THE SACRED OCEAN
HOW LONG HAVE WE GOT?

(26 pages and 42 slides)

An illustrated public lecture prepared by Robert Anderson PhD following the departure of a protest vessel from the Port of Tauranga, New Zealand, heading for the Southern Ocean where Japanese whaling ships were operating. Bob died before he was able to finalize and present it to the very public who had asked him to tell them about the state of Earth's oceans.

N.B. Some facts may have changed since the preparation period in 2008.

Why are there concerns about the state of Earth's oceans?

Here is just one update – on dead zones.[1] Dead zones have been increasing since the 1970s[2] and estimates of how many there are varies, with up to 400 worldwide suggested.

Dead zones are areas where the water at the sea floor has very low or zero concentrations of dissolved oxygen. It is *anoxic*. The reason is the organic matter produced by phytoplankton at the surface. That organic matter sinks and bacteria at the bottom break it down in a process called bacterial respiration.[1]

Phytoplankton use carbon dioxide (CO_2) and produce oxygen, while the bottom dwelling bacteria use oxygen and give off CO_2 during respiration. The oxygen used by the bacteria is the oxygen dissolved in the water, the very oxygen that bottom-dwelling, oxygen-respiring animals require.[1]

Back on the surface, the excess of nitrogen from fertilizers and sewage - what experts call a *nitrogen cascade*[2] - generally flows untreated into the oceans and can trigger a proliferation of plankton; effects magnified by heavy rains that carry, for example, dead animals and flooded animal-waste water. Increased phytoplankton productivity at the surface means more organic matter produced to sink to the bottom to be respired by bacteria, and the release of more CO_2.

Any restriction in the flow of water with normal dissolved oxygen concentrations - oxic water - means oxygen levels are depleted even faster.[1] A restriction concentrates nutrients, such as into and out of the Baltic Sea. The largest known "dead zone" is the Black Sea below 150 metres due to the water flow between the Black Sea and the Mediterranean Sea being restricted through the Bosporus.[1]

A review of ocean data records concluded that "low-oxygen events" affecting the American Pacific Northwest coast since 2002 had not occurred in the previous five decades.[3]

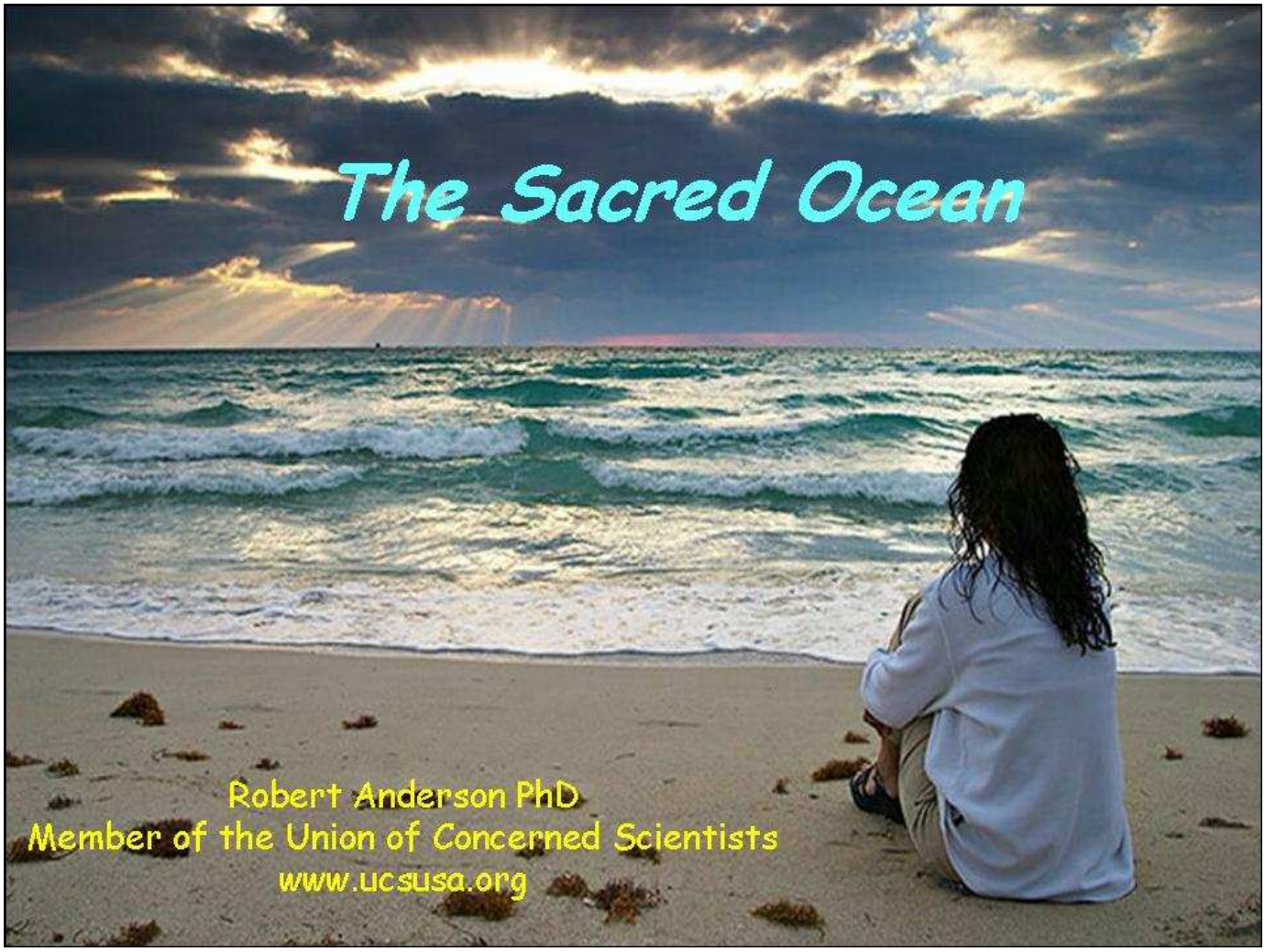
Dead zones have been found near the mouths of major river systems, e.g. the Mississippi River delta and the mouth of the Pearl River in China, and others off the coasts of South America, Japan, southeast Australia and New Zealand.

Aquatic ecologist, Donald Scavia, of the University of Michigan, and his team, predict the 2009 Gulf of Mexico "dead zone" will continue a decades-long trend and increase in size, becoming be one of the largest on record; about the size of New Jersey.[4]

Professor Gary Shaffer of the Niels Bohr Institute, University of Copenhagen, is the leader of the research team at the Danish Centre for Earth System Science (DCESS). He explains that controlling fertilizer usage, for example, could improve coastal dead zones, but expanded low-oxygen areas caused by global warming could remain for thousands of years, adversely affecting fisheries and ocean ecosystems far into the future. "Such expansion would lead to increased frequency and severity of fish and shellfish mortality events."[5]

(See also 'Climate Change' on this website.)

References. 1. http://daac.gsfc.nasa.gov/oceancolor/additional/science-focus/ocean-color/dead_zones.shtml; 2. www.msnbc.msn.com/id/4624359; 3. www.sciencedaily.com/releases/2008/02/080214144547.htm; 4 http://www.sciencedaily.com/releases/2009/06/090618124956.htm; 5. www.sciencedaily.com/releases/2009/01/090125142118.htm.
See also http://seawifs.gsfc.nasa.gov/SEAWIFS.html; http://state-of-coast.noaa.gov/bulletins/html/hyp_09/national.html; www.nationalgeographic.com/blacksea;



Friends, I do not need to extol the beauties of living near the ocean in a place like Tauranga. We are all used to seeing it. We swim in it, we sail on it, and generally enjoy all the bounties it has to offer. In New Zealand, we are blessed with some of the world's finest beaches and an ocean that is, generally speaking, relatively clean. Unfortunately, overall Earth's oceans are approaching a crisis point.

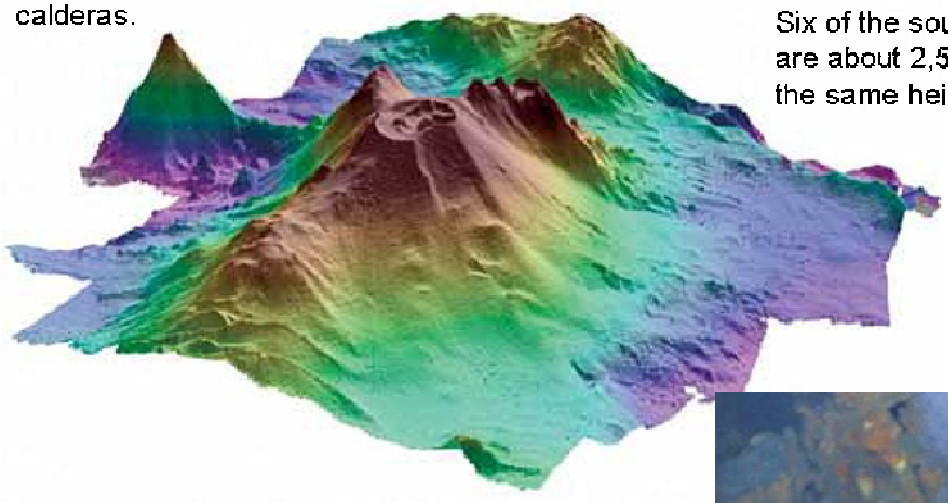
Putting aside the killing of whales and dolphins, over-fishing, and using the ocean as a dustbin, I would like to show you some of the lesser-known but interesting facts.

Let us start by looking below the surface of this vast world that surrounds us.

Slide 1

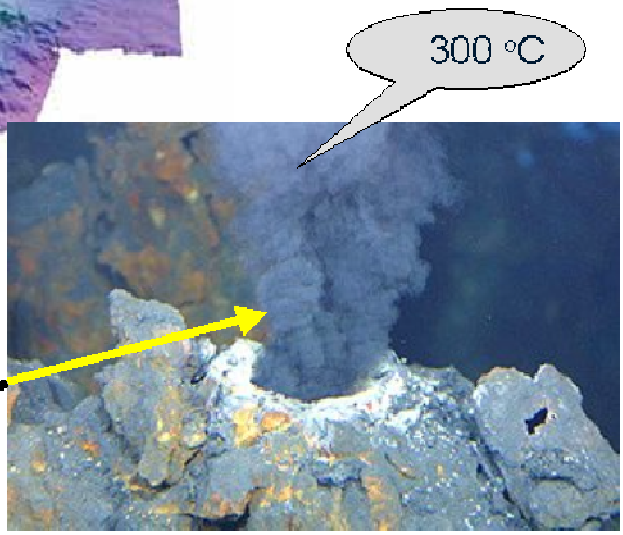
Under Our Oceans

The Brothers seamount off northeast of the New Zealand mainland, showing the volcanic features of nested summit calderas.



Six of the southern Kermadec seamounts are about 2,500 metres in height, roughly the same height as Mt Taranaki.

New Zealand seamounts are regarded as the highest productive area of the southwest Pacific, and a centre of global ecosystem production.



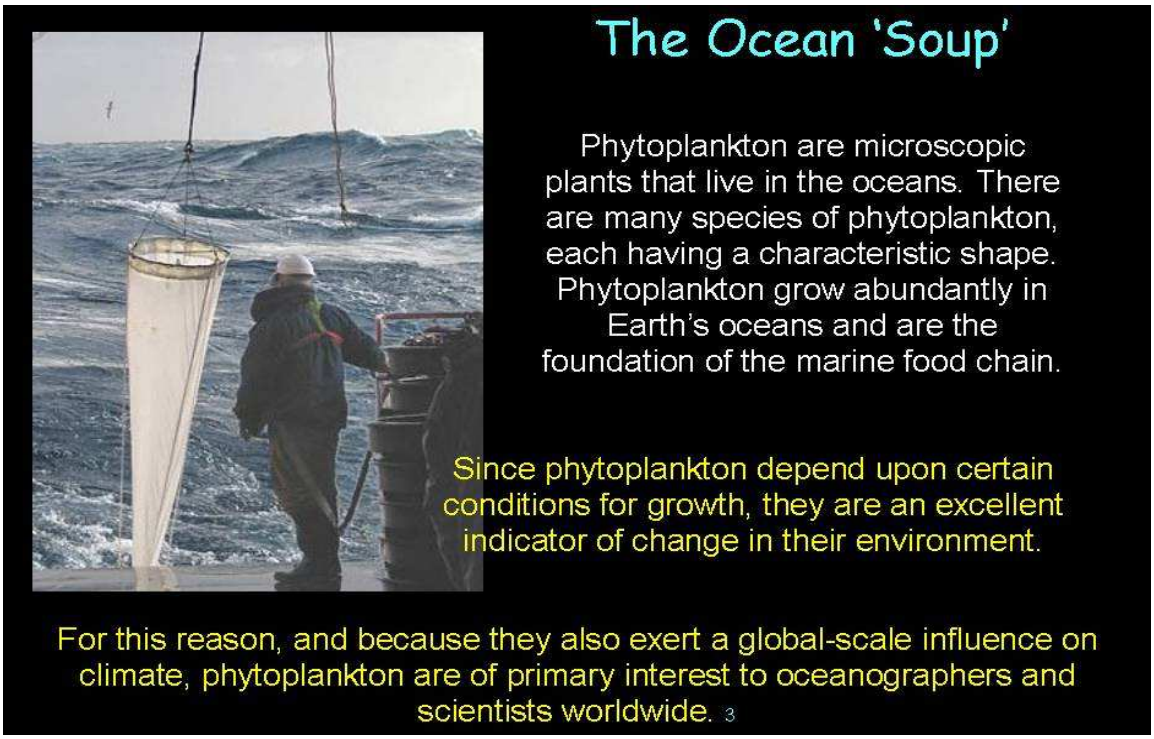
What you see the arrow pointing to in the bottom picture is a fumarole.

