Comment: We'll skip the "deliberately caused extinctions" for now. Not sure this was ever such a good idea - basically the concept was to discuss if it's a good idea to totally eradicate pest species and/or pathogens (if possible).

E.g. - smallpox - should we kill off the last surviving cultures?

This might be going outside the purview of this course a little too much.

Environmental factors:

This is defined as factors that affect the environment, usually in an adverse way. This includes such things as pollution and climate change and gross habitat modifications.

Air pollution - The main problem here is that it's sometimes difficult to quantify the effects of air pollution on animals or other organisms. We know, for example, that ozone is bad for us (at low altitudes), but there are few studies that show it's bad for animals. It seems common sense that this would be true, but consider a counter-example:

Acetaminophin (Tylonel) is deadly for dogs, yet perfectly safe for humans (overdosage can be very nasty, however). One would think that humans and dogs are close enough, but this shows otherwise.

Still, the basic physiology of lungs in mammals is similar, so one could make a good argument for ozone being harmful to other animals.

What are some examples (just a few highlights)?

Chloroflourocarbons - a former ingredient in aerosols and air-conditioners. Perfectly harmless in direct contact (unless it's burning), but it has been shown to destroy the ozone layer (the paradox here is that ozone is beneficial at very high altitudes, but very nasty at lower altitudes).

Ozone blocks ultraviolet rays from reaching the surface. UV radiation can cause lots of biological damage and is implicated in many skin cancers, as well as a possible cause in the amphibian decline. It affects numerous species around the world adversely.

Leaded gasoline - we all know about the dangers of lead poisoning. Lead is poisonous to many organisms, and can do irreversible damage to children (and presumably the young of other species, though this hasn't been proven).

Acid rain - many factories (particularly power plants) release large

quantities of nitrogen and sulfur into the atmosphere. This reacts with water in the atmosphere to form acids. The result is very acidic rain. A large part of the North East had been adversely affected by pollution produced in the mid-west. In other parts of the world, the former East Block countries have been particularly hard hit. High-sulfur coal was used for years (it was what was easily available). Large tracts of forest have simply ceased to exist. For example, driving into the Czech Republic (the former Czechoslovakia) from Germany there used to be mile upon mile of dead trees.

Carbon dioxide - we'll save this one under it's own topic further down.

Water pollution - The effects are generally a little more localized, but more obvious. With air pollution, pollutants get spread out a bit more. Still, we differentiate between:

Point source pollution - pollution coming from an obvious point such as sewage being dumped into a river.

Non-point source pollution - pollution that is more spread out, such as excessive fertilizer being spread across fields.

(One can make the same distinction for air pollution).

What are some examples (again, just some highlights)?

dioxin - a byproduct of paper manufacture and other things. Lethal in very small concentrations.

sewage - not everything is treated. In other parts of the world, sewage is simply dumped into local streams, rivers, or even the ocean. Large parts of the Mediterranean are in trouble due to countries simply dumping sewage into the ocean. Sewage contains many nutrients, but these are in the wrong place at the wrong time (algal blooms and die offs can result).

sedimentation - clouds up rivers and streams. This can lead to increased turbidity in many areas (prevents light from penetrating water, makes it difficult for animals to clear grunge off their gills, dumps unwanted minerals into the water). This is also a major cause in coral die off.

fertilizer - adds excessive nutrients to the water (algal blooms, etc.)

oil - everyone knows of the serious consequences of oil spills. Even now, the tanker that went down off the coast of Spain still carries an enormous load of fuel that folks are trying to figure out how to salvage.

In general, oceans are less affected (there's an enormous amount of water) so pollutants get more and more diluted. However, local areas in marine ecosystems can be strongly affected (e.g., the Baltic or Sea of Japan).

A concrete example of some of this from another text: The total diversity of invertebrates in the Rhine decreased from 193 species in the early part of the 1900's to 74 by the mid 80's.

Other types of pollution:

Light pollution: In many areas, lights (at night) confuse different animals. Some specific examples include:

Turtle hatchlings. These move toward the "bright" horizon after hatching (at night). Before the advent of chains of ocean front hotels, all brightly lit, this was the direction to go in if one wanted to reach the ocean. Now they are found wandering inland towards hotels.

Bird migrations. Lights have been found to interfere with birds, particularly when visibility conditions are low (e.g. fog). Birds often wind up flying into towers and other structures, attracted by the light.

An obvious example is insects being attracted to lights. There are even bug-zappers which take advantage of this. Note that these are indiscriminate killers.

Of course, some animals like bats have learned to take advantage of all this.

Some asides on this:

There is a "dark sky society", www.darksky.org. They promote the use of intelligent outdoor lighting. This has two advantages:

- It requires less energy, since more light is reflected down instead of "lighting up bird butts" [illustrate].

- It helps restore darkness to our skies.

- The group is made up mostly of astronomers, but biologists and conservationists should be more aware of this group.

- There are numerous businesses that use huge skylights to light up

the sky at night as part of an advertising campaign. This really should be discouraged.

Noise pollution: This one's kind of obvious. It might have less of an impact than other kinds, but it can still be very annoying and even dangerous. Shy animals are often chased away by noise.

- E.g., - if you don't want to run into a bear, make lots of noise walking through the woods. But at the same time, you wind up chasing the bear away (probably a good thing for you, though!)

- Incidentally, some products try to take advantage of this, but there are no studies that show, for instance, that deer whistles like those folks get to put on the front of their car bother deer at all.

Pesticides: These are kind of in their own category since they are specifically designed to kill things.

Herbicides - used to kill weed species, Insecticides - kill insects, Fungicides - kill fungi, etc.

Some more modern pesticides are pretty good in that they target specific species and break down shortly after being used.

But, unfortunately, they have a nasty history. Some kill almost anything and are very persistent.

