World	Understanding order and pattern.	Investigate special features of common animals and plants. Describe how some species have become extinct or are endangered.
4	Science	Living World	Understanding the interdependence of living organisms and their relationship to the environment.	Use simple food chains to explain the feeding relationships of familiar animals and plants, and investigate effects of human intervention on these relationships.
2	Science	Planet Earth and Beyond	Investigate people's decisions and develop a responsibility for the guardianship of the planet.	Investigate easily observable physical features and patterns and consider how the features are affected by people.
3	Science	Planet Earth and Beyond	Investigate people's decisions and develop a responsibility for the guardianship of the planet.	Justify their personal involvement in a school or class-initiated local environmental project.
4	Science	Planet Earth and Beyond	Investigate people's decisions and develop a responsibility for the guardianship of the planet.	Investigate a local environment issue and explain the reasons for the community's involvement.

## Scientific Skills and Attitudes

- Focusing and Planning
- Information Gathering
- Processing and Interpreting
- Reporting

The 'Environmental Issues' programme at the National Aquarium of New Zealand lays the foundation for developing the above investigative skills and attitudes.

## **Specific Learning Outcomes**

- To understand, interdependence, biodiversity and sustainability
- To become aware how humans affect the environment

#### MAJOR TOPICS COVERED BY THIS BOOKLET consisting of three parts:

- 1) New Zealand a special place for biodiversity
- 2) Help! Our biodiversity
- 3) Habitat loss
- 4) Introduction of species
- 5) Pollution
- 6) Population growth and over-consumption
- 7) What can we do?

## Environmental Issues Pre -visit Activities

## Part 2- Pre-visit activities

#### Freshwater systems

New Zealand freshwater systems are just as important as marine or terrestrial ecosystems. The freshwater systems include rivers, creeks, lakes and swamps. New Zealand has a variety of freshwater animals, many of which are endemic. Many of the native fishes, crayfish and invertebrates lurk in small muddy creeks or swamps and are often hard to see. Some of the rare New Zealand fish (mud fish) are confined to small specific locations in New Zealand. The main threats to freshwater systems and their wildlife is, habitat destruction (e.g. clearing of bush along stream sides, draining of wetlands and pollution of waterways) and introduction of unwanted fish.

#### **Brainstorm**

Ask the class to describe some of the freshwater systems they know and suggest what some of the threats to those special places might be.

#### Whitebait and eels

Do a research project on whitebait (*Glaxiid* spp.) or longfin eels. Where are these native fish found? Do they migrate outside New Zealand waters? What are some of the cultural significances of these fish? How long do the fish live for and are they rare or threatened? What are some of the threats to the native fish.

While you are at the aquarium check out the Glaxiids and eels on display. Take note of the habitat in the aquarium displays. Do any of the fresh water places you know have a similar habitat to the displays? Suggest what habitats the displays are depicting.

Use the eel and whitebait colouring in picture at the back of the booklet to revise some facts you have learnt.

## Fabulous Facts .... Do you know?

What are those threats to freshwater systems again?...

#### Threats to the river system habitat:

- Dams and weirs stop migration of some fish, low water levels below limit fish breeding, and food sources.
- Removal of trees may lead to stream bank erosion, leaves and berries from trees could be a food source to fish and invertebrates, provide shelter. Although, removal of *some* trees types could be a good thing. For example crack willow can block water ways and may be a problem during flood events.
- Fertilizers and effluent (see pollution section).
- Introduced species (e.g. carp, trout and catfish) can eat native fish, introduce diseases and muddy waters.

#### Destructive humans

Make posters showing how humans contribute to habitat loss. For example, cutting down trees, polluting habitats, ploughing up wetlands, landfills, burning of scrub and tussock grassland, overstocking fragile places with animals (e.g. cattle).

#### What are the consequences?

Ask the children to choose a habitat and list all the threats to that habitat. Using coloured paper, make arrows to link threats to and impacts on the habitat and therefore the effects on animal and plant life. For example, the loss of bush will lead to  $\rightarrow$  loss of insects and flowers and berries  $\rightarrow$  no food for the birds  $\rightarrow$  more competition between birds  $\rightarrow$  fewer birds in the area. Nutrification of streams will lead to  $\rightarrow$  fertilisers will add to the nutrients in the water  $\rightarrow$  this encourages algal growth  $\rightarrow$  the algae shades other aquatic plants from sunlight  $\rightarrow$  the algal bloom eventually dies  $\rightarrow$  the break down of algae by bacteria leads to a decrease in oxygen in the water column  $\rightarrow$  fish and other freshwater animals may die.