Fumaroles are immensely rich in iron, manganese and other nutrients. Discharged from hydrothermal vents, they are carried by seafloor currents to provide nutrients for the microscopic organisms on which ocean food chains and fisheries are based.

What other organisms do ocean food chains and fisheries rely on?

The smallest and most important of sea creatures are plankton. These tiny dwellers form the very base of the ocean food chain. They are immensely important. Fish, whales, dolphins, crabs, seabirds, and just about everything else that lives in or around our oceans owes their existence to phytoplankton.

Slide 2

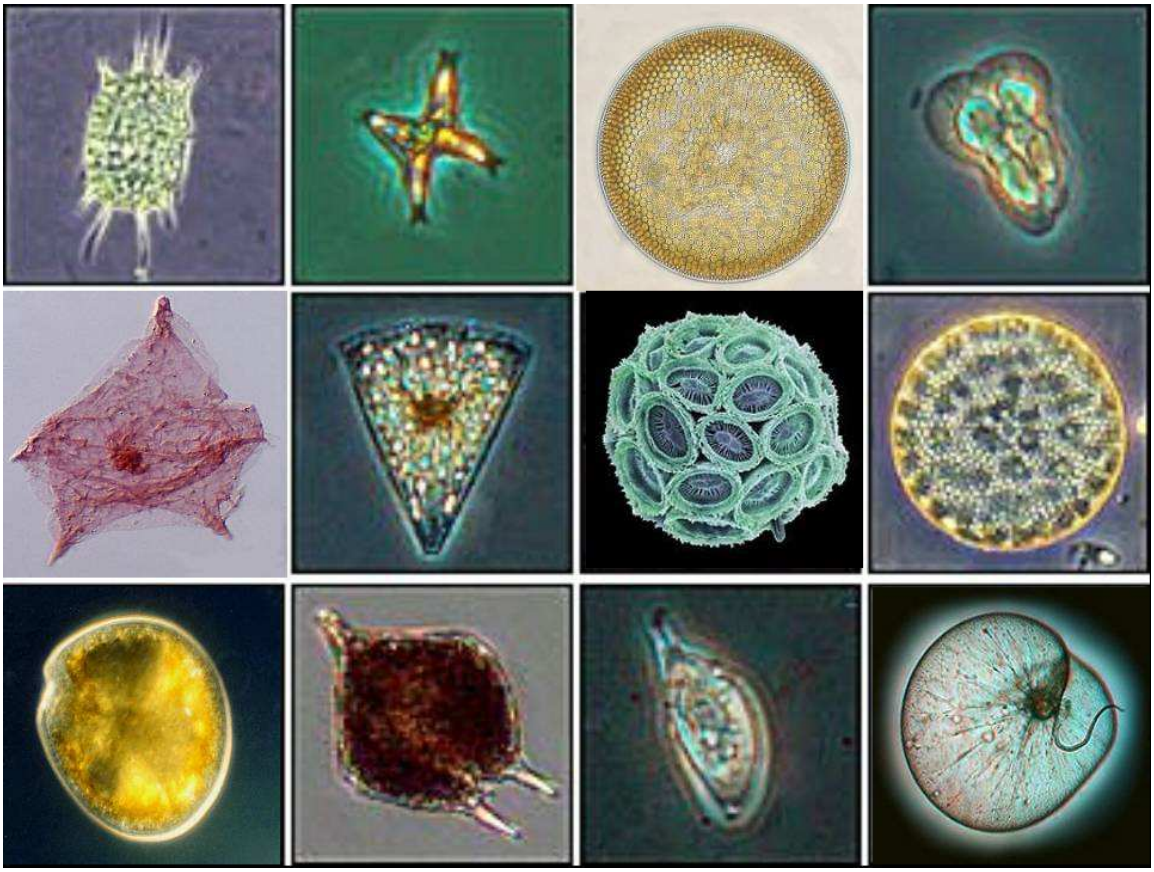


The name plankton comes from the Greek word *planktos* meaning wanderers. There are two types of plankton - phytoplankton, and zooplankton. There are many species of each of these having a characteristic shape.

Collectively, phytoplankton have grown abundantly in Earth's oceans and are, I repeat, the foundation of the marine food chain. Like tiny gems, they multiply in the cold waters of our seas.

This next slide gives some idea of the amazing beauty that nature creates among these tiny creatures.

Slide 3 - Plankton



These single-celled organisms far outnumber the sum of all the other marine organisms in the oceans.

While phytoplankton are largely invisible to the naked eye, their total effects can be seen from space. The literally uncountable trillions of phytoplankton make up the oceans' 'soup.'

Phytoplankton convert huge quantities of carbon dioxide (CO_2) into living matter; they take in CO_2 and give out oxygen just as any forest of trees, but on a much larger scale. In that process, they produce a major percentage of Earth's oxygen.

These life processes help regulate Earth's overall climate and habitability. Thus phytoplankton are wonderful indicators of climate change. They are super sensitive to environmental conditions and exert a global-scale influence on climate.

We are often told that the Polar bear is the 'canary' of global warming. It is not. Phytoplankton are.

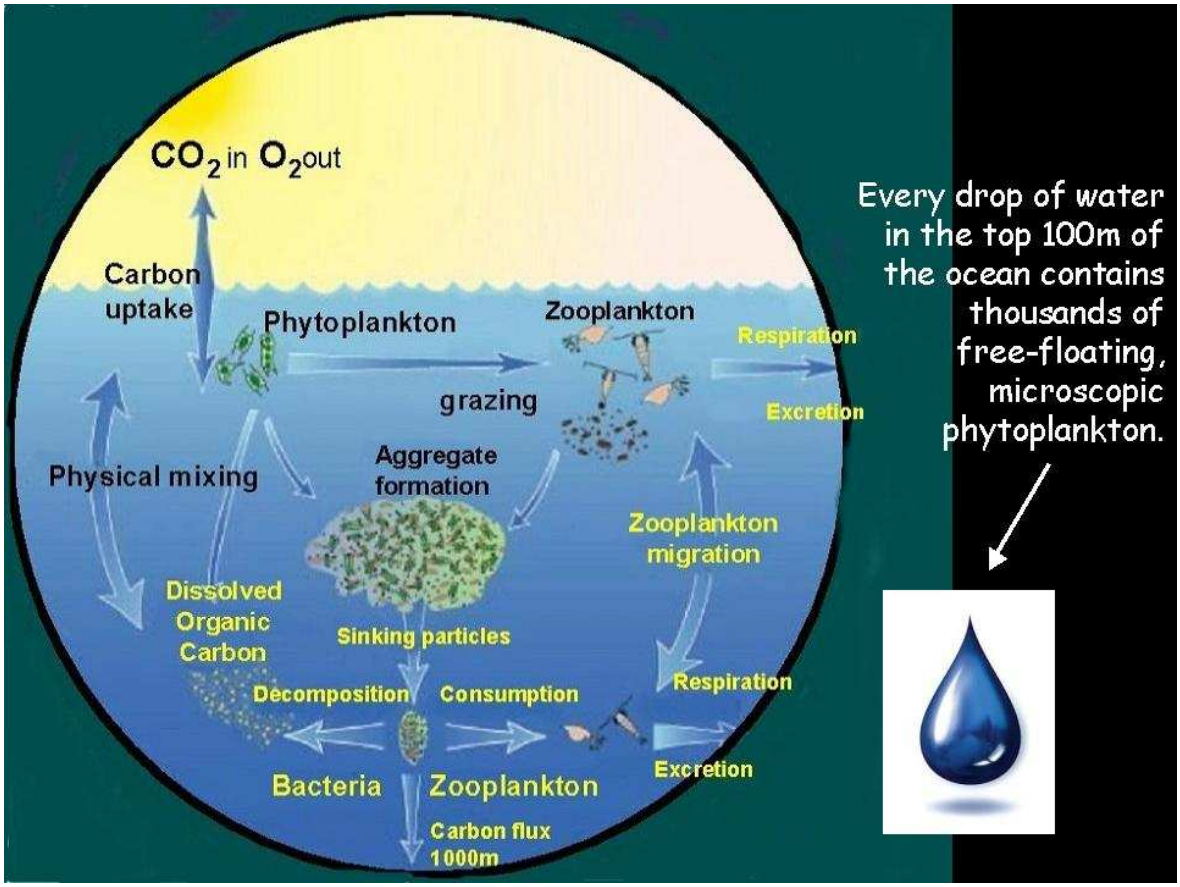
For this reason, phytoplankton are of enormous interest to oceanographers and Earth scientists around the world.

One problem that phytoplankton now face is acidification. Dr Ken Caldeira, an oceanographer at Stanford University who briefs lawmakers on climate change, said the ocean is more acid than it has been for "many millions of years." Phytoplankton do not like living in acid waters.[1]

It is useful here to look at the vital role these tiny creatures play.

[1] Check out the work of Professor Keith Hunter, pro-vice chancellor of sciences at the University of Otago, who has been researching the effects on the ocean and marine life of increased levels of CO_2 in the atmosphere, taking samples from beyond the continental shelf lying off the Otago coast http://www.odt.co.nz/lifestyle/magazine/269957/oceans-concern.

Slide 4 - Plankton cycles

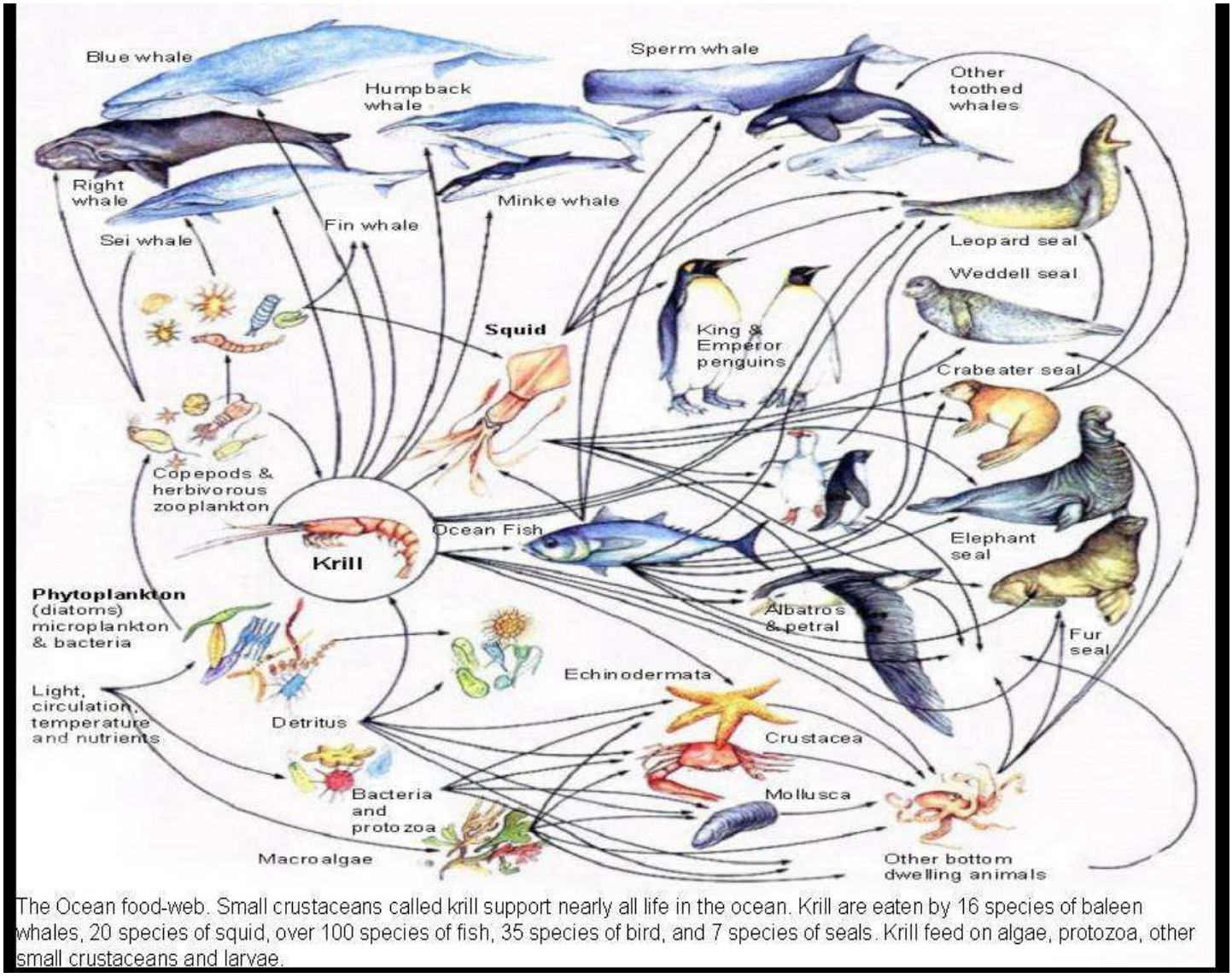


The colour of an ocean changes from blue to green as the abundance of phytoplankton in the water increases. Scientists use this phenomenon - recorded by satellites - to determine the total quantity of phytoplankton in Earth's oceans. Until now, they have been unable to determine total phytoplankton growth rates so this development represents a major achievement in understanding the processes of life in our seas.

