Conservation Education

SPRING TERM 2010 ISSUE TWENTY ONE

Published by the
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ISSN 1756 - 9087

Wildlife & Climate Change

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20,000 years ago the landscape looked very different. Wooly mammoths and sabre toothed tigers roamed the frozen earth - it was of course the ice age. Then, slowly but surely the ice started to melt as temperatures gradually increased. Sea levels rose and a thousand years later, the earth was looking quite different. Today the world's climate is still changing, but this time it's happening much more quickly and its probably something to do with us! Temperatures across the world over the last 200 years have been rising faster than ever before and meteorologists believe that this pattern is set to continue unless we do something about it by drastically cutting greenhouse gas emissions (see Conservation Education issue 16).

The term "climate change" refers to a change in long term global weather patterns such as an increased occurrence of drought, storms and flooding. Climate change is affecting wildlife in different ways as their habitats - the places where they live, breed, find shelter and food change. Wildlife can usually adapt to changes, especially when they happen over hundreds or thousands of years and they have time to adapt and move to new environments which suit them better. Now climate change is happening so quickly, nature is finding it hard to keep up and some species are doing better than others. In the ice age, wildlife wasn't already under pressure from other environmental factors such as pollution and habitat destruction which our wildlife has to deal with today.

Bumblebee

Through this edition of Conservation Education we will look at the natural world to see what effect climate change is having and how nature is responding to it. One thing is for sure, many creatures need our help to adapt to these changing conditions and need their habitats preserving now, more than ever. Perhaps we can also learn a lesson about looking after our world. Nature is providing us with early warning signs as to what is happening to our climate - are we going to ignore them or pay attention and try to stop climate change from getting any worse?

Spring Has Sprung!

Hazel dormouse

About 100 years ago, people started to have a very strange hobby known as phenology - the study of the seasons. These early records have helped us to see the ways in which nature has responded to our changing climate as winters have become warmer and wetter and spring has been arriving earlier. In fact spring time is estimated to advance by 6 days for every 1 degree temperature rise. Snowdrops and daffodils are blooming earlier and wildlife is displaying unusual behaviour.

Hibernation - The favourite activity of so many creatures which sleep through the cold winter months, preserving their energy when food is scarce. Their reappearance is a sure sign of spring, yet in recent years these creatures have been going to bed later and getting up earlier!

Swallow

Bumblebees are being seen in January and even December. It is normal for them to emerge from hibernation in March.

Dormice are known for their love of sleep during the winter when there are no food supplies available. Recently there have been more sightings of this loveable rodent during the winter when they have been spotted eating nuts and seeds from people's garden bird feeders!

Migration - Certain birds are finding some British winters so mild that they aren't bothering to migrate at all, as is the case with the **chiff chaff**.

The **dunlin** is a bird which migrates to Britain in the winter because it is warmer than its Arctic home. Now some of them decide to stay in Scandanavia or if they come to Britain, they don't venture as far south because they are happy with the temperatures and food availability further north.

The first **swallows** are returning from Africa a week earlier than they did in 1970. The timing of migration is very important so that they don't start their journey too early or too late and miss the food they need to survive.

This is all very interesting but surely it doesn't matter if creatures have a bit less sleep or arrive on our doorsteps a little earlier, does it? Well unfortunately it does matter if it means that they can't find their usual source of food or they come into competition will other creatures which they wouldn't have done normally. Read on to find out more!

Get Active!

Help wildlife to adapt by making your garden at home or school more wildlife friendly by providing a variety of habitats for them - see Conservation Education, issue 10 - "Wildlife in the Garden".

Help wildlife to survive the winter by putting out food and water for them.

Plant spring flowers so there is food available for the first bees that emerge.

Put hibernation and nesting boxes in the garden.

Take part in a butterfly or bird survey to monitor their numbers and track their movements.

Do your own spring watch! Record when you see the first spring flowers, birds and butterflies and keep these records year on year to see if you can spot any patterns and changes.

Out Of Synch

Bluetit

The natural world has had a long time to evolve and adapt to climatic changes in the past. Eco-systems are wonderfully balanced and every occurrence is timed to perfection allowing everything to thrive. Climate change is happening so quickly that nature's balance is being upset and everything is being thrown out of synch because some living things adapt more quickly than others and change their timings by different amounts.