#### Experimental consequences of habitat loss

Make your own mini landscapes. Make hills out of mounds of soil and sand. Plant the landscape with different small plants (e.g. marigolds, clover and grass seed). Gently water and watch the landscape grow. Once plants are well established, conduct a rainfall experiment. Make a new landscape (with soil and sand) without vegetation, modify some of the classroom landscapes so that they have half bare soil and half vegetated and leave some landscapes fully vegetated. Sprinkle water over the different landscapes and then pour water over the landscapes. Observe what happens! Ask the class to discuss the different types of landscapes and how they coped with the different water regimes.

## **Introduced Species**

Introduced plants and animals are ones which are not naturally found in New Zealand, that is they have been introduced by humans (usually many times to get successful populations established in New Zealand). For example, rabbits were introduced in several locations in the South Island in 1862. By 1870 - 1900 rabbits had become a major problem in central parts of the South Island due to the fact that they did not have any predators (the predators had to be introduced too!) or diseases.

#### What is introduced?

Brainstorm the word **introduced**. Ask the class to give examples of **introduced** plants and animals that they know. Fill in the suggested table (see back of the booklet) make the results into a classroom poster.

#### Research an introduced animal or plant

Students could present research on N.Z. introduced species and the effect they have had on N.Z. native species and ecosystems. For example: Koi carp in the Waikato River, the effect of Northern Pacific Starfish in Australia, Asian mussel, *Musculista senhousia*, the seaweed *Undaria* and ballast water, toxic phytoplankton.

#### Fabulous Facts .... Do you know?

There are many species introduced into New Zealand, often unintentionally.

Invasive seaweed called *Undaria* (Wakame) has taken over many ports and parts of the coastline around New Zealand. *Undaria* is large, brown seaweed which is farmed and used in food products in Japan and other Asian countries. *Undaria* was most likely introduced into New Zealand water via ballast water and via vessels that had the seaweed attach to the bottom of their hulls. This seaweed is bad news as it can spread widely (one adult can produce 200 million zoospores) and can grow rapidly (1cm per day) leaving very little space and light for the native seaweeds.

Freshwater weeds can be just as bad. *Lagarosiphon major*, is a major freshwater weed that has invaded most North Island lakes and rivers and many of the South Island freshwater systems. In the lower part of the South Island there is a programme to prevent further spread. This aquatic weed originates from southern Africa and can grow from small bits of vegetative material. *Lagarosiphon* can grow into large swards and can out compete many of the native freshwater plants.

Tracking weed problems! *Lagarosiphon major* was accidentally introduced into Lake Wanaka. This lead to a massive diving campaign aimed at 'weeding out' the plant. The source of the introduction was thought to have been due to the contents of a fish bowl been tipped into the lake!

#### What is ballast water?

Ballast water is the term given to water that is held in the hull of large ships to provide stability. Ballast water is only needed when ships are out in the open ocean so water is pumped out when the ship comes to port, normally within a harbour or sheltered bay and is pumped back in when the ship leaves the port. Ballast water is pumped through an intake pipe with coarse filters, these stop large fish and other organisms being sucked into the hull. However, small organisms (<1cm) are taken in with the ballast water and can survive long journeys, for example Japan to New Zealand. Most small organisms don't survive temperature differences in waters, once pumped out into a new environment. However occasionally, particularly if the water between ports is a similar temperature, the small organisms do survive and grow into adult animals and plants.

#### **De-contamination!**

Discuss the problems of ballast water with the class. Ask the class to come up with some ideas how to stop the ballast water problem. How would you de-contaminate ballast water?

There are several ways in which to stop the spread of invasive marine organisms from ballast water:

- A high dosage of U.V. light kills many organisms within the ballast water. However this is an expensive option.
- Fine mesh filters fitted to the intake pipes stop organisms entering the hull of ships. However, fine filters slow down the entry of water into the hull and filters get blocked regularly.
- Chemical treatment of ballast water will kill any organism. However, any chemicals used may affect marine organisms outside the ship once the ballast water is discharged.
- Disallow ships to discharge water within coastal waters. This method is a voluntary option within New Zealand coastal waters. However, not all ships dump their ballast water out at sea and the very large ships are unable to discharge ballast water out in the open sea as they can become unstable and sink, particularly if there are rough seas.

