**CHAPTER 19 Climate Change and Ozone Depletion**



**Core Case Study: Studying a Volcano to Understand Climate Change**

1. In 1991, Mount *Pinatubo* erupted, which allowed

scientists to further study global *climate* change.

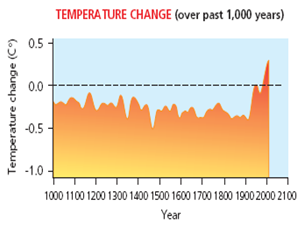
1. Scientists studied that amount of *SO2* released by the

volcano to determine if pollutants would indeed change the

climate of the Earth on a larger scale. It does.

**19-1: How Might the Earth’s Temperature and Climate Change in the Future?**

For the past 900,000 years the Earth has experienced period of global *cooling* and global *warming*. For the past 1,000 years the temperature has been *stable*, but has begun to rise in the last century when people began *clearing forests and burning fossil fuels*.



How are past temperatures determined?

* Radioisotopes in *rocks and fossils*
* Bubbles of ancient *air* in ice cores
* Temperature taken at different depths in Earth
* Historical records

Life on Earth wouldn’t be possible without the natural

*Greenhouse Effect*:

* *warms* the Earth’s lower atmosphere

and surface due to greenhouse gasses like

*CO2, water vapor, and CH4* that trap heat from the sun

The problem is when we have *too many* greenhouse gases and *human* activities have led to this increase.

- Mainly due to agriculture, *deforestation*, and burning *fossil fuels.*

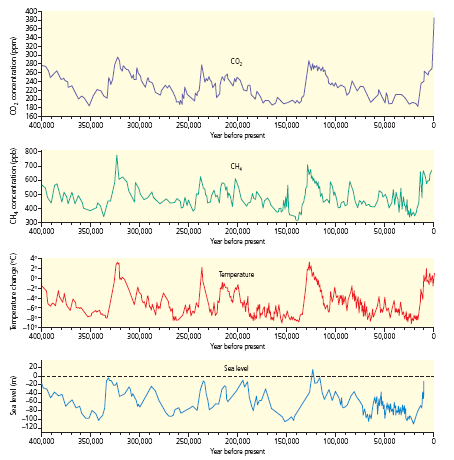
- At our current rate of emission of CO2 we will have a concentration of *560ppm* by 2050, and according to research the *tipping* point is*450* ppm.

\* Top 2 CO2 emitting countries:

*China and the US*

- Data from *ice* cores also shows that 60% of *methane* emissions is due to *humans* activity from extracting fossil fuels, *landfills*, and livestock.

- Nitrous Oxide levels have also increased due to use of Nitrogen *fertilizers (releases NOx in the air during the decomposition process)*.



|  |
| --- |
| Evidence that Supports Climate Change: |
| 1. Between 1906-2000, average global surface temp has increased by *1.3° F* 2. Greenhouse gas emissions has risen *70*% since 1970 3. *Arctic* temps have risen twice as fast in the past 50 years 4. *Glaciers* and floating sea ice are melting 5. Rainfall patterns are changing 6. Sea level has risen by *4-8* inches |

What Role Does the Ocean Play?

* Oceans absorb *half* of all of the *CO2* released and help moderate temperature
* Some Carbon is converted to *carbonate* salts that are buried in the sediments for millions of years
* *Solubility* of CO2 decreases with w*armer* temperatures
* As water heats, the CO2  isn’t *absorbed* as easily and could amplify global warming= *positive* feedback loop
* Higher levels of CO2 increases the *acidity* of the ocean, which decreases the ability of *corals* to make calcium carbonate shells

**\*\*Bottom Line: Temperature, acidity, and ability to absorb CO2 from atmosphere are changing as a result of human activities**

**19-2: What are Some Possible Effects of a Warmer Atmosphere?**

Ice and Snow are Melting:

Sea Levels are Rising:

Browning of the Earth:

Permafrost is Likely to Melt:

Ocean Currents Changing:

Extreme Weather:

Health:

Agriculture:

Threat to Biodiversity:

**19-3: What Can We Do to Slow Climate Change?**

Why this complex problem is difficult to tackle:

1. The problem is *global*- much international cooperation
2. Effects of climate change will last a long time- CO2 stays in atmosphere *120 years*.
3. It is a long term *political* issue.
4. Impacts of climate change are not spread *evenly* across the globe.
5. Phasing out fossil fuels will change our lifestyles, & disrupt *economies* and lifestyles.