Bluetits time the arrival of their chicks to coincide with a plentiful supply of caterpillars but many caterpillars are going into their crysalises earlier. If they're already butterflies by the time the bluetit eggs hatch there's less food for their chicks. Pied flycatchers are migrating back from Africa to find that the caterpillars are one step ahead of them too!

Beech Trees

The south of England is well known for the autumnal colours of its beech woodlands where the tree was first introduced, probably after the last ice age, in about 4000BC. The tree has been particularly successful there, preferring the milder weather. However, climate change could put its future in jeopardy.

If British summers get hotter and drier as climate models suggest (something which has not happened of late!) and winters become warmer and wetter, this spells bad news for the beech trees. They do not like water-logged soils yet they do need to absorb a great deal of water and cannot tolerate droughts. Their shallow root system makes them particularly vulnerable in stormy weather, the frequency and intensity of which are set to increase. In fact the number of winter storms in Britain has already doubled over the last 50 years. One solution would be to plant more beech trees further north and see if they fare any better up there.

Get Active!

Reduce your own personal carbon footprint and help slow down climate change!
Here are 4 areas in which you can make a difference:

Energy - try and save it! Switching things off when you're not using them is a good start.

Food - eating less meat and buying organic food can all help protect our planet!

Transport - Travel less by car and more by foot, bike, bus and train. It keeps you fit too!

Waste - Reduce it, reuse it and recycle it!

Bluebells

An estimated 70% of the world's common bluebells to be found in Britain. These delicate flowers exploit a small window of opportunity between the beginning of April and the end of May when the spring time sunshine warms up the soils. This is when the bluebells are able to grow, flower and sow their seeds for the following year. They need to do this while trees' branches are still bare, before the woodland canopy fully opens its leaves, casting its shade. As springtime creeps forward, the canopy may open before the bulbs have had a chance to set their seeds.

Bluebells are not temperature dependent like other plants as they grow from bulbs. They start forming underground in the autumn of the previous year and are ready to begin growing in the cold of winter, with the first shoots appearing as early as January. This gives them a fantastic head start against other plants which are more temperature dependent, but as springtime gets earlier this time gap is narrowing and bluebells are losing their advantage. They could become swamped by other plants such as bracken before they've had a chance to set their seeds.

Milder temperatures are not the only threat that bluebells are facing. British bluebells are in competition with Spanish and hybrid varieties which were first introduced into people's gardens as an ornamental plant back in 1680 and have since moved in to the wild. Since facing this competition it has also lost a lot of its woodland habitat. Then there are the people who illegally dig up the wild bulbs to sell them on. This well loved spring flower may have some challenging times ahead.

Common garden frogs are sometimes mistaking a warm autumn and beginning of winter for spring time. They lay their frog spawn in ponds only to find that when winter finally does arrive, the tadpoles don't survive. As they only lay eggs once a year this means that they won't have any young that year at all.

Wings to fly

If you are a bird you have one particular advantage when facing climate change - you can fly! Some birds such as the goldfinch and the collared dove are enjoying the milder weather and are expanding their range. Meanwhile, other birds are moving in, preferring the conditions in Britain to hotter countries. This means that birdspotters in Britain in 2050 may see some very different species to the ones they might spot through their binoculars today!

Hoopoe

Already the Cetti's warbler has taken up residence here from the Mediterranean and Central Europe and the cattle egret has been a regular visitor for the last 20 years. The hoopoe and the bee eater could possibly become our next colourful additions. Hoopoes are already found in some parts of Europe, North Africa and West Asia. They sometimes come to Britain when they are migrating and overshoot their destination by accident. Perhaps as they find conditions here favourable, more and more of them will stay. Depending on how many new birds move here we will see whether they will put native species under strain as they compete for the same food and living spaces. Who knows whether in the future our cliffs could be covered with hoopoes instead of kittiwakes and puffins!

As conditions change in Britain some native birds may find it difficult to find a new habitat. The snow bunting and the Scottish crossbill like the cold but cannot go any further north than where they are already in Scotland. The Scottish crossbill is an endemic species - it is unique to Britain and is not found any where else in the world. Its only hope is to move to a colder country or else it may become extinct. Birds such as the red grouse, lesser spotted woodpecker and meadow pipit, snipe, brambling, lap wing and willow tit could all move further north but may struggle to find enough suitable habitats.

A biting problem!