#### Ministry of Fisheries and Ministry of Agriculture and Forestry

Invite a person from the Ministry of Fisheries or Ministry of Agriculture and Forestry to come and talk about some of the different issues that they deal with (for example – illegal fishing or bio security issues). Make a list of questions during the course of your lessons to ask the invited speaker. Make a *pest* or *marine* related 'thank you' gift for the invited speaker.

#### Fabulous Facts .... Do you know?

Ballast water has been the linked between New Zealand coastal waters and introduced unwanted species.

So what species have taken a ride or could have taken a ride to New Zealand via Ballast water?

**Undaria** (*Undaria pinnatifida*) originally from Japan and is now found along many parts of the New Zealand coastline, particularly in harbours.

#### SERIOUS THREATS - CAUSING PROBLEMS OVERSEAS...

**Swimming Crab** (*Charybdis japonica*) originally from Japan, Korea and Malaysia and has been found in Auckland waters (in 2000).

**Northern Pacific Starfish** (*Asterias amurensis*) originally from the North Pacific and is now found in Australia. Not in New Zealand yet, but is considered to be a possible threat to New Zealand marine species.

**Young Mediterranean Fanworm** (*Sabella spallanzanii*) originally from the Mediterranean and east Atlantic coast. Not yet in New Zealand waters but may cause a threat to commercial shellfish farming and will compete with native filter feeders.

**European Shore Crab** (*Carcinus maenas*) originally found along the coast from Norway to the Mediterranean. Not yet in New Zealand but may displace native crabs.

**Chinese Mitten Crab** (*Eriocheir sinensis*) originally from China and Korea. Not yet in New Zealand but if it arrives may cause a problem burrowing into stream and river banks near estuaries.

Asian Clam (*Potamocorbula amurensis*) originally from Japan, China and Korea. Not in New Zealand yet but likely to displace native benthic (ground-dwelling) communities and change the dynamics of phytoplankton communities.

Undaria





Northern pacific starfish

For more information and identification sheets, check out the Ministry of Fisheries web site.

#### Wanted dead or alive!

Make a class set of 'WANTED DEAD OR ALIVE' posters for introduced species. For example, Koi carp, possums, *Undaria* seaweed. On the poster write a few sentences why they are wanted..... What is the reward? See example of poster at back of booklet for ideas.

#### Pests and native animals

Introduced animals, such as possums, stoats, ferrets, weasels, including domesticated animals such as cats and dogs are a threat to New Zealand native wildlife.

Kiwi, our national icon is under threat from introduced pests such as ferrets, stoats, weasels and possums. Ferrets are the largest of the mustelid family (includes ferrets, stoats and weasels) and are capable of killing both kiwi chicks and adults. Stoats and weasels kill kiwi chicks. Possums, may disturb kiwi nests, destroy native habitat of kiwi and eat invertebrates that may be food sources for kiwi.

#### Fabulous Facts .... Do you know?

How do you tell the difference between ferrets, stoats and weasels?

Ferrets (*Mustela furo*) are the largest of the mustelids. They have creamy fur flecked with black. They can often have black or brown 'banding' around the face and neck.

Stoats (*Mustela ermina*) are the second largest of the mustelids. They have ginger/tan fur with a white chest and belly region. They can be distinguished from weasels by the black tip at the end of their tails.

Weasels (*Mustela nivalis*) are the smallest of the mustelids. They have similar colouration to stoats but do not have black tip on their tails. Their tails are usually smaller and less bushy than those of stoats.

Feral cats and even the pet dog are also capable killing kiwi chicks and adults!

Ask the class how they would stop the pests from harming or killing the kiwi? What sort of traps would they devise? How would they stop dogs and cats from killing kiwi chicks and adults? Make posters advocating keeping dogs and cats away from kiwi areas.

Invite a 'Kiwi recovery' or 'Department of Conservation' person to the school to give a talk about kiwi and ways they trap/kill kiwi predators.

Hint: Schools from the Hawke's Bay region could do a trip to Boundary Stream Mainland Island, where kiwi have been re-introduced.

#### Fabulous Facts .... Do you know?

Tuatara have lived without modification for ~200 million years! A true living fossil!