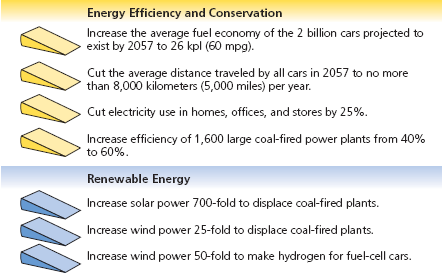
Solutions: Three Major Prevention Strategies-

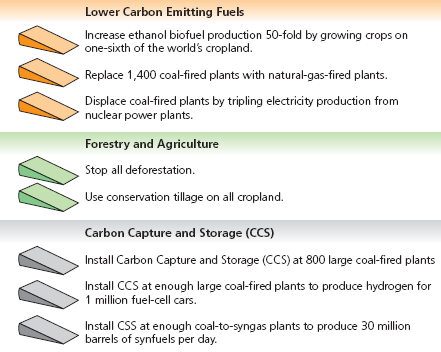
1. Improve energy *efficiency* to reduce fossil fuel use.
2. Shift from nonrenewable *C* based fossil fuels to a mix of Carbon *free* renewable energy resources.
3. Stop cutting down tropical *rainforests*.

\*\* Effectiveness of these strategies would be enhanced by reducing *population* and reducing *poverty*.

Climate Stabilization Wedges:







1. Massive *tree* planting on degraded

land in the tropics.

2. Plant fast growing perennial plants like

switchgrass- stores CO2 in *soil* to be

harvested for *biofuels*.

3. Carbon Capture & Storage (CCS)- removing

CO2 from *smokestacks* and pumping it

deep into *coal beds* or abandoned oil or

gas fields

-CCS is expensive and could raise prices

-require large inputs of *money* to

operate= counterproductive

-earthquakes, war, etc could cause a

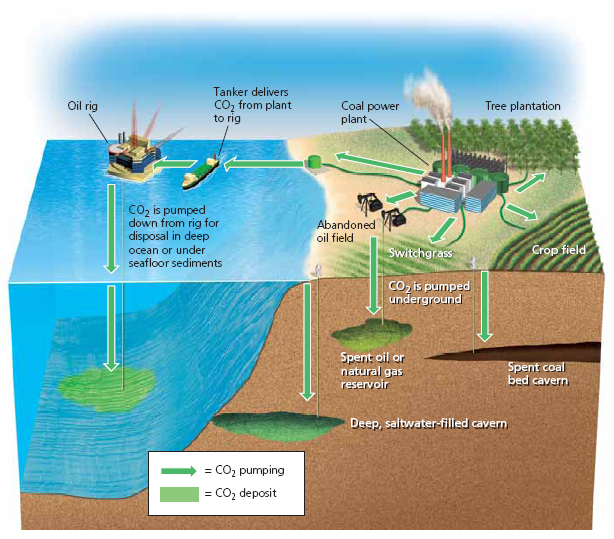
*leak*; even a small leak would be

disastrous

Random Suggestions:

1. Inject sulfate particles into *stratosphere* -reflects *sunlight* to cool troposphere
2. “Re-ice” the *Arctic*
3. Deep sea *pipes* to bring up nutrients for algal blooms which can take in *CO2*

Output Strategies for Reducing Climate Change:



**19-4: How Have We Depleted Ozone in the Stratosphere and What Can We Do About It?**

What Can the Government Do to Slow Climate Change?