Of course birds aren't the only creatures with wings. Warmer weather means that more insects and creepy crawlies brought in on cargo ships such as the Asian longhorn beetle are likely to survive in countries where they wouldn't have done so before.

Mosquito

Malaria carrying mosquitoes which have always been restricted to hot countries could move further north into Europe, as well as higher up mountain sides. Malaria is a disease which exists in tropical countries and already kills 1 - 3 million people every year.

Beautiful Butterflies

Records show that over the past 100 years average temperatures in Britain have been warming. For some butterflies this is good news. The comma is thriving as its caterpillars can feed off many different kinds of plants such as nettles. Along with the holly blue and the Essex skipper, these have more than doubled their distribution throughout Britain in the last 20 years. The speckled wood butterfly is also becoming more widespread. It used to be found in the south of England and in a small patch of Wales, but now it is found as far north as the highlands of Scotland!

Comma butterfly

In theory, all butterflies should be benefitting from the warmer weather, but they are not. As they try to spread north, some will not be able to find the habitats that suit them such as the Adonis blue which lives on chalk downland slopes. Many habitats have disappeared over the last century so there are no longer the woodlands, grasslands and heaths for the butterflies to use. The high brown fritillary is one of those at risk as its caterpillars only eat specific foods such as the common dog violet found in woodland clearings.

Double Trouble!

Climate change is not the only threat to wildlife. Animals have already had to cope with numerous pressures caused by mankind such as hunting, pollution and loss of habitat, but with the additional pressure of climate change by the year **2050 we could lose one in 10 animal and plant species including a quarter of all mammals.** Climate change is causing conditions in their habitats to change so much that they are no longer suitable for them to live there. Conditions can be too dry or wet, food sources in short supply and little fresh water to drink. So they go in search of new territories but finding them is not always easy. There are both natural and physical barriers which can get in the way of where they want to go, such as mountains or building developments. New houses and factories are built on green fields and roads carve up the countryside. **Rainforests** are destroyed for agriculture, rivers are polluted and the areas where animals can find food, water and shelter get smaller and smaller. This is when their search can bring them into conflict with man.

Thirsty work!

Water is necessary for life, but with a lack of rainfall and their **drinking water** pools drying up, many animals are being forced to move. The difficulty that large mammals face is that they don't have wings and they can't swim long distances so they have to cross over land instead. If a mountain is in the way, or they are on an island, they may have little choice of where to go. Many of these animals live in protected national parks, but when they move out of these areas they are in danger.

Naturally, big animals like elephants would have large territories but more and more people are moving into their territories. Increasingly this is bringing them into conflict with people. **Elephants, rhino** and **buffalo** stray from wildlife parks in search of water inadvertently trampling the farmers' crops. In Kenya **lions** have been entering villages and killing sheep and goats. In Asia, **tigers** enter villages and kill livestock or even the people living there!

It is possible to help these animals by providing "corridors" for them to get from one habitat to another. This is just as important for wildlife in Britain as it is for wildlife in Africa so that they are are not trapped in places which are too dry for them. People can also intervene more directly. There has been debate in Spain over whether to relocate a population of **Iberian lynx** to a more suitable, less dry place. However, one has to be careful when interfering with nature. In the past introducing new species to a place has upset the whole balance of an area, especially when introducing predators which can prey on unsuspecting creatures.

Maneaters!

The Sunderbans, an area of mangrove forest covering parts of Bangladesh and West Bengal, India by the Bay of Bengal is a unique eco-system rich in wildlife. It is so important that it is a UNESCO world heritage site and is home to as many as 279 Bengal tigers, 60% of India's total tiger population. The area is a mixture of islands, sand banks and water. The tigers thrive here because of a lack of human interference and protection from poaching.

Satellite imagery shows the sea level has risen by an average of 3.14 cm a year in the past two decades - much higher than the global average of 2 mm a year. Rising sea levels have caused an increased salinity of the water in the southern Sunderbans, so the tigers have had to move northwards, nearer to the villages where the water is fresher.

The Sunderbans is home to some 4 million people who rely on the mangrove forests for fish and honey and who collect firewood there. It has protected zones where the tigers live and it is illegal for people to enter. Tigers do not normally attack humans, unless they feel weak, hungry or threatened, but in the Sunderbans everything is different. Dozens of men are killed every year. Those who stay out of the reserve are hardly ever killed, but there are some who say they need to go there to in order to survive. The "tiger widows" are the women in the villages whose husbands have been killed by these powerful predators.