What we know is that, as the ocean warms, it also becomes more acidic and, with that increased acidity, the phytoplankton will diminish. Even if you do not believe CO_2 causes climate change, it certainly acidifies the oceans.

To give you some idea of the importance of these microscopic creatures - phytoplankton - just look at the vast food chain they support.

Slide 5 - Ocean food chain

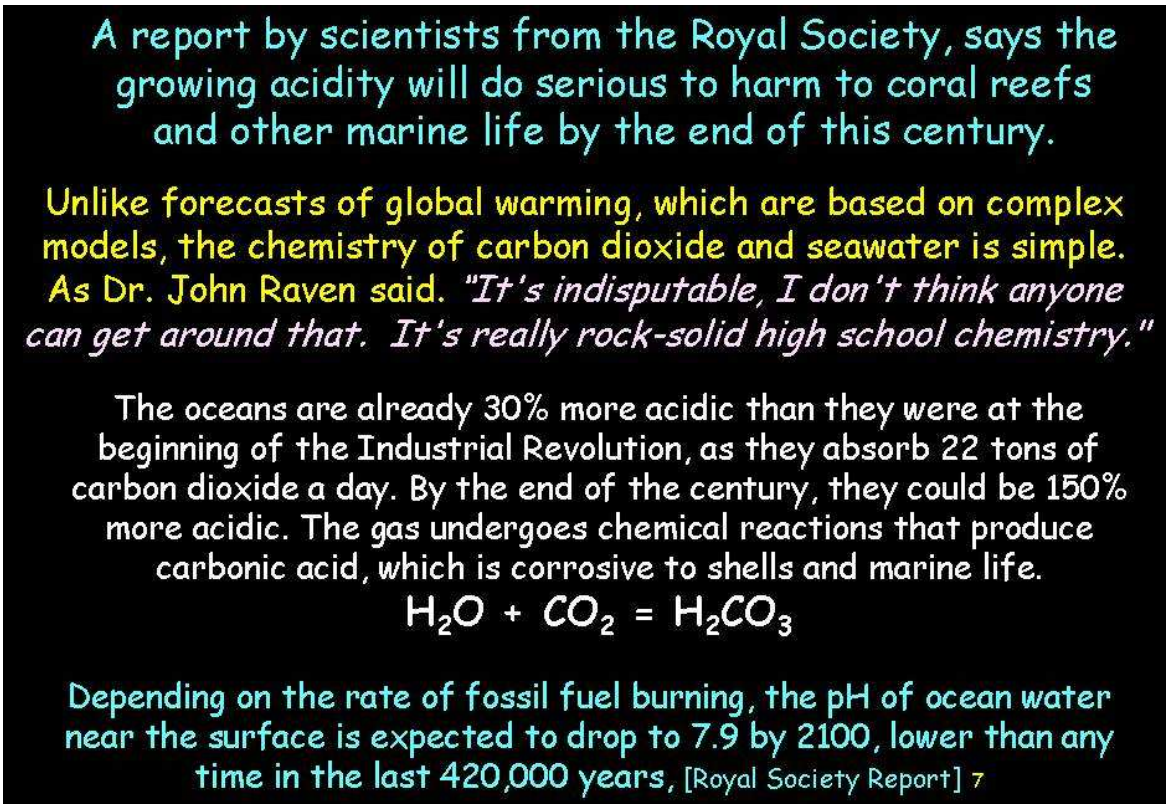


The Ocean food-web. Small crustaceans called krill support nearly all life in the ocean. Krill are eaten by 16 species of baleen whales, 20 species of squid, over 100 species of fish, 35 species of bird, and 7 species of seals. Krill feed on algae, protozoa, other small crustaceans and larvae.

Many scientists believe that a breakdown in any part of this chain could spell disaster for the ocean as a whole.

Now I want to show you the results of a recent report coming from scientists in the British Royal Society.

Slide – 6



N.B. Water is neutral - or pH 7 - while seawater is about pH 8.3.

That is pretty serious stuff.

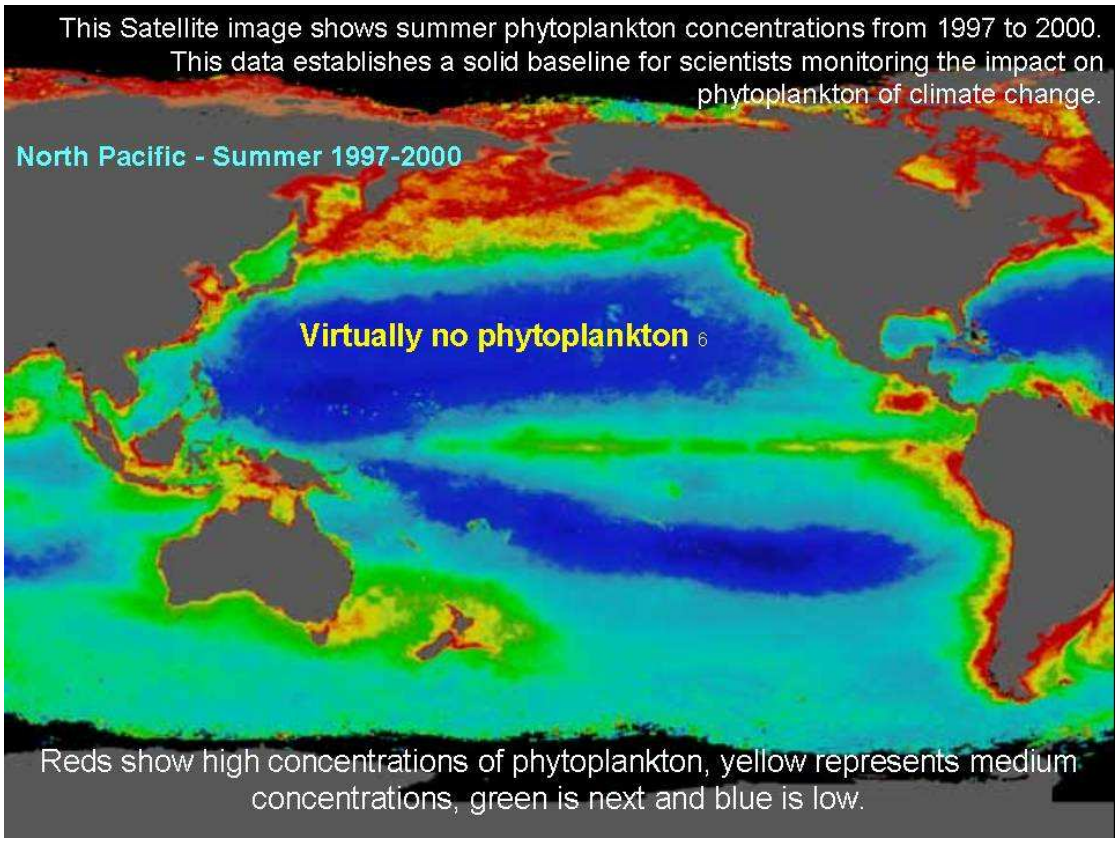
The question arises, would phytoplankton survive? If not, how would this affect other marine creatures?

The global importance of phytoplankton *cannot be overstated*. Phytoplankton represent a category of life on Earth with some of the most profound potential effects.

An understanding of net phytoplankton productivity allows scientists to address vital issues concerning our ecological sustainability. These include overall-water quality, distribution of and overall health of fisheries, global climate changes, and much more.

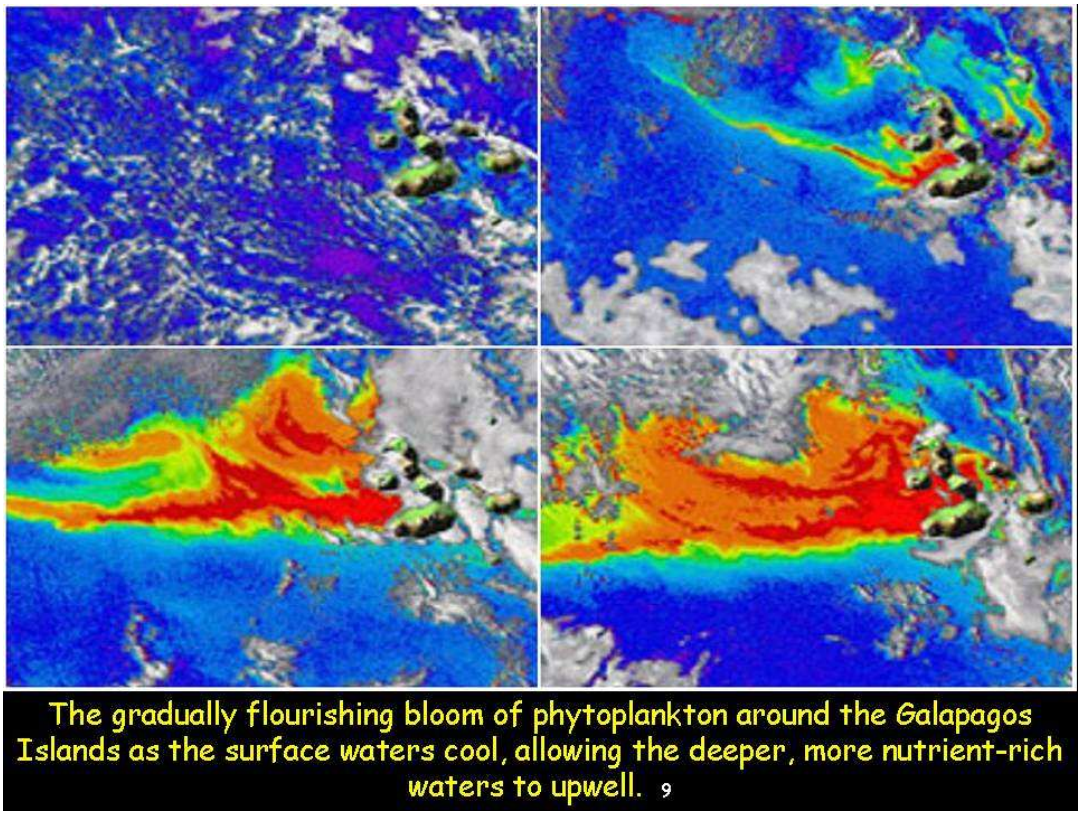
Phytoplankton do not like acid conditions and already their numbers are decreasing. If we look at the North Pacific for the Summers of 1997 through to 2000, we can see huge areas of phytoplankton loss.

Slide 7



Satellite imaging improves accuracy of estimates and also indicates more clearly the loss of phytoplankton. Some areas, such as the Galapagos Islands (below), are still rich in phytoplankton growth.