1. Strictly regulate *CO2* and *methane* pollutants.
2. Carbon *taxes*
3. *Cap and Trade* Approach
4. *Subsidies* to businesses who use green

technologies

1. Technology transfer to *developing* countries

\**Kyoto* Protocol- a treaty to slow climate change (2005)

-required countries to cut emissions of *CO2, CH4, and N2O* by 5.2%



of their 1990 levels by 2012. Did it work?

-countries can *trade* greenhouse gas emissions- the “cap

and trade” system

-174 countries agreed to this. The US *did not*.

\*George W. Bush decided not to comply because he felt it

would harm the *economy* and he did not like how

rapidly developing countries (like *China*) were

exempt.

Who’s been successful?

* *Costa Rica* aims to be the first carbon *free* country. They currently generate 78% of their electricity from renewable *hydroelectric* power and 18% from *wind* and *geothermal* energy!
* Some US States are tired of waiting on the federal government to take charge.
  + Portland, Oregon- 1st city to cut greenhouse gas emissions back to *1990* levels.

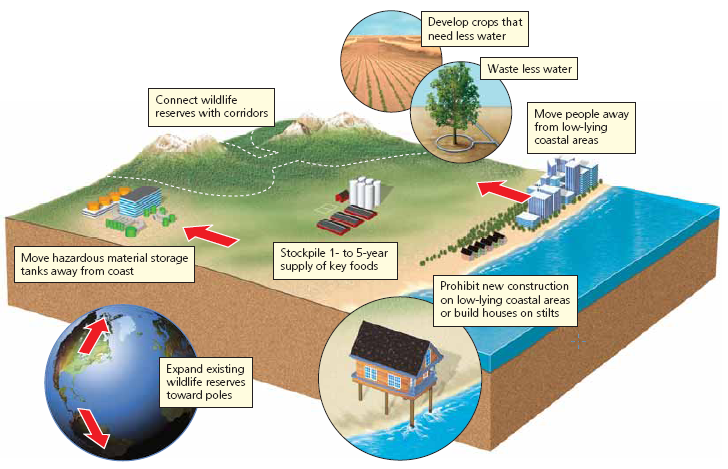


* + - The city promotes energy efficient *buildings* and use of electricity from *wind* and *solar* sources.
    - Has built many bicycle trails & has greatly expanded *mass transit*.
    - This has actually produced an economic *boom* and has saved the city $*2million*/year in energy costs!
  + California- 12th largest producer of greenhouse gases (GHG) in the world!
    - 2006- CA passed a law to cut GHG to *25%* below 1990 levels by 2020.
    - Set fuel efficiency and carbon emissions standards and let the free market find the best ways to meet standards- EPA refused this request. CA and 17 other states are now suing the federal government to allow states to set tougher CO2 emission standards.
  + Companies and Schools are reducing their Carbon Footprints
    - DuPont, IBM, Toyota, & Walmart have cut GHG emissions

What Can You Do to Reduce Your CO2 emissions?

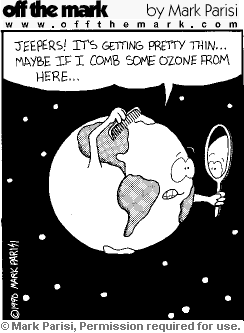
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Preparing for the Harmful Effects of Climate Change:



Global climate models say we must make a *50-85%* cut in GHG emissions by 2050 to prevent Earth from heating up more than 3.6°F, which will likely be difficult to do. Therefore, analysts have compiled a list of things we need to do to prepare for the long-term effects of climate change. See Picture.

**19-4: How Have We Depleted Ozone in the Stratosphere and What Can We Do about It?**



Not only is there considerable thinning of the ozone in the

polar regions, but there is overall thinning everywhere as well.

Ozone depletion in the *stratosphere* poses a serious threat to *humans*, animals, and *primary producers*.

**Chlorofluorocarbons (CFCs)**

\*Discovered in *1930s* and use expanded rapidly

\*Trade name = *Freons*

\*Thought to be the dream chemical because it is chemically unreactive, *nonflammable*, nontoxic, *inexpensive*, and *noncorrosive*

\*Became popular as *coolants* in ACs, refrigerators, cleaners for electric parts, propellant in spray cans, etc.