In a strange kind of way the tigers are actually helping to protect the people from disaster by preventing the logging of the mangrove forest. Without the tigers there would be no forest and without the forest the people would suffer even more from the storms and cyclones which have been hitting them harder and more often in recent times.

Arctic Expedition

We are all familiar with the sight of polar bears as an iconic image of climate change. They live within the **Arctic circle**, an imaginary line which encircles the earth near the north pole and includes parts of Alaska, north west Canada, Greenland, some parts of Norway and northern Russia. They surround the Arctic Ocean, part of which is always frozen and is called the polar ice cap.

The **polar ice cap** lies at the centre of the Arctic sea, extending 500 miles from the north pole. The rest of the Arctic sea only freezes for a part of the year so that during the winter time the area of ice more than doubles. This crust of ice is called **"pack ice"** and is where the polar bears like to hunt during the winter. Every year between June and October this ice melts. However global warming has resulted in about 15% less ice than there was 20 years ago. In 2005 the ice pack had receded 200 miles further north than it did in the 1970s. It is also thinner - an average 1.8 metres in thickness compared to 3 metres in the 1950s.

So how does this affect polar bears? **Polar bears** hunt near to the edge of the pack ice where it is thinner so that they can catch their favourite food - ringed and bearded **seals**. They use their great sense of smell to locate a seal's breathing hole. Then they crouch down and wait for them to come near the surface. Then they strike!

Polar bear

They may also stalk a seal across the ice. They only need to eat one seal every 4 to 5 days but finding food is becoming more of a problem for polar bears as the area of pack ice gets smaller. Its not that polar bears can't live on land - they do, but they need to eat and the place to find food is on the ice!

During the June to October the sea **ice melts** and the bears are unable to hunt seals until it freezes over again. They will eat a variety of other foods if they find any such

as reindeer or berries, but they are capable of **fasting** during this time and surviving off their reserves of blubber. The bears of Hudson Bay, Canada depend heavily on the sea ice, fasting for the other 6 - 8 months of the year. Less sea ice means less time to hunt and less space to hunt on. Longer times of fasting mean they are going hungry and are less likely to survive. The lack of food has also caused a drop in the birth rate.

Polar bears sometimes hunt from **ice floes** - these are frozen masses of sea water which are not joined to the main pack ice but float on the surface of the sea. As the ice melts they are forced to swim further between them. One study showed that whereas in the years of 1986 and 2005 4% of bears were spotted swimming in open water, in September 2005 this had increased to 20% of all sightings. Many people argue that polar bears can swim and that this is all a load of nonsense. Polar bears are **excellent swimmers** indeed and 15 miles for them poses no problem at all. However, in recent years they have been forced to to swim longer distances between ice floes sometimes swimming up to 60 miles across open sea to find an ice platform from which to hunt. This can leave the polar bears feeling exhausted and vulnerable to hypothermia. They are used to being relatively close to the shore, not out in the **open sea** where they can be swamped by the waves during stormy weather. In 2005, four polar bear carcasses were found floating off the north coat of Alaska where summer temperatures have increased by two to three degrees since the 1950s.

Polar bears readily cross from one country to another, but the majority (about 60%) live in Canada. They generally don't come into contact with humans and therefore don't eat them. However a starving polar bear is more likely to stray further south into areas where people live. Already they have been found raiding people's dustbins in Canada just like their brown cousins! There have also been reports of cannibalism as polar bears have been seen eating their own cubs! But the **Inuit** (traditional people of the Arctic circle) say that this behaviour is nothing new and is perfectly normal and natural, except that the number of cases reported has increased from one to two to at least eight per year.

Another possible threat to polar bears as a result of warming temperatures is the presence of **grizzly bears** wandering further north into their territories which used to be too cold for them. This brings them into competition over food and places to build dens but has already resulted with the discovery in 2006 of a cross breed of bear with a grizzly father and a polar mother! This is genetically possible since these bears are closely related and shared a common ancestor originally from an **ice age** about 200,000 years ago.

We can look at what is happening at the north pole as an early indication of what is happening globally. The earth does not warm evenly, with the north pole warming faster than parts of the world nearer to the equator. If it warms by **one degree** centigrade in these places, the poles warm by **three degrees.**

The Rising Tide

Rising sea levels are not due to the arctic ice melting as it is already floating on the sea and displacing the water. Like an ice cube in a glass, when it melts, the area it uses is no greater than when it was frozen. Sea levels can rise however, due to the melting of glaciers based on land as well as ice and snow from mountains melting. Additionally as water heats up it expands so as oceans warm up, the water rises.