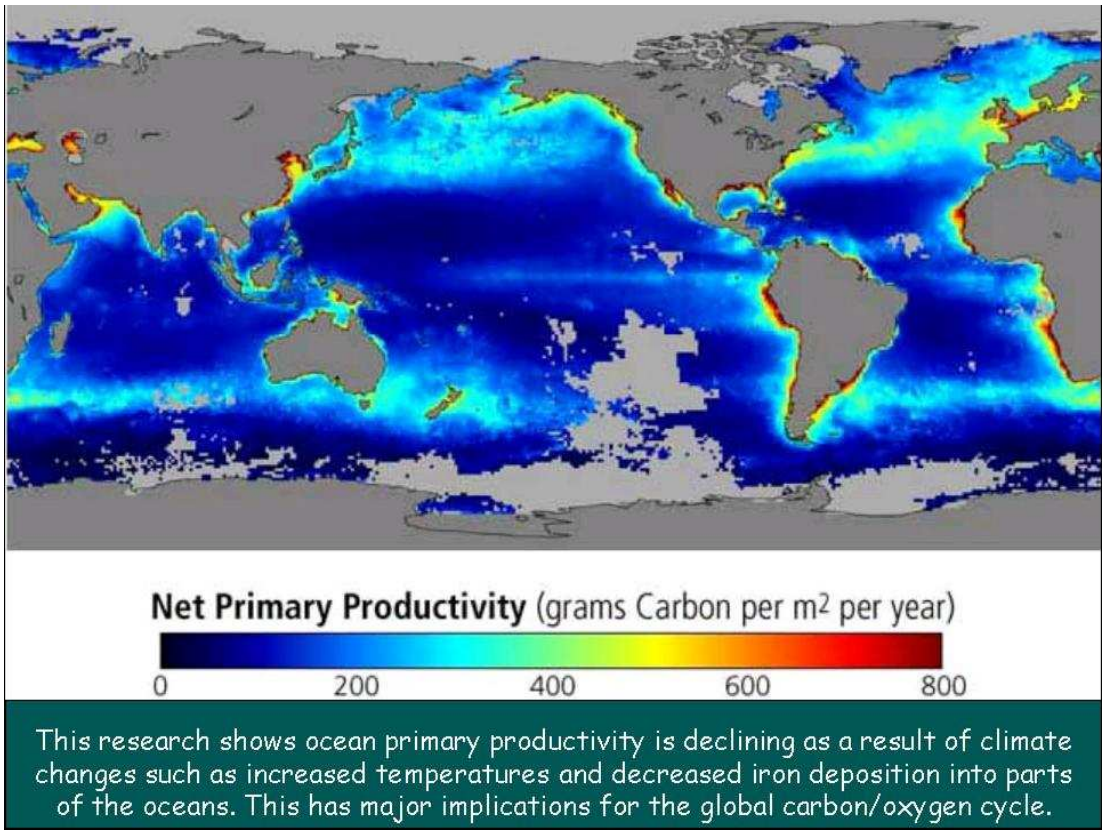
Slide 8



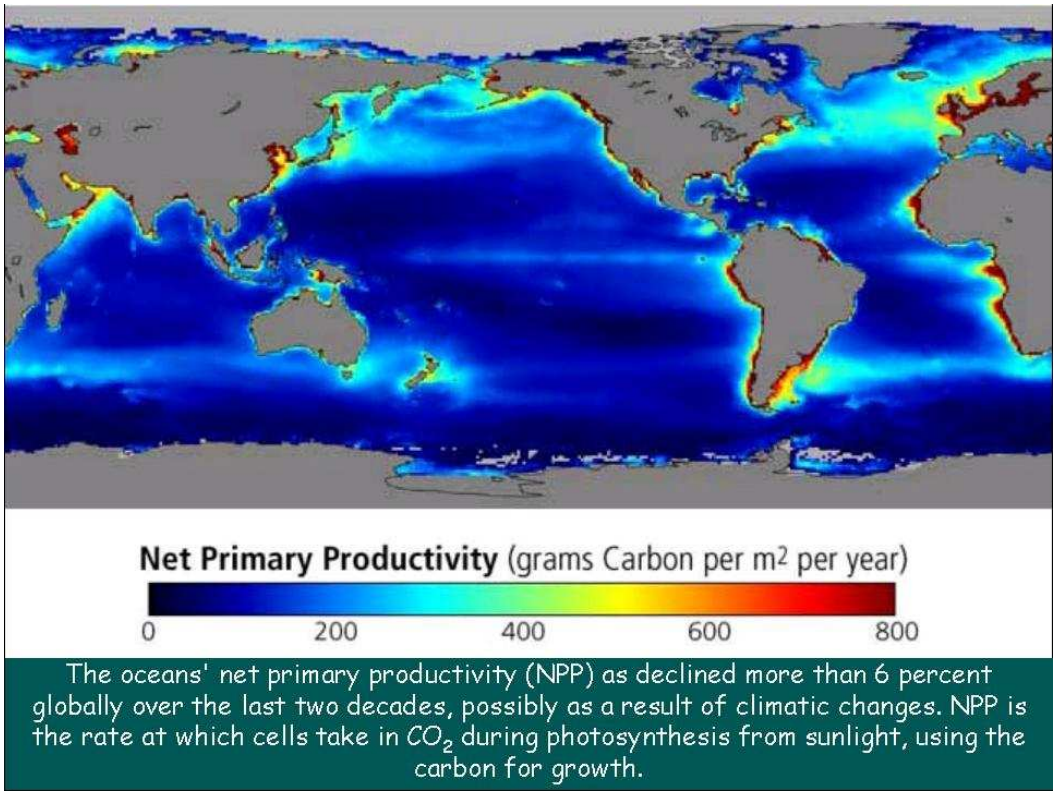
But these are small areas.

One problem of decreasing phytoplankton growth is what is called "the Net Primary Productivity" or NPP of the ocean. This has declined by 6% over the last two decades. A major effect of this is a decrease in oxygen production. These next two slides illustrate this very vividly.

Slides 9 and 10



This research shows ocean primary productivity is declining as a result of climate changes such as increased temperatures and decreased iron deposition into parts of the oceans. This has major implications for the global carbon/oxygen cycle.

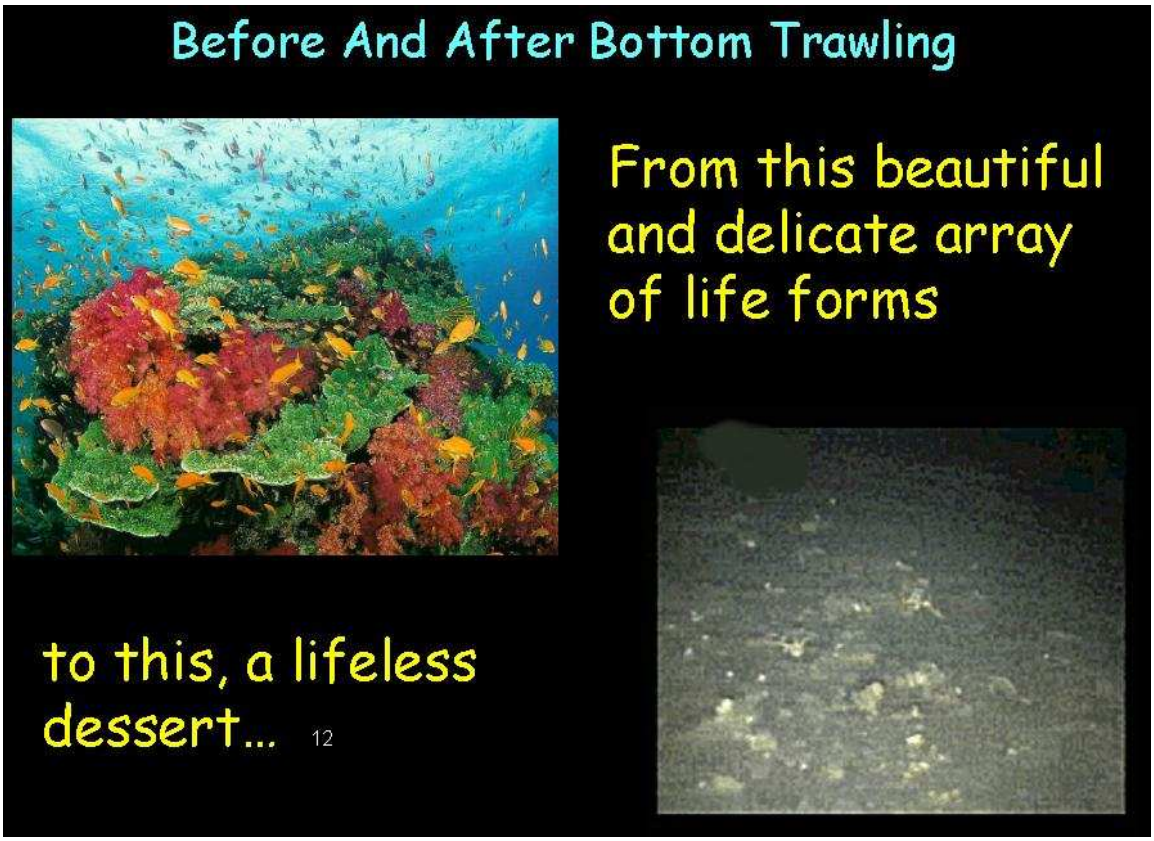


The oceans' net primary productivity (NPP) as declined more than 6 percent globally over the last two decades, possibly as a result of climatic changes. NPP is the rate at which cells take in CO_2 during photosynthesis from sunlight, using the carbon for growth.

Gross methods of fishing, such as bottom trawling and long lines, are yet another way in which we are destroying the oceans ecosystem. The commercial fishing industry knows about the rich pickings that exist in deep waters and it has extended unsustainable fishing practices into previously unexploited deep waters and seamounts using the technique of bottom trawling. This involves dragging huge, heavy nets along the sea floor. Large metal plates and rubber wheels attached to these nets move along the bottom and crush everything in their path.

All evidence indicates that deep-water life forms are very slow to recover from such damage, taking decades to hundreds of years.

Slide 11



The United Nations Food and Agriculture Organisation (FAO) maintains that three-quarters of global fish stocks are now over-exploited or seriously depleted.

The global fishing fleet is also two and a half times *larger* than our oceans can sustain.

In 1992, the Newfoundland cod fisheries collapsed and 40,000 people lost their jobs. In the following fifteen years, the cod did not return.

Much the same can be said of the Dogger Bank in the North Sea. What was once upon a time an enormous resource is now virtually dry.

A friend of mine was at the Festival of the Herring Queen in Wick, Scotland, a few short years ago and he talked to an old fisherman who said they "haven't seen a herring for 20 years."

Fortunately, the Alaskan fishing fleet has introduced strict fish quotas and, so far, maintained the sustainability of that area.

When hundreds of tons of fish are scooped up in the enormous nets used by commercial fishing vessels, many fish are simply crushed. Valuable marine animals are simply discarded – labelled the "bycatch." The next slide illustrates perfectly what I mean…

Slide 12

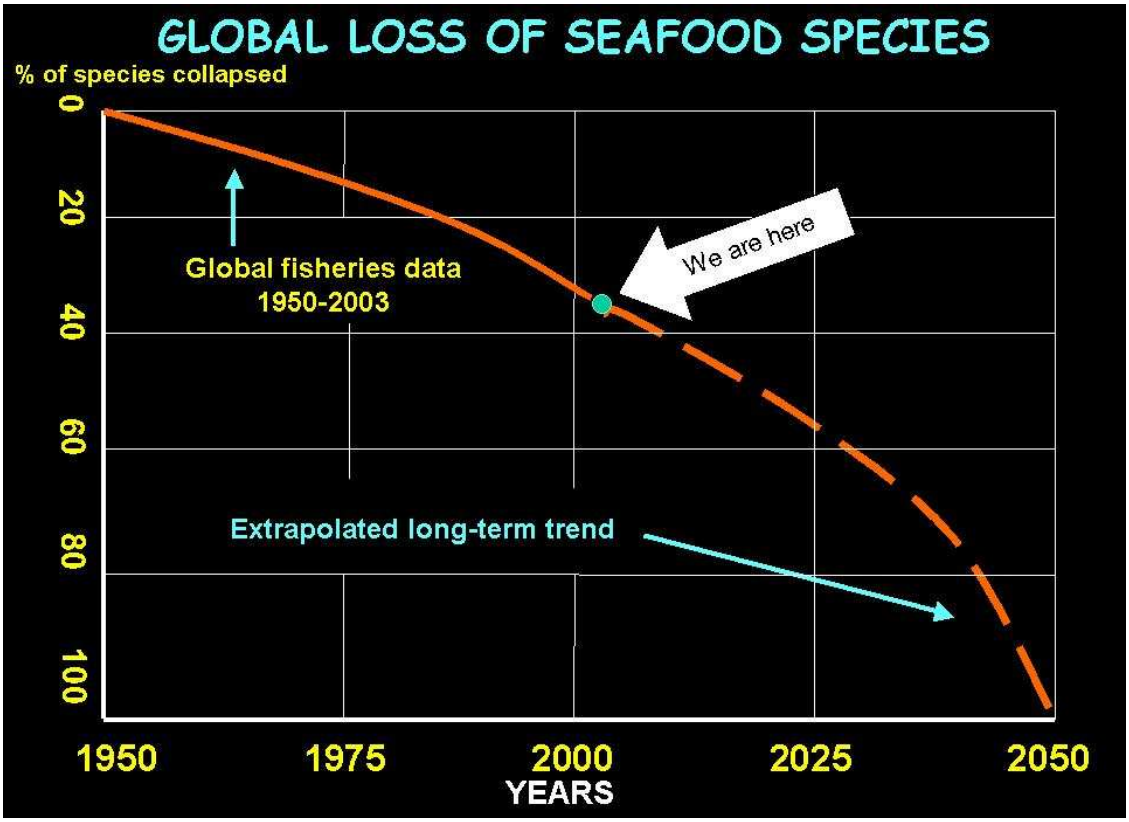
This was once a giant squid. Secretly photographed by Kate Davison for Greenpeace, the spectacular animal and others such as this are simply thrown back into the sea. Many creatures from the deeper oceans have not even been classified yet. Much the same happens to dolphins caught in the lethal long nets.

As well as squid, dolphins, whales, etc. the fishing scene is a disaster waiting to happen.

Slide 13

Let me show you an even clearer picture of the effects of this industry to date.