\*Too good to be true: 1974- “CFCs destroy *ozone* in stratosphere” said Rowland and Molina

-CFCs rise and remain in atmosphere

-Once CFCs reach atmosphere, it breaks

down under the influence of the *UV light*

which releases a highly reactive *chlorine*

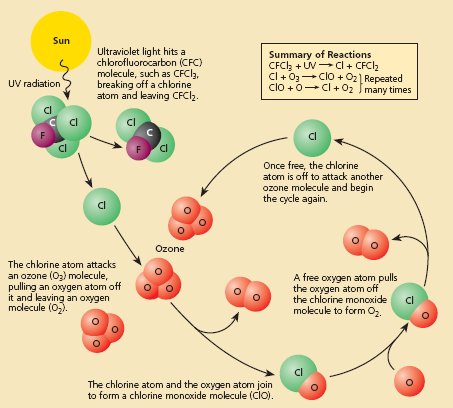
which break O3 into O2 and O

-CFCs persist in atmosphere for *65-385*

years depending on conditions

-It took Rowland and Molina 14 years to

convince DuPont to stop production



Why Should We Worry about Ozone Depletion?

1. More damaging *UV-A* and *UV-B*

radiation reaches the Earth’s surface.

1. Sunburns, skin *cancer*
2. Destroy *phytoplankton*- they play a key role in removing *CO2* and are

the base of ocean food web

How Can We Reverse Stratospheric Ozone Depletion?

1. Stop use of all *ozone depleting* chemicals
2. Montreal Protocol- treaty’s goal is to cut *CFCs* emissions by 35%

**CHAPTER 9 Sustaining Biodiversity: The Species Approach**

**Core Case Study: The Passenger Pigeon: Gone Forever**

Describe in detail the 2 main reasons why passenger pigeons were once the most numerous bird species, but are now extinct.

1. *Uncontrolled commercial hunting- they tasted delicious, their feathers made good pillows, and their bones were used as fertilizers*

-they were easy to kill because they traveled in large flocks

1. *Habitat loss as forests were cleared to make room for farms and cities*

**9-1: What Role Do Humans Play in the Premature Extinction of Species?**

During the last 3.65 billion years that life has existed on Earth, there has been a continuous, low level of extinction called *background extinction*.

Extinction Rate is expressed as *a percentage or # of species that go extinct*.



Define: Mass Extinction- *extinction of many animals in a*

*short amount of time*

How many mass extinctions has the Earth gone through?

*5*

What are some of the possible causes of these past

mass extinctions?

*The causes are poorly understood, but most likely*

*due to global changes in environmental conditions.*

*(like asteroids)*

|  |  |  |
| --- | --- | --- |
| Local Extinction- | Ecological Extinction- | Biological Extinction- |
| *When a species is no longer found in an area it once inhabited but can still be found elsewhere* | *When so few members of a population are left that it can no longer play its ecological role in the community* | *No longer found anywhere in the world* |

Conservation biologists project that extinction rate will increase to *10,000* times the normal background extinction rate due to *habitat loss, climate change, and other human activities*. This equates to an annual extinction of about *1%* per year.

Extinction experts consider extinction rates of 0.01%-1% to be conservative because:

1. *Rates of extinction and biodiversity loss will likely increase due to an increasing size of the human population.*
2. *Current and projected extinction rates are higher than the global average in parts of the world that are highly endangered centers of biodiversity (hotspots).*
3. *We are eliminating, degrading, fragmenting, and simplifying many biologically diverse environments such as the tropical forests, reefs, wetlands, and estuaries.*

|  |  |
| --- | --- |
| Endangered Species | |
| Definition:  *So few individual survivors that the species could soon become extinct over all or most of its natural range* | Examples:  *Giant Panda, Siberian Tiger, Whooping Crane, California Condor, Bluefin Tuna* |

|  |  |
| --- | --- |
| Threatened Species | |
| Definition:  *Still abundant in its natural range but, because of declining numbers, it is likely to become endangered in the near future* | Examples:  *Polar Bear, African Elephant, Great White Shark* |

The International Union for the Conservation of Nature and Natural Resources has put out a *Red* Lists which lists the world’s *threatened* species.