Sea levels have already risen by 10 cm in the last 100 years. This can have consequences for wildlife such as the **grey seal** which breeds and gives birth above the high tide mark on isolated shingle beaches in the British autumn time. As these beaches get narrower, the pups are at an increased risk of being washed away.

Kilimanjaro

Kilimanjaro, the highest peak in Africa stands at 5,892m. In the last 100 years (since 1912) it has lost 82% of its ice, with 33% lost in the last twenty years showing the acceleration of this process. By about 2033 there may be no ice cap left at all. Kilimanjaro highlights what is happening to glaciers on mountains around the world as they melt away. Yet many scientists believe that climate change is only one explanation for the lack of snow. Another is the **deforestation** at the bottom of the mountain which can affect precipitation levels, including snow fall.

Climbing up a mountainside takes you through many different **vegetation zones.** Mountains situated near the equator have the widest range, from the hot and humid forests at the base, through alpine heath and moorland, to the highland deserts and finally the ice capped peaks. As temperatures rise plants are forced to move to higher ground, with some plants more able to reestablish themselves than others, with some dying on the way and those already at the top being forced out completely, with no-where else to go.

Mount Snowdon

Africa's mountains are an important source of **drinking water** during the dry summer months supplying people and animals when the melting snow and ice steadily feeds the streams. If no snow falls and no ice forms during the winter months then there is nothing to melt during the summer which means no drinking water for animals on the hot plains below. This can leave them with a stark choice - move or die!

Snowdon Lily

The Snowdon Lily, a remnant of the last ice age clings to the slopes of a few mountains in Snowdonia, North Wales, the only place the UK where it grows. Further afield it can be found on the Alps and Rockies. This hardy flower flourishes in cold, harsh conditions, but by 2020 a snowcapped Mount Snowdon may be a thing of the past. In the last 10 years the **snow line** has moved up the mountainside by 560 metres and snow levels have decreased by 35%.

As temperatures rise, plants find themselves moving to **higher altitudes**. For the Snowdon lily its solitude will be lost as other plants start to grow there and take over. It could try and move up the mountain side itself but this takes time as few seeds are successful and eventually the plant will literally run out of mountain as it won't be able to go any higher. The Snowdon lily was first recorded in 1696 and only 6 patches survive. Plans are already on the table to move it to the colder conditions of the mountains of Scotland. Again, the climate is not the only factor this delicate flower struggles against. The appetites of grazing sheep are an equally important threat.

Antarctic Krill

Krill are tiny shrimp-like **crustaceans** which live in oceans all around the world, but by far the most abundant and important are the Antarctic krill living in the Southern Oceans of you guessed it, the Antarctic! Krill are a type of **zooplankton**. "Zoo" means a kind of animal and "plankton" are organisms which drift in the oceans. They can't swim against the currents but can move up and down the water column.

They are filter feeders mainly eating **phytoplankton**, floating plant matter which is usually microscopic. In the Antarctic, there are plentiful phytoplankton for krill to eat, perhaps the most to be found in any place in the world. Upwellings of water bring it up the water column from the depths of the ocean, especially in the summer when the 24 hour daylight which they use to get their energy makes them flourish. During the dark winter months, phytoplankton is in short supply, so instead the krill and their larvae graze on ice algae, which is found growing on the underside of the pack-ice. Juvenile krill especially need the nooks and crannies of the pack ice's cave-like formations too, as a place where they can shelter and hide from potential predators.

Being only a slightly bigger than a large paperclip (about 5 cm long) antarctic krill are the largest of the 85 known species in the world and are vitally important to the Antarctic's eco-system as they are a vital part of the **food chain.** Many creatures rely on krill for their survival. Even though they are so near the bottom of the food chain, they get eaten by creatures much bigger than themselves such as baleen whales (right, fin and blue), seals (fur, leopard and crabeater), squid, penguins, albatrosses, petrels and other birds. Without the krill these creatures would struggle to survive.