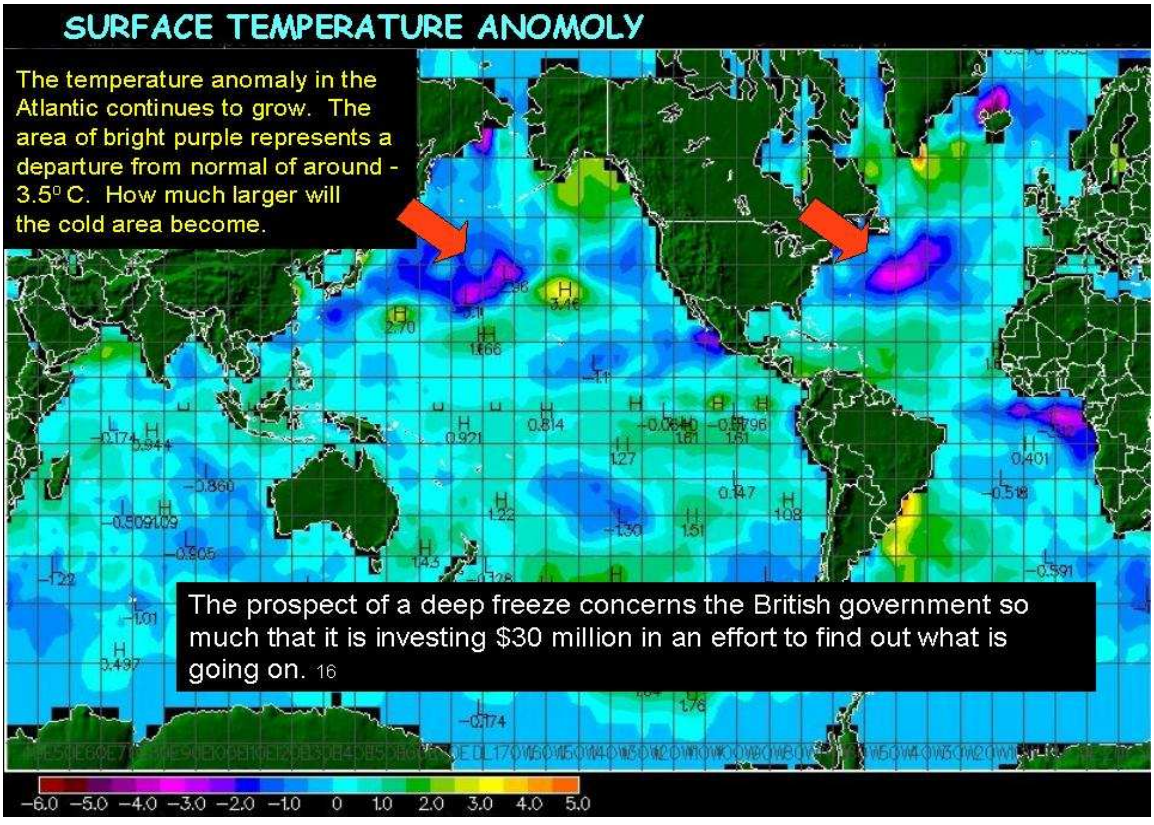
Slide 14



If we continue to rape the oceans as we are at present, it will be the end of fish as a sustainable food source.

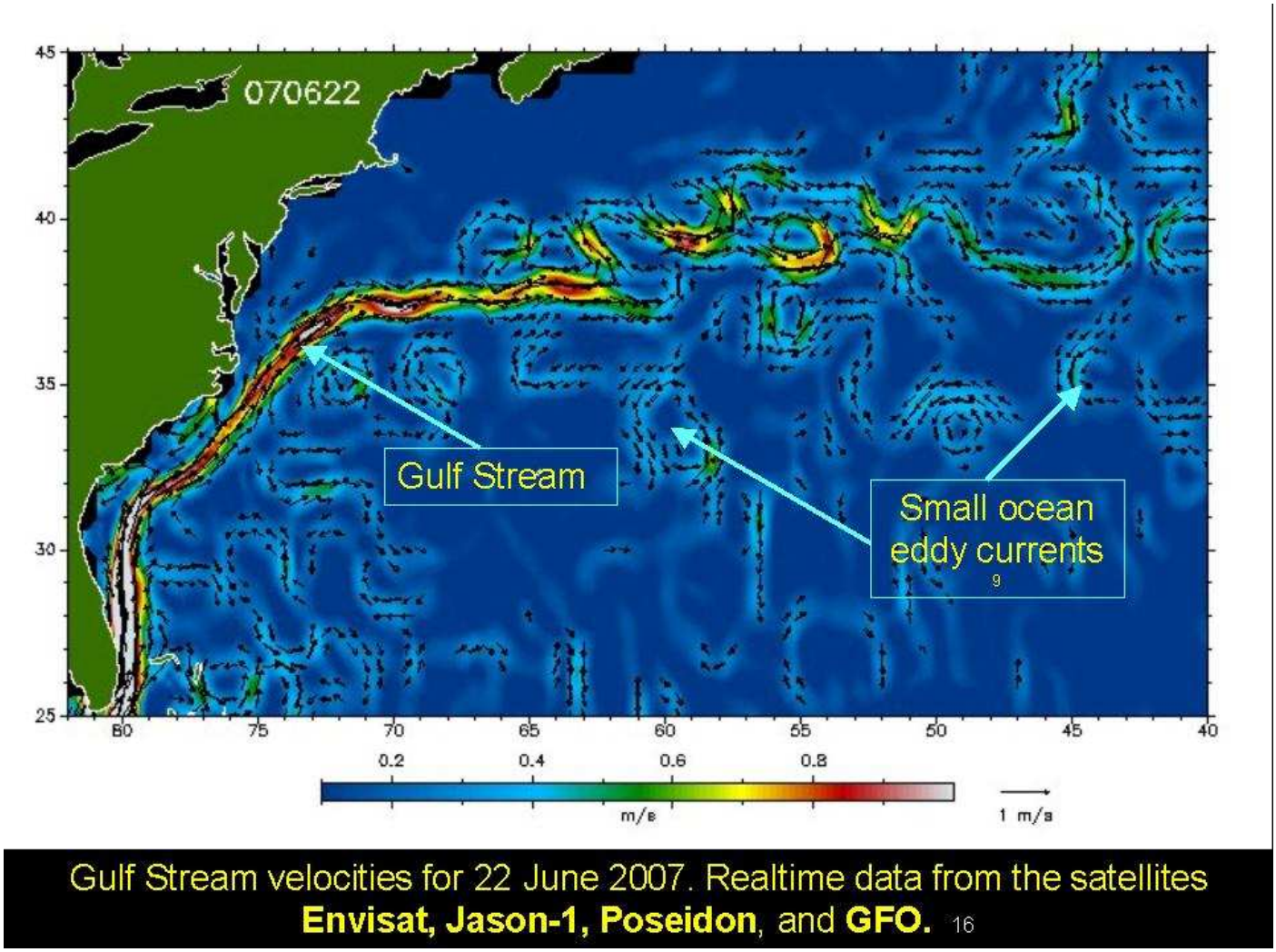
Slide 15

Another strange change occurring in the oceans is what is known as the surface temperature anomaly.



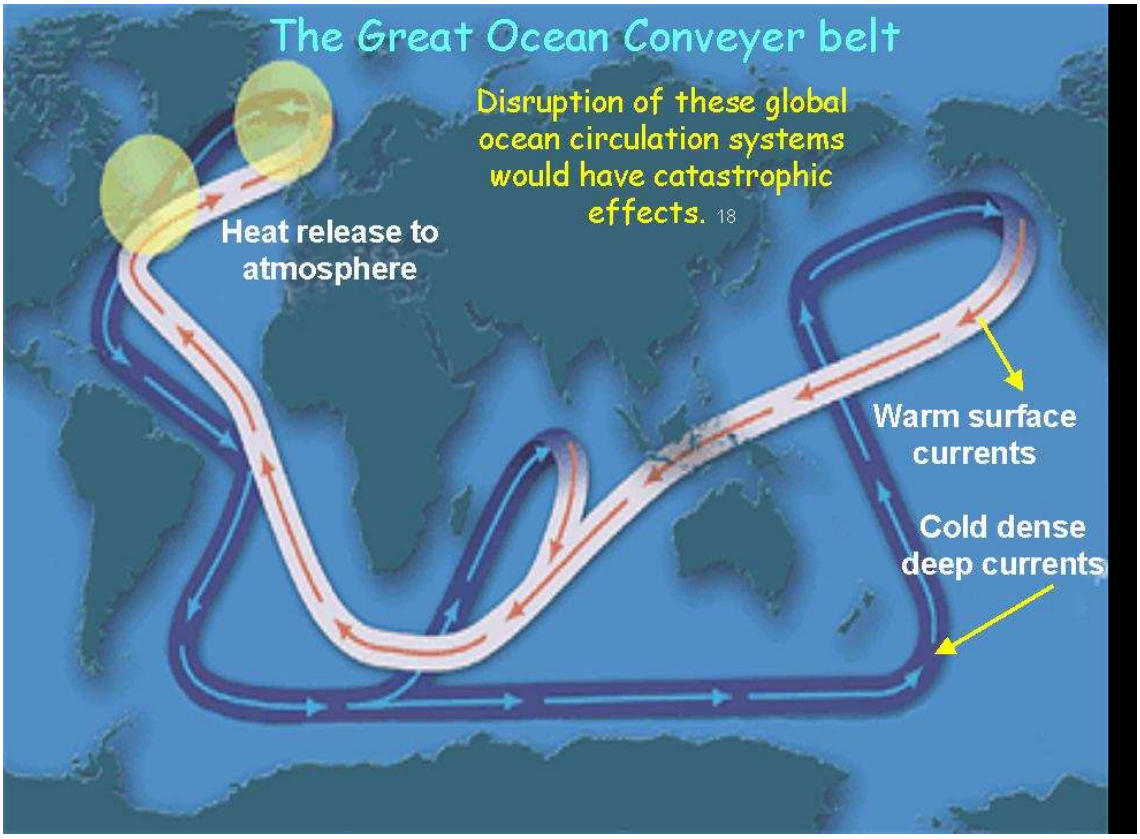
Having modern satellite imaging now enables scientists to monitor more closely the great ocean currents and conveyor systems.

Slide 16 - Speed of the Gulf Stream, North Atlantic



Tiny changes in lesser ocean currents often affect the larger ones such as the massive Gulf Stream.

Slide 17



The North Atlantic Gulf Stream is what moderates Europe's climate. If it were to stop, it would plunge that continent into a Siberian winter.

These enormous ocean currents control the temperatures of landmasses and it is critical that their velocity does not alter appreciably. Unfortunately, it seems they are gradually changing over time.

The entire global ocean circulation system - often called the Ocean Conveyor - transports heat throughout our planet. Earth's oceans are not static ponds, but bodies of water in constant motion. Any change to that motion radically affects our world.

The Conveyor is slow moving - at most, 10cm per second - but its vast extent is equivalent to one hundred times that of the River Amazon.

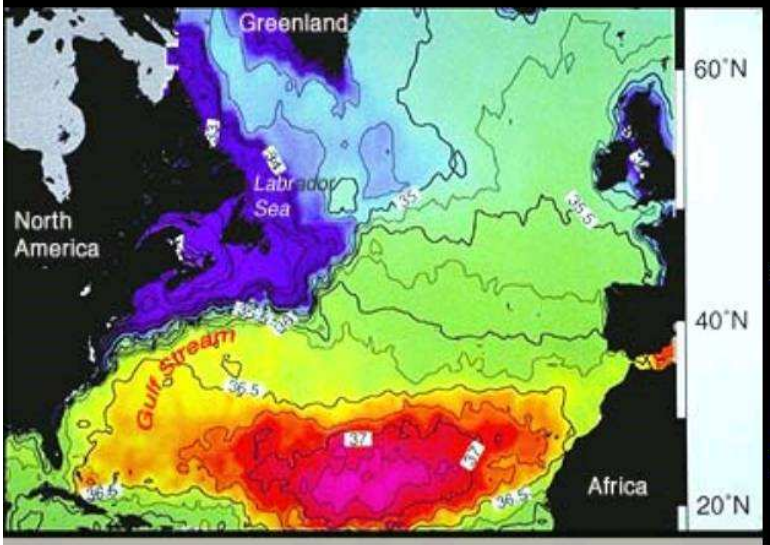
On average, 30 million cubic metres of water enter the Conveyor every second. This surface water is warmed at the equator, and then moves to high latitudes where it releases its heat into the atmosphere. As a result of releasing its heat, it cools, becomes denser, and sinks into the deep ocean.

Deep water slowly travels through the oceanic abyss, eventually mixing at the surface in distant parts of the world. This process takes hundreds of years.

So what changes are scientists seeing in these great currents and oceans? Let us look at the changes in the salinity.

Slide 18

The northern waters are getting fresher while the southern waters (near the equator) are increasing in salinity. This indicates a change in the climate with more precipitation and ice melt in the north and much stronger evaporation in the south. In other words "Global warming."



Map of salinity in Atlantic Ocean, 2002. Red = more saline. Blue = fresher. Courtesy Drs Ruth and Bill Curry, Woods Hole Oceanographic Institute.

Scientists are concerned that the point at which the current Conveyor does begin to slow may be nearer than we think. 19

The salinity of the North Atlantic is considered by many oceanographers as another vital clue to climate change.

Slide 19

Should we be concerned about this?

Yes, because this may herald the start of the giant ocean conveyer belt slowing down.

- The Gulf Stream is flowing at a quarter of the strength of five years ago. This will bring much colder temperatures to Europe and the eastern US within a few years." Cambridge University scientists report

- The reason for the decline is that gigantic chimneys of cold water (5 billion gals/sec) that were sinking from the surface to the sea bed off Greenland have disappeared. These chimneys are the key engine of world climate as we know it today.

- "The prediction that a big chill will follow this water is based on experience. Sediments, ice cores, and other natural records of climates in the past show that Europe plunged into frigid cold spells whenever large amounts of fresh water were dumped into the North Atlantic." meteorologist Dr Joe Bastardi, 20

As ocean temperatures increase, all kinds of other destructive changes begin to take place.