Describe what makes some species particularly vulnerable to ecological and biological extinction:

|  |  |
| --- | --- |
| Characteristic: | Example: |
| *-Low Reproductive Rate (k-strategist)*  *-Specialized Niche*  *-Feeds at High Trophic Levels*  *-Commercially Valuable* | *-Blue Whale*  *-Giant Panda*  *-Grizzly Bear*  *-Rhinoceros* |

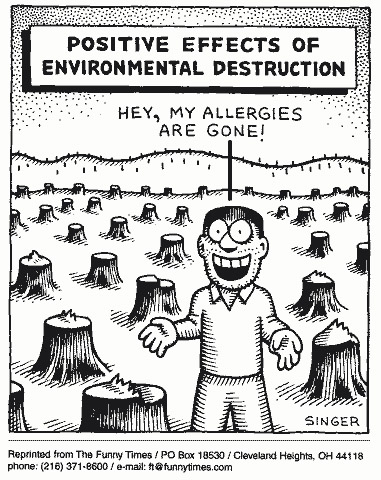
**9-2: Why Should We Care About Preventing Premature Species Extinction?**

We should care about preventing premature species extinction because:

1. Instrumental Value- *usefulness to us in providing many ecological and economic services*
2. Ecotourism- *species diversity that provides economic benefit from wildlife tourism*
3. Genetic Information- *allows species to adapt to changing environmental conditions through evolution*
4. Existence Value- *satisfaction of knowing that the biodiversity exists*
5. Aesthetic Value- *appreciation for the beauty*

**9-3: How Do Humans Accelerate Species Extinction?**

Most important causes of premature extinction:



|  |  |
| --- | --- |
| H | *Habitat Loss* |
| I | *Invasive Species* |
| P | *Population Growth* |
| P | *Pollution* |
| C | *Climate Change* |
| O | *Overexploitation* |

Why are temperate areas more likely to be affected

by habitat loss and degradation?

*Because of widespread economic development*

*in temperate countries*

Define: Endemic Species- *found in only 1 area of the world*

Why are they so vulnerable to extinction? *Habitat loss in that area will wipe out the entire population*

What creates Habitat Islands? *Any habitat that is surrounded by a different one is a habitat island. National Parks are often considered habitat islands because the protected areacan be encircled by industrial activities.*

Define: Habitat Fragmentation- *caused by roads, logging, agriculture, and urban development and occurs when a large area of land is reduced and divided into smaller patches*

*-decreases tree populations*

*-pushes populations into smaller areas that can increase disease, competition, etc*

*-block migration routes*

Case Study: A Disturbing Message from the Birds

Worldwide, *70%* of birds are declining.

Major reasons are: *habitat loss* and fragmentation of breeding habitats,

introduction of *invasive species*, and illegal trapping for *pet trade*.

For seabirds, an issue is being caught in *baited lines from fishing boats*, for migratory birds, flying into power lines, towers and *wind turbines*.

Birds are important ecologically because they: control *populations of rodents and insects*, remove *dead animal carcasses*, and spread *seeds of plants*.

Birds are also environmental *indicators* because *they live in every climate and biome, respond quickly to environmental changes, and are relatively easy to track and count.*

After habitat loss and degradation, introduction of *invasive* species is the biggest cause of premature animal and plant extinction.

What is the Kudzu vine and what problems is it causing?

-*deliberately introduced in the 1930s from Japan to help control soil erosion*

*-quickly engulfs and suffocates gardens, trees, etc and is difficult to kill*

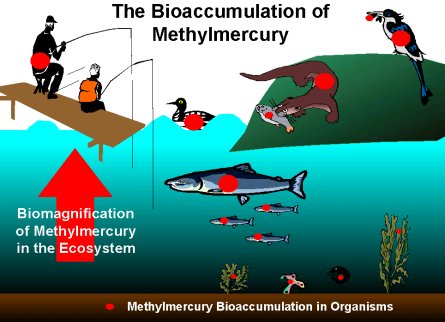
Describe how the fire ant got to the southeast US. What problems are they causing?