Blue whales are the largest creatures ever to live on earth, weighing the same as 30 African elephants. For them to eat such a tiny creature seems absurd! Blue whales are a kind of baleen whale so instead of having teeth they use a special filter in their mouths known as a baleen to strain the krill out of the water. A whale may eat 4 tonnes of krill a day. Krill also form 45% of the leopard seal's diet but **crabeater seals** eat even more. Despite their name, krill make up 98% of their diet! Over the course of a year, they consume twenty to twenty five times their own body weight in krill. More than one in every two seals in the world are crabeaters which means that all together what they eat amounts to 80 million tonnes of krill a year - that's more than the quantity which all the baleen whales in the world eat!

Crabeater Seal

Southern Right Whale

With an estimated krill population of up to 500 million tonnes there doesn't appear to be anything to worry about. If you gathered together all the Antarctic krill they could fill Wembley stadium 1,500 times! Is that possible?! Krill can swim in **swarms** so immense that shoals can be kilometres wide and weigh more than the world's population of humans! Their swarms are so large and dense it has been said that you can see them from space! Yet despite the impressive figures, numbers of Antarctic krill are estimated to have declined by 80% since the 1970s. That's a lot of krill - that means that only one-fifth remain! So what's happened?

One of the main causes is the ice melt caused by global warming. Average **temperatures** in the Antarctic have risen by 2.5 degrees centigrade in the last 50 years, decreasing the amount of sea ice for ice algae to grow on. Less ice-algae means less food for the krill to eat when their other food source phytoplankton is already scarce. Less krill means less food for the other animals in the eco-system that rely on them. In the case of the **baleen whales**, their numbers were decimated during the 20th century due to hunting and only since they have been protected have their numbers been able to increase again. A lack of krill will put a stop to that. The threat is intensified by huge quantities of krill being fished to meet the demand for them as an ingredient in health products such as Omega 3 oil and as fish-farm feed.

During the day krill try and avoid predators by moving down to the depths of the sea, but at night they move up nearer to the surface where they can find food.

As crustaceans, krill also face the problem of **ocean acidification**, like coral, due to an increase in levels of carbon dioxide in the water which can make their **exoskeletons** dissolve, become fragile and break. Conversely, krill are very good at removing carbon dioxide by eating phytoplankton which are rich in carbon. They then deposit this at lower depths in the oceans when they excrete. They can sequester carbon equivalent to the emissions of 35 million cars year. Who would have thought that such a tiny creature could be so important!

Coral Reefs

The Great Barrier Reef is the world's biggest single natural structure. It lies along the north east coast of Australia and is made of living organisms called coral. It is over 1,600 miles long (about 2,300 km) and can even be seen from outer space! In fact its 400 species of coral provides a habitat for 1,500 species of fish! There have been 30 different species of whales, dolphins and porpoises recorded there and six different species of turtle are known to breed there.

Coral reefs are unique **eco-systems**, home to a quarter of all the world's marine life. They are colourful underwater jungles except that corals are not plants at all! Though they do not move, they are actually **polyps**, tiny living creatures which join with others to form colonies. Their skeletons are made of white calcium carbonate, better known as limestone. They get their colour from colonies of tiny single celled plants called **zooxanthallae**, which live in the tissue of the coral. Zooxanthallae are microscopic algae which the corals feed off to get up to 90% of their energy. In return they give the algae protection and shelter, nutrients and carbon dioxide to survive. It is a **symbiotic** relationship as both sides benefit.

Divers exploring coral reefs these days may come across a startling sight - instead of colourful living corals they see corals white and lifeless, like human skeletons. This is known as **coral bleaching** and is caused by higher water temperatures and greater light intensity than the corals are accustomed to. They are very sensitive and only survive in waters of a certain temperature - an increase above maximum summer sea temperatures of just 2 - 3 degrees over a period of about 8 weeks is enough to kill them. When temperatures increase, they lose their colourful algae and starve.

Since the end of the 19th century, the average global air temperature has warmed by 0.6 degrees and the average water temperature buy 0.4 degrees. If trends continue then tropical oceans could warm by 1 - 3 degrees centigrade which is bad news for corals. In 1998 a major coral bleaching event occurred around the world killing 16% of the world's reefs. 2005 was Australia's hottest year on record making the sea warmer than usual and resulted in massive coral bleaching along the Great Barrier Reef, although some areas did recover. Recovery can happen if conditions return to normal quickly enough and the coral hasn't lost all its algae or can attract the algae back.