Tuatara was once wide-spread in New Zealand. However, **predation** and '**nest-robbing**' from a range of predators such as rats (kiore, ship rat, Norwegian rat), cats and mustelids (stoats and ferrets), now means Tuatara are confined to offshore islands around New Zealand. Other factors, such as overseas collectors in the 1800s and habitat destruction also contributed to the Tuataras decline.

The Department of Conservation is responsible for the protection of Tuatara populations and have initiated a recovery plan including artificial incubation/captive breeding programmes.

Check out what role the National Aquarium has with its captive Tuatara

#### The impacts of introduced species on food webs

Many of the introduced species in New Zealand environments have a huge impact on food webs. Some introduced species have large appetites and not only eat native species but also compete with them for food sources. For example, possums will eat young birds, bird eggs and weta and compete with native birds for food such as flowers, berries and insects. Catfish prey on small native fish, fish eggs and fresh water crayfish and stir up sediment layers in streams and lakes making an unsuitable environment for many aquatic plants and animals.

Quiz the class about the impacts of a known pest of food webs, for example what effects do possums, introduced starfish, rats, stoats or koi carp have on a food web.

Make a class poster on the impacts of pests on food webs. Make a contrasting set of posters using terrestrial, freshwater and marine habitats.

Learn about *keynote species* and examine the effect of the depletion of a keynote species on the food web.

Construct food webs for the rocky shore. Suggest how an introduced starfish or seaweed would impact on the rocky shore food web. See ideas in the National Aquarium of New Zealand Rocky Shore education resource.

#### A biosecurity threat!

MAF (Ministry of Agriculture and Forestry) intercepts huge numbers of animal and plant organisms coming into New Zealand every day! For example, in 367 sea containers searched there were 1,160 live specimens (Sea container review, 2003)! Just imagine how many organisms that might enter the country unrecognised or unchecked. Note: many organisms that are considered not to be a bio security threat. However, often little is known about whether introduced plants or animals (e.g. spiders) may displace native organisms or predate on native plants or animals.

Do a class research project on a bio security threat (e.g. Painted Apple Moth, Gypsy Moth, snakes, ants and spiders entering ports via shipping containers). Make posters

of newspaper articles about bio security threats. Hint: use old newspapers from the library for articles on the Painted apple moth or Ross River virus mosquito in Napier. Also check out the bio security section in the Ministry of Agriculture and Forestry web site: www.maf.govt.nz.

Have a class debate about why an insect (like the Painted Apple Moth or Australian mosquito that causes Ross River virus) should be, should not be eradicated from New Zealand.

#### Fabulous Facts .... Do you know?

Who do you contact if you find an invasive animal or plant?

You should contact your nearest Department of Conservation or Ministry of Agriculture and Forestry (bio security group) office. If it is specifically a marine invasive organism, you could contact the Ministry of Fisheries – bio security group. It is often best to keep a specimen of the animal that you are concerned about. Place the specimen in a plastic bag and freeze it. If it is a plant, place in a *dry* plastic bag with absorbent tissues – you may need to change the tissues regularly.

## Pollution

#### Pollution?

Brainstorm with the class what **pollution** means to the class. List the different types of pollution that they can think of. From the list, ask the class to discuss what the possible effects for each type of pollution might be.

#### Current Events

Get the class to look through the newspaper to see what marine or pollution issues are currently in the media spotlight.

#### All that fertiliser and soil erosion

Fertilisers used on farms and horticultural areas and soil erosion eventually ends up in lakes, rivers, streams and then out to sea. The increased level of nutrients and sediments in the waterways can be a bad thing as it can lead to an increase in algal growth. Increases in algae can decrease the light levels and therefore kill off any other aquatic plants. Certain types of algae 'bloom' and can be toxic to fish, shellfish and even humans. Once the algal 'blooms' have fulfilled their life-cycle, they die. The mass die off of algae leads to increased bacteria activity (decomposition) and will decrease the available oxygen in the water. The lack of oxygen in the water may lead to the death of fish and other freshwater organisms. *Note: the limited oxygen levels are more likely to be a problem in smaller water bodies.* 

#### Blooming problem

Investigate past and recent algal blooms recorded along the New Zealand coast. Learn how algal blooms form and whether they are toxic to humans.

Hint: Information on the NIWA web site may be useful. Write two to three sentences about what you know about algal blooms. Use the sheet provided in the back of the booklet to write your ideas.

#### Central North Island Lakes

Investigate the algae problems found in the Rotorua lakes, what caused these problems? What are the solutions?