Read the warning labels on almost any pesticide. It's **nasty** stuff!

Some examples:

DDT - kind of the classic "bad" pesticide. There are numerous problems with DDT:

- It takes a long time to break down.

- It is toxic to many different animals.

- It is "biomagnified". Animals higher up the food chain get increasing dosages of DDT as this is stored in fat tissue. For example, an otter might feed on a fish. It will get the DDT from the fish and store this in its fat tissues. As it feeds on more fish, the concentration of DDT in it's fat tissues keeps rising. Predators are very susceptible to this.

- Insects are increasingly resistant to DDT (in other words, it doesn't even work anymore).

- In the U.S., the use of DDT has been outlawed. But manufacturers are still free to export the stuff overseas.

- But fortunately international treaties are in place that prevent the use of DDT except in a few carefully proscribed situations (it's still cheaper than many alternatives and in some areas it's used, for example, to help control malaria by careful application to houses and other structures).

- one of the nastiest chemicals around. One of the main reasons many birds of prey (including the bald eagle) in the U.S. wound up on the endangered species list.

- the biomagnification effect led to eggshells that were too thin and started breaking before the young could hatch.

Malathion - used to kill a number of different insects. Highly toxic to bees, and has also been implicated in fish kills.

Paraquat - an herbicide that is very effective on plants, but unfortunately also extremely toxic to animals. One report lists "thousands" of poisonings every year due to paraquat, particularly in the third world where application methods are less refined.

Recently some pesticides have been found to mimic the effect of female sex hormones. This had led to sterility, delayed maturity, abnormal reproductive organs and other problems.

A final thought on pesticides - many insecticides are very closely related to nerve gas (they work the same way, except on insects).

Carbon dioxide: The main reason we're worried about global warming. The basic problem with CO2 is that it acts as a green house gas.

Greenhouse gas - prevents the radiation of heat back into space. A simple example of this effect is a closed car in the sun - it's warmer in the car than outside. In both cases, visible light penetrates the glass or CO2, has a warming effect, and is re-radiated as infrared. Glass (e.g. the car) and CO2 are barriers to infrared radiation, so heat is trapped. For more details, take a look at a physics text book.

Carbon dioxide is produced by numerous human activities, but the main problem is the burning of fossil fuels (and the removal of carbon sinks (burn & slash agriculture, for example).

CO2 is a byproduct of combustion. It's harmless in the sense of causing adverse medical effects (except in much high concentrations).

The concentrations of CO2 have been rising, and as a result meteorologists have observed an increase in the overall average temperature on earth.

This can be difficult to detect because of year to year variations in temperature, or even long-term climactic trends.

What are the long term consequences?

Rising sea levels - as temperatures rise, less ice is bound up in the polar caps. This means more water in the oceans. Recent satellite imagery shows that some areas do have less ice.

Global disruption in climate patters. A couple of degrees may not sound like much, but it's enough to make some areas much drier, and others much wetter. It also doesn't mean that every spot on the planet rises by a couple of degrees. Local effects can much greater, even if the world wide average is only a few degrees (climate models show the highest increase in temperatures at higher latitudes (as much as 8 degrees C (14 degrees F) in the Arctic, and 6 degrees C (10 degrees F) in the Antarctic).

We already have evidence of:

Increased incidence of heat waves

Increased incidence of droughts and fires

Melting of glaciers and polar ice (in 1999, 2992 square kilometers of the Antarctic ice shelf collapsed - this was previous stable)

Rising sea levels (even in the Chesapeake).

In addition, we see such effects as:

spread of disease (malaria spread to new areas as mosquitoes extend their range)

earlier nesting of birds and leafing out of trees (for example, in England).

shifts in species range

Population declines (Adelie penguins have declined by 1/3 in the last 25 years, possibly as a result of sea ice reductions.

The real problem is that it is difficult to separate out long term and short term effects. Folks that discount global warming insist that it is too early to tell if this is happening for sure.

- it is true that we have longer term climactic cycles such as Europe's mini ice age from 1150 to 1850 was marked by cooling trends and cooler temperatures than found today.

- even year to year variations are difficult to deal with (this winter was colder than average in the Washington area).

But some inescapable facts:

- Carbon Dioxide ***is*** a greenhouse gas - one can't argue with the physics.

- levels of Carbon dioxide have risen from 290 ppm to 360 ppm in the last 100 years, and are projected to double before the end of the century.

- Fossil fuel use has increased from 1 to 7 billion tons of oil (or equivalent) in the last 50 years.

Finally, what are the consequences of doing nothing? One can make a powerful argument that since the consequences are so serious, taking a "wait and see" attitude is downright reckless.

Most climatologists and scientists no longer argue about the greenhouse effect. A recent comprehensive study supports a .6 degree rise in temperature throughout the last century as being a direct consequence of increased greenhouse gases (this isn't that much, but remember that CO2 levels are projected to double by 2100.

But the exact extent of global warming is a subject of some argument.

Before we leave this topic:

There are other greenhouse gases. Methane is particularly notorious (seriously, cows passing gas are not to be overlooked!)

A couple of concluding remarks about on environmental factors:

- we haven't looked at all of them (nuclear waste, wars, heavy metals, toxins in farm animals, antibiotics (in feed, causing the emergence of resistant pathogens), etc.)

- this is not a class on "pollution", but we need to be aware of the basics.

- A very important point:

- What would be the consequences to the environment if all 6 billion people on earth consumed and polluted as much as the developed world?

- This raises some important ethical questions.

- Obviously, people in underdeveloped countries have just as much of a right to resources as elsewhere. But the earth would almost certainly not withstand the onslaught.

- We need to find a different way of doing things!

(Sorry if I'm being too political here - unfortunately our next lecture will become even more political!)