*The Argentina Fire Ant was accidentally introduced in Alabama because the shipment of lumber was infested with these ants.*

*These ants have no natural predators and spread rapidly killing off native ant species and have caused thousands in economic damage to crops.*

|  |  |
| --- | --- |
| **Characteristics of Successful Invader Species:** | **Characteristics of Ecosystems Vulnerable to Invader Species:** |
| *High Reproductive Rate (r-selected)* | *Climate Similar To Habitat of Invader* |
| *Pioneer Species* | *Absences of Predators* |
| *Long Lived* | Early successional systems |
| High dispersal rate | Low diversity of native species |
| *Generalist* | *Absences of Fire* |
| High genetic variability | *Disturbed by Human Activity* |

List 2 ways of controlling invasive species:



1. *Don’t capture or buy wild animals*
2. *Don’t dump contents of an aquarium into*

*waterways, wetlands, or storm drains*

Pesticide Pollution Problems:

Define BIOACCUMULATION: *accumulation of*

*chemicals (like DDT and methyl mercury) in*

*the fat cells of animals*

Define BIOMAGNIFICATION: *the concentration of*

*chemicals is at the highest concentration at the*

*top of the food chain*

Two Alarming Disappearances:

Honeybees are responsible for 80% of pollination in insect-pollinated plants, but are dying due to *pesticide use*, parasites, fungi, invasion, and bee colony collapse syndrome.

Polar bears are suffering because of less *floating sea ice*, and pollutants like *PCBs* & DDT.

*Poaching* is the illegal killing, capturing, and selling of wild species.

-rapidly growing wildlife smuggling is a high profit, low risk business

-smugglers are rarely caught or punished

Illegal pet trade:

-exotic animals carry dangerous infectious *diseases*

What is bush meat and why is it causing such problems in Africa?

*Bush meat= meat from a gorilla*

*Hunting and killing has rapidly increased in Africa due to an increasing population and reduced food from fishing*

*The increased hunting has led to local extinction and threatens other species within the food chain.*

Who is Jane Goodall?

*She works to protect Chimpanzees and their habitats by educating people around the world.*

**9-4: How Can We Protect Wild Species From Extinction Resulting From Our Activities?**

|  |  |
| --- | --- |
| Law or Treaty: | Description: |
| Convention on International Trade in Endangered Species (CITES) | *-internationally bans hunting, capturing, and*  http://t0.gstatic.com/images?q=tbn:ANd9GcRxX-0GBuaQ2cP2CG49XvpHdl2_Lt3iTSWB7IHwhOKnDxCK1FN_MQ&t=1  *selling threatened* or endangered species  *-lists over 900 species that can’t be commercially*  *traded*  *-however, enforcement varies by country* |
| US Endangered Species Act | *-designed to identify and protect endangered*  *species in the US*  *-forbids federally funded projects that would*  *damage the habitat of endangered or*  *threatened species*  *-illegal for Americans to buy or sell products made from endangered or threatened species*  *-close inspection of animals entering the US*  *-private land owners are given financial incentives to help protect endangered species on their land* |

**Solutions:**

1. *Wildlife Refuges*- serve as sanctuaries for animals and birds
   * + - * Ex: Pelican Island- established as a refuge for birds by President Roosevelt
2. *Seed Banks*- preserve genetic information and endangered plant species by storing their seeds around the world- expensive though
3. *Botanical Gardens*
4. *Zoos, Aquariums, Game Parks*
5. *Captive Breeding* and then release into the wild to build up populations

*California Condor*- nearly extinct from lead poisoning from ammunition

-in order to save the species, the birds were captured to breed in captivity

1. Define: THE PRECAUTIONARY PRINCIPLE- *precaution should be taken if there is preliminary evidence that indicates a human activity causes harm to health or the environment*