#### Clean streams

In a joint effort to clean up New Zealand streams, rivers, lakes and ground water the Fonterra co-operative group, regional councils, Ministry for the Environment and Ministry of Agriculture and Forestry have got together and formed a "Dairying and clean streams accord". The focus is to encourage farmers and other organisations to work together and achieve clean healthy water, including streams, rivers, lakes, ground water and wetland in dairying areas.

Make a class poster about the "Dairying and clean stream accord". Hint: For further information look up any of the above organisations web-sites or use the keyword 'clean streams accord'. Discuss with the class what they could do to help clean up New Zealand waterways.

Learn about riparian management. How does planting around stream banks limit stream pollution? Investigate a stream bank around your school. Does it have stream plantings? Get the class involved in a stream-side planting at the local stream.

#### In the poo!

Sewage waste is also a serious form of pollution. Sewage even in a filtered form can contain toxins and bacteria which can be harmful for marine life. For example, filter feeders such as shellfish can take in toxins and are therefore 'poisonous' for other animals further up the food chain (including humans). That is why you often see signs near sewage outfalls saying, 'Do not collect shellfish - consumption of shellfish from this shore area may be harmful'. Sewage waste can also affect marine mammals such as Hooker's Sea Lion. Salmonella bacteria infection found in seals may be linked to contamination of the seals environment by human sewage!

Ask the class to investigate how sewage in the local area is dealt with. For example does it get put in resting ponds? Does it get filtered? Decontaminated using chemicals or U.V. lights? Do the chemicals or U.V. lights kill bacteria or viruses? Where does the outfall go? Once the class has investigated how the sewage is dealt with ask the class to discuss whether the sewerage system in the local area is adequate for preventing contamination of marine life. If not what suggestions can the class come up with to make the local sewerage system better! Hint: for information about the local sewerage system contact your local or regional council.

#### Oil spills

Oil spills occur all around the world and occasionally along the New Zealand coastline (e.g. The Jody F Millennium oil spill in Gisborne, New Zealand 2002). As well as looking unsightly, oil can affect marine organisms in numerous ways. Oil is **toxic** to many fish and other marine creatures if they come into contact with the substance. Oil **smothers animals and plants**. The thicker substances of oil stick and mat together fur and feathers of animals. This can lead to loss of insulation properties and may eventually cause hypothermia! Matting effect of oil can also reduce to

'buoyancy' characteristics of feathers and in some cases birds may drown. **Heavy metals** with oil accumulate within food webs and the heavy metals will eventually affect on the top predators, including humans.

Make a class poster of all the newspaper clippings or news articles about oil spills off the coast of New Zealand.

Ask the class to devise a way to prevent oil spills from happening. Would ships have to be designed differently? If an oil spill occurred, how would the class go about cleaning it up?

Hint: check out websites for methods used to clean up oil spills.

#### Do detergents work?

One of the ways used to clean up oil spills is the use of detergents. These chemicals break-up the oil and bind to the little droplets. Do a class experiment with detergent foam and cooking oil. How effective is the detergent foam at dispersing the oil. How concentrated does the foam have to be before it works? Note: Some of the chemicals used to clean up oils can be toxic to marine life.

#### A load of rubbish!

Rubbish in the marine environment is unsightly but it can also be harmful to marine life. For example, a plastic bag may be mistakenly eaten by a seal or turtle (floating plastic can look like jellyfish) and can kill their victims. Old rope netting can entangle seals or dolphins and may lead to them eventually drowning.

Ask the class to suggest how long different pieces of rubbish last? Make a poster -put rubbish items on a decomposition continuum from one year to over one hundred years.

Do a '*rubbish' experiment*. Discover how long it takes for different types of rubbish to decompose. Put different types of rubbish (e.g. grass clippings, fruit, thin paper tissue, thick newspaper, plastic bag, plastic bags and tin can) into separate containers with soil (with worms). Water the soil occasionally. Make a time line. Add the length of time taken for each of the different types of rubbish to decompose.

Do a '*how clean is that water*?' *experiment*. Make up different solutions of water (e.g. some water with oil on it, with soil mixed through it, pond water). Ask the class to rank the different water types from cleanest to the most polluted. Discuss why the class came up with that ranking. Test each water type for pH, oxygen level and amount of suspended sediment.

Hint: Ian Cairns from National Waterways (Hawke's Bay) has water kits available and may do class demonstrations.