Coral Reef

Temperature increases have the biggest effect on the health of reefs but the amount of **carbon dioxide** that the sea absorbs from the air is also very important. Corals and other marine organisms take free carbonate ions from the sea to build their shells and **exo-skeletons**. As the levels of atmospheric carbon dioxide increase, so do the levels in the sea, making it more acidic. About 30% of carbon dioxide from the atmosphere is being absorbed by the oceans. The more acidic the water is, the less carbonate ions are available for corals and other organisms to use. So the corals can't grow and become fragile. This makes them more vulnerable to predators and other environmental conditions.

Button Polyps

Apart from the consequences for coral reefs and the wildlife that rely on this important eco-system, there are also consequences for people. Coral reefs act as **underwater barriers**, protecting land from the full force of the waves. That's why beyond the reef the sea looks a lot rougher than closer to land. When reefs die there's nothing to stop the full force of the sea from hitting the land which means that stormy weather will cause more damage. Corals slow down the eroding effects of the sea on the land. The island of Moorea in French Polynesia only has a 10 cm tidal range thanks to the buffering effects of the reef. Without it the island's low lying areas would be put at the mercy of the sea.

Additionally, millions of people rely on the reefs as a way of earning a living be it through **fishing** or taking tourists on boat rides. Perhaps as some coral reefs die, others will form in places previously unsuitable for them. However, reefs do not form overnight - 1 metre of height takes about a thousand years to grow!

Warming Waters

Fish which only live in the specific temperatures of coral reefs may leave or die out if waters warm too much. This could have a knock-on effect throughout the eco-system as many birds rely on them for food. Without the fish their chicks would die.

British waters are also warming, attracting rare visitors, so the presence of Meditteranean fish, sharks and turtles near our shores, whilst not unheard of may become a more common occurrence. Basking sharks, a huge but harmless species were seen off the coast of Cornwall in record numbers in July 2009 as warm waters increased the availability of their food source, zooplankton.

Rivers and streams are also warming which is making life harder for Atlantic trout and salmon which need to breed in cold waters. There is already evidence of their decline in southern England. Since they always return to the place where they were born in order to breed, they will have to fight their strong instincts if they are to adapt and relocate!

Turtle Power!

Marine turtles have existed on this planet for between 150 - 200 million years and were even here before the time of the dinosaurs! Obviously they're a hardy species yet 6 out of the 7 species are officially **endangered**. Why? For a number of reasons which are all to do with people. Sometimes turtles get trapped in fishing nets or caught accidently on fishing lines. In many countries their eggs are a seen as a delicacy and are dug up out of the sand to eat, or their shells are used as souvenirs whilst their meat can be used to make soup. Now rising temperatures are playing their part and are having an unusual effect.

Female turtles visit **sandy beaches** every two to three years to lay their eggs in holes they dig in the sand. Then they bury their eggs and return to the water, having nothing more to do with their young. Two months later, the hatchlings emerge and make a dash for the sea. Whether they are male or female will have been determined, not by their genes but by their incubation temperature! The higher the temperature of the sand, the more likely the hatchlings will be female.

For **loggerhead** turtles above 30 degrees centigrade results in females and below produces males. Too warm altogether means boiled eggs and no hatchlings at all! Turtles may vary the depth at which they bury the eggs - the deeper they are, the cooler it will be. Other reptiles such as crocodiles and alligators are similar, but with the opposite result; the warmer their eggs are, the more likely they will turn out to be male.

As global warming continues, the likelihood is that there will be a disproportionate number of **female** turtles being born - in fact there are already! In Costa Rica, clutches on those beaches are between 70% and 90% female already. Florida, USA is host to 90% of loggerhead nesting sites in the USA where 90% of hatchlings are female. Without enough males to breed with the turtles could become extinct.

Perhaps we are not giving turtles enough credit. After all, they have been around for **millions of years** and have survived great climatic changes so perhaps they will be able to adapt. Sometimes turtles lay their eggs on different parts of the beach or even on a number of beaches to increases the chances that at least some of them may hatch. Scientists could not understand why loggerhead turtles sometimes nest in southern Baja California, an area where the beaches are not warm enough for the incubation of turtles eggs. Now they see a possible purpose for this odd behaviour. If the climate warms then this will be precisely where the eggs will hatch, thus enabling the species to survive!