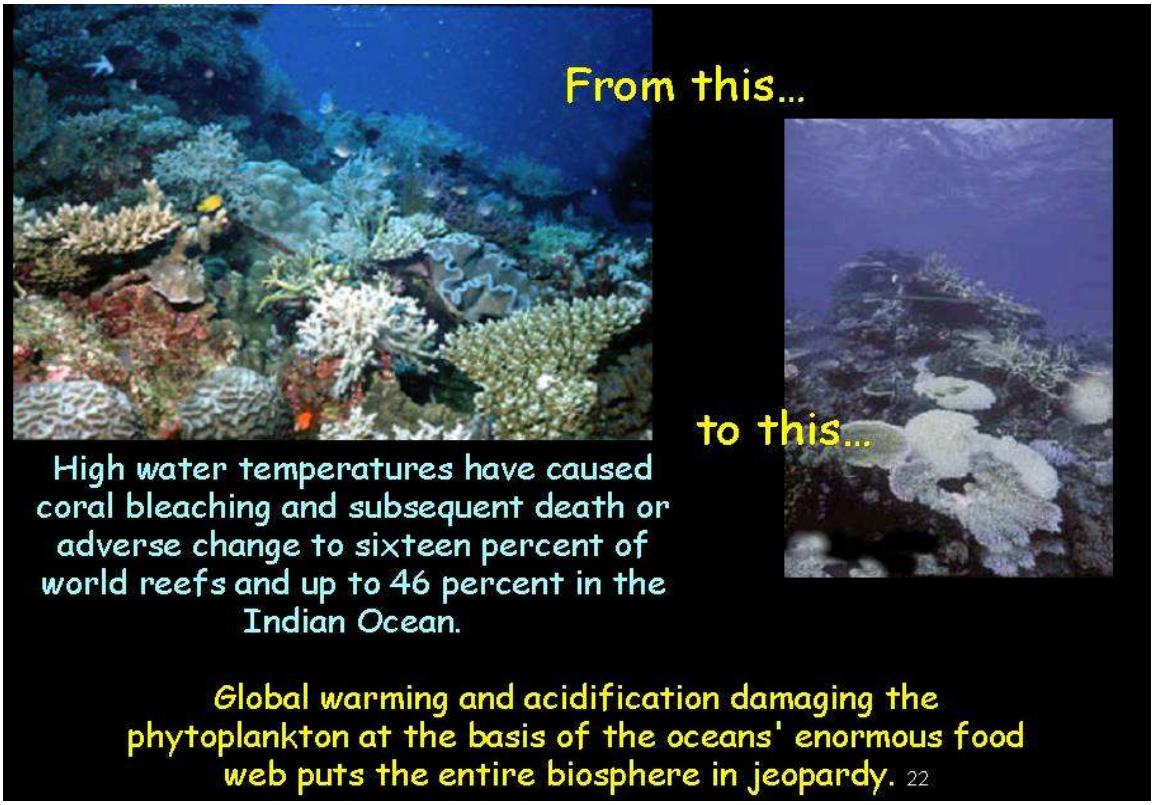
It is not only Polar bears that are threatened.

Slide 20

As the sea ice melts, these birds have no place to nest. In particular danger of extinction is the Emperor penguin. Their numbers have plummeted with the decrease in sea ice.

The effects on coral reefs are also overwhelmingly destructive…

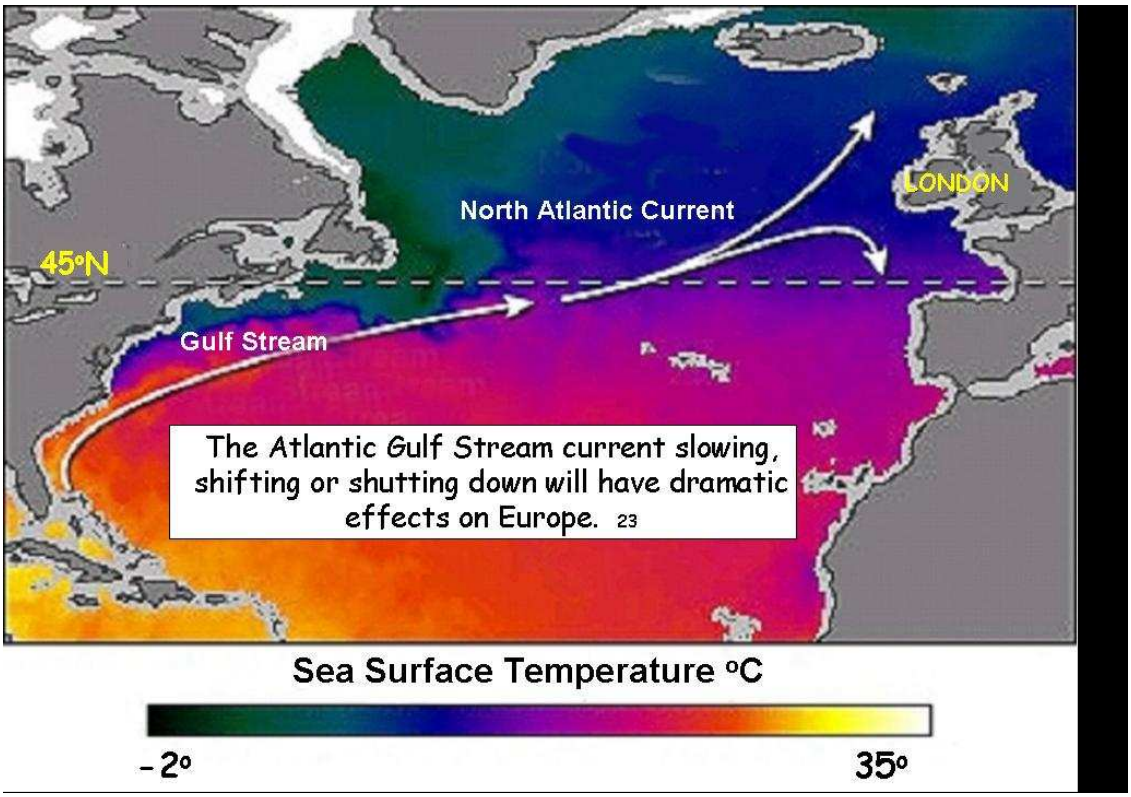
Slide 21



Coral reefs are one of the most productive ecosystems. Just as acid rain virtually destroyed the Black Forest in Europe, a similar destruction can take place in the oceans. As the ocean absorbs more and more CO_2, its acidity level rises and destroys coral. The pH change is also likely to slow the rate of growth of coral reefs, which are already suffering from warmer temperatures. (Royal Society Report)

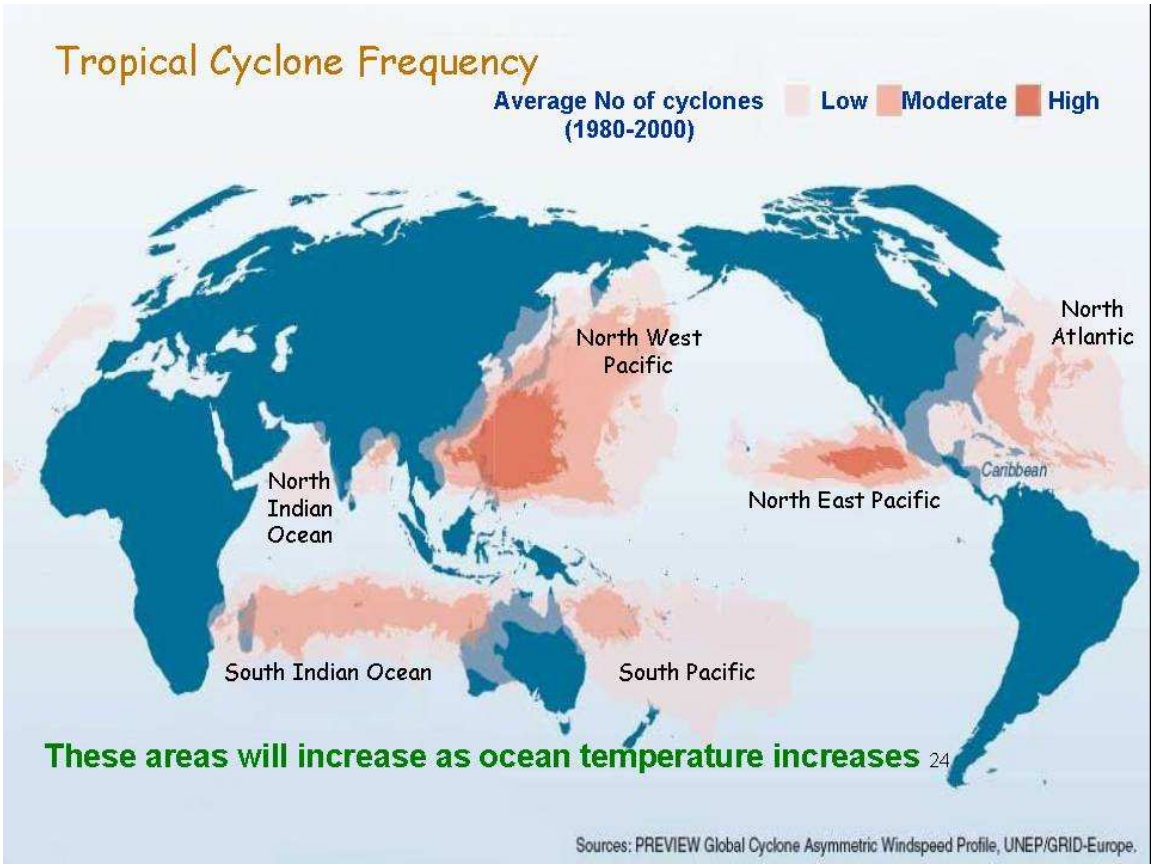
If we look at the ocean heat distribution it gives a clearer picture.

Slide 22



Another problem is that warming seas bring more storms. The areas and frequency of cyclones and storms will also tend to increase.

Slide 23



Areas and coastlines that were free of these storms in the past may now start to experience them. Storms may also become far more destructive. Can you even imagine the force required to do this?

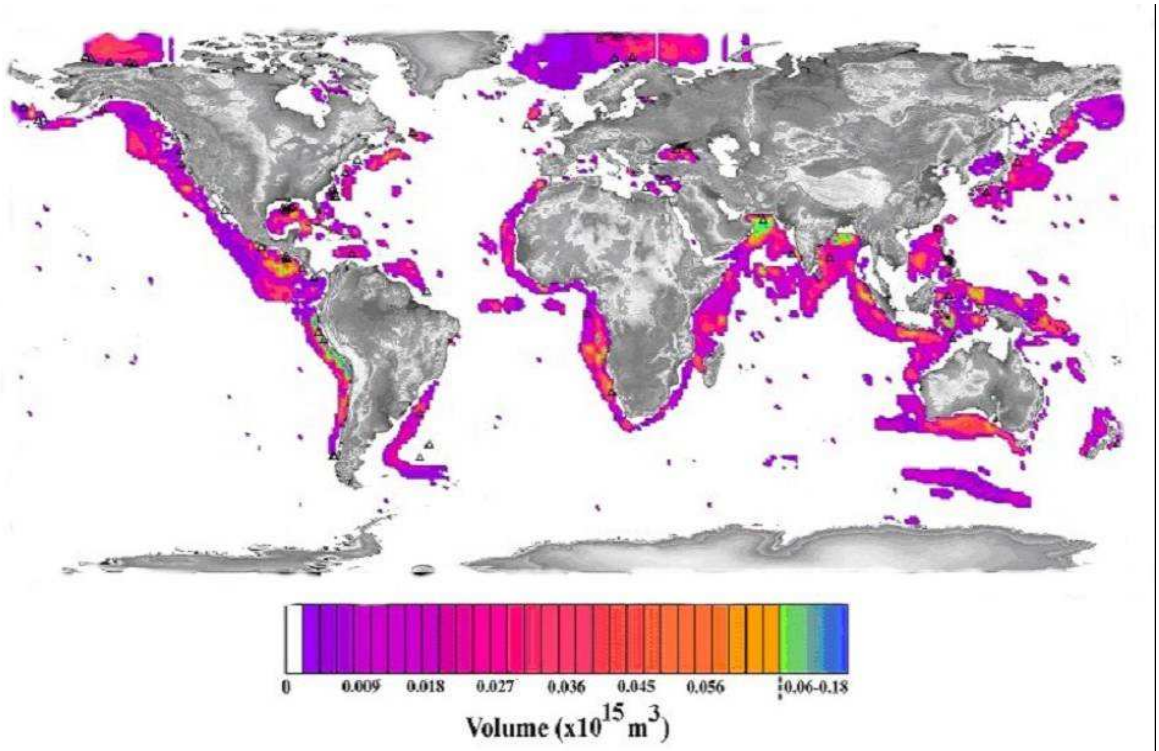
Slide 24

Should we be concerned? My answer is, *Yes*.

Now I want to talk for a moment about a little known effect of ocean warming. It is the effect warming has on the methane (CH_4) trapped on the ocean floor. Methane is 21 times more powerful than CO_2 as a green house gas. Fortunately, it has a short half-life and soon breaks up. Nevertheless, we are talking of enormous quantities when we consider ocean hydrates.