Do a survey of school rubbish. What sort of rubbish gets put in rubbish bins (make pie diagrams to display results). What percentage of the rubbish put in bins could be recycled? Ask the class to suggest ways in which they could separate out, rubbish which could be composted or recycled from other types of rubbish.

#### Recycling

Set up a recycling programme in your school. Devise a class or school plan how to reduce, reuse, recycle and /or repair everyday items?

#### Fabulous Facts .... Do you know?

What individuals can do to help protect aquatic habitats?

- Keep debris out of waterways
- Do not introduce non-native plants and animals into waterways
- Keep waters clean
- Fish for the future
- Don't change physical characteristics of an environment
- Adopt a habitat
- Design a poster on coast care

## **Over-consumption**

How to catch fish ...

There are many different ways to catch fish (or other marine animals such as lobsters, and squid). Fishing techniques can be split up into three main groups:

1) Catching fish singly or in schools using nets or spears

- 2) Catching fish by trapping them in fish traps or set nets (e.g. stationary nets, pots).
- 3) Catching fish by attracting fish with baited hooks or artificial lures (e.g. lights)

Below are some descriptions of different fishing techniques:

#### Netting

The most common form of netting is called a set-net. These nets are long, narrow and flat nets which are weighted at the bottom and supported by floats at the water surface. The idea is that fishes such as flounder and butterfish swim into the net surface and become entangled.



#### Drift net

Drift nets consist of very long 'curtains' of fine nylon netting and are usually left to drift behind boats or on moorings for days or weeks. Drift nets are used to catch tuna, squid and salmon but can catch anything (indiscriminate) including sea birds, turtles, sharks, and even sperm whales! Occasionally drift nets break loose and can float

through oceans, catching everything in their path (ghost fishing) until they sink to the bottom of the ocean with the weight of dead animals in the net.



#### Line fishing

Long-lines are the most common form of commercial line fishing. Long lines consist of a main line with shorter baited lines coming off at right angles. The line is anchored at both ends and held at the surface by floats. Long lines are used to catch fish such as snapper.



#### Trawling

Trawling involves one or two fishing vessels towing a large net along the bottom of the ocean. The nets which can be 60 metres wide are held by large chains and steel plates 'doors' that keep the net open. Trawling catches large quantities of commercial fishes, such as orange roughy, hoki, hake and ling. There are some concerns with deep sea trawling (or bottom trawls) as these nets are indiscriminate about what they catch and could wipe out some species even before scientists can discover them. Also the heavy nets, chains and steel plates may destroy important deep ocean habitats such as seamounts and oceanic ridges.



#### Jigging

Jigging is a form of fishing used to catch squid. It is carried out by lowering and retrieving a baited line in the water 'jigging the line'. Fishing is generally done at night when squid are attracted by bright lights on the boat.



#### Drift nets and Set-nets

Ask the class to draw pictures or describe the different net types and their differences. Design a poster that outlines some rules for their use, i.e. are they allowed to be used by commercial or recreational fishers? Where are these nets not allowed to be used? Are they internationally accepted? Hint: check out web-sites to see who uses them and what groups are opposed to them.

#### By-catch...

By-catch is a term used to describe all unwanted animals caught in net. That is, all animals other than the fish targeted by the fisheries. By-catch is often dead when is brought up in the nets and is usually discarded overboard. Many of the fishing methods have by-catch problems, for example set-nets may entangle and drown marine mammals, such as the Hector's Dolphin. Long lines catch and drown seabirds attracted to the bait floating on the water surface. Trawling fisheries catch Hooker's Sea Lion and many other deep sea creatures, such as corals, sponges, starfish, crabs and fish that are unknown to scientists!

#### The environmentally friendly net!

Get the class to devise a fishing net which is environmentally friendly. What features does the net need to have? For example, is the aim to catch young or old fish? How does it stop catching by-catch?

Survey a few local fishing communities. What types of fish do they catch? What types of fishing methods do they use? Do they get by-catch? What types of animals or plants do they get as by-catch? Use the survey sheet provided in the back of the booklet.

#### How do we protect marine mammals?

Many different marine mammals live in or pass through New Zealand waters. New Zealand has a strong policy of protecting marine mammals, for example advocating for a South Pacific Whale Sanctuary, protection of fur seals and protection of Hector's Dolphins by banning set nets in some parts of New Zealand.