Loggerhead Turtle

Even without **human interference** only 1 in 1000 turtles actually survive into adulthood and it takes decades for them to reach an age when they can reproduce. If it was simply a case of the turtles moving to sandy beaches further north where the weather is cooler that would be fine. But turtles aren't the only ones that like sandy beaches, people do too and it's not easy for the two to live side by side. People can be noisy and may disturb the nesting sites. Lights from nearby buildings can confuse the hatchlings so they don't know which way to go to get to the sea!

Rising sea levels could exacerbate the problem as sandy beaches get covered in water and stronger storms wear them away. Beaches can naturally shift inland but with buildings and other structures there to reinforce the beach instead of natural vegetation, this is not possible.

So what's the **solution**?
Conservationists can step in and dig up the eggs, placing them in cooler areas of the beach where they are safe and more likely to hatch and have a better proportion of male and female hatchlings. This prevents the eggs from being stolen by people as well. They guard the hatchlings on their journey to the sea to protect them from hungry predators like crabs, foxes and birds to try and give them a good start in life!

Why are amphibians croaking it?

Amphibians include frogs, toads and newts. They have shown a remarkable capacity to survive over many periods in the world's history when there have been great climatic changes, yet for some reason now their population is being decimated.

Take a look at these statistics:

5,743 - the number of amphibian species in the world
32.5% - are under threat
43% - are in serious decline
122 - the number of amphibians which have become extinct since 1980.

Amphibians are very sensitive creatures, spending the early stage of their lives in water and the latter part on land but with an ability to survive underwater by breathing through their very thin skin. Their skin is covered in a slime to stop them from drying out but it is very **sensitive** to minor changes in temperature, levels of UV light, humidity, pollution (air and water quality) and loss of habitat, leaving them vulnerable to disease if conditions change.

The biggest reason for their current rapid decline is a **fungal disease** known as **Chytrid** (chytridiomycosis). It can wipe out 50 - 80% of amphibians in a given area within four to six months. It flourishes in a temperature range of between 17 - 25 degrees centigrade, so the reason for its spread is possibly favourable climatic conditions.

The Monteverde **cloud forest** reserve in Costa Rica and other such places in south and central America were home to some unique amphibians. The **Golden toad**

*Golden Harlequin Frog*Suite

was only discovered in 1967 and as an **endemic species**, it could be found no where else in the world. There were also abundant varieties of **harlequin frog**. In 1987 several thousand golden toads all gathered to breed in pools during April, but by the following year their numbers had plummeted to just 10! By 1989 only one golden toad remained and none have been seen since. The golden toad had become extinct in a matter of a few years. During the 1980s and 1990s two thirds of 110 known harlequin frog species that lived there also vanished. No-one could understand why they had suddenly disappeared when they lived in such a pristine habitat.

So what happened? The cloud forests experienced a rise in temperatures that led to more **evaporation** and even greater cloud cover. The extra clouds blocked the sunlight and actually lowered the temperatures within the forest itself during the day time, whilst at night time the cloud cover acted as an insulating blanket and made the forests warmer. The less extreme temperatures provided ideal conditions for the fungus to spread.

There are some scientists who are in **doubt** as to whether Chytrid fungi has anything to do with global warming at all. Whilst there is a general correlation between the air temperature in the tropics and the spread of the disease, it doesn't mean that one is causing the other. One scientist argues that the disease started spreading before temperatures increased.

A number of amphibian deformities have been reported which could be linked to increasing exposure **ultra violet UV-B radiation**. If these changes were natural and slow, the frogs could develop ways of dealing with them. However, changes in animals' **behaviour** in response to changes in their environment don't happen overnight, they take years. Frogs could adapt by laying their eggs in deeper water, but their instincts tell them to choose shallow water so that the eggs are warmed by the heat of the sun. Besides which the frogs aren't able to put their tadpoles in deeper water if all the pools are getting shallower or drying up altogether!

Yellowstone National Park, USA is the world's oldest national park. Here the number of permanently dry ponds has increased by 4 times, preventing the amphibians from spawning. Three out of four native amphibian species have suffered a major decline. Figures covering the same period of time as these declines in 1992 - 3 compared to 2006 - 2008 show a decrease in rain and an increase in temperatures during the warmest months of the year.

For amphibians, as with many of the previous examples we have looked at, climate change is adding to a number of existing problems and may present one challenge too many.

Published by the Young People's Trust for the Environment

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Design: Vanessa Adnitt
ISSN 1756 - 9087