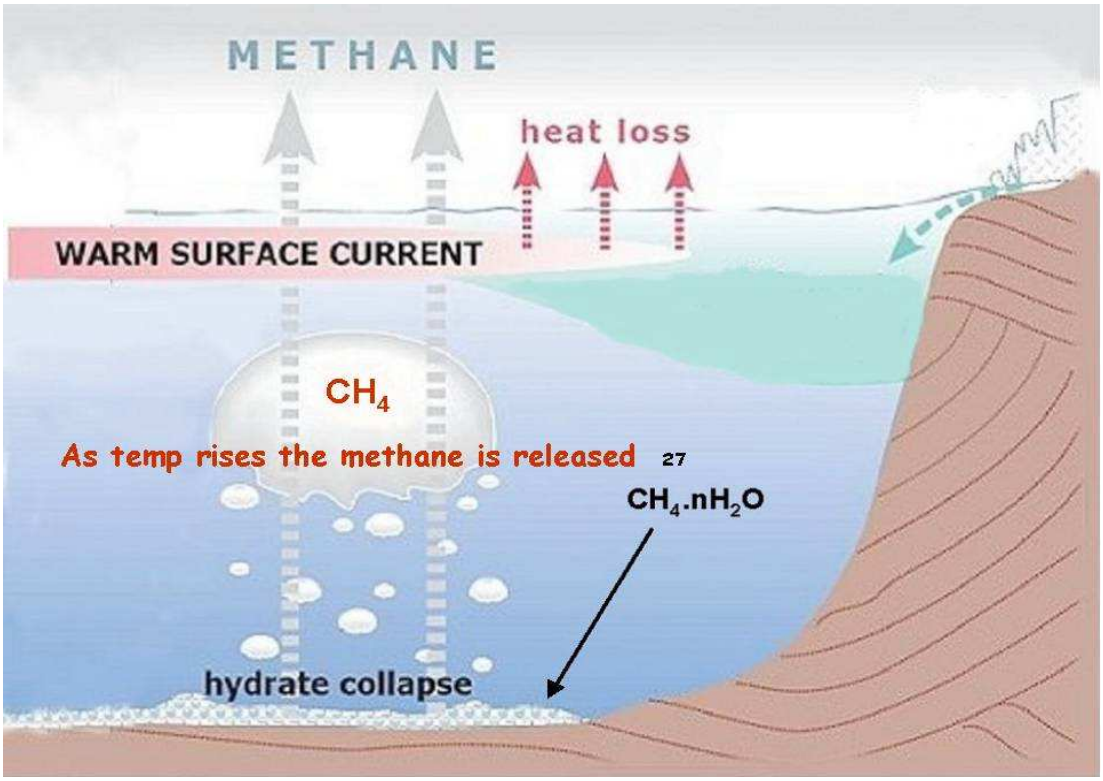
Dr David Etheridge of Australia's CSIRO Division of Atmospheric Research, says methane levels overall have increased dramatically over the past 200 years. Its concentration in the atmosphere now averages 1700 parts per billion, compared to 700 parts per billion 200 years ago. Methane levels were fairly stable up until the industrial revolution 200 years ago, but subsequent human activities – e.g. burning of biomass, fossil fuel exploration, livestock, landfills - are main contributing sources of the increase.

Slide 25



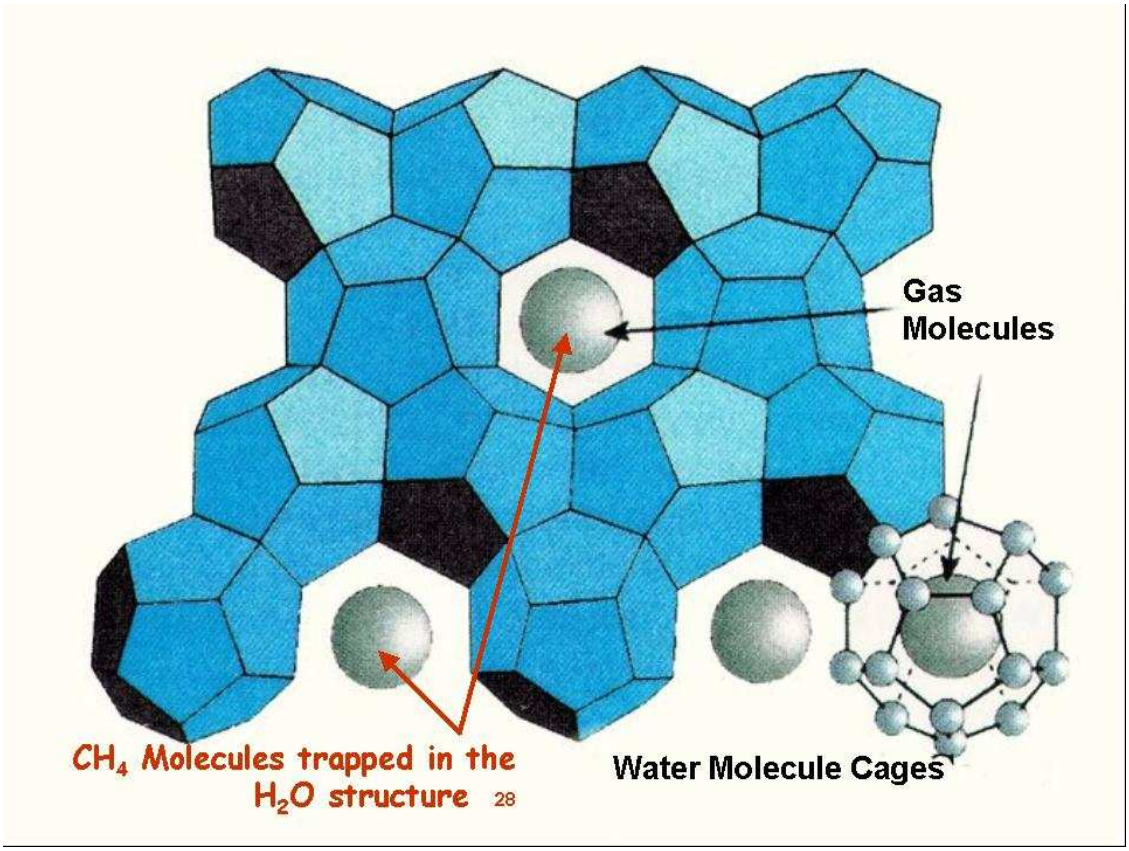
Core samples and soundings taken off the east coast of Florida indicate that massive amounts of methane, stored as frozen hydrate in sediments on the ocean floor, were freed at about the same time as a rapid warming of the global climate. How does this work?

Slide 26



Known as the "Oceanic Burp" researchers have found evidence to support a theory that an abrupt warming of Earth 55 million years ago was caused by the sudden release from the ocean of methane. The methane is trapped inside a water lattice.

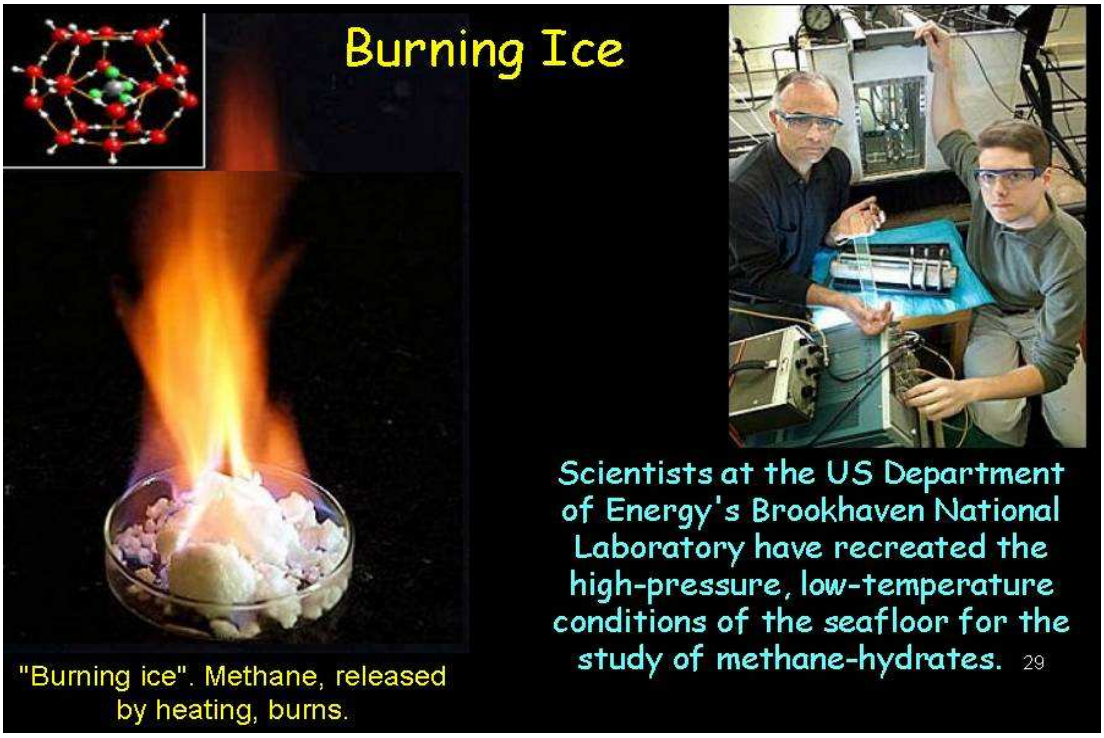
Slide 27 - Methane Hydrate



As you can see, the methane molecule is trapped inside a cage formed from interlocking water molecules. As this lattice of water molecules breaks down, the methane is released.

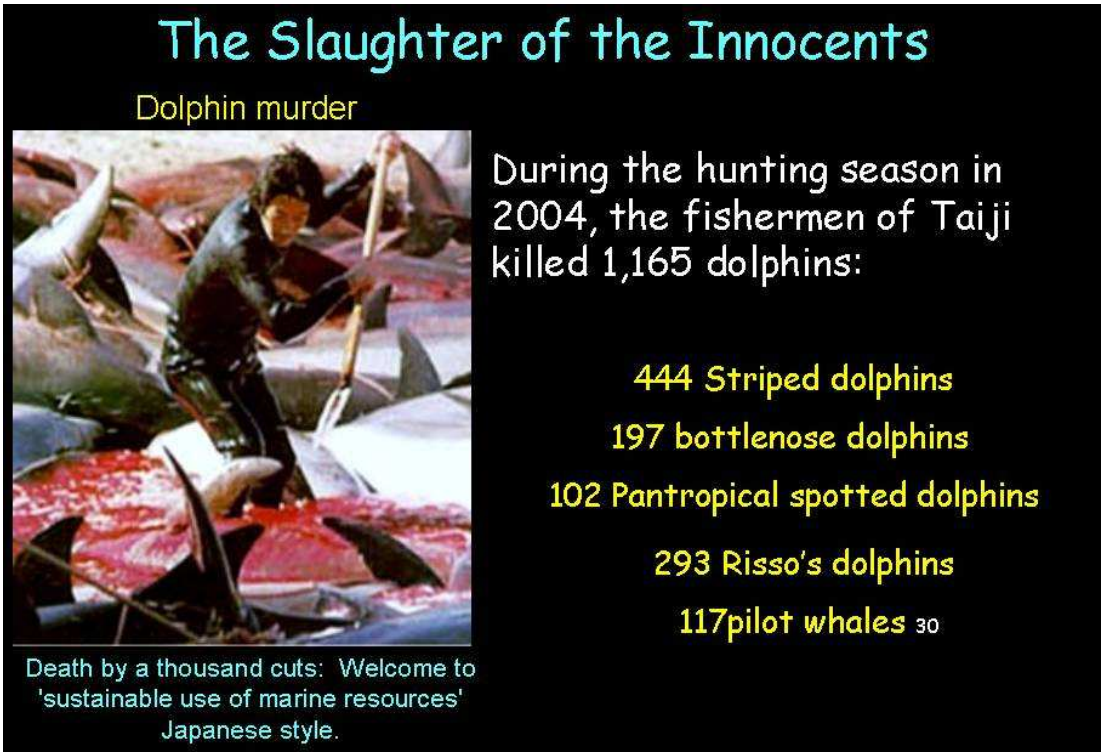
This next slide shows the process as "burning ice."

Slide 28



Let us now look at a more obvious abuse of the oceans: the outright slaughter of marine species. In this respect, the Japanese are one of the most brutally aggressive. The needless and regular slaughtering of whales, and dolphins, has enraged and sickened the rest of the world. The fact that dolphins and whales are mammals and not fish does not seem to make the slightest difference.

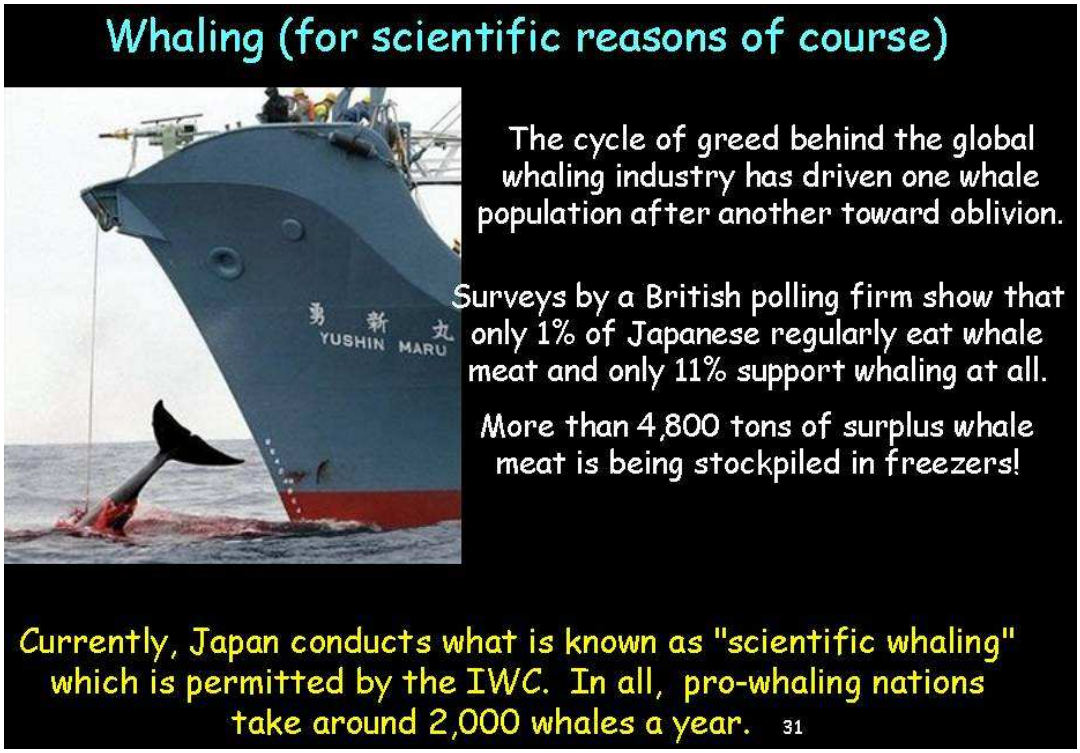
Slide 29



The truth is, Japan is a wealthy country and they do not need to eat dolphin or whale meat. In fact, reports in television documentaries tell of vast stores of unused whale meat, and that the Japanese people have reduced their intake.