Make a poster of the world's oceans and highlight on the map the known areas of whale sanctuaries. You could extend on this task by adding in the migratory patterns of the different whales or areas where the whales give birth. Discuss with the class whether the sanctuaries do enough to protect these animals.

Investigate countries such as Japan and Norway who are still involved with whale hunting. Why do they hunt whales? What products are whales used for? Have a class debate about why we should/should not keep hunting whales (or other marine mammals).

Ask the class to examine the law changes in New Zealand that protect marine mammals or find out about the Marine Mammals Protection Act which is administered by Department of Conservation.

#### Over-fishing ....taking too much a bad thing?

Often the aim of fishing is to get as many fish as you can. This means that fish of all sizes within a population are taken, both young as well as old fish. Taking large fish can be a problem as these fish usually are the fish that produce the most offspring and in doing so the number of offspring that can be produced each year is limited. Smaller fish might be a delicacy but taking fish not ready to reproduce will limit the size of the population which later can produce offspring. Also if not enough is known about the fish life history, a whole population could be fished out in one go or by taking a large number of the older fish may result in the population taking a very long time to become sexually mature therefore limiting the population's chance to reproduce for many years. In a worst case scenario, over-fishing can lead to fish populations becoming extinct and will definitely be un-economical to fish!

Fishing techniques are becoming better at targeting certain age-groups within a population (based on size). Mesh size of net and hook size are often selected so that smaller fish are not caught.

#### Over-fishing debate

Have a class debate about fishing in a small part of the coastline near a township. A debate topic could be 'open fishing for everyone – all year round!' Have characters such as fishermen, scientists, environmentalist, the town mayor and recreational fishers involved in the debate.

#### Managing fish populations

Ask the class to discuss how they manage two different fish populations (see details of fish populations in back of booklet). What is the class strategy? Ask them when they would fish each of the fish populations and how many fish they would take per year. Details of each fish population and pictures of the fish are found at the back of the book. Note these fish populations are fictional.

#### Sizing up ... legal sizes of fish and paua

Discuss with the class the legal size of fish and shellfish and the maximum number of fish/shellfish you are allowed to take. Why do we need these rules? Hint: information pamphlets guidelines on legal sizes and maximum catch amounts can be obtained from Ministry of Fisheries. Take the class to the beach or rocky shore. Collect some shells (e.g. paua) from the beach or rocky shore, without the animals! Back in the classroom measure the different paua shells. How many of them were legal size? Make a poster with the collected paua. On the poster, indicate the correct size of a

paua to harvest (125mm or over). Note: many of the paua shells wash up on the beach are undersized, that does not necessarily mean that the paua were illegally harvested. Many young paua are preyed upon by other marine creatures and as young paua often live close to the shore their shells are more likely to be washed up on the beach. There are also likely to be more juvenile paua than adult paua.

#### Fabulous Facts .... Do you know?

There are two types of paua found along the New Zealand coastline. *Haliotis iris* is the black paua and the larger of the two species. The outside of the shell often has white and pink blotches (coralline algae) on it. The inside of the shell has a recognisable blue/green/pink colours.

Pink paua (*Haliotis australis*) is much smaller (adult size) than black paua. The shells look similar to black paua shells although the outer surface is often more dimply and the inside of the shell is much pinker in colour.

*Pictures of the types of paua can be found in the* The Mobil New Zealand Nature Series: seashore life. By R.K. Dell and E.Heath (1981). Reed Ltd, Wellington.

#### Fabulous Facts .... Do you know?

Here's an example of over-fishing with some good and not so good results....

#### Orange Roughy

Orange Roughy was only discovered by New Zealand fisheries in 1979, although overseas Soviet trawlers were probably fishing fish stocks since 1972. Once discovered, fishing started with great intensity. In 1980-81 season 26,733 tonnes of fish was taken and in 1982 56,000 tonnes were caught. During this time very little was known about the life history of Orange Roughy, basic facts such as its distribution, growth rate, their maximum age, age at maturity and reproductive rate were unknown! As scientist discovered important facts; Orange Roughy can live for 50-100 years, the fish only becomes sexually mature at 30 years and that the first fisheries grounds (Chatham Rise) was beginning to shrink, alarm bells began to ring! Orange Roughy was not likely to survive at the then present fishing rates. Using the evidence found about the Orange Roughy life history, fishing quotas were cut back dramatically. In 1995-96 the total allowable catch was only 7200 tonnes. The Orange Roughy fisheries still exists but as a much smaller fisheries than when it started out.