The whaling scene is very serious. There is a cycle of greed that drives the global whaling industry. It has driven some whale populations toward oblivion and it is still not known if some species will recover, even after decades of protection. Many of the rarer species are close to or at the point of extinction.

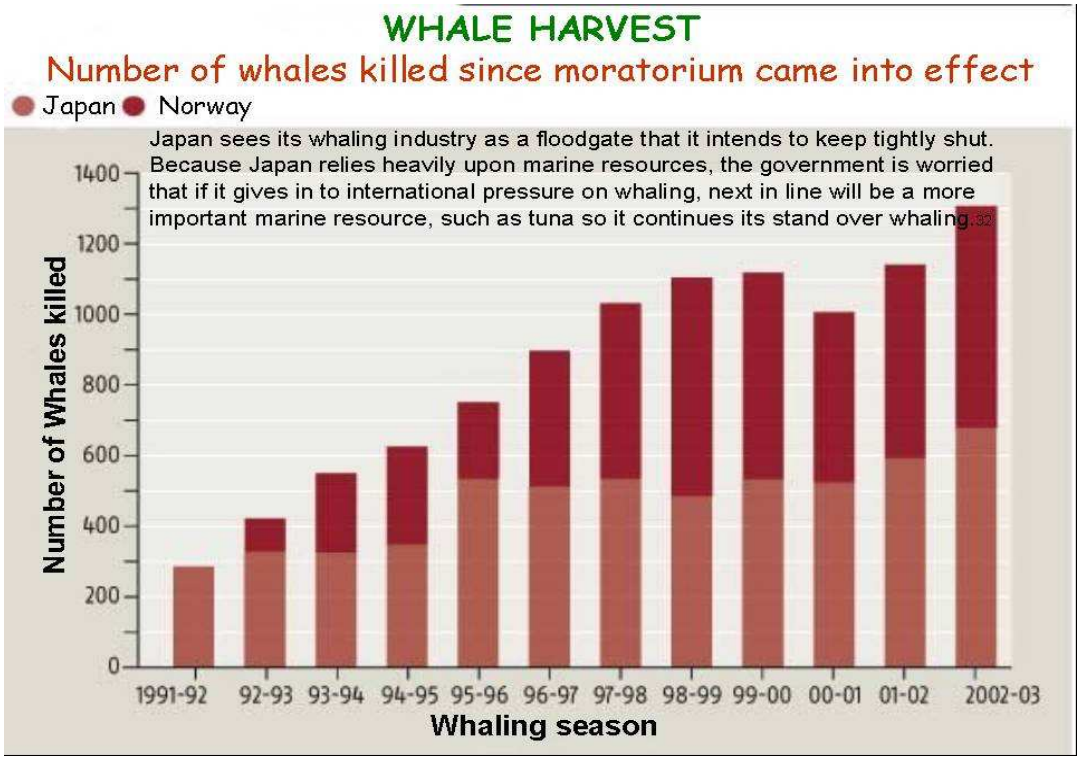
Slide 30



- The blue whales of the Antarctic number less than 1% of their original tally, despite 40 years of complete protection.
- The West Pacific Grey whale population is the most endangered in the world. It hovers on the edge of extinction with just over 100 remaining.

According to Dr Steve Palumbi, a marine biologist at Stanford University, most estimates of whale populations have been extrapolated from old whaling figures, and this method is very inaccurate.

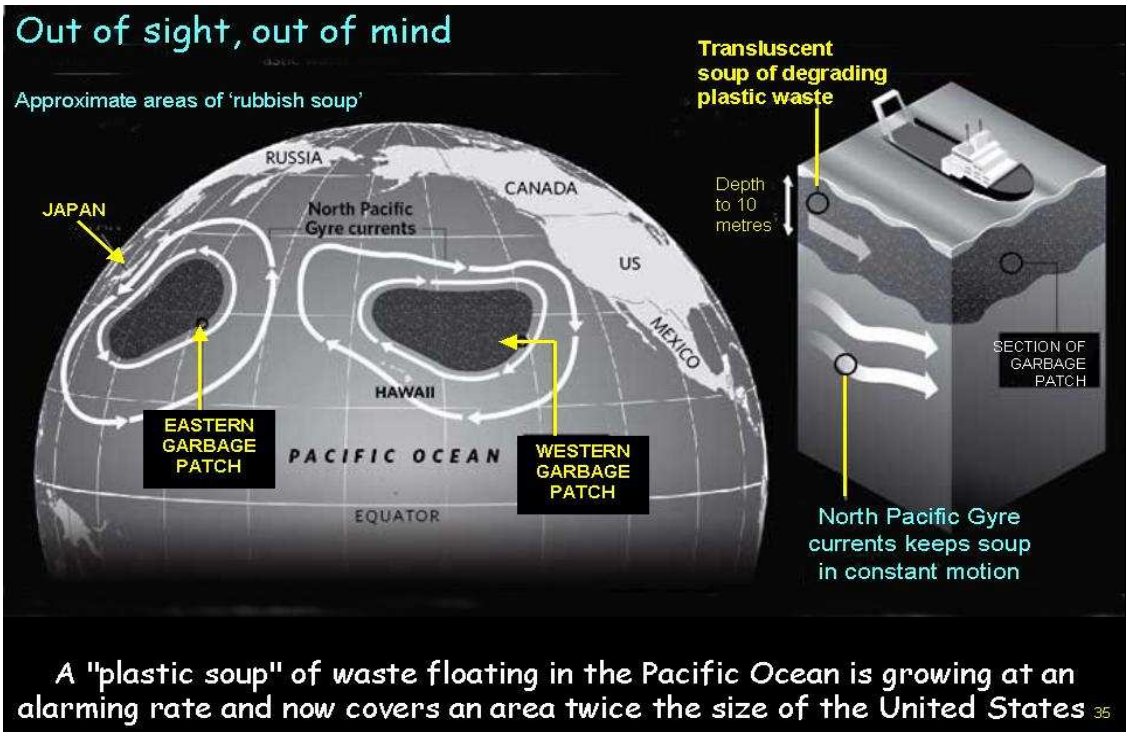
Slide 31



Hunting is no longer the only threat to whales. The oceans, or rather, our impacts on them, have changed dramatically. Known environmental threats to whales include global warming, pollution, over-fishing, and noise such as sonar weaponry. Industrial fishing also threatens the food supply of whales and puts whales at risk of entanglement in fishing gear. Plastic pollution just adds to it.

Slide 32

Slide 33



This slide gives an indication of the pollution gyre in just the North Pacific region. Some of the plastic is swept to shore - like the thousands of Nike shoes that washed up in the Pacific Northwest (see below). But much of this is trapped by calm winds and sluggish water within the North Pacific's loop of currents.

At the eye of the gyre, plastic reaches concentrations of a million pieces per square mile. Researchers have mapped a giant spill of bags and a mile-long strip of wind-driven garbage. Curtis Ebbesmeyer, a well-known researcher, traced a 1990 containership spill that dumped 80,000 Nike running shoes into the North Pacific. These washed up on beaches from British Columbia to California.

Degraded plastic pieces outweigh surface zooplankton in the central North Pacific by a factor of 6-1. That means six kilos of plastic for every single kilo of zooplankton. We have used our oceans as a rubbish bin for too long and we will pay the price.

Slide 34

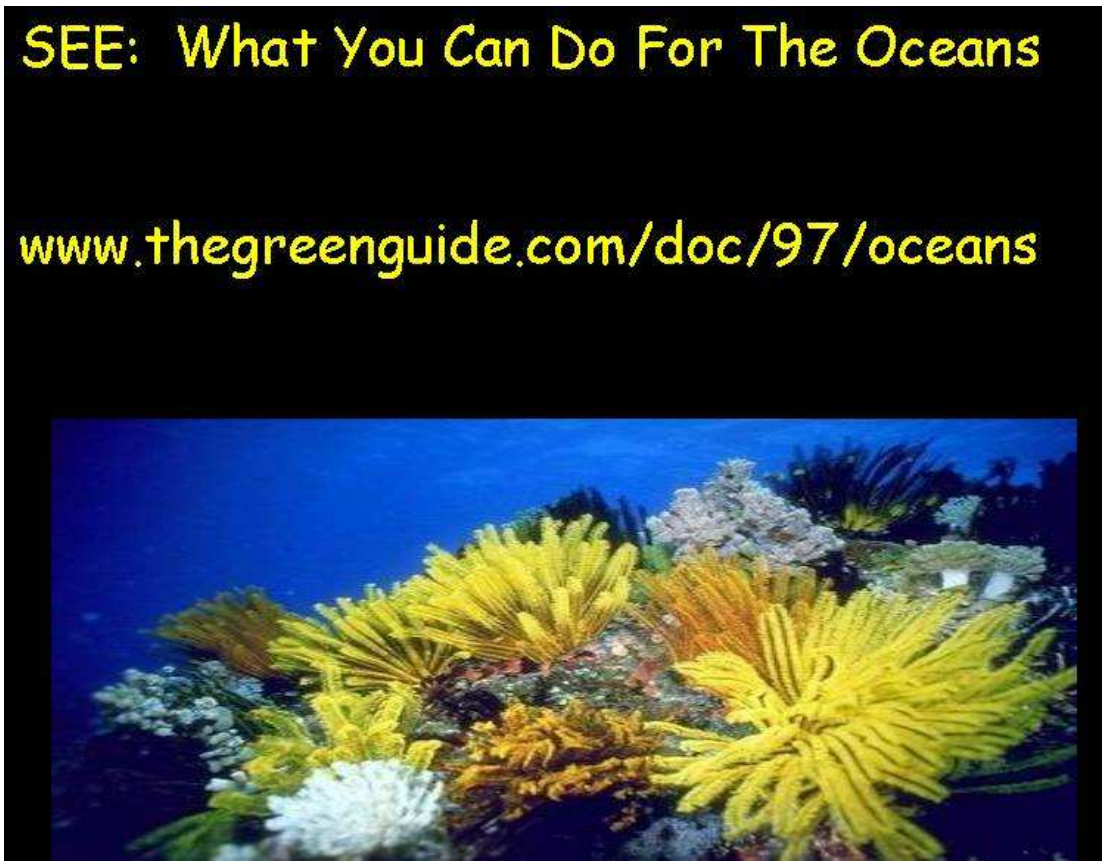
Putting aside ice ages or killer heat waves or tornadoes, one thing is for sure our oceans are in very grave danger. And friends…

Slide 35

Changes can and must be made.

Slide 36

Slide 37



Continues/

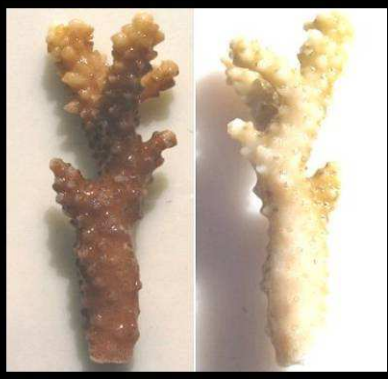
Postscripts

Slide 38

Lotion in the ocean

The sunscreen that you put on before a swim may protect you, but the chemicals are also killing coral reefs worldwide.

Researchers estimate that 4,000 to 6,000 metric tons of sunscreen wash off swimmers annually in oceans worldwide, and that up to 10 percent of coral reefs are threatened by sunscreen-induced bleaching.



Results showed that even low levels of sunscreen, at or below the typical amount used by swimmers, can activate the algae viruses and completely bleach coral in just four days 39

National Geographic News 2008

Slide 39

The scientist who found the Oceans' "Ebola"

Dr JoAnn Burkholder

Her investigative research pointed to a strange microbe [the cell from Hell] which could transform itself from a benign bacteria into a flesh-eating killer.

Dr Burkholder won the "Scientific Freedom and Responsibility Award." for her struggle in the face of intense political pressure and at great peril to her own career, pursuing scientific truth and maintaining her integrity.41

"And the waters turned to blood." Rodney Barker; Simon & Schuster

Slide 40

Pfiesteria piscicida (Fish killer)

This seemingly harmless dinoflagellate once polluted by animal manures (pig farming, etc.) turns into a ferocious protein eater. It exudes a toxin which dissolves the flesh of fish (and humans if bathing) and feeds on the carcass.

Toxic algal blooms are on the rise throughout the world and this kind of phenomena will increase. 42

Slide 41

Enquiries about books written by Robert Anderson should be addressed to connectedbooks@clear.net.nz

Ends