## Population growth

Population growth is an environmental concern because with population growth, overconsumption, pollution and loss of habitat generally increase.

#### The world's population...

Look at a map of the world. Work out the population density of each country. Which country has the most amounts of people? Which country has had the greatest rise in population?

Hint: Many atlases have human statistics included in them or check out websites; world population information or global statistics.

Discuss with the class how population growth will affect different habitats, e.g. the sea or terrestrial places. What resources are likely to be used first, what will there be a demand for? Food? Water? Fuel?

If food, water or fuel were the first resources to be used up. Discuss with the class how the world population could minimise or effectively use these resources.

#### Population control

Population control can be seen as a way of slowing down the demand for resources. Check out different countries that promote population control (e.g. China). Discuss with the class what the positive and negative effects of enforcing population control both socially and environmentally.

#### How energy efficient are you?

One way we can counteract the effect of population growth is to become more efficient in the way we use resources. Check out this web-site to see how energy efficient you are: Energy efficiency, how do you measure up? http://news.bbc.co.uk/2/hi/science/nature/3915245.stm

#### Your environmental footstep?

How much food, fuel and water do New Zealanders and the rest of the world consume? Are we living within the carrying capacity of the land we have available? Find out your eco-footprint, look up www.mfe.govt.nz, keyword: ecofootprint. Alternatively look up world websites, for example: www.environment.govt.nz/footprint www/lead.org/leadnet/footprint/intro.htm

#### Global warming??

Global warming is a difficult issue to tackle, generally because there just isn't enough long term data out there to come up with any real hard conclusions. One thing we can be sure is that humans have increased the levels of greenhouse gases (e.g.  $CO_2$  and methane) in the atmosphere through agriculture, industrial uses and burning of fossil fuels. The impacts of increased greenhouse emissions are less well understood. There have been some suggestions that due to increased levels of greenhouse gases there will be an increase in global temperatures, leading to a melting of the ice caps at the poles and therefore a rise in sea levels globally. Also changes in precipitation and other local climate conditions are expected. However, other discussions suggest that we are overdue for an ice-age!! So will the two factors counteract each other?? Very complicated indeed! All we can do at this stage is keep collecting and analysing valuable data and try to minimise our *total* impact on the Earth, at all levels.

For more information check out: Global warming: A chilling perspective (Nov. 2004): http://www.clearlight.com/~mhieb/WVFossils/ice\_ages.html

The EPA Global warming kids page (Nov 2004): www.epa.gov/globalwarming/kids

New Scientist hot topics (Nov 2004): www.newscientist.com/hottopics/climate

Discuss with the class the different issues associated with global warming or global cooling. What do the students feel we should do about the global warming or global cooling? Should we take any action at all?

Make a class poster presenting all of the issues related to global warming. Do a research project about ice ages. What was the climate like during an ice age? How often do we have ice ages?

## So if global warming is for real... what impact might this have on different animals??

#### Lizards and corals

Interestingly the sex of lizards while developing in the egg can change with temperature. For example, baby Tuatara will hatch as males if treated with warm temperatures while developing in the egg or females if treated with cooler temperatures. So will this mean that we end up with populations of only one sex in the future? Note: Temperature and sex change varies between reptiles.

Do some research about a favourite reptile. Compile some questions to ask at the aquarium staff about their reptiles. Do they have more female or male turtles or Tuatara?



Corals are an interesting association of animals and algae. The algae part of the association needs a certain amount of sunlight to photosynthesise and produce sugars for the whole coral. So without sunlight most coral wouldn't survive. If sea levels were to rise, small atolls in the pacific are likely to be the first to feel the effects. Corals found around the atolls may have to change their distribution (move upwards on the shore) in order to gain enough sunlight. *Would sea level change affect the shape of the Great Barrier Reef?* 

Do some research about corals. Where are they found in the world? How many different types of coral are there? Are they sensitive to pollution or the amount of light they receive? Ask the aquarium staff about the corals they keep. Do they require a certain amount of light? What type of light?

#### The whole picture!

Here is a chance for you and your class to revise all those facts learnt when studying environmental issues. Brainstorm about how population growth can affect a particular habitat (e.g. an estuary, the sea, a forest). Draw a mind map of how each factor is interlinked. Note this activity can be used as a post - visit activity as well. See example below and make